GE Fanuc Automation

Programmable Control Products

VersaMax®

Micro PLCs and Nano PLCs

User's Manual, GFK-1645E

September 2005

Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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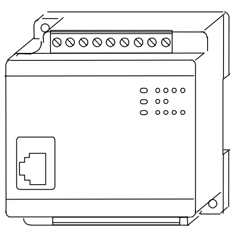
Field Control	Motion Mate	Series 90	VersaPro
GEnet	PACSystems	Series Five	VuMaster
	Proficy	Series One	Workmaster

Contents

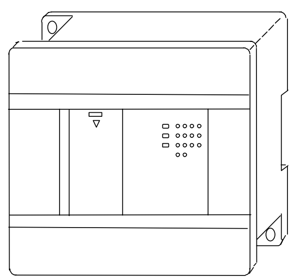
Chapter 1 Introduction

The VersaMax® PLC family of products includes a broad range of small-size programmable logic controllers (PLCs) with big-PLC features. Called Nano PLCs (10 points) and Micro PLCs (up to 176 I/O points using optional Expansion Units), these small PLCs are the perfect solution for applications such as packaging machines, dispensing machines, and relay replacement.

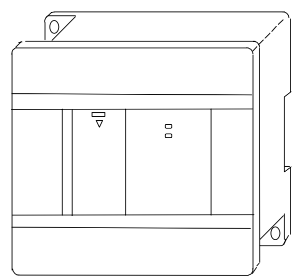
This chapter compares the features of the many VersaMax Nano PLC and Micro PLC models that are available.



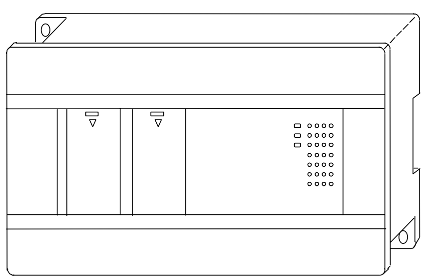
10-Point Nano PLCs



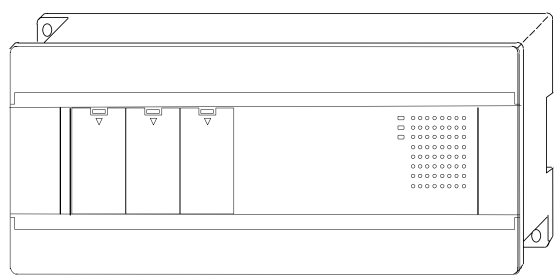
14-Point Micro PLCs



I/O Expansion Units



23-Point and 28 Point Micro PLCs and 28-Point Expansion Units



64-Point Micro PLCs

These versatile controllers provide powerful programming features such as built-in high-speed counter functionality, support for floating-point function blocks and subroutines, ability to assign passwords and privilege levels to control access, and override capability.

VersaMax Micro PLC and Nano PLC Models

Versions of these compact, powerful controllers are available for AC and DC power, and with several different combinations of discrete and analog input and output points.

VersaMax Nano PLCs

VersaMax Nano PLCs have 10 points of discrete I/O. Two models also provide a 0V to 10V analog input.

Model Number	***Description***
IC200NAL110	10 Point (6) 12 VDC In, (4) 12 Relay Out, (1) Analog Input, 12 VDC Power Supply
IC200NAL211	10 Point (6) 24 VDC In, (4) 24 Relay Out, (1) Analog Input, 24 VDC Power Supply
IC200NDD010	10 Point (6) 12 VDC In, (4) 12 VDC Out, 12 VDC Power Supply
IC200NDD101	10 Point (6) 24 VDC In, (4) 24 VDC Out, 24 VDC Power Supply
IC200NDR001	10 Point (6) 24 VDC In, (4) Relay Out, 24 VDC Power Supply
IC200NDR010	10 Point (6) 12 VDC In, (4) Relay Out, 12 VDC Power Supply

VersaMax Micro PLCs

VersaMax Micro PLCs are available with 14, 23, 28, or 64 points of I/O.

Model Number	***Description***
IC200UAA003	14 Point (8) 120 VAC In, (6) 120 VAC Out, 120/240 VAC Power Supply
IC200UAA007	28 Point (16) 120 VAC In, (12) 120 VAC Out, 120/240 VAC Power Supply
IC200UAL004	23 Point (13) 12 VDC In, (10) Relay Out, (2) Analog In and (1) Analog Out, 12 VDC Power Supply
IC200UAL005	23 Point (13) 24 VDC In, (1) 24 VDC Out, (9) Relay Out, (2) Analog In and (1) Analog Out, 24 VDC Power Supply
IC200UAL006	23 Point (13) 24 VDC In, (9) Relay Out, (1) 24 VDC Out, (2) Analog In and (1) Analog Out, 120/240 VAC Power Supply
IC200UAR014	14 Point (8) 120 VAC In, (2) Relay Out at 10 Amp, (4) Relay Out at 2 Amp, 120/240 VAC Power Supply
IC200UAR028	28 Point (16) 120 VAC In, (4) Relay Out at 10 Amp, (8) Relay Out at 2 Amp, 120/240 VAC Power Supply
IC200UDD104	14 Point (8) 24 VDC In, (6) 24 VDC Out 2 at 1.0 Amp and 4 at 0.5 Amp, 24 VDC Power Supply
IC200UDD110	28 Point (16) 24 VDC In, (12) 24 VDC Out, 6 at 1.0 Amp and, 6 at 0.5 Amp, 24 VDC Power Supply
IC200UDD112	14 Point (8) 12 VDC In, (6) 12 VDC Out, 12 VDC Power Supply
IC200UDD120	28 Point (16) 24 VDC In, (12) 24 VDC Out with ESCP, 24 VDC Power Supply
IC200UDD212	28 Point (16) 12 VDC In, (12) 12 VDC Out, 12 VDC Power Supply
IC200UDD064	64 Point (40) 24VDC In, (24) 24VDC Out with ESCP (source), 24VDC Power Supply
IC200UDD164	64 Point (40) 24VDC In, (24) 24VDC Out (sink), 24VDC Power Supply
IC200UDR001	14 Point (8) 24 VDC In, (6) Relay Out, 120/240 VAC Power Supply
IC200UDR002	14 Point (8) 24 VDC In, (6) Relay Out, 24 VDC Power Supply
IC200UDR003	14 Point (8) 12 VDC In, (6) Relay Out, 12 VDC Power Supply
IC200UDR005	28 Point (16) 24 VDC In, (11) Relay Out, (1) 24 VDC Out, 120/240 VAC Power Supply
IC200UDR006	28 Point (16) 12 VDC In, (12) Relay Out, 12 VDC Power Supply
IC200UDR010	28 Point (16) 24 VDC In, (11) Relay Out, (1) 24 VDC Out, 24 VDC Power Supply
IC200UDR064	64 Point (40) 24VDC In, (24) Relay Out, 24VDC Power Supply
IC200UDR164	64 Point (40) 24VDC In, (24) Relay Out, 120/240VAC Power Supply

Option Modules for 64-Point Micro PLCs

Available Option Modules can be used to enhance the functionality of a 64-Point VersaMax Micro PLC. Four different Option Modules are available.

IC200USB001	RS232, Extra Port Option Module with 2 analog inputs
IC200USB002	RS485, Extra Port Option Module with 2 analog inputs
IC200UMB001	Memory Pack Module
IC200UUB001	USB / RS232 Conversion Option Module

1

VersaMax Micro PLC Expansion Units

VersaMax Micro PLC Expansion Units provide additional discrete points and analog I/O channels for the PLC system. Up to four VersaMax Micro PLC Expansion Units of any type can be connected to any VersaMax Micro PLC. Expansion units can be connected in any sequence.

Model Number	***Description***
IC200UEC008	8 Point (4) 24VDC In, (4) 24VDC Out with ESCP, 24VDC Power Supply
IC200UEC108	8 Point (4) 24VDC In, (4) 24VDC Out, 24VDC Power Supply
IC200UEC208	8 Point (4) 24VDC In, (4) Relay Out, 24VDC Power Supply
IC200UEI008	8 Point (8) 24VDC In, 24VDC Power Supply
IC200UEI016	16 Point (16) 24VDC In, 24VDC Power Supply
IC200UEO008	8 Point (8) 24VDC Out with ESCP, 24VDC Power Supply
IC200UEO016	16 Point (16) 24VDC Out with ESCP, 24VDC Power Supply
IC200UEO108	8 Point (8) 24VDC Out, 24VDC Power Supply
IC200UEO116	16 Point (16) 24VDC Out, 24VDC Power Supply
IC200UER008	8 Point (8) Relay Out, 24VDC Power Supply
IC200UER016	16 Point (16) Relay Out, 24VDC Power Supply
IC200UEX009	14 Point (8) 120 VAC In, (2) Relay Out @ 10 Amps (4) Relay Out @ 2 Amps, 120/240 VAC Power Supply
IC200UEX010	14 Point (8) 120 VAC In, (6) 120 VAC Out, 120/240 VAC Power Supply
IC200UEX011	14 Point (8) 24 VDC In, (6) Relay Out, 120/240 VAC Power Supply
IC200UEX012	14 Point (8) 24 VDC In, (6) Relay Out, 24 VDC Power Supply
IC200UEX013	14 Point (8) 12 VDC In, (6) Relay Out, 12 VDC Power Supply
IC200UEX014	14 Point (8) 24 VDC In, (6) 24 VDC Out, 24 VDC Power Supply
IC200UEX015	14 Point (8) 12 VDC In, (6) 12 VDC Out, 12 VDC Power Supply
IC200UEX122	14 Point (8) 24 VDC In, (6) 24 VDC Out with ESCP, 24 VDC Power Supply
IC200UEX209	28 Point (16) 120 VAC In, (4) Relay Out at 10 Amp, (8) Relay Out at 2 Amp, 120/240 VAC Power Supply
IC200UEX210	28 Point (16) 120 VAC In, (12) 120 VAC Out, 120/240 VAC Power Supply
IC200UEX211	28 Point (16) 24 VDC In, (12) Relay Out, 120/240 VAC Power Supply
IC200UEX212	28 Point (16) 24 VDC In, (12) Relay Out, 24 VDC Power Supply
IC200UEX213	28 Point (16) 12 VDC In, (12) Relay Out, 12 VDC Power Supply
IC200UEX214	28 Point (16) 24 VDC In, (12) 24 VDC Out, 6 at 1.0 Amp and, 6 at 0.5 Amp, 24 VDC Power Supply
IC200UEX215	28 Point (16) 12 VDC In, (12) 12 VDC Out, 12 VDC Power Supply
IC200UEX222	28 Point (16) 24 VDC In, (12) 24 VDC Out with ESCP, 24 VDC Power Supply
IC200UEX616	6 Point (4) Analog In and (2) Analog Out, 12 VDC Power Supply
IC200UEX626	6 Point (4) Analog In and (2) Analog Out, 24 VDC Power Supply
IC200UEX636	6 Point (4) Analog In and (2) Analog Out, 100-240 VAC Power Supply
IC200UEX724	4 RTD, Pt 100 In, 24VDC Power Supply
IC200UEX726	4 RTD, Pt 100 In and (2) Analog Out, 0 to 20mA , 4 to 20mA or 0 to 10VDC, 24VDC Power Supply
IC200UEX734	4 RTD, Pt 100 In, 120/240VAC Power Supply
IC200UEX736	4 RTD, Pt 100 In and (2) Analog Out, 0 to 20mA , 4 to 20mA or 0 to 10VDC, 120/240VDC Power Supply

Comparison of Program and Data Memory Available

The following table compares the amounts of program and data memory available with VersaMax Nano PLCs and Micro PLCs.

Reference Type	*Reference Range*	*10-Point Nano PLCs*	*14-Point Micro PLCs*	*23 and 28-Point Micro PLCs*	*64-Point Micro PLCs*
User program logic	Not applicable	2K words	9K words	9K words	48K words
Discrete inputs	%I0001 - %I0512	512 bits	512 bits	512 bits	512 bits
Discrete outputs	%Q0001 - %Q0512	512 bits	512 bits	512 bits	512 bits
Discrete global references	%G0001 - %G1280	1280 bits	1280 bits	1280 bits	1280 bits
Discrete internal coils	%M0001 - %M1024	1024 bits	1024 bits	1024 bits	1024 bits
Discrete temporary coils	%T0001 - %T0256	256 bits	256 bits	256 bits	256 bits
System status references	%S0001 - %S0032	32 bits	32 bits	32 bits	32 bits
	%SA0001 - %SA0032	32 bits	32 bits	32 bits	32 bits
	%SB0001 - %SB0032	32 bits	32 bits	32 bits	32 bits
	%SC0001 - %SC0032	32 bits	32 bits	32 bits	32 bits
System register references					
10-pt, 14-pt PLCs	%R0001 - %R0256	256 words	256 words		
23-pt and 28-pt PLCs	%R0001 - %R2048			2K words	
64-pt PLCs	%R0001 - %R32640				32K words
Analog and High Speed Counter inputs	%AI0001 - %AI0128	128 words	128 words	128 words	128 words
Analog outputs	%AQ0001 - %AQ0128	128 words	128 words	128 words	128 words

Comparison of PLC Features

The table below compares the features of VersaMax Nano PLCs and Micro PLCs.

Feature	***10-Point Nano PLCs***	***14-Point Micro PLCs***	***23 Point Micro PLCs***	***28-Point Micro PLCs***	***64-Point Micro PLCs***
Run/Stop Mode Select Switch		✓	✓	✓	✓
Connection for an external mode switch	✓				
Potentiometer Inputs (2)		✓	✓	✓	optional
Built-in Analog I/O	1 voltage out on some models		2 in (V/C) and 1 (V/C) out		
Capacitor memory backup time, minimum (Hardware version C and above)	3 days	3 days	30 minutes	30 minutes	30 minutes
External high capacity battery to back up RAM			optional	optional	optional
LEDs: PWR, RUN, OK, point status	✓	✓	✓	✓	✓
Removable wiring terminal assemblies		✓	✓	✓	✓
Accepts Up to 4 Expansion Units		✓	✓	✓	✓
Maximum I/O Count with Expansion Units		126	135	140	176
RS-232 Port 1 with RJ-45 Connector	✓	✓	✓	✓	✓
SNP/SNPX Master					✓
SNP/SNPX Slave	✓	✓	✓	✓	✓
2-Wire RTU Slave	✓	✓			✓
4-Wire RTU Slave	✓	✓			✓
Configurable for Serial I/O	✓	✓			✓
Modbus RTU Master					✓
Port 2			✓	✓	✓
SNP/SNPX Slave			✓	✓	✓
SNP/SNPX Master			✓	✓	✓
2-Wire RTU Slave			✓	✓	✓
4-Wire RTU Slave			✓	✓	✓
Modbus RTU Master			✓ (rel. 2.02 and later)	✓ (rel. 2.02 and later)	✓
Configurable for Serial I/O			✓	✓	✓
RS-232, RS-485/422, USB, and Memory Option Modules					✓
VersaMax Serial to Ethernet Support	✓	✓	✓	✓	✓
LD and Instruction List programming	✓	✓	✓	✓	✓
Program Functions compatible with Series 90-30 and Series 90 Micro PLCs	✓	✓	✓	✓	✓
Subroutines	8	64	64	64	64
Floating Point functions	✓	✓	✓	✓	✓

Comparison of I/O and Power Features for PLCs

	Model Number	Discrete Points	12VDC Power	24VDC Power	100/240V AC Power	DC Power for inputs and field devices	DC Inputs	AC Inputs	Analog Inputs	Relay Outputs	DC Outputs	AC Outputs	Analog Outputs
Nano PLCs	NAL110	10	✓				6		1	4			
	NAL211	10		✓			6		1	4			
	NDD010	10	✓				6				4		
	NDD101	10		✓			6				4		
	NDR001	10		✓			6			4			
	NDR010	10	✓				6			4			
Micro PLCs	UAA003	14			✓			8				6	
	UAA007	28			✓			16				12	
	UAL004	23	✓			✓	13		2	10			1
	UAL005	23		✓		✓	13		2	9	1		1
	UAL006	23			✓	✓	13		2	9	1		1
	UAR014	14			✓	✓		8		* 6			
	UAR028	28			✓	✓		16		* 12			
	UDD104	14		✓		✓	8				6		
	UDD064	64		✓		✓	40				24, ESCP		
	UDD110	28		✓		✓	16				12		
	UDD112	14	✓			✓	8				6		
	UDD120	28		✓		✓	16				12, ESCP		
	UDD164	64		✓		✓	40				24		
	UDD212	28	✓			✓	16				12		
	UDR001	14			✓	✓	8			6			
	UDR002	14		✓		✓	8			6			
	UDR003	14	✓			✓	8			6			
	UDR005	28			✓	✓	16			11	1		
	UDR006	28	✓			✓	16			12			
	UDR010	28		✓		✓	16			11	1		
	UDR064	64		✓		✓	40			24			
	UDR164	64			✓	✓	40			24			

* 2 outputs rated 10 Amps

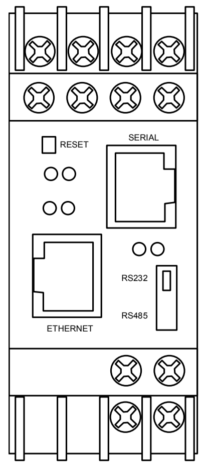
Comparison of I/O and Power Features for Expansion Units

	Model Number	Total Points	12VDC Power	24VDC Power	100/240V AC Power	DC Power for inputs and field devices	DC Inputs	AC Inputs	Analog Inputs	Relay Outputs	DC Outputs	AC Outputs	Analog Outputs
Expansion Units	UEC008	8		✓		✓	4				4, ESCP		
	UEC108	8		✓		✓	4				4		
	UEC208	8		✓		✓	4			4			
	UEI008	8		✓		✓	8						
	UEI016	16		✓		✓	16						
	UEO008	8		✓		✓					8, ESCP		
	UEO108	8		✓		✓	8			8			
	UEO016	16		✓		✓					16, ESCP		
	UEO116	16		✓		✓					16		
	UER008	8		✓		✓				8			
	UER016	16		✓		✓				16			
	UEX009	14			✓	✓		8		* 6			
	UEX010	14			✓	✓		8				6	
	UEX011	14			✓	✓	8			6			
	UEX012	14		✓		✓	8			6			
	UEX013	14	✓			✓	8			6			
	UEX014	14		✓		✓	8				6		
	UEX015	14	✓			✓	8				6		
	UEX122	14		✓		✓	8				6, ESCP		
	UEX209	28			✓			16		* 12			
	UEX210	28			✓	✓		16				12	
	UEX211	28			✓	✓	16			12	1		
	UEX212	28		✓		✓	16			12	1		
	UEX213	28	✓			✓	16			12			
	UEX214	28		✓		✓	16				12		
	UEX215	28	✓			✓	16				12		
	UEX222	28		✓		✓	16				12, ESCP		
	UEX616	6	✓						4				2
	UEX626	6		✓					4				2
	UEX636	6			✓				4				2
	UEX724	6		✓					4 RTD				
	UEX726	6		✓					4 RTD				2
	UEX734	6			✓				4 RTD				
	UEX736	6			✓				4 RTD				2

* 2 outputs rated 10 Amps

VersaMax Serial to Ethernet Adapter

The VersaMax™ IC200SET001 Serial to Ethernet Adapter (VMSE) can be used to connect a VersaMax Micro PLC or Nano PLC to an Ethernet network.



Firmware Options

By default, SRTP/SNP firmware is loaded in flash memory. Use SRTP/SNP to communicate with VersaPro™, CIMPLICITY™ HMI, Series 90-30™, Series 90-70™, and other GE Fanuc products.

Additional firmware options are provided on the CD that is shipped with the VMSE. These include Modbus TCP/RTU, and Pass Thru firmware, which can be used to send serial communication via Ethernet.

Serial Interface

The RJ45 port on the VMSE supports RS232. The screw block port supports both RS232 and RS485/422. Setting the switch on the front of the VMSE and configuring the VMSE setup selects RS232 or RS485/422. Only one port can be used at a time.

Network Interface

The VMSE supports 10/100 Mbit Ethernet through its RJ45 (10BaseT) connector.

Power Requirements

The required input voltage can vary between 9VDC and 30VDC (or 24VAC) with a maximum of 3 Watts. The VMSE can be powered from the 12 or 24 Volt supply on a VersaMax Micro PLC (200mA available), or an external supply can be used. For a Nano PLC, an external power supply is required.

Logic-Driven Read/Write Flash Memory Feature

Release 3.0 and later Micro PLCs support two Service Requests that can be used in the application program to read data from and write data to flash memory.

The Logic-Driven Read/Write Flash feature can:

- Write selected data to flash using Service Request (SVCREQ) logic in the application program
- Write / read one to ten consecutive Reference Variables of same type with one Service Request
  - Up to 10 words of %R, %AI, %AQ
  - Up to 10 bytes of %I, %Q, %M, %T, %G
- Up to 8k bytes of reference memory can be stored in flash. If a request is made to store more than 8k bytes in flash, a fault is logged in the PLC Fault Table.

See chapter 21 for details and example logic.

Chapter 2

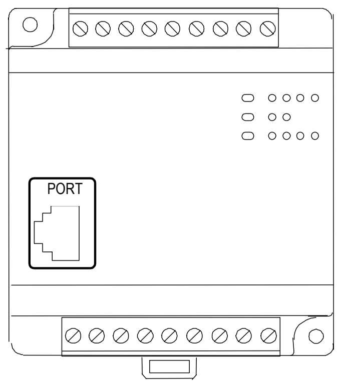
VersaMax Nano PLCs

This chapter describes the features and specifications of VersaMax Nano PLCs.

- IC200NAL110 Nano PLC with 10 Discrete Points and 1 Analog Input: 11 Point (6) 12VDC In, (4) Relay Out, 1 Analog input, 12VDC Power Supply
- IC200NAL211 Nano PLC with 10 Discrete Points and 1 Analog Input: (6) 24VDC In, (4) Relay Out, 1 Analog input, 24VDC Power Supply
- IC200NDD010 10 Point Nano PLC: (6) 12VDC In, (4) 12VDC Out, 12VDC Power Supply
- IC200NDD101 10 Point Nano PLC: (6) 24VDC In, (4) 24VDC Out, 24VDC Power Supply
- IC200NDR001 10 Point Nano PLC: (6) 24VDC In, (4) Relay Out, 24VDC Power Supply
- IC200NDR010 10 Point Nano PLC: (6) 12VDC In, (4) Relay Out, 12VDC Power Supply

VersaMax Nano PLC Features

VersaMax Nano PLCs offer the perfect solution for smaller packaging machines, dispensing machines, and relay replacement applications with up to 6 inputs and 4 outputs. In spite of their small size, these versatile controllers provide powerful programming features such as built-in high-speed counter functionality, support for floating-point function blocks and subroutines, ability to assign passwords and privilege levels, and override capability.



All VersaMax Nano PLCs feature:

- Two non-removable recessed "box-style" terminal strips.
- An external Run/Stop switch can be wired to the Nano PLC. The switch can be configured as a run/stop switch, or a memory protect switch, and used for clearing faults when a fatal fault exists.
- Configurable to read configuration at powerup from either RAM or flash memory (ROM). Can also be configured to read application program from flash at powerup.
- Capacitor backs up RAM for at least 30 minutes on hardware revisions C or above.
- Full-featured programming Instruction Set with floating point math.
- 2K words of program memory, 256 words of registers.

Nano PLC General Specifications

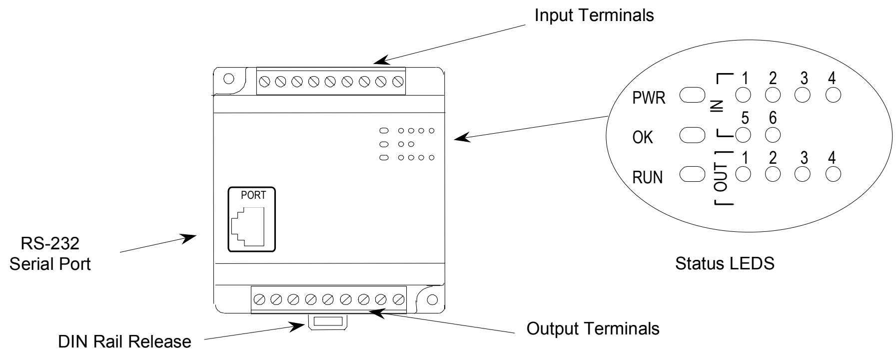
Typical Scan Rate	1.3 ms/K for Boolean logic (see appendix A)
Output Power Supplies	+5VDC on pin 7 of Serial Port, 100mA max
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater). Requires IC200ACC415.
Realtime clock accuracy (for timer functions)	+/- 0.5%

RS-232 Serial Port

The RS-232 serial port has an RJ-45 connector. The serial port defaults to SNP protocol, and can be configured for SNP/SNPX, slave or RTU slave using the configuration software. It can also be configured for Serial I/O and controlled using COMMREQs from the application program. The port automatically switches from RTU to SNP for programmer communications.

Status LEDs

LEDs provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.



High Speed Counters

A VersaMax Nano PLC can be configured to provide built-in high-speed counter and pulse operation.

When configured for High-speed Counter operation, inputs can be set up as:

- Up to three Type A Counters or
- 1 Type A and 1 Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

Nano PLCs with DC outputs provide up to 3 High-Speed Counter outputs, and/or Pulse Train or Pulse-Width Modulated outputs.

Nano PLCs with relay outputs also provide up to 3 High-Speed Counter outputs. However, relay outputs cannot be used as Pulse Train or Pulse-Width Modulated outputs.

IC200NAL110
Nano PLCs with 10 Discrete Points and 1 Analog Input: (6) 12 VDC In, (4) Relay Out, 1 Analog Input, 12VDC Power Supply

VersaMax Nano PLC IC200NAL110 has six DC inputs, one analog input, and four normally-open 2 Amp relay outputs that can control 5 to 30VDC or 5 to 250VAC output devices. It uses +12VDC nominal input power for PLC operation.

DC Inputs

The module's six configurable DC inputs can be used as positive or negative logic standard inputs or High-speed Counter inputs. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Analog Input

Input IN1 can be used as an analog input (8-bit resolution), for analog signals in the 0V to 10V range. The analog input cannot be software-calibrated.

Relay Outputs

The four Form A (SPST-single pole single throw) normally-open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24 volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

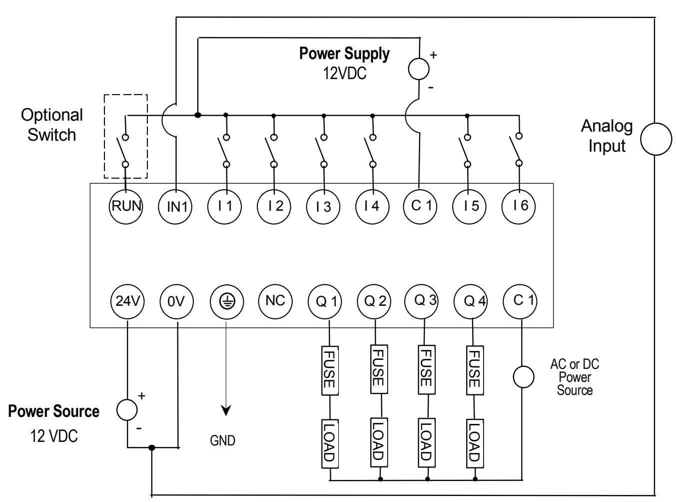
The relay outputs can be used as up to three High-Speed Counter outputs. They cannot be used as Pulse Train or Pulse-Width Modulated outputs. Connections and specifications for High-speed Counter outputs are the same as for standard relay outputs.

Nano PLC IC200NAL110 Specifications

Inputs	Six 12 VDC positive/negative logic inputs, one analog input, 0 to 10V
Outputs	Four normally open 2 Amp relay circuits
High Speed Counters	Three Type A or One Type A and One Type B
DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	8A typical at 12 VDC
Inrush Time	200mS typical
Input Current	250mA typical at 12 VDC
Input Power Supply Rating	3W
DC Input Specifications	
Number of Inputs	6
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Impedance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between group
Analog Input Specifications	
Number of Analog Inputs	1, single
Input range	0 to 10 V (10.24 maximum)
Resolution	8 bits
Accuracy	1% of full scale over temperature range
Voltage input impedance	100K Ohm
Input filter time	200ms to reach 1% error for step input

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-Speed Counter Input and Output Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 9V, OFF: 2.5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16bits		
Outputs			
Load Voltage	12V		
Number of Pulse Outputs	None		

Wiring Diagram, IC200NAL110



IC200NAL211
Nano PLC with 10 Discrete Points and 1 Analog Input: (6) 12 VDC In, (4) Relay Out, 1 Analog Input, 24VDC Power Supply

VersaMax Nano PLC IC200NAL211 has six DC inputs, one analog input, and four normally-open 2 Amp relay outputs that can control 5 to 30VDC or 5 to 250VAC output devices. It uses +24VDC nominal input power for PLC operation.

DC Inputs

The module's six configurable DC inputs can be used as positive or negative logic standard inputs. Whether used as a standard or HSC input, each DC input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Analog Input

Input IN1 can be used as an analog input (8-bit resolution), for analog signals in the 0V to 10V range. The analog input cannot be software-calibrated.

Relay Outputs

The four Form A (SPST-single pole single throw) normally-open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24 volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

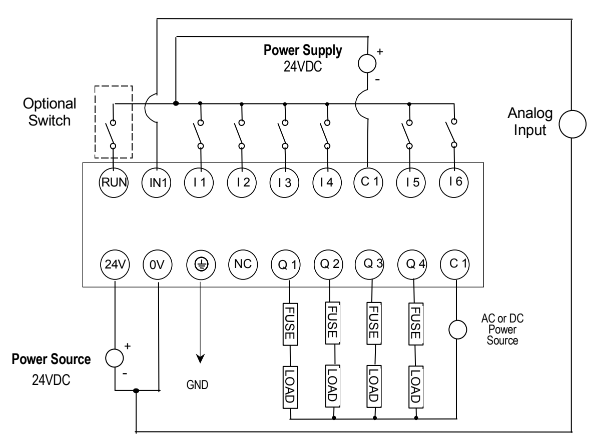
The relay outputs can be used as up to three High-Speed Counter outputs. They cannot be used as Pulse Train or Pulse-Width Modulated outputs. Connections and specifications for High-speed Counter outputs are the same as for standard relay outputs.

Nano PLC IC200NAL211 Specifications

Inputs	Six 24 VDC positive/negative logic inputs, one analog input, 0 to 10V
Outputs	Four normally open 2 Amp relay circuits
High Speed Counters	Three Type A or One Type A and One Type B
DC Power Specifications	
Range	19.2VDC - 30.0VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30 VDC
Inrush Time	10mS for 1 Amp
Input Current	0.12 Amp typical at 24 VDC
Input Power Supply Rating	3W
DC Input Specifications	
Number of Inputs	6
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Impedance	2.8 kOhms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between group
Analog Input Specifications	
Number of Analog Inputs	1, single
Input range	0 to 10 V (10.24 maximum)
Resolution	8 bits
Accuracy	1% of full scale over temperature range
Voltage input impedance	100K Ohm
Input filter time	200ms to reach 1% error for step input

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-Speed Counter Input and Output Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 15V, OFF: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16bits		
Outputs			
Load Voltage	12/24V		
Number of Pulse Outputs	None		

Wiring Diagram, IC200NAL211



IC200NDD010
10 Point Nano PLC: (6) 12 VDC In, (4) 12 VDC Out, 12 VDC Power Supply

VersaMax Nano PLC IC200NDD010 has six 12VDC inputs and four DC transistor outputs. It uses +12VDC nominal input power for PLC operation.

DC Inputs

The module's six configurable DC inputs can be used as standard inputs or High-speed Counter inputs. Whether used as a standard or HSC input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Transistor Outputs

The four transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Then can also be used as Pulse Train and/or Pulse Width Modulation (PWM) outputs.

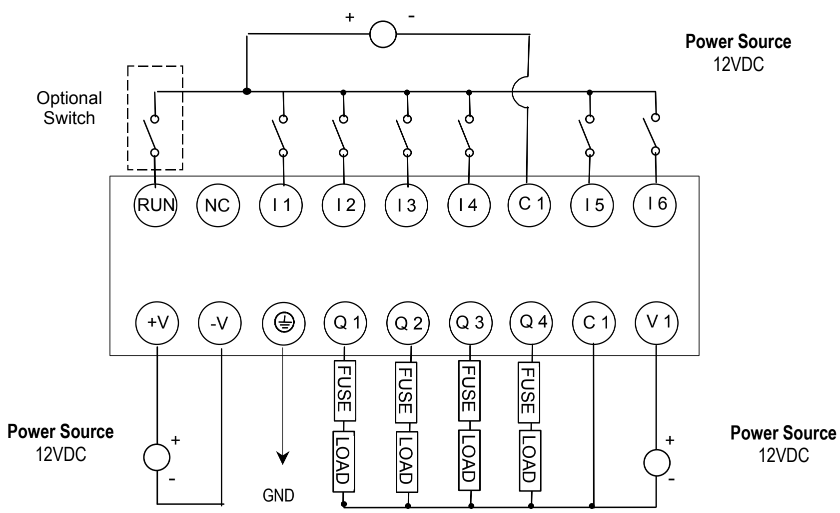
All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Nano PLC IC200NDD010 Specifications

Inputs	Six 12 VDC positive/negative logic input circuits
Outputs	Four transistor outputs
High Speed Counters	Three Type A or One Type A and One Type B
DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	8A typical at 12 VDC
Inrush Time	200mS typical
Input Current	250mA typical at 12 VDC
Input Power Supply Rating	3W
DC Input Specifications	
Number of Inputs	6
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Impedance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between group
Transistor Output Specifications	
Voltage Range	12VDC (12VDC +20%, -20%)
Maximum Load	0.7A per circuit, 4A per common
Maximum Inrush Current	4A for 20mS
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA maximum
Response	OFF to ON: 0.1mS maximum 12VDC 0.2A ON to OFF: 0.1mS maximum 12VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12VDC +10%, -20%
Fuse	Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

High-Speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 9V, OFF 2.5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Number of Outputs	Up to three HSC/PT and/or PWM outputs
Load Voltage	12V
Maximum Pulse/PWM Frequency	5kHz

Wiring Diagram, IC200NDD010



IC200NDD101
10 Point Nano PLC: (6) 24 VDC In, (4) 12 VDC Out, 24 VDC Power Supply

VersaMax Nano PLC IC200NDD101 has six 24VDC inputs and four DC transistor outputs. It uses +24VDC nominal input power for PLC operation.

DC Inputs

Six configurable DC inputs can be used as standard inputs or High-speed Counter inputs. Whether used as a standard or HSC input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Transistor Outputs

The four transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Then can also be used as Pulse Train and/or Pulse Width Modulation (PWM) outputs.

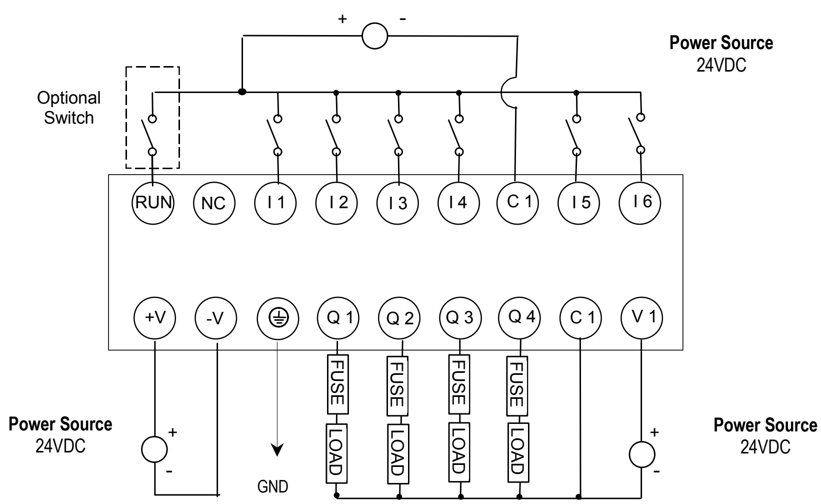
All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Nano PLC IC200NDD101 Specifications

Inputs	Six 24 VDC positive/negative logic input circuits
Outputs	Four transistor outputs
High Speed Counters	Three Type A or One Type A and One Type B
DC Power Specifications	
Range	19.2VDC - 30.0VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30 VDC
Inrush Time	10mS for 1 Amp
Input Current	0.12 Amp typical at 24 VDC
Input Power Supply Rating	3W
DC Input Specifications	
Number of Inputs	6
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Impedance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side 500V RMS between group
Transistor Output Specifications	
Voltage Range	12VDC/24VDC (24VDC +10% / -43% input at V1,C1)
Maximum Load	0.75A per point (Q1 - Q4) at 24VDC at 100 % ON duration 0.5A per point (Q1 - Q4) at 12VDC at 100 % ON duration
Maximum Inrush Current	8A for 20ms, 1 pulse (0.75A outputs) 4A for 20ms, 1 pulse (0.5A outputs)
Output Voltage Drop	0.3V maximum
OFF state leakage	100µA maximum
Response	OFF to ON: 0.1mS maximum 24VDC 0.2A ON to OFF: 0.1mS maximum 24VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	16-30VDC required to power the outputs.
Fuse	Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

High-Speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
High Speed Counter Outputs	
Number of Outputs	Up to three HSC/PT and/or PWM outputs
Load Voltage	12/24V
Maximum Pulse/PWM Frequency	5kHz

Wiring Diagram, IC200NDD101



IC200NDR001
10 Point Nano PLC: (6) 24 VDC In, (4) Relay Out, 24 VDC Power Supply

VersaMax Nano PLC IC200NDR001 has six 24VDC inputs, and four normally-open 2 Amp relay outputs that can control 5 to 30VDC or 5 to 250VAC output devices. It uses +12VDC nominal input power for PLC operation.

DC Inputs

The module's six configurable DC inputs can be used as standard inputs or High-speed Counter inputs. Whether used as a standard or High-Speed Counter input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Relay Outputs

The four Form A (SPST-single pole single throw) normally-open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24 volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

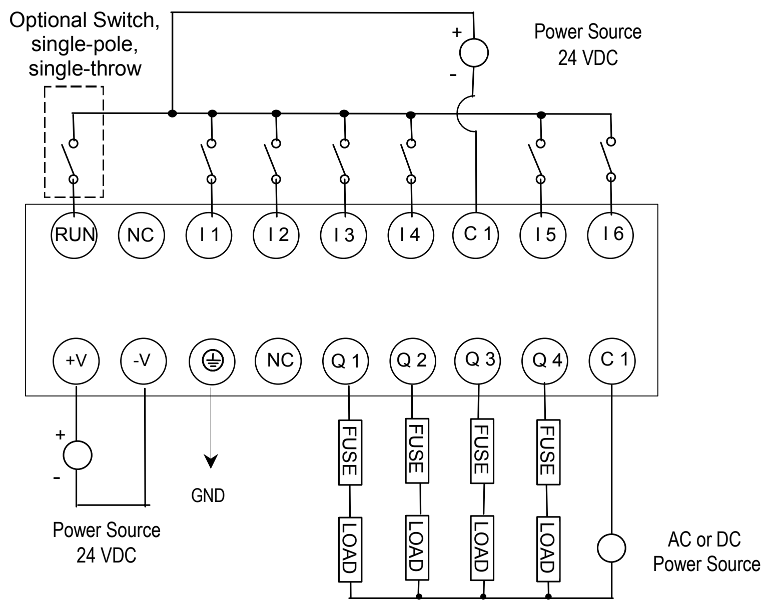
Connections and specifications for HSC outputs are the same as for standard relay outputs.

Nano PLC IC200NDR001 Specifications

Inputs	Six 24 VDC positive/negative logic input circuits		
Outputs	Four normally open 2 Amp relay circuits		
High Speed Counters	Three Type A or One Type A and One Type B		
DC Power Specifications			
Range	24 –20%/+25% VDC		
Hold-up	10 ms at 19.2 VDC		
Inrush Current	1A maximum at 24 VDC		
Inrush Time	10 ms for 1 A		
Input Current	0.12A typical at 24 VDC		
Input Power Supply Rating	3W		
Input Specifications			
Number of Inputs	6		
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current	7.5mA typical		
Input Resistance	2.8 Kohms		
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum		
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

High-Speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
High Speed Counter Outputs	
Load Voltage	refer to relay output specifications
Number of Pulse Outputs	None

Wiring Diagram, IC200NDR001



IC200NDR010
10 Point Nano PLC: (6) 24 VDC In, (4) Relay Out, 12VDC Power Supply

VersaMax Nano PLC IC200NDR010 has six 24VDC inputs, and four normally-open 2 Amp relay outputs that can control 5 to 30VDC or 5 to 250VAC output devices. It uses +12VDC nominal input power for PLC operation.

Inputs

The module's six configurable DC inputs can be used as standard inputs or High-speed Counter inputs. Whether used as a standard or High-Speed Counter input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Relay Outputs

The four Form A (SPST-single pole single throw) normally-open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24 volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

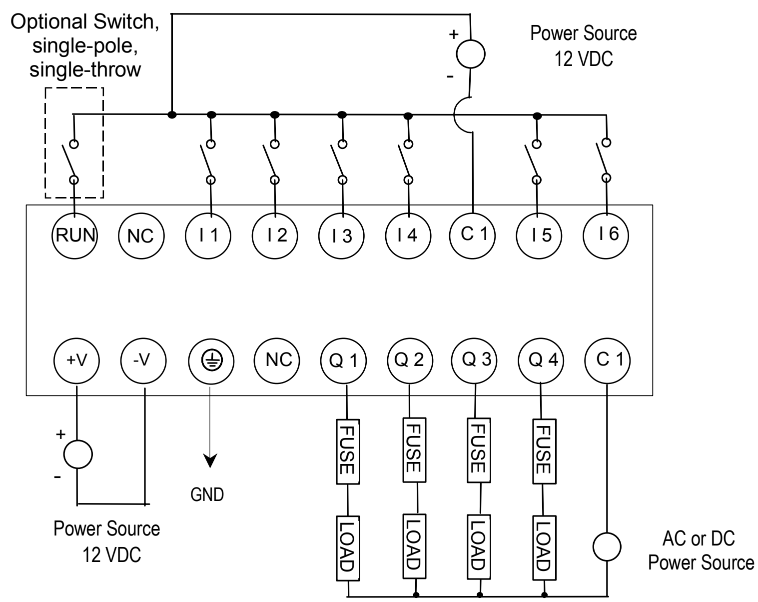
Connections and specifications for High-speed Counter outputs are the same as for standard relay outputs.

Nano PLC IC200NDR010 Specifications

Inputs	Six 12 VDC positive/negative logic input circuits		
Outputs	Four normally open 2 Amp relay circuits		
High Speed Counters	Three Type A or One Type A and One Type B		
DC Power Specifications			
Range	9.6VDC - 15VDC		
Hold-up	3.0mS		
Inrush Current	8A typical at 12 VDC		
Inrush Time	200mS typical		
Input Current	250mA typical at 12 VDC		
Input Power Supply Rating	3W		
Input Specifications			
Number of Inputs	6		
Rated Input Voltage	12 volts DC		
Input Voltage Range	0 to 15 volts DC		
Input Current	9.0mA typical		
Input Resistance	1.3 kOhms		
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum		
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum		
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
240VAC, 120VAC, 24VDC	2A	0.6A	200,000

High-Speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 9V, OFF: 2.5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	refer to relay output specifications
Number of Pulse Outputs	None

Wiring Diagram, IC200NR010

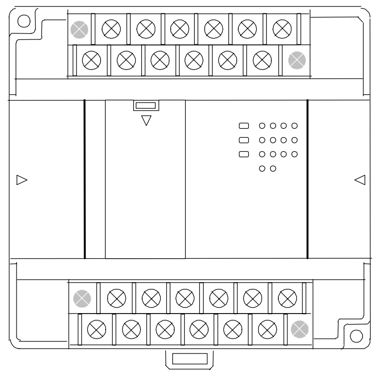


Chapter 3

VersaMax 14-Point Micro PLCs

- IC200UAA003 14 Point Micro PLC, (8) 120VAC In, (6) 120VAC Out, 120/240VAC Power Supply
- IC200UAR014 14 Point Micro PLC, (8) 120VAC In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240VAC Power Supply
- IC200UDD104 14 Point Micro PLC, (8) 24VDC Source In, (6) 24VDC Source Out, 24VDC Power Supply
- IC200UDD112 14 Point Micro PLC, (8) 12VDC In, (6) 12VDC Out, 12VDC Power Supply
- IC200UDR001 14 Point Micro PLC, (8) 24VDC In, (6) Relay Out, 120/240VAC Power Supply
- IC200UDR002 14 Point Micro PLC, (8) 24VDC In, (6) Relay Out, 24VDC Power Supply
- IC200UDR003 14 Point Micro PLC, (8) 12VDC In, (6) Relay Out, 12VDC Power Supply

VersaMax 14-Point Micro PLC Features



All VersaMax 14 Point Micro PLCs feature:

- Two removable screw-down “barrier-style” terminal strips with protective covers.
- RS-232 serial port that supports SNP/SNPX, RTU slave protocols, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 256 words of registers.
- Support for up to four Expansion Units in any combination.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration at powerup from either RAM or flash memory (ROM). Can also be configured to read application program from flash at powerup.
- Capacitor backs up RAM for at least 3 days.

14-Point Micro PLC General Specifications

Typical Scan Rate	1.3 ms/K for Boolean logic (see appendix A)
Output Power Supplies	+5VDC on pin 7 of Serial Port, 100mA max
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater). Requires IC200ACC415.
Realtime clock accuracy (for timer functions)	+/- 0.5%

High Speed Counters

All VersaMax Micro with DC power can be configured to provide built-in high-speed counter and pulse operation.

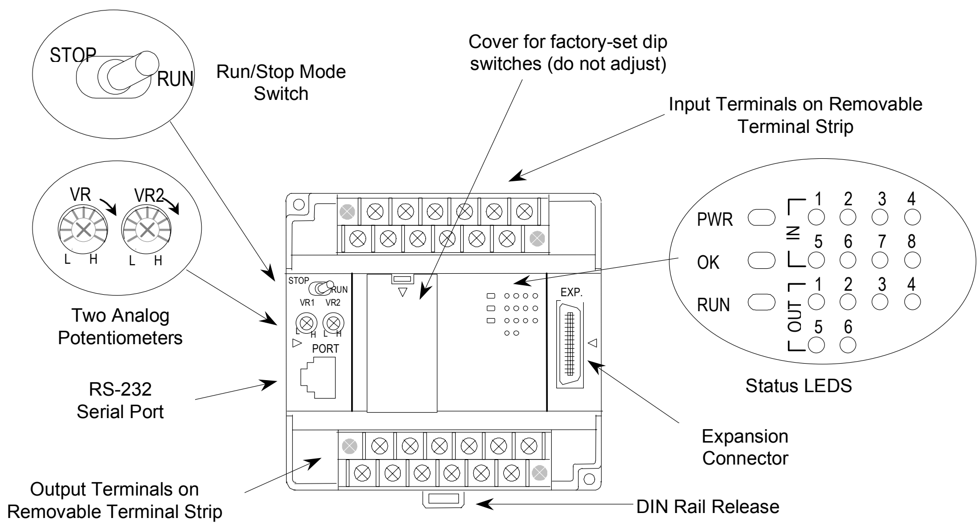
When configured for High-speed Counter operation, inputs can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

Models with DC outputs can be configured to provide up to four counter, Pulse Train or PWM outputs.



IC200UAA003
14 Point Micro PLC, (8) 120VAC In, (6) 120VAC Out, 120/240VAC Power Supply

VersaMax Micro PLC model IC200UAA003 accepts eight AC inputs and provides six AC outputs. It uses 100VAC to 240VAC nominal input power.

AC Inputs

The module's eight 120 VAC input circuits are reactive (resistor/capacitor) inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied. The input circuits require an AC power source: they cannot be used with a DC power source.

AC Outputs

The 120/240 VAC, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

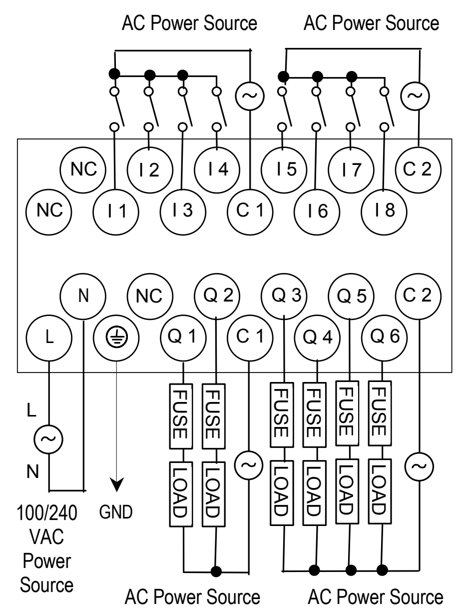
This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling many types of inductive and incandescent loads. AC power to operate loads connected to outputs must be supplied from an external source.

Micro PLC IC200UAA003 Specifications

Inputs	Eight AC inputs
Outputs	Six AC outputs
High-speed Counters	None
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85 to 100VAC, 20mS at 100 to 264VAC
Inrush Time	2mS for 40 Amp
Inrush Current	18 Amp maximum at 120VAC 30 Amp maximum at 200VAC 40 Amp maximum at 265VAC
Input Current	0.05 Amp typical at 200VAC, 0.10 Amp Typical at 100 VAC
Input Power Supply Rating	11 VA

AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80V rms, 4.5mA rms, OFF: maximum 30V rms, 2mA rms
Response Time	OFF to ON: maximum 25mS, ON to OFF: maximum 30mS
Isolation	1500V rms field side to logic side, 500V rms between groups
AC Output Specifications	
Rated Load Voltage	100 -15% to 240 +10% VAC, 50 -5% to 60 +5% Hz
Maximum Resistive Load Current	0.5 Amp per point
Maximum UL Pilot Duty Rating	0.5 Amp per point at 240 VAC 0.6 Amp maximum on C1 1.2 Amps maximum on C2
Maximum Inrush Current	5A (1 period)/point, 10A (1 period)/common
Maximum voltage drop when ON	1.5 V RMS
Maximum leak current when OFF	1.8 mA RMS (115 VAC), 3.5 mA RMS (230 VAC)
Response Time (Maximum)	OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 mS
Isolation	1500V RMS field side to logic side 500V RMS between groups

Wiring Diagram, IC200UAA003



IC200UAR014
14 Point Micro PLC, (8) 120VAC In, (6) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC model IC200UAR014 accepts eight AC inputs and provides six relay outputs: 2 at 10 Amps and 4 at 2 Amps. It uses 100VAC to 240VAC nominal input power.

Inputs

The module's 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

Relay Outputs

The six normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. There are two individual 10 Amp relay outputs and one group of four 2-Amp relay outputs. Power for the internal relay coils is provided by the internal supply. Separate external sources of AC or DC power must be supplied to operate field output devices.

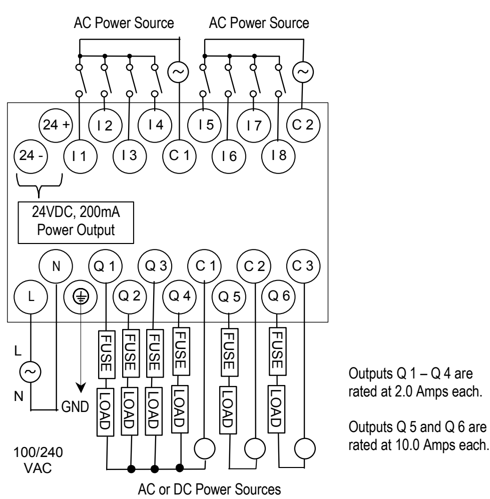
Micro PLC IC200UAR014 Specifications

Inputs	Eight AC inputs
Outputs	Six Relay outputs
High-speed Counters	None
Output Power Supplies	24VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85 to 100VAC, 20mS at 100 to 264VAC
Inrush Time	2mS for 40 Amp
Inrush Current	18 Amp maximum at 120VAC 30 Amp maximum at 200VAC 40 Amp maximum at 265VAC
Input Current	0.05 Amp typical at 200VAC, 0.10 Amp Typical at 100 VAC
Input Power Supply Rating	11 VA

AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms
Response Time	OFF to ON: maximum 25mS, ON to OFF: maximum 30mS
Isolation	1500V rms field side to logic side, 500V rms between groups
Relay Output Specifications	
Operating Voltage	5 to 30 VDC or 5 to 250 VAC
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups
Leakage Current	15 mA maximum
Maximum UL Pilot Duty Rating	Q1 – Q4: 2 amps at 24 VDC and 240 VAC, Q5, Q6: 10 amps at 24 VDC and 240 VAC
Maximum Resistive Load Rating	Q1 – Q4: 2 amps at 24 VDC and 240 VAC, Q5, Q6: 10 amps at 24 VDC and 240 VAC
Minimum Load	10 mA
Maximum Inrush	Q1 – Q4: 5 amps per half cycle, Q5, Q6: 14 amps per half cycle
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum
Fuse	None
Contact Life: Mechanical	20 x 10^6 mechanical operations

Contact Life: Electrical Voltage:	Current: Resistive	Current: Lamp and Solenoid	Typical Operations:
	2A	0.6A	200,000
	10A	4A	100,000
	4 A	1A	200,000

Wiring Diagram, IC200UAR014



IC200UDD104
14 Point Micro PLC, (8) 24VDC In, (6) 24VDC Source Out, 24VDC Power Supply

VersaMax Micro PLC IC200UDD104 accepts eight DC inputs and provides four low-current and two high-current DC transistor outputs. It uses +24VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains its nominal voltage (24VDC). The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level (see power supply specifications for inrush requirements).

DC Inputs

The module's eight configurable DC inputs can be used as standard or High-speed Counter inputs. Each input can have positive or negative logic characteristics. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's DC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Outputs

All outputs are isolated between field and logic and are switching positive voltage.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

External fusing should be provided to protect the outputs. Fast fuses are recommended.

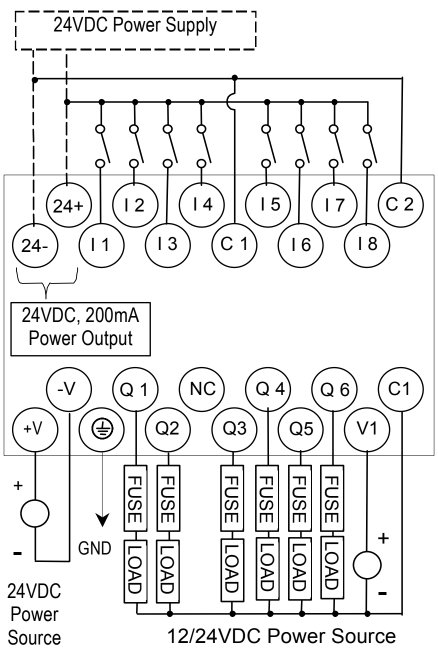
The outputs share one common incoming DC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Micro PLC IC200UDD104 Specifications

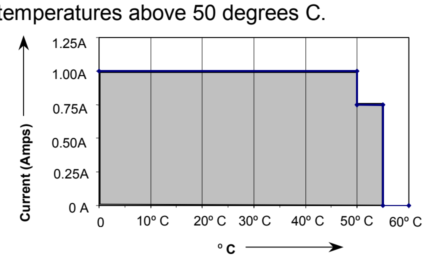
Inputs	Eight 24 VDC positive/negative logic input circuits
Outputs	Four low-current and two high-current DC output circuits
High-speed Counters	Four Type A or One Type A and One Type B
Output Power Supplies	24VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10 ms at 19.2 VDC
Inrush Current	1A maximum at 30 VDC
Inrush Time	10 ms for 1 A
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W
DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Output Specifications	
Voltage Range	12VDC/24VDC (24VDC +10% / -43% input at V1,C1)
Maximum Load	1.0A per point (Q1 - Q2) at 24VDC at 100% ON duration 0.75A per point (Q3 - Q6) at 24VDC at 100 % ON duration 0.5A per point (Q3 - Q6) at 12VDC at 100 % ON duration
Maximum Inrush Current	Q1, Q2: 8A for 20ms, 1 pulse Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse
Output Voltage Drop	0.3V maximum
OFF state leakage	100µA maximum
Response	OFF to ON: 0.1ms maximum (24 VDC, 0.2A), ON to OFF: 0.1ms maximum (24 VDC, 0.2A)
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Fuse	Outputs should be fused externally. Otherwise, a load short damage the module output transistor, which is not user replaceable.

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	12/24V
Maximum Pulse/PWM Frequency	5kHz
Number of Pulse Outputs	4
Types available	HSC, PT, PWM

Wiring Diagram, IC200UDD104



The maximum current that can be used for output points Q1 and Q2 is lower for ambient temperatures above 50 degrees C.



IC200UDD112
14 Point Micro PLC, (8) 12VDC In, (6) 12VDC Out, 12VDC Power Supply

VersaMax Micro PLC IC200UDD112 accepts eight DC inputs and provides four low-current and two high-current DC transistor outputs. It uses +12VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains its nominal voltage. The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level (see power supply specifications for inrush requirements).

DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's DC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA..

Transistor Outputs

Micro PLC IC200UDD112 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). All outputs are isolated between field and logic and are switching positive voltage.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

External fusing should be provided to protect the outputs. Fast fuses are recommended.

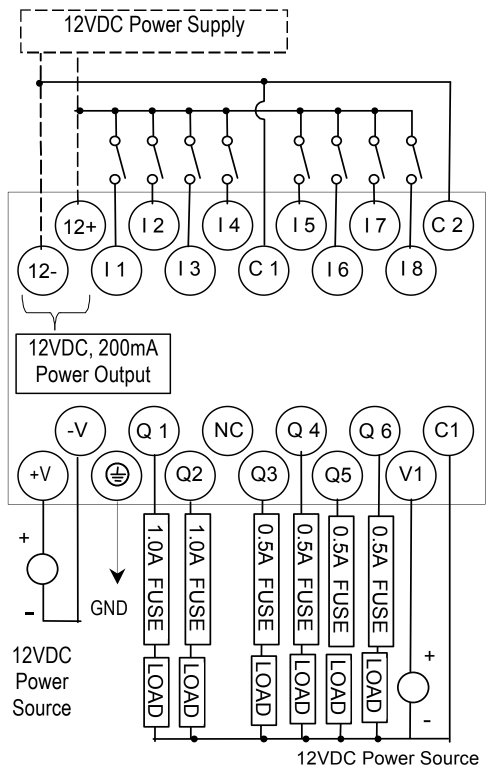
The outputs share one common incoming DC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Micro PLC IC200UDD112 Specifications

Inputs	Eight 12 VDC positive/negative logic input circuits
Outputs	Four low-current and two high-current DC output circuits
High-speed Counters	Four Type A or One Type A and One Type B
Output Power Supplies	12VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.
DC Power Specifications	
Range	9.6VDC to 15 VDC
Hold-up	3.0mS
Inrush Current	9.2A typical
Inrush Time	200mS typical
Input Current	300mA typical at 12 VDC
Input Power Supply Rating	3W
DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Resistance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100μs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Output Specifications	
Voltage Range	12VDC –20%, +20%
Maximum Load	0.7A per circuit, 4A per common
Maximum Inrush Current	4A for 20mS
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA maximum
Response	OFF to ON: 0.1mS maximum 12VDC 0.2A, ON to OFF: 0.1mS maximum 12VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Fuse	Outputs should be fused externally. Otherwise, a load short may damage the module output transistor, which is not user replaceable.

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	12V
Maximum Pulse/PWM Frequency	5kHz
Number of Pulse Outputs	4
Types available	HSC, PT, PWM

Wiring Diagram, IC200UDD112



IC200UDR001
14 Point Micro PLC, (8) 24VDC In, (6) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC IC200UDR001 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5-30VDC or 5-250VAC output devices. It uses 100VAC to 240VAC nominal input power.

DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC provides a +24 VDC supply that can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

The six Form A relay outputs (SPST-single pole single throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four counter outputs. They cannot be used as Pulse Train or PWM outputs.

Connections and specifications for HSC outputs are the same as for standard relay outputs.

Micro PLC IC200UDR001 Specifications

Inputs	Eight 24 VDC positive/negative logic input circuits
Outputs	Six normally open 2 Amp relay circuits
High-speed Counters	Up to four Type A or one Type A and one Type B
Output Power Supplies	24VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.

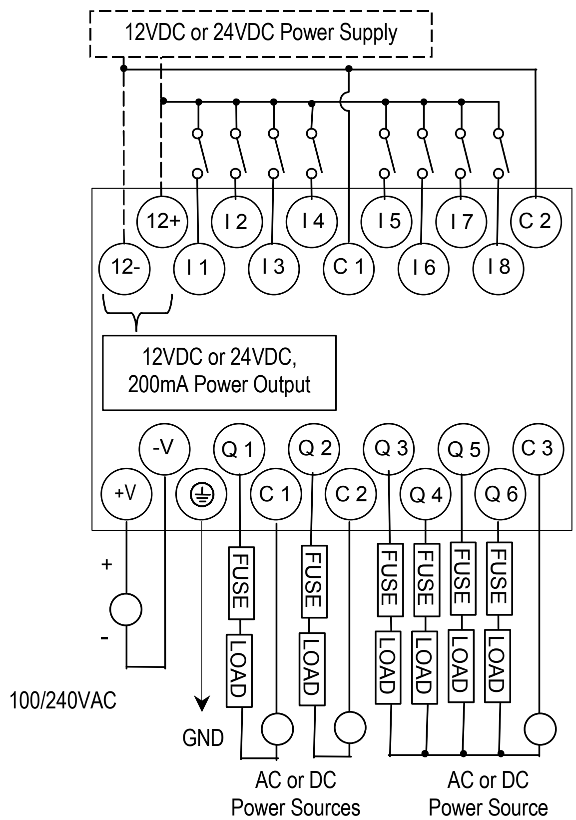
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85 to 100VAC. 20mS at 100 to 264VAC
Inrush Time	2mS for 40A
Inrush Current	18 Amp maximum at 120 VAC 30 Amp maximum at 200 VAC 40 Amp maximum at 265 VAC
Input Current	0.06 Amp typical at 200 VAC, 0.10 Amp typical at 100 VAC
Input Power Supply Rating	13 VA
Isolation	1500VAC RMS field-side to logic (power supply input).

DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

High-speed Counter Input and Output Specifications	
Available High Speed Counters	Four Type A or One Type A and One Type B
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16 bits
Outputs	
Available Pulse Outputs	None
Load Voltage	Refer to relay output specifications

Wiring Diagram, IC200UDR001



IC200UDR002
14 Point Micro PLC, (8) 24VDC In, (6) Relay Out, 24VDC Power Supply

VersaMax Micro PLC IC200UDR002 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5 to 30 VDC or 5 to 250VAC output devices. It uses +24VDC nominal input power for PLC operation.

DC Power

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard inputs or High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's 24VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

Six Form A (SPST-single pole single throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as HSC outputs. They cannot be used as Pulse Train or PWM outputs. Connections and specifications for HSC outputs are the same as for standard relay outputs.

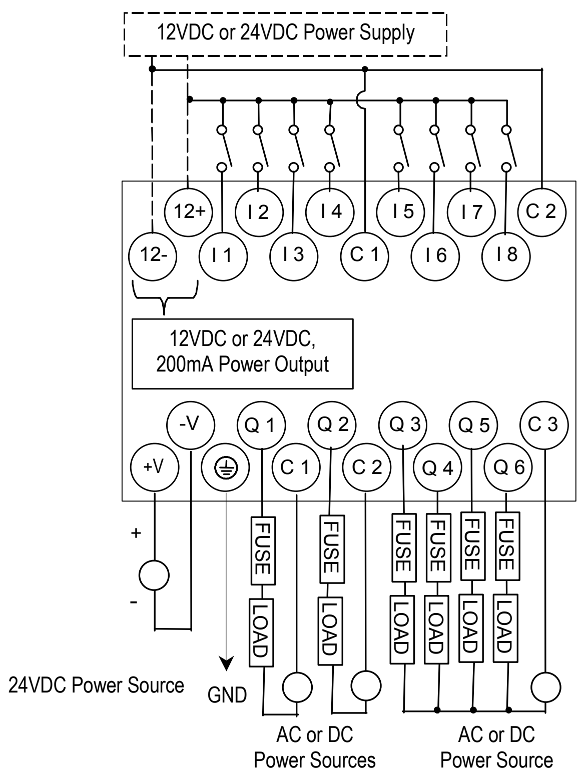
Micro PLC IC200UDR002 Specifications

Inputs	Eight 24 VDC positive/negative logic input circuits
Outputs	Six normally open 2 Amp relay circuits
High-speed Counters	Up to four Type A or one Type A and one Type B
Output Power Supplies	24VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	10 ms at 19.2 VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 A
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W
DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Relay Output Specifications	
Operating Voltage	5 to 30 VDC or 5 to 250 VAC
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups
Leakage Current	15 mA at 240 VAC maximum
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC
Minimum Load	10 mA
Maximum Inrush	5 amps per half cycle
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum
Contact Life: Mechanical	20 x 10^6 mechanical operations

Contact Life: Electrical Voltage	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
240VAC, 120VAC, 24VDC	2A	0.6A	200,000

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16 bits
Outputs	
Available Pulse Outputs	None
Load Voltage	Refer to relay specifications

Wiring Diagram, IC200UDR002



IC200UDR003
14 Point Micro PLC, (8) 12VDC In, (6) Relay Out, 12 VDC Power Supply

VersaMax Micro PLC IC200UDR003 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5 to 30 VDC or 5 to 250VAC output devices. It uses +12VDC nominal input power for PLC operation.

DC Power

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply. If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's 12VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

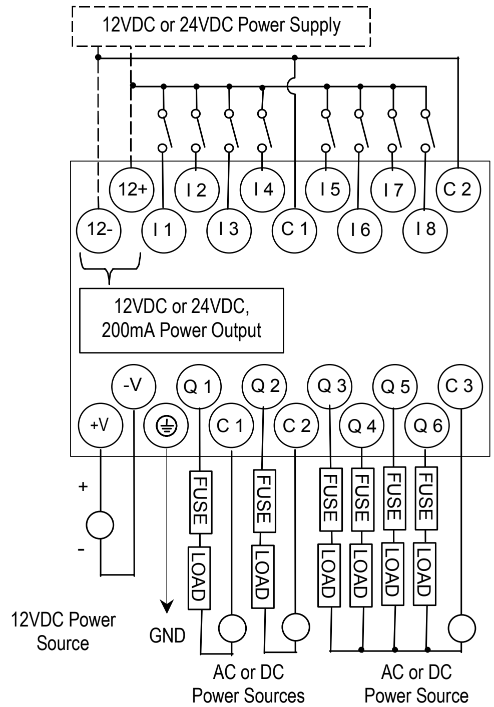
The six normally-open Form A relay outputs (SPST-single pole single throw) can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as HSC outputs. They cannot be used as Pulse Train or PWM outputs. Connections and specifications for HSC outputs are the same as for standard relay outputs.

Micro PLC IC200UDR003 Specifications

Inputs	Eight 12 VDC positive/negative logic input circuits		
Outputs	Six normally open 2 Amp relay circuits		
High-speed Counters	Up to four Type A or one Type A and one Type B		
Output Power Supplies	12VDC for input circuits & user devices, 200mA max. +5VDC on pin 7 of Serial Port, 100mA max.		
DC Power Specifications			
Range	9.6VDC - 15VDC		
Hold-up	3.0mS		
Inrush Current	9.2A typical at 12 VDC		
Inrush Time	200μS typical		
Input Current	200mA typical at 12 VDC		
Input Power Supply Rating	3W		
DC Input Specifications			
Number of Inputs	8		
Rated Input Voltage	12 volts DC		
Input Voltage Range	0 to 15 volts DC		
Input Current	9.0mA typical		
Input Resistance	1.3 kOhms		
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum		
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum		
Response Time	0.5 to 20ms configurable as regular input; 100μs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Input and Output Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 9V, OFF: 2.5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16 bits		
Outputs			
Available Pulse Outputs	None		
Load Voltage	Refer to relay specifications		

Wiring Diagram, IC200UDR003



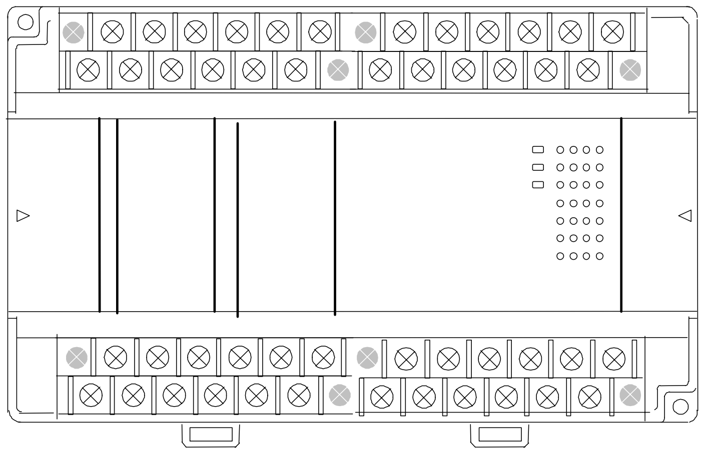
Chapter 4

VersaMax Micro PLCs with 23 Discrete Points and 3 Analog Channels

This chapter describes the features and specifications of the VersaMax Micro PLCs with 23 Discrete Points and 3 Analog Channels. It also provides additional information about analog operation and calibration.

- IC200UAL004 Micro PLC with 23 Discrete Points and 3 Analog Channels: (13) 12VDC In, (10) Relay Out, (2) Analog In and (1) Analog Out, 12VDC Power Supply
- IC200UAL005 Micro PLC with 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In and (1) Analog Out, 24VDC Power Supply
- IC200UAL006 Micro PLC with 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In and (1) Analog Out, 120/240VAC Power Supply

VersaMax 23 Discrete / 3 Analog Micro PLC Features



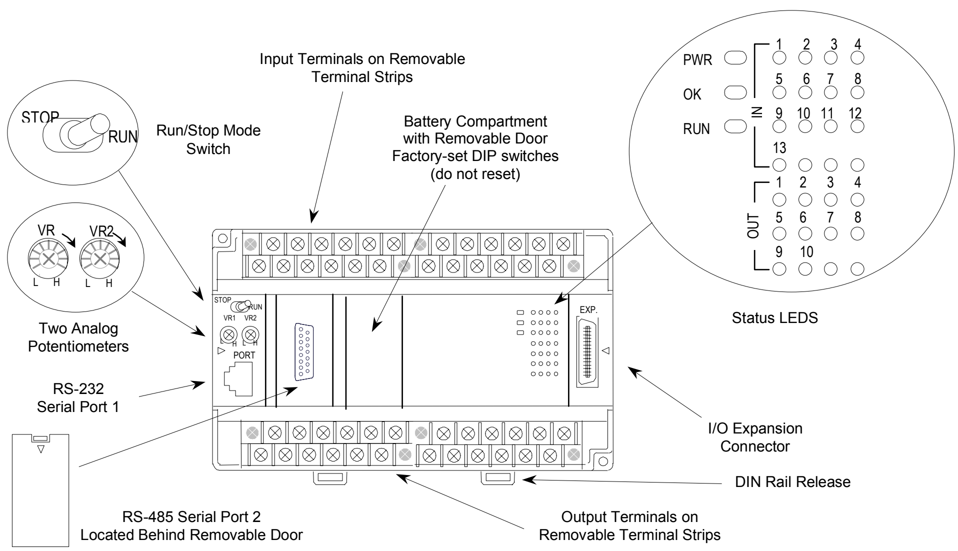
- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective covers.
- Two Serial communications ports. Port 1 (RS-232) supports SNP/SNPX slave protocols. Port 2 (RS-485) supports SNP/ SNPX master and slave, RTU master and slave, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Time-of-Day Clock.
- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 2048 words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration at powerup from either RAM or flash memory (ROM). Can also be configured to read application program from flash at powerup.
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes.
- Optional lithium battery backup for RAM and real-time clock.

General Specifications for 23-Point VersaMax Micro PLCs

Weight	600 grams (1.32lbs)
Module Dimensions	Height: 90mm (3.6 inches) Depth: 76mm (3.0 inches) Width: 150mm (6.0 inches)
Typical Scan Rate	1.1 ms/K for Boolean logic (see appendix A)
Real Time Clock accuracy (for Timer contacts and Timer function blocks)	+/-0.5%
Time-of-Day Clock accuracy	+/-5 sec/day @10degC, +/-5 sec/day @25degC, and +/-11 sec/day @55degC or across full temperature range
High-speed Counters	Up to four Type A or one Type A and one Type B
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater)
+5 VDC Output of Serial Ports	Port 1, pin 7: 100mA maximum* Port 2, pin 5: 100mA maximum* *Combined port 1 and port 2 total not to exceed 100mA max.
Lithium battery (IC200ACC403	Storage: Up to 5 years typical at 30 °C Installed: Up to 3 years typical at 55 °C 4 months battery backup time (powered down) minimum at 55 °C

Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.



Serial Ports

Port 1 is an RS-232 serial port with an RJ-45 connector. Port 2, located behind a removable door on the front of the Micro PLC, is an RS-485 serial port with a DB-15 connector. Both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time. Port 1 uses SNP slave protocol. Port 2 is software-configurable for SNP master/slave RTU slave or Serial I/O operation. CPUs with firmware version 2.02 or later support Modbus RTU Master on port 2. 4-wire and 2-wire RTU are supported. If Port 2 is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 2 defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode, if configured for Serial I/O.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from both ports if it requires 100mA or less at 5VDC.

Analog Potentiometers

The two potentiometers can be used to adjust the values in analog registers %AI016 and %AI017. An example use would be to set thresholds for use in logical relationships with other inputs/outputs.

Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

Status LEDs

LEDs for Power, OK, and Run mode, plus individual LEDs for each I/O point.

Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a lithium coin cell assembly (IC200ACC403) can be installed in the battery holder. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

High Speed Counters

These VersaMax Micro PLCs can be configured to provide built-in high-speed counter operation.

When configured for High-speed Counter operation, inputs can be set up as:

- Up to four High-speed Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

The relay outputs of IC200UAL004 and IC200UAL005 can be configured as up to four counter outputs. They cannot be used as Pulse Train or PWM outputs.

Analog I/O

All VersaMax 23-Point Micro PLCs provide two analog input channels that can be configured to accept inputs from 0 to +10V or from 0 to 20mA or 4 to 20mA input signals. They also have one analog output configurable for the same voltage or current ranges. See chapter 10 for information about configuring voltage/current operation and range. See chapter 11 for details of analog operation, automatic gain and offset adjustment, automatic program reference configuration, and calibration procedures.

Analog I/O Specifications	
Input and output ranges	0 to 10V (10.24V maximum) 0 to 20mA (20.5mA maximum) 4 to 20mA (20.5mA maximum)
Resolution	12 bits over 0 to 10V range (1 LSB=2.5mV) 12 bits over 0 to 20mA range (1 LSB=5µA) 11+ bits over 4 to 20mA range (1 LSB=5µA)
Accuracy	±1% of full scale over full operating temperature range
Analog Inputs	2, differential
Factory calibrated to:	2.50mV per count on 0 to 10V range 5.00µA per count on 0 to 20mA and 4 to 20mA ranges
Linearity	±3 LSB maximum
Isolation	non-isolated
Common mode voltage	±200 V maximum
Current input impedance	249 ohms
Voltage input impedance	100 Kohms
Input filter time	20ms to reach 1% error for step input
Analog Output	1, single-ended, non isolated
Current: maximum terminal voltage user load range output load capacitance output load inductance	10V (at 20mA output) 0 to 500 ohms 2000 pF maximum 1 henry maximum
Voltage: output loading output load capacitance	2 Kohm minimum at 10 volts 1 µF maximum

IC200UAL004
Micro PLC, 23 Discrete Points and 3 Analog Channels:
(13) 12VDC In, (10) Relay Out, (2) Analog In, (1) Analog Out, 12VDC Power Supply

VersaMax Micro PLC IC200UAL004 accepts thirteen 12VDC inputs and two analog inputs. It provides ten normally-open 2 Amp relay outputs and one analog output. It uses +12VDC nominal input power.

DC Inputs

Thirteen configurable 12VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

Normally-Open Relay Outputs

Ten Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each relay output is 2 amps. An external source of AC or DC power must be supplied for field devices. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

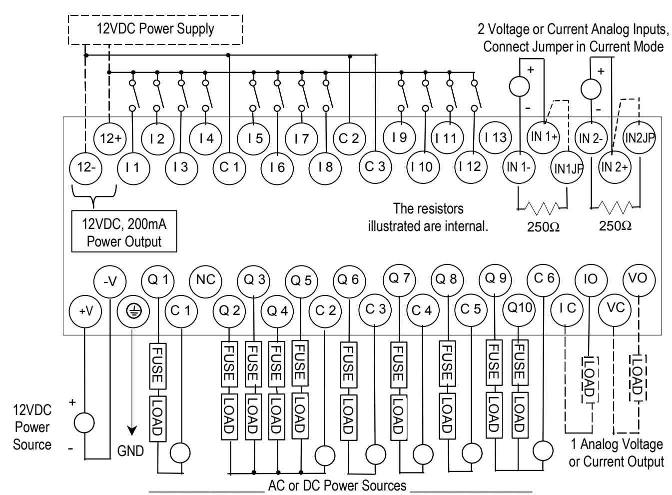
If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12VDC. The 12VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level (see power supply specifications for inrush requirements).

Micro PLC IC200UAL004 Specifications

Inputs	13 DC inputs and 2 Analog inputs
Outputs	10 relay outputs and 1 analog output
+12 VDC Output Power Supply	200 mA maximum (for input circuits and user devices)
High Speed Counters	Up to four Type A or one Type A and one Type B
DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200mS typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W

Input Specifications			
Number of Inputs	13		
Rated Input Voltage	12 volts DC		
Input Voltage Range	0 to 15 volts DC		
Input Current	9.0mA typical		
Input Impedance	1.3 kOhms		
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum		
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum		
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 9V, OFF: Off: 2.5V		
Count Registers	16 bits		
Available Pulse Outputs	None		

Wiring Diagram, IC200UAL004



IC200UAL005
Micro PLC, 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 24VDC Power Supply

VersaMax Micro PLC IC200UAL005 accepts thirteen 24VDC inputs and two analog inputs. It provides one 24VDC output, nine normally-open 2 Amp relay outputs, and one analog output. It uses +24VDC nominal input power.

DC Inputs

Thirteen configurable 24VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The module provides +24VDC output power available for field devices.

DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High Speed Counter, Pulse Train or PWM output.

Normally-Open Relay Outputs

Nine Form A relay outputs (SPST-single pole single throw). The nine isolated 2-amp, normally-open outputs can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

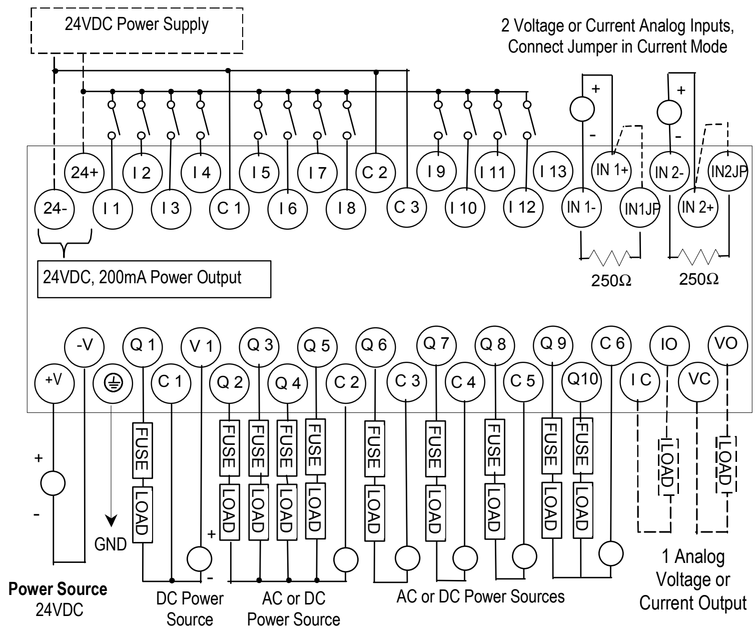
If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

Micro PLC IC200UAL005 Specifications

Inputs	13 DC inputs and 2 analog inputs
Outputs	9 relay outputs, 1 analog output, 1 24VDC output
+24 VDC Output Power Supply	200 mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24 -20%, +25% VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 A
Input Current	0.30 Amp typical at 24VDC
Input Power Supply Rating	8W
High-speed Counter Specifications	
Available High Speed Counters	Up to four Type A or one Type A and one Type B
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16 bits
High-speed Counter Outputs	Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs.
Load Voltage	Q1: 5/12/24V
Maximum Pulse/PWM Frequency	(Q1 only) 5kHz
Input Specifications	
Number of Inputs	13
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

DC Output (Q1) Specifications			
Output logic	Positive Logic		
Operating Voltage	24VDC / 12VDC / 5VDC		
Voltage Range	24 VDC, +20%, -80%		
Maximum UL Pilot Duty Rating	0.75A at 24 VDC		
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC		
Output Voltage Drop	0.3 VDC maximum		
Response ON	0.1ms maximum (24 VDC, 0.2A)		
OFF	0.1ms maximum (24 VDC, 0.2A)		
OFF state leakage	0.1mA maximum		
Isolation	1500 VAC between field side and logic side 500 VAC between groups		
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
240VAC, 120VAC, 24VDC	2A	0.6A	200,000

Wiring Diagram, IC200UAL005



The resistors illustrated are internal.

IC200UAL006
Micro PLC, 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 120/240VAC Power Supply

VersaMax Micro PLC IC200UAL006 accepts thirteen DC inputs and two analog inputs. It provides one DC output, nine normally-open 2 Amp relay outputs, and one analog output. It uses 100VAC to 240VAC nominal input power.

DC Inputs

Thirteen configurable 24VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate field devices and the input circuits is supplied by an isolated +24 VDC supply.

DC Output (Q1)

Output circuit Q1 is a 24 VDC transistor output. It can be used as a normal DC output or as a High-speed Counter-controlled output, Pulse Train output, or Pulse Width Modulation (PWM) output.

Normally-Open Relay Outputs

Nine isolated 2-amp, normally-open Form A relay outputs (SPST-single pole single throw can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

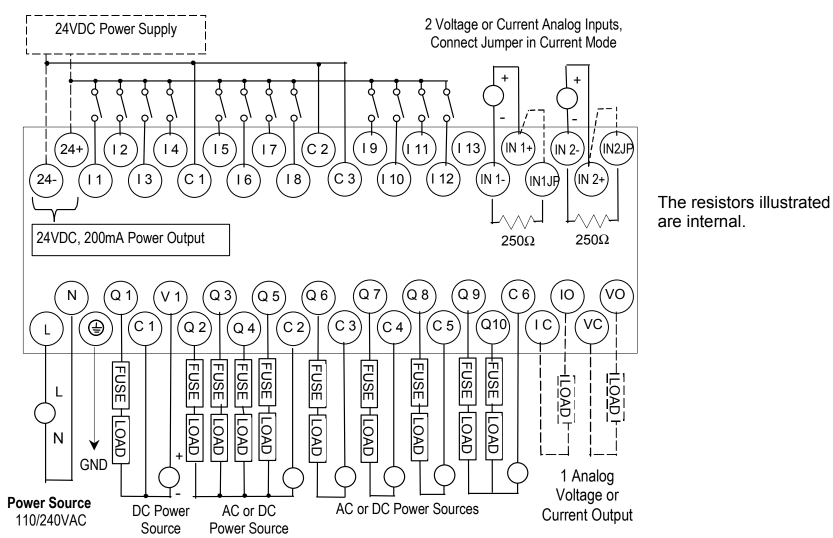
Micro PLC IC200UAL006 Specifications

Inputs	13 DC inputs and 2 Analog inputs
Outputs	1 DC output, 9 relay outputs, 1 analog output
High Speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply (for input circuits and user devices)	200 mA maximum

AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 to 100VAC, 20mS at 100 to 265VAC
Inrush Time	2mS for 40A
Inrush Current	35 Amp maximum at 200 VAC 46 Amp maximum at 265 VAC
Input Current	0.13 Amp typical at 200 VAC 0.20 Amp typical at 100 VAC
Input Power Supply Rating	34 VA
Isolation	1500VAC rms field-side to logic (power supply input).
Input Specifications	
Number of Inputs	13
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Output logic	Positive Logic
Operating Voltage	24VDC / 12VDC / 5VDC
Voltage Range	24 VDC, +20%, -80%
Maximum UL Pilot Duty Rating	0.75A at 24 VDC
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC
Output Voltage Drop	0.3 VDC maximum
Response Time	ON: 0.1ms maximum (24 VDC, 0.2A), OFF: 0.1ms maximum (24 VDC, 0.2A)
OFF state leakage	0.1mA maximum
Isolation	1500 VAC between field side and logic side, 500 VAC between groups
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 1V, OFF: Off: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16 bits		
Available Pulse Outputs	None		
Outputs			
Load Voltage	Q1: 5/12/24V		
Maximum Pulse/PWM Frequency	(Q1 only) 5kHz		
Types available	Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs.		

Wiring Diagram, IC200UAL006



Analog Operation

This section explains how a VersaMax Micro PLC with analog channels processes analog data.

Analog I/O Parameters

Each analog channel can be configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA.

Parameter	***Choices***	***Default Value***
Voltage or current mode	Voltage, Current	Voltage
Current range selection	4–20mA, 0–20mA	4–20mA

Input/Output Values Compared to Process Data

The Micro PLC processes analog channels using gain and offset values for both current and voltage mode operation. Default gain and offset values are loaded into the Micro PLC flash memory at the factory. For these 23-point Micro PLCs (only) gain and offset can be recalibrated if necessary, as explained later in this section.

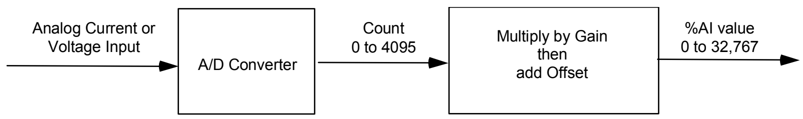
The table below shows the relationship between the analog input and output values used by the application program, and the actual analog input or output for each mode. These values include the automatic adjustments for offset and gain.

In this Configured Mode:	***This is the Analog Signal Range***	***This is the Equivalent Process Data %AI or %AQ Range***	***For the Default Calibration, the Value in the %AI or %AQ Reference Equals:***
Voltage 0 to +10V	0 to 10,000mV	0 to 32000	3.2 x mV
Current 0 to 20mA	0 to 20,000µA	0 to 32000	1.6 x µA
Current 4 to 20mA	4,000 to 20,000µA	0 to 32000	2 x µA –8000

The following pages explain how the Micro PLC performs the necessary data conversions between the analog signal levels and the numeric values used by the application program.

Analog Input Processing

The Micro PLC processes analog input channels with a 12-bit successive-approximation A/D converter. It converts the analog value into a digital count, calculates the %AI value as described below, then places the result into the configured %AI input reference.



Automatic Conversion of Analog Voltage or Current to Counts

In voltage mode, the Micro PLC first converts the 0 to 10,000mV input signal to a count in the range of 0 to 4,000. The fixed multiplier for this conversion is 2.5.

In current mode, the Micro PLC first converts the 0 to 20,000µA input signal to a count value in the range of 0 to 4,000. The fixed multiplier for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Automatic Gain and Offset Adjustment for Analog Inputs

The Micro PLC then converts the A/D converter's input count value from the range of 0 to 4000 to a final %AI input value in the range of 0 to 32,000. It multiplies the count value by a stored gain value and adds an offset value to get the final analog input ($AI):

(input count X Gain) + Offset = %AI value

The default input gain used for this conversion is 8 (32000 / 4000) and the default offset is 0. These can be changed as described later. Any calculated value above 32,767 is clamped at that maximum value. Any calculated value less than 0 is clamped at 0.

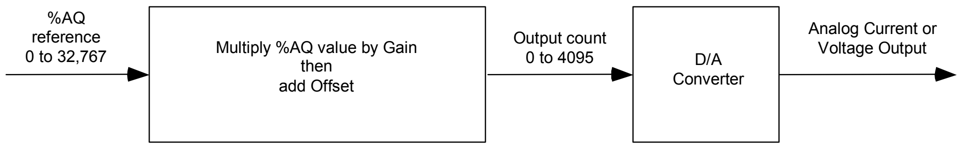
Analog Input Conversion Summary

The table below summarizes the conversion of voltage or current inputs to counts and then to %AI values.

Input Signal	Conversion Factor	A/D Converter Value	Default Gain	Default Offset	%AI Range
Voltage Mode (0–10,000mV)	2.5	0–4000 counts	8	0	0–32,000
Current Mode (0–20mA) or (4–20mA)	5	0–4000 counts	8	0	0–32,000

Analog Output Processing

To generate the analog output signal, the Micro PLC converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.



Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Micro PLC first multiplies the %AQ value from the program by a gain value and adds a predefined offset to produce the count value for the D/A converter:

(%AQ X Gain) + Offset = D/A count

Any calculated value that exceeds 4095 (2^{12}-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,767.

The default output gain used for this conversion is 0.125 (4000 / 32000) and the default offset is 0. These can be changed as described later.

Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000µA. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Analog Output Data Conversion Summary

The table below summarizes the conversion of %AQ values to counts and then to voltage or current levels.

%AQ Range	Default Gain, %AQ to Counts	Default Offset	D/A Converter Range	Conversion Factor	Output Signal
0– 32,000	0.125	0	0–4,000 counts	2.5	Voltage Mode (0–10,000mV)
0–32,000	0.125	0	0–4,000 counts	5	Current Mode (0–20mA) or (4–20mA)

Adjusting the Calibration of Analog Channels

For the 23-point Micro PLCs with analog channels, it is possible to adjust the calibration of the analog channels as described below. Analog channels on Expansion Units and 10-point Nano PLCs cannot be recalibrated. A set of default gains and offsets is maintained in the PLC firmware if you want to restore the original values.

To perform the calibration procedures you will need a precision analog meter (1mV voltage accuracy and 1µA current accuracy). Do not try the procedures in this section unless you are familiar with the operation of D/A and A/D converters.

Recalibrating Input Channels

1. Apply a reference voltage or current at a low range to the input. (The reference signal must be measured accurately by a precision analog meter.) Record the value.
2. For the channel being calibrated, read the %AI register and record the low value.
3. Apply a reference voltage or current at a high range to the input. Precisely measure the reference signal and record the value.
4. For the channel being calibrated, read the %AI register and record the high value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in chapter 17.

   The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{Meter_{High} - Meter_{Low}}{\%AI_{High} - \%AI_{Low}} \times DefaultGain$$

$$Offset = Meter_{High} - \frac{\%AI_{High} \times Gain}{DefaultGain}$$

Recalibrating Output Channels

1. Write a low value to the %AQ register.
2. At the output, measure the voltage or current using a precision analog meter and record the value.
3. Write a high value to the %AQ register.
4. At the output, measure the voltage or current using a precision analog meter and record the value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in chapter 17.
6. The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{\%AQ_{High} - \%AQ_{Low}}{Meter_{High} - Meter_{Low}} x DefaultGain$$

$$Offset = \%AQ_{High} \times DefaultGain - Meter_{High} \times Gain$$

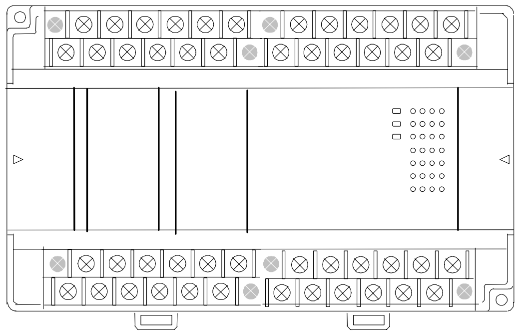
Chapter 5

VersaMax 28-Point Micro PLCs

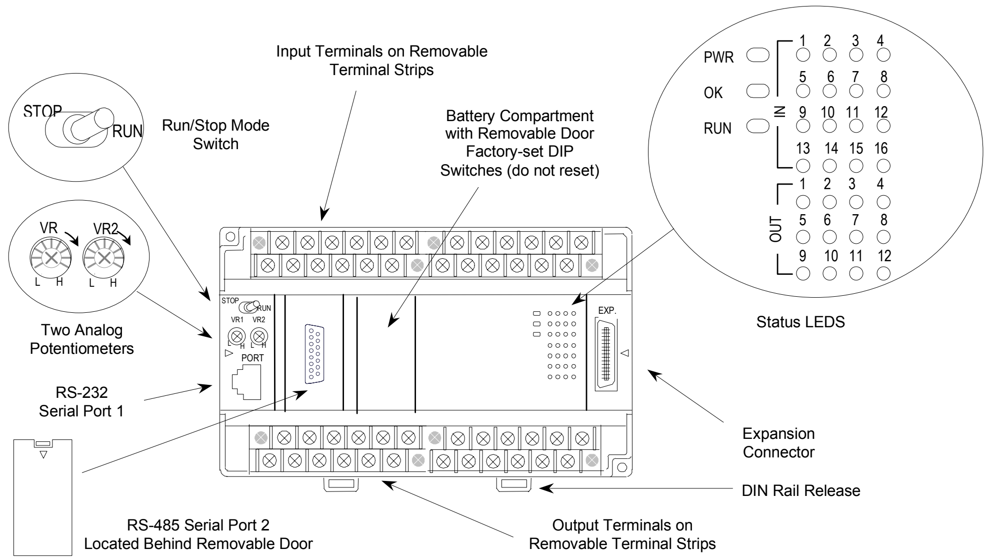
This chapter describes the features, specifications, and field wiring of these VersaMax Micro PLCs:

- IC200UAA007 28 Point Micro PLC, (16) 120VAC In, (12) 120VAC Out, 120/240VAC Power Supply
- IC200UAR028 28 Point Micro PLC, (16) 120VAC In, (2) Relay Out at 10 Amps, (10) Relay Out at 2 Amps, 120/240VAC Power Supply
- IC200UDD110 28 Point Micro PLC, (16) 24VDC In, (12) 24VDC Out, 24VDC Power Supply
- IC200UDD120 28 Point Micro PLC, (16) 24VDC In, (12) 24VDC Out with ESCP, 24VDC Power Supply
- IC200UDD212 28 Point Micro PLC, (16) 12VDC In, (12) 12VDC Out, 12VDC Power Supply
- IC200UDR005 28 Point Micro PLC, (16) 24VDC In, (1) 24VDC Out, (11) Relay Out, 120/240VAC Power Supply
- IC200UDR006 28 Point Micro PLC, (16) 12VDC In, (12) Relay Out, 12VDC Power Supply
- IC200UDR010 28 Point Micro PLC, (16) 24VDC In, (1) 24VDC Out, (11) Relay Out, 24VDC Power Supply

Features of VersaMax 28-Point Micro PLCs



- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective covers.
- Two Serial communications ports. Port 1 (RS-232) supports SNP/SNPX slave protocols. Port 2 (RS-485) supports SNP/ SNPX master and slave, RTU master and slave protocol, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Time-of-Day Clock.
- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 2048 words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware
- Configurable to read configuration at powerup from either RAM or flash memory (ROM). Can also be configured to read application program from flash at powerup.
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes.
- Optional lithium battery backup for RAM and real-time clock.



Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.

Serial Ports

Port 1 is an RS-232 serial port with an RJ-45 connector. Port 2, located behind a removable door, is an RS-485 serial port with a standard DB-15 connector. Both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time. Port 1 uses SNP slave protocol. Port 2 is software-configurable for SNP master/slave or RTU slave operation. CPUs with firmware version 2.02 or later support Modbus RTU Master on port 2. 4-wire and 2-wire RTU are supported. If Port 2 is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 2 defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode, if configured for Serial I/O.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from both ports if it requires 100mA or less at 5VDC.

Analog Potentiometers

The two potentiometers on the front of a Micro PLC can be used to adjust the values in analog registers %AI016 and %AI017. An example use for the potentiometers would be to set threshold values for use in logical relationships with other inputs/outputs.

Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in chapter 10. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

General Specifications for 28-Point VersaMax Micro PLCs

Module Dimensions	Height: 90mm (3.6 inches) Depth: 76mm (3.0 inches) Width: 150mm (6.0 inches)
Typical Scan Rate	1.1 ms/K for Boolean logic (see appendix A)
Real Time Clock accuracy (for Timer contacts and Timer function blocks)	+/-0.5%
Time of Day Clock accuracy	+/-5 sec/day @10degC, +/-5 sec/day @25degC, and +/-11 sec/day @55degC or across full temp. range
Maximum number of slave devices per network	8 (can be increased with a repeater)
+5 VDC output of Serial Ports	Serial Port 1, pin 7: 100mA maximum* Serial Port 2, pin 5: 100mA maximum* *Combined port 1 and port 2 total not to exceed 100mA max
Lithium battery (IC200ACC403): shelf life installed	 Up to 5 years typical at 30 °C, Up to 3 years typical at 55 °C 4 months battery backup time (powered down) minimum at 55 °C

High Speed Counters

VersaMax Micro PLCs with DC inputs can be configured to provide built-in high-speed counter and pulse operation.

When configured for High-speed Counter operation, inputs I1 to I8 can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The Type B counter provides an A Quad B counting function.

Models with DC outputs can be configured to provide up to a total of four counter, Pulse Train, or PWM outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

IC200UAA007
28 Point Micro PLC, (16) 120VAC In, (12) 120VAC Out, 120/240VAC Power Supply

VersaMax Micro PLC model IC200UAA007 accepts sixteen AC inputs and provides twelve AC outputs. It uses 100VAC to 240VAC nominal input power for PLC operation.

This module does not provide High-speed Counter, PWM or Pulse Train operation.

Inputs

The sixteen 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source.

Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

AC Outputs

The 120/240 VAC, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

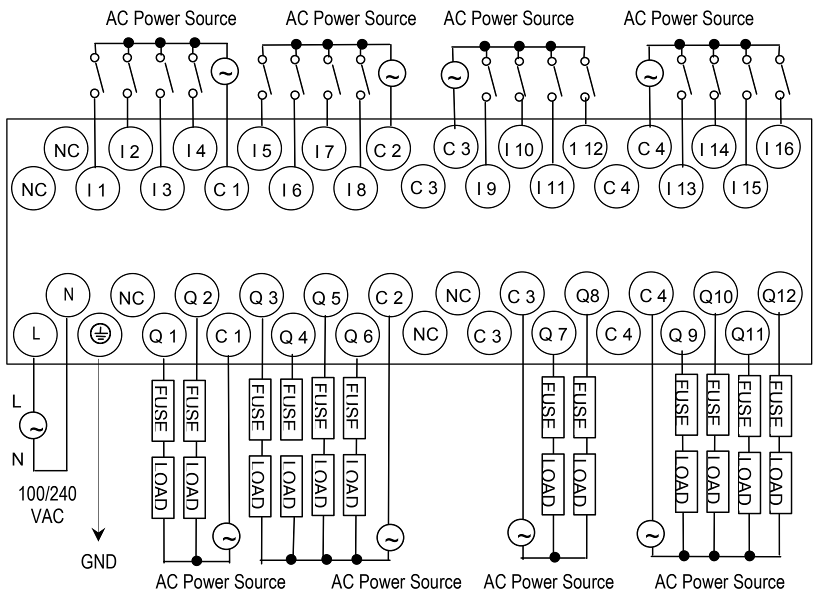
AC power to operate loads connected to outputs must be supplied from an external source.

This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling many types of inductive and incandescent loads.

Micro PLC IC200UAA007 Specifications

Weight	600 grams (1.32 lb)
Inputs	16 AC inputs
Outputs	12 AC outputs
High-speed Counters	None
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85-100 VAC, 20mS at 100-264 VAC
Inrush Time	2mS for 40 Amp
Inrush Current	30 Amp maximum at 200VAC, 40 Amp maximum at 265VAC
Input Current	0.10 Amp typical at 100VAC, 0.06 Amp typical at 200VAC
Input Power Supply Rating	16 VA
AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms
Response Time	OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms
Isolation	1500V rms field side to logic side, 500V rms between groups
AC Output Specifications	
Rated Load Voltage	100 -15% to 240 +10% VAC, 50 -5% to 60 +5% Hz
Maximum Resistive Load Current	0.5 Amp per point
Maximum UL Pilot Duty Rating	0.5 Amp per point at 240 VAC 0.6 Amp maximum on C1 and C3 1.2 Amps maximum on C2 and C4
Maximum Inrush Current	5A (1 period)/point, 10A (1 period)/common
Maximum voltage drop when ON	1.5 V RMS
Maximum leak current when OFF	1.8 mA RMS (115 VAC), 3.5 mA RMS (230 VAC)
Response Time (Maximum)	OFF to ON: 1ms, ON to OFF: 1/2 cycle + 1 ms
Isolation	1500V RMS field side to logic side, 500V RMS between groups

Wiring Diagram IC200UAA007



IC200UAR028
28 Point Micro PLC, (16) 120VAC In, (2/10) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC model IC200UAR028 accepts sixteen AC inputs and provides two relay outputs at 10 Amps and ten relay outputs at 2 Amps. It uses 100VAC to 240VAC nominal input power for PLC operation.

This module does not provide High-speed Counter, PWM or Pulse Train operation.

Inputs

The sixteen 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source.

Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

Relay Outputs

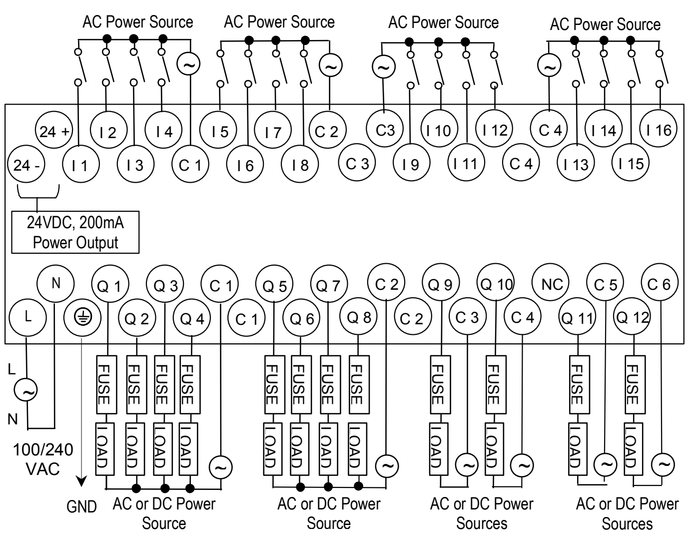
The Micro PLC's relay outputs can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

Micro PLC IC200UAR028 Specifications

Weight	600 grams (1.32 lb)
Inputs	16 AC inputs
Outputs	2 relay outputs at 10 Amps and 10 relay outputs at 2 Amps
High-speed Counters	None
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85-100 VAC, 20mS at 100-264 VAC
Inrush Time	2mS for 40 Amp
Inrush Current	30 Amp maximum at 200VAC, 40 Amp maximum at 265VAC
Input Current	0.10 Amp typical at 100VAC, 0.06 Amp typical at 200VAC
Input Power Supply Rating	16 VA

AC Input Specifications			
Points/Common	4 (I1–I4) and (I5–I8)		
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz		
Maximum Input Voltage	132V rms, 50/60 Hz		
Input Current	8 mA rms (100 VAC, 60 Hz)		
Voltage	ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms		
Response Time	OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms		
Isolation	1500V rms field side to logic side, 500V rms between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24VDC and 240VAC		10 amps at 24VDC and 240VAC
Maximum Resistive Load Rating	2 amps at 24VDC and 240VAC		10 amps at24 VDC and 240VAC
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		14 amps per half cycle
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2.0A 10.0A 4.0A	Current: Lamp and Solenoid 0.6A 4.0A 1.0A	Typical Operations 100,000 100,000 200,000

Wiring Diagram IC200UAR028



Outputs Q 1 – Q 10 are rated at 2.0 Amps each. Outputs Q 11 and Q 12 are rated at 10.0 Amps each.

IC200UDD110
28 Point Micro PLC, (16) 24VDC In, (12) 24VDC Out, 24VDC Power Supply

VersaMax Micro PLC model IC200UDD110 accepts sixteen DC inputs and provides twelve 24VDC outputs. It uses +24VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

The module has sixteen configurable DC inputs that can be used as positive or negative logic standard inputs. As standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Eight of the inputs can be used for High-speed Counter inputs.

The Micro PLC's +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA..

Transistor Outputs

The module provides twelve transistor output circuits that can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

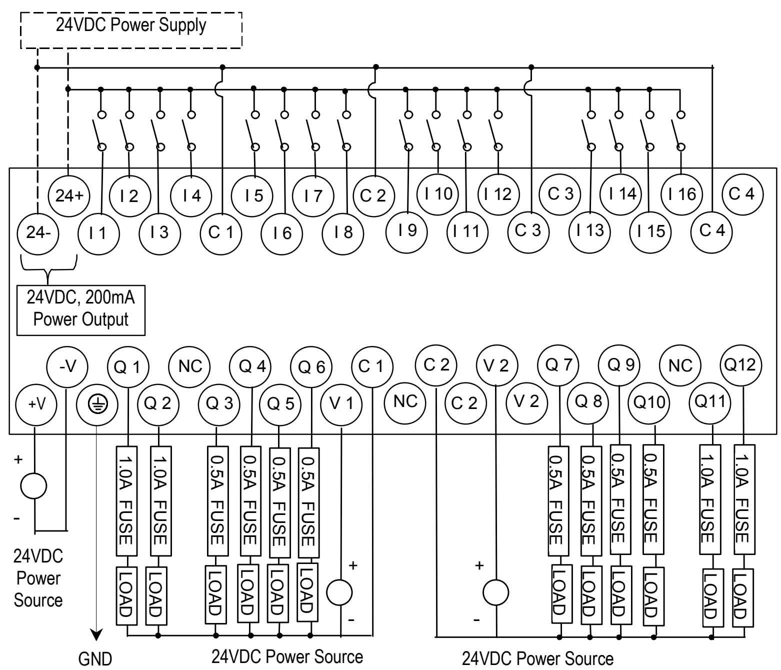
All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Micro PLC IC200UDD110 Specifications

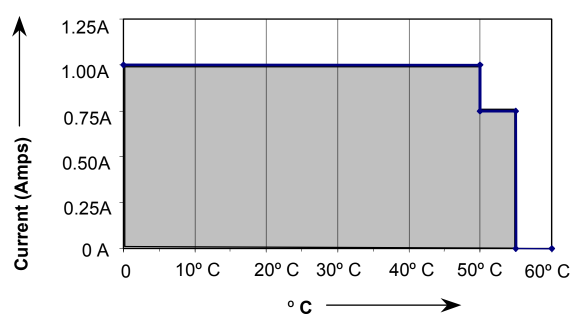
Weight	460 grams (1.01 lb)
Inputs	Sixteen 24 VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 24 VDC. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A.
High-speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Output Specifications	
Voltage Range	12VDC/24VDC (24VDC +10% / -43% input at V1,C1)
Maximum Load Current	1.0A per point (Q1, Q2, Q11, Q12) at 24VDC at 100% ON duration 0.75A per point (Q3 - Q10) at 24VDC at 100 % ON duration 0.5A per point (Q3 - Q10) at 12VDC at 100 % ON duration
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	0.3V maximum
OFF state leakage current	100µA maximum
Response Time	OFF to ON, ON to OFF 0.1ms maximum (24 VDC, 0.2A)
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuse	Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

High-speed Counter Input / PWM and Pulse Train Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON : 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	Q1-Q4: 12/24VDC
Maximum Pulse/PWM Frequency	5kHz
Types available	Up to four HSC, PT, and/or PWM outputs

Wiring Diagram IC200UDD110



The maximum current that can be used for output points Q1, Q2, Q11 and Q12 is lower for ambient temperatures above 50 degrees C



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IC200UDD120
28 Point Micro PLC, (16) 24VDC In, (12) 24VDC Out with ESCP, 24VDC Power Supply

VersaMax Micro PLC model IC220UDD120 accepts sixteen DC inputs and provide twelve 24VDC outputs. The outputs have electronic short-circuit protection. The module uses +24VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

The module’s sixteen configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-speed Counter inputs.

When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC’s +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA..

Transistor Outputs

The twelve transistor outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

The output circuits can be used to switch devices like valves, lamps or contactors.

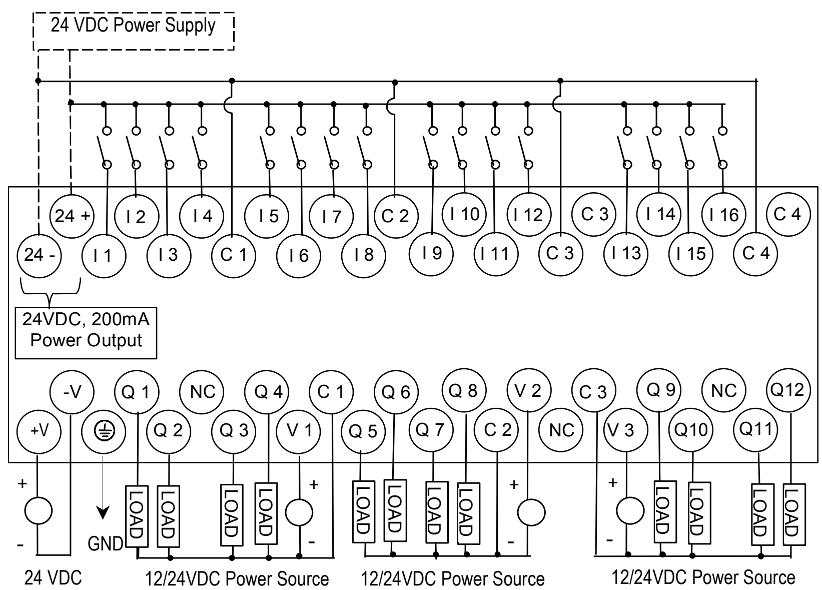
Outputs require no fusing, they provide electronic short-circuit protection.

Micro PLC IC200UDD120 Specifications

Weight	460 grams (1.01 lb)
Inputs	Sixteen 24 VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 24 VDC. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A.
High Speed Counters	Four Type A or One Type A and One Type B
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	Q1 – Q12: 12/24VDC +10%, -15%
External Power Supply (for supplying power to the V terminal)	12/24V -10%, +20%
Maximum Load Current	Q1 and Q2: 1A per point, Q3 - Q12: 0.7A per point
Minimum Switching Current	10mA
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	Q1– Q12: 0.3V maximum
OFF state leakage current	0.1mA
Response Time	OFF to ON, ON to OFF: 0.05mS maximum @ 24VDC
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuse	Not required
Undervoltage shutdown	Q1 - Q12: 5V minimum, 8V maximum
DC short circuit current	Q1 – Q12: 0.7A minimum, 2A maximum
Peak short circuit current	4A maximum
Delay time of peak short circuit current	100µS
Delay time of current limit	100µS

High-speed Counter Input / PWM and Pulse Train Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON : 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	Q1-Q4: 12/24VDC
Maximum Pulse/PWM Frequency	5kHz
Types available	Up to four HSC, PT, and/or PWM outputs

Wiring Diagram IC200UDD120



IC200UDD212
28 Point Micro PLC, (16) 12VDC In, (12) 12VDC Out, 12VDC Power Supply

VersaMax Micro PLC model IC200UDD212 accepts sixteen 12VDC inputs and provides twelve DC transistor outputs. It uses +12VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12VDC. The 12VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic standard inputs. Eight of the inputs can be configured as four Type A Counters or one Type A and one Type B Counter. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +12 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Micro PLC IC200UDD212 has four high-current transistor outputs (Q1, Q2, Q11, and Q12) and eight low-current transistor outputs (Q3 to Q10).

All outputs are isolated between field and logic and are switching positive voltage.

The output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

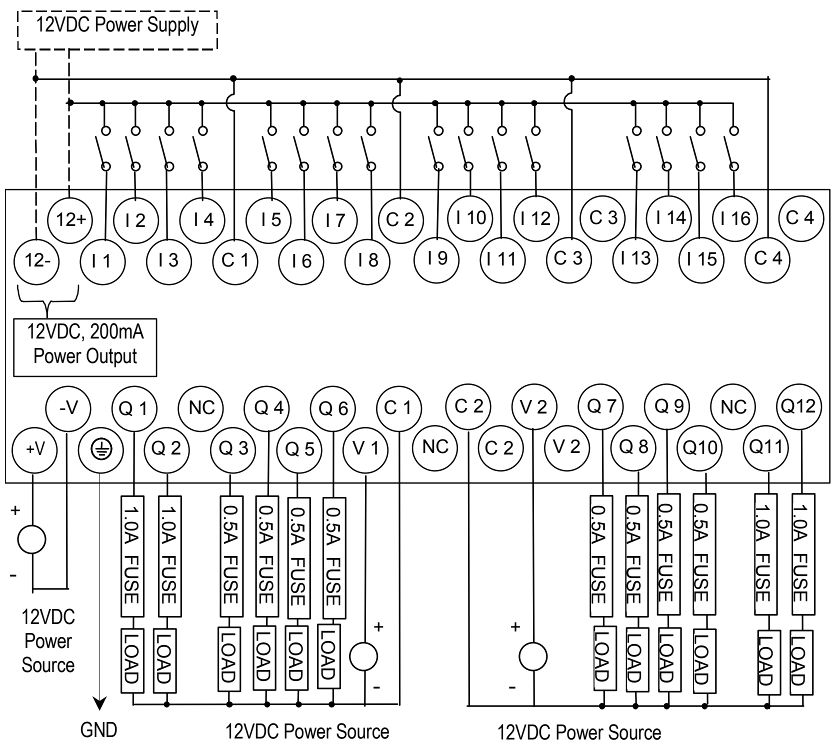
Each group of 6 outputs has one common incoming supply (V1, V2) and one common ground (C1, C2). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Micro PLC IC200UDD212 Specifications

Weight	460 grams (1.01 lb)
Inputs	Sixteen 12VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 12 VDC. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A.
High-speed Counters	Up to four Type A or one Type A and one Type B
+12 VDC Output Power Supply)	200mA maximum (for input circuits and user devices
DC Power Specifications	
Range	9.6VDC to 15 VDC
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200mS typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W
DC Input Specifications	
Number of Inputs	16
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Resistance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	12VDC (+20%, -20%)
Maximum Load	0.7A per point (Q1 - Q12) at 24VDC at 100 % ON duration, 4A per common
Maximum Inrush Current	4A for 20mS
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA maximum
Response	OFF to ON: 0.1mS maximum (12 VDC), ON to OFF 0.1mS maximum (12 VDC)
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuse	Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

High-speed Counter Input / PWM & Pulse-Train Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON : 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	Q1-Q4: 12VDC
Maximum Pulse/PWM Frequency	5kHz
Types available	Up to four HSC, PT, and/or PWM outputs

Wiring Diagram IC200UDD212



IC200UDR005
28 Point Micro PLC, (16) 24VDC In, (1) 24VDC Out, (11) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC IC200UDR005 accepts sixteen DC inputs and provides one 24VDC output and eleven normally-open 2 Amp relay outputs. It uses 100VAC to 240VAC nominal input power for PLC operation.

DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic standard inputs, including up to four High-speed Counter inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. The module provides +24VDC output power for field devices, up to 200mA maximum.

DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High Speed Counter, pulse train, or PWM output.

Relay Outputs (Q2 – Q12)

The module has eleven Form A relay outputs (SPST-single pole single throw). The normally-open relay outputs can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to three High-speed Counter outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

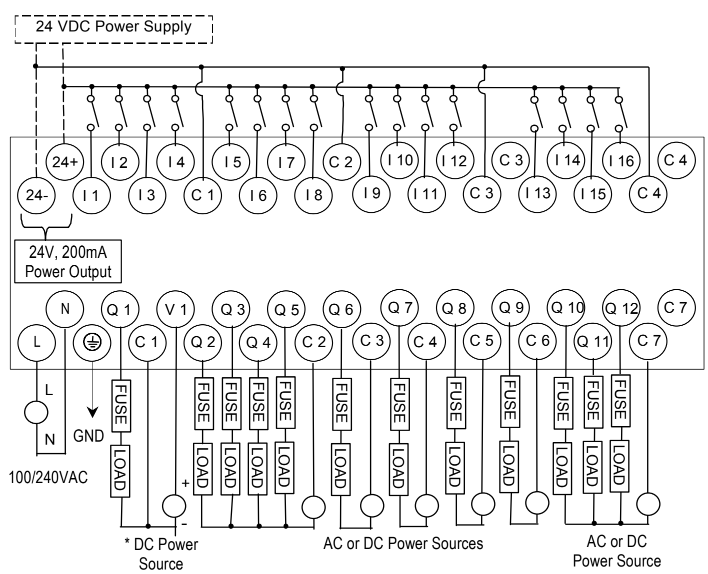
Micro PLC IC200UDR005 Specifications

Weight	580 grams (1.28lbs)
Inputs	Sixteen 24 VDC positive/negative logic input circuits
Outputs	Eleven normally open 2 amp relay circuits and One DC Output (Q1)
High Speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)

AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85 to 100VAC, 20mS at 100 to 265VAC
Inrush Current	30 Amp maximum at 200 VAC, 40 Amp maximum at 265 VAC
Inrush Time	2 ms for 40Amp
Input Current	0.20 Amp typical at 200 VAC, 0.10 Amp typical at 100 VAC
Input Power Supply Rating	26 VA
DC Input Specifications	
Number of Inputs	16
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Output logic	Positive Logic
Operating Voltage	24VDC / 12VDC / 5VDC
Voltage Range	24 VDC, +20%, -80%
Maximum UL Pilot Duty Rating	0.75A at 24 VDC
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC
Output Voltage Drop	0.3 VDC maximum
Response	ON: 0.1ms maximum (24 VDC, 0.2A), OFF: 0.1ms maximum (24 VDC, 0.2A)
OFF state leakage	0.1mA maximum
Isolation	1500 VAC between field side and logic side, 500 VAC between groups
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2.0A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter / PWM and Pulse Train Output Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 15V, OFF: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16bits		
Outputs			
Type available	Up to four HSC outputs or three HSC outputs plus one PT or PWM output.		
Load Voltage	Q1: 5/12/24V, Q2-Q4: See relay output specifications		
Maximum Pulse/PWM Frequency	5kHz (Q1 only)		

Wiring Diagram IC200UDR005



IC200UDR006
28 Point Micro PLC, (16) 12VDC In, (12) Relay Out, 12VDC Power Supply

VersaMax Micro PLC IC200UDR006 accepts sixteen 12VDC inputs and provides twelve normally-open 2 Amp relay outputs. It uses +12VDC nominal input power.

DC Power

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12VDC. The 12VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level (see power supply specifications for inrush requirements).

Inputs

The sixteen configurable 12VDC inputs can be used as positive or negative logic standard inputs or High-speed Counter inputs. Inputs are compatible with a wide range of devices such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +12 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs (Q1 – Q12)

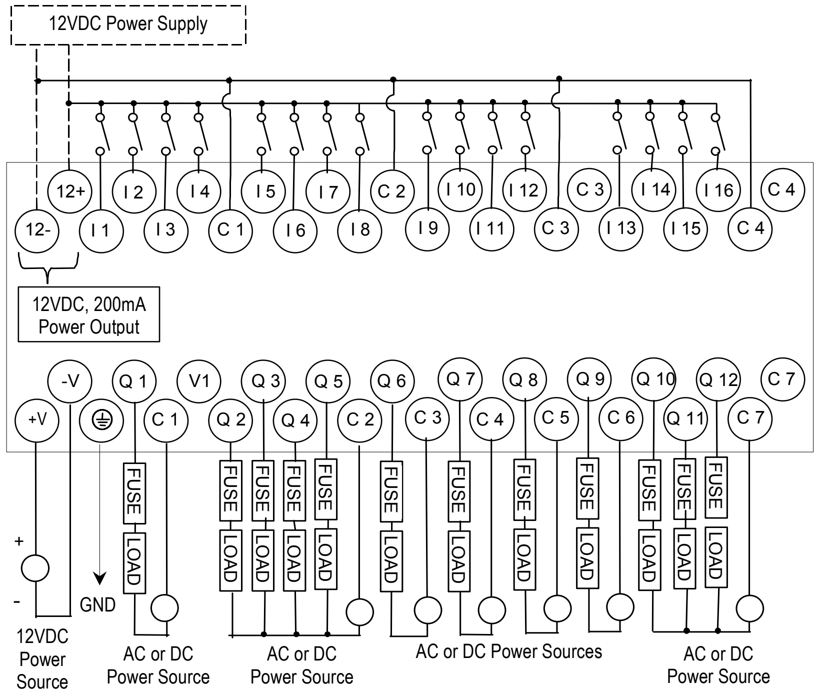
The module's twelve Form A relay outputs (SPST-single pole single throw) can be configured as normal or High-speed Counter outputs. Relay outputs cannot be used as Pulse Train or PWM outputs. The 12 normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied for field devices.

Micro PLC IC200UDR006 Specifications

Weight	500 grams (1.10 lb)
Inputs	Sixteen 12 VDC positive/negative logic input circuits
Outputs	Twelve normally open 2 amp relay circuits
High-speed Counters	Up to four Type A or one Type A and one Type B
+12 VDC Output Power Supply	200mA maximum (for input circuits and user devices)

DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200mS typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W
DC Input Specifications	
Number of Inputs	16
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Impedance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Relay Output Specifications	
Operating Voltage	5 to 30 VDC or 5 to 250 VAC
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups
Leakage Current	15 mA maximum
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC
Minimum Load	1 mA
Maximum Inrush	5 amps per half cycle
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum
Contact Life: Mechanical	20×10^6 mechanical operations
Contact Life: Electrical Voltage	Current: Resistive 2A; Current: Lamp and Solenoid 0.6A; Typical Operations 200,000
High-speed Counter Input / PWM and Pulse Train Output Specifications	
Maximum Counter Frequency	10kHz
Input Voltage	ON: 9V, OFF: 2.5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16 bits
Outputs	
Available Pulse Outputs	None
Load Voltage	Refer to relay specifications

Wiring Diagram IC200UDR006



IC200UDR010
28 Point Micro PLC, (16) 24VDC In, (1) 24VDC Out, (11) Relay Out, 24VDC Power Supply

VersaMax Micro PLC IC200UDR010 accepts sixteen DC inputs and provides one DC output and eleven normally-open 2 Amp relay outputs. It uses +24VDC nominal input power.

DC Power

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic standard inputs or up to three High-speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High Speed Counter, pulse train, or PWM output.

Relay Outputs (Q2 – Q12)

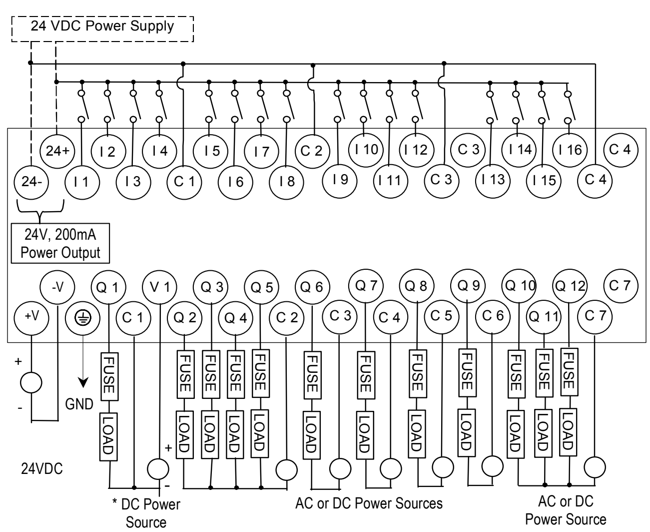
Eleven Form A relay outputs (SPST-single pole single throw) can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices. Relay outputs cannot be used as Pulse Train or PWM outputs.

Micro PLC IC200UDR010 Specifications

Weight	500 grams (1.10 lb)
Inputs	Sixteen 24 VDC positive/negative logic input circuits
Outputs	Eleven normally-open 2 amp relay circuits and One DC Output (Q1)
High-speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24 -20%, +25% VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 A
Input Current	0.30 Amp typical at 24VDC
Input Power Supply Rating	8W
DC Input Specifications	
Number of Inputs	16
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Output logic	Positive Logic
Operating Voltage	24VDC / 12VDC / 5VDC
Voltage Range	24 VDC, +20%, -80%
Maximum UL Pilot Duty Rating	0.75A at 24 VDC
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC
Output Voltage Drop	0.3 VDC maximum
Response	ON: 0.1ms maximum (24 VDC, 0.2A), OFF: 0.1ms maximum (24 VDC, 0.2A)
OFF state leakage	0.1mA maximum
Isolation	1500 VAC between field side and logic side, 500 VAC between groups
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Input / PWM and Pulse-Train Output Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 15V, OFF: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16bits		
Outputs			
Load Voltage	Q1: 5/12/24V, Q2-Q4: See Relay output specifications		
Maximum Pulse/PWM Frequency	(Q1 only) 5kHz		
Types available	Up to four HSC outputs or three HSC outputs plus one PT/PWM output.		

Wiring Diagram IC200UDR010



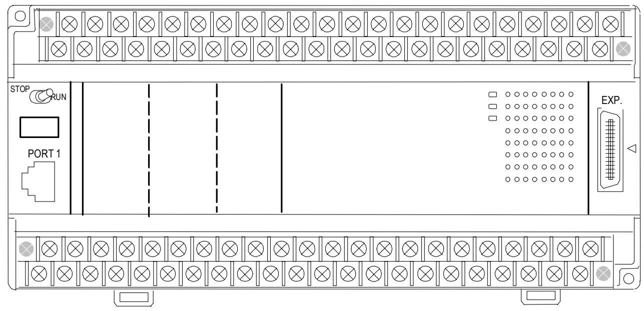
Chapter 6

VersaMax 64-Point Micro PLCs

This chapter describes the features, specifications, and field wiring for 64-Point VersaMax Micro PLCs. It also describes option modules that can be used with 64-Point VersaMax Micro PLCs.

- IC200UDD064   64 Point Micro PLC, (40) 24VDC In, (24) 24VDC Out (Source), 24VDC Power Supply
- IC200UDD164   64 Point Micro PLC, (40) 24VDC In, (24) 24VDC Out (Sink), 24VDC Power Supply
- IC200UDR064   64 Point Micro PLC, (40) 24VDC In, (24) Relay Out, 24VDC Power Supply
- IC200UDR164   64 Point Micro PLC, (40) 24VDC In, (24) Relay Out, 120/240VAC Power Supply
- IC200UMB001   Memory Pack Module
- IC200USB001   RS232, Extra Port Option Module
- IC200USB002   RS485, Extra Port Option Module
- IC200UUB001   USB / RS232 Conversion Option Module

Features of VersaMax 64-Point Micro PLCs



- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective hinged covers.
- Built-in serial communications port supports SNP/ SNPX master and slave, Modbus RTU master and slave, and Serial I/O.
- Removable Memory Pack Module available.
- Optional Port 2.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Resettable calendar clock.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 64K words of program memory, 32K words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration and application program at powerup from either RAM or flash memory (ROM).
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes at 25 degrees C
- Optional lithium battery backup for RAM and real-time clock.

General Specifications of 64-Point VersaMax Micro PLCs

Module Dimensions	Height: 90mm (3.6 inches) Depth: 76mm (3.0 inches) Width: 195mm (7.68 inches)
Typical Scan Rate	1.1 ms/K for Boolean logic (see appendix A)
Real Time Clock accuracy (for Timer contacts and Timer function blocks)	+/-0.5%
Time-of-Day Clock accuracy	+/-5 sec/day @10degC, +/-5 sec/day @25degC, and +/-11 sec/day @ 55°C or across full temperature range
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater)
+24 VDC Output Power Supply (for input circuits and user devices)	200mA maximum
+5 VDC output of Serial Ports	200mA per port, 400mA total for both ports, maximum

High Speed Counters

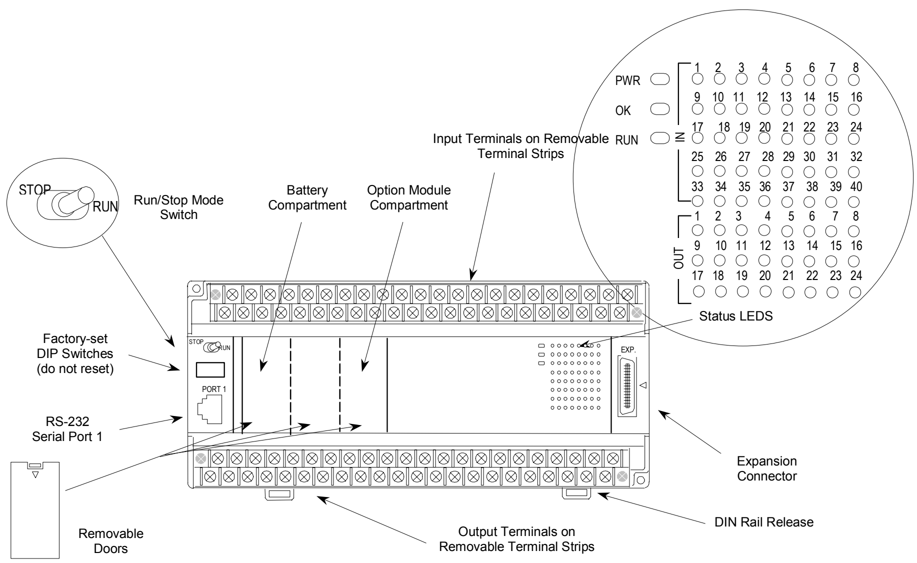
VersaMax 64-Point Micro PLCs can be configured to provide built-in high-speed counter and pulse operation. When configured for High-speed Counter operation, inputs I1 to I8 can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 100kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

The DC output (Q1) can be configured as a counter, Pulse Train, Pulse Train with Ramp, or PWM output. The relay outputs can be configured as up to three HSC outputs. Relay outputs cannot be used as Pulse Train, Pulse Train with Ramp, or PWM outputs.



Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.

Ports

Port 1 is a built-in RS-232 serial port with an RJ-45 connector.
A second port can be added to a 64-Point Micro PLC using one of the port Option Modules described in this section. If a second port is installed, both ports can be

used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time.

Port 1 and the optional Port 2 are individually-configurable for SNP master/slave, RTU master/slave, and Serial I/O protocols. Both 4-wire and 2-wire RTU are supported when the RS-485 Port Option module is installed as port 2. Port 2 does not support hardware flow control . When either port is being used for RTU slave, it automatically switches to SNP slave mode when that port is being used by the programmer. If a port is configured for Serial I/O, RTU Master, or SNP Master operation, that port defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from the port if it requires 200mA or less at 5VDC.

Analog Inputs

If an Option Module with analog inputs is installed as described in this section, the two inputs can be used to adjust the values in analog registers %AI016 and %AI017. An example use for the analog inputs would be to set threshold values for use in logical relationships with other inputs/outputs.

Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in chapter 9. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

IC200UDD064
64 Point Micro PLC, (40) 24VDC In, (24) 24VDC Out (Source), 24VDC Power Supply

VersaMax Micro PLC IC200UDD064 accepts forty DC inputs and provides twenty-four DC outputs. It uses +24VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

The forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC’s +24 VDC supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435 mA.

Transistor Outputs

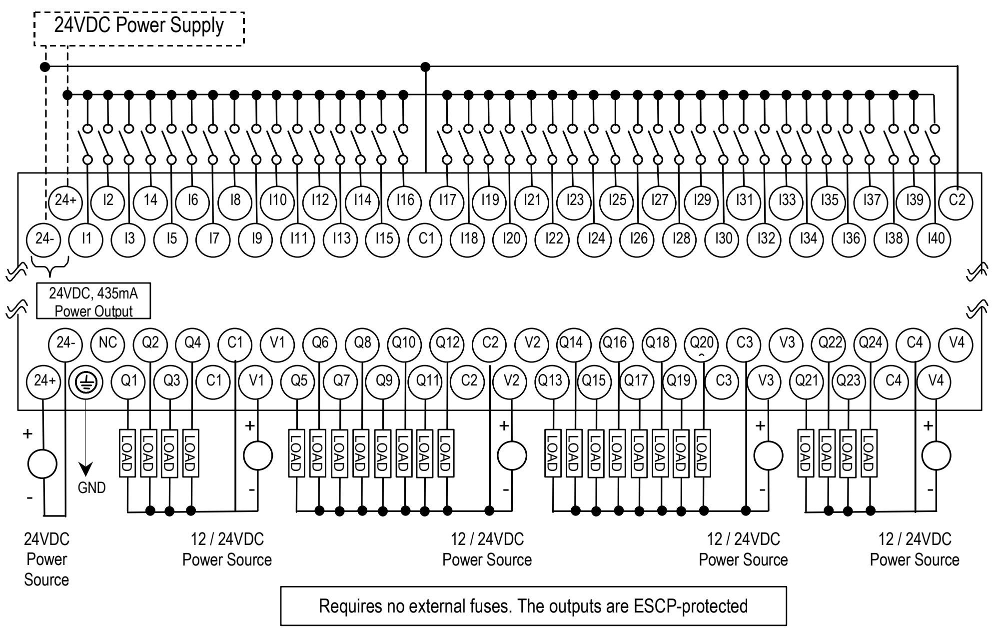
The twenty transistor outputs can be used as standard, High-speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping. All standard outputs are all source-type. Outputs can be used to switch devices like valves, lamps or contactors. The outputs provide Electronic Short-Circuit Protection; no external fuses are required.

Micro PLC IC200UDD064 Specifications

Inputs	Forty 24 VDC positive logic inputs
Outputs	Twenty-four transistor outputs, 24 VDC.
High-speed Counters	Up to four Type A or one Type A and one Type B
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current at 24VDC	8mA typical
Input Impedance	2.7 Kohms
Input Threshold Voltage	ON: 18VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON 4.5mA maximum, OFF: 1.8mA minimum
Response Time	1ms to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Output Specifications	
Voltage Range	12VDC/24VDC
External Power Supply	12/24VDC –10%, +20%
Maximum Load Current	0.5A per point (Q1 – Q4) at 24VDC at 100 % ON duration 0.7A per point (Q5 – Q20) at 24VDC at 100 % ON duration 1.0A per point (Q21 – Q24) at 24VDC at 100% ON duration
Minimum Switching Current	10mA
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	0.3V maximum
OFF state leakage current	0.1mA maximum
Response Time	OFF to ON, ON to OFF: 0.1ms maximum (24 VDC)
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuse	None, outputs are ESCP protected
Undervoltage shutdown	Q5 – Q20: 5V minimum, 8V maximum
DC short circuit current	Q1 – Q4, Q21 – Q24: 5A typical Q5 - Q19: 0.7A minimum, 2A maximum
Peak short circuit current	Q5 - Q19:4A maximum
Delay time of peak short circuit current	100 microseconds
Delay time of current limit	100 microseconds

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	100kHz
Input Voltage	ON : 18V, OFF: 5V
Count Pulse Width	500 microseconds
Count Registers	16bits
Outputs	
Load Voltage	12/24VDC
Maximum Pulse/Pulse Train with Ramping/PWM Frequency	Type A: 100kHz Type B: 60kHz PWM and PTO: 65kHz Pulse Train with Ramping: 65kHz
Types available	Up to four HSC, PT,PT with Ramping and/or PWM outputs

Wiring Diagram, IC200UDD064



IC200UDD164
64 Point Micro PLC, (40) 24VDC In, (24) 24VDC Out (Sink), 24VDC Power Supply

VersaMax Micro PLC IC200UDD164 accepts forty DC inputs and provides twenty-four DC outputs. It uses +24VDC nominal input power for PLC operation.

DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +24 VDC supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

DC Outputs

Micro PLC IC200UDD164 has 24 Sink-type DC outputs. All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

DC outputs can be used as standard, High-speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping.

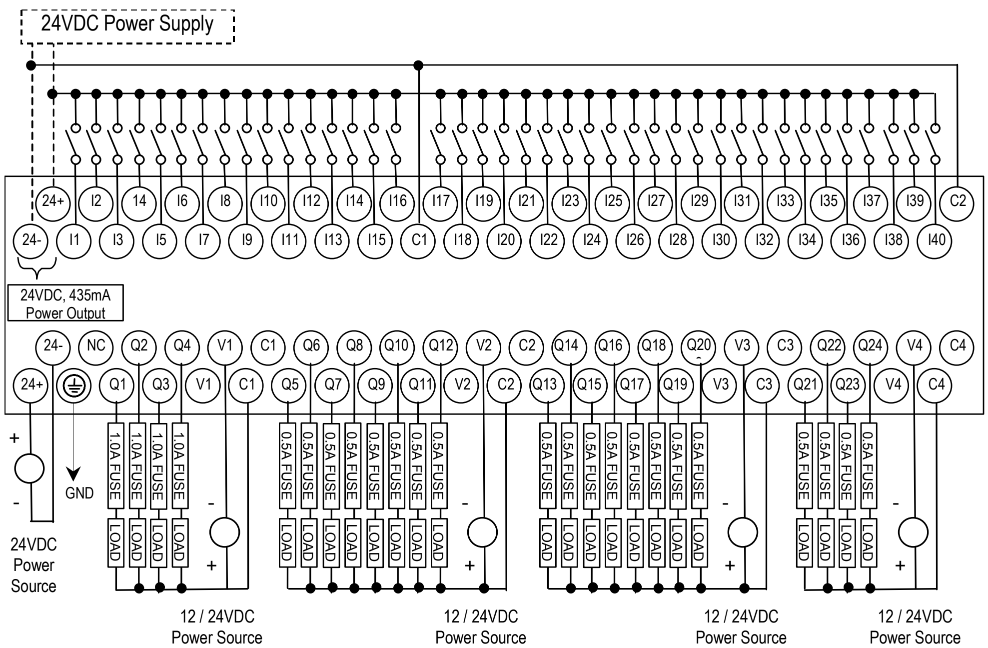
Outputs are ESCP protected; they require no fusing.

Micro PLC IC200UDD164 Specifications

Inputs	Forty 24 VDC positive logic inputs
Outputs	Twenty-four transistor outputs, 24 VDC.
High-speed Counters	Up to four Type A or one Type A and one Type B
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current at 24VDC	8mA typical
Input Impedance	2.7 Kohms
Input Threshold Voltage	ON: 18VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON 4.5mA maximum, OFF: 1.8mA minimum
Response Time	1ms to 20ms configurable as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Output Specifications	
Voltage Range	12VDC/24VDC
External Power Supply	12/24VDC –10%, +20%
Maximum Load Current	0.5A per point (Q1 – Q24) at 24VDC
Minimum Switching Current	10mA
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	Q1– Q12: 12V
OFF state leakage current	0.1mA
Response Time	OFF to ON, ON to OFF: 0.05mS maximum @ 24VDC
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuses	Not required
Undervoltage shutdown	Q1 - Q12: 5V minimum, 8V maximum
DC short circuit current	Q1 – Q12: 0.7A minimum, 2A maximum

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	100kHz
Input Voltage	ON : 18V, OFF: 5V
Count Pulse Width	500 microseconds
Count Registers	16bits
Outputs	
Load Voltage	12/24VDC
Maximum Pulse/PWM Frequency	Type A: 100kHz Type B: 60kHz PWM and PTO: 65kHz
Types available	Up to four HSC, PT, and/or PWM outputs

Wiring Diagram, IC200UDD164



IC200UDR064
64 Point Micro PLC, (40) 24VDC In, (24) Relay Out, 24VDC Power Supply

VersaMax Micro PLC IC200UDR064 accepts forty DC inputs and provides twenty-four normally-open 2 Amp relay outputs. It uses +24VDC nominal input power for PLC operation.

DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +24 VDC supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

Relay Outputs

The twenty-four normally-open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

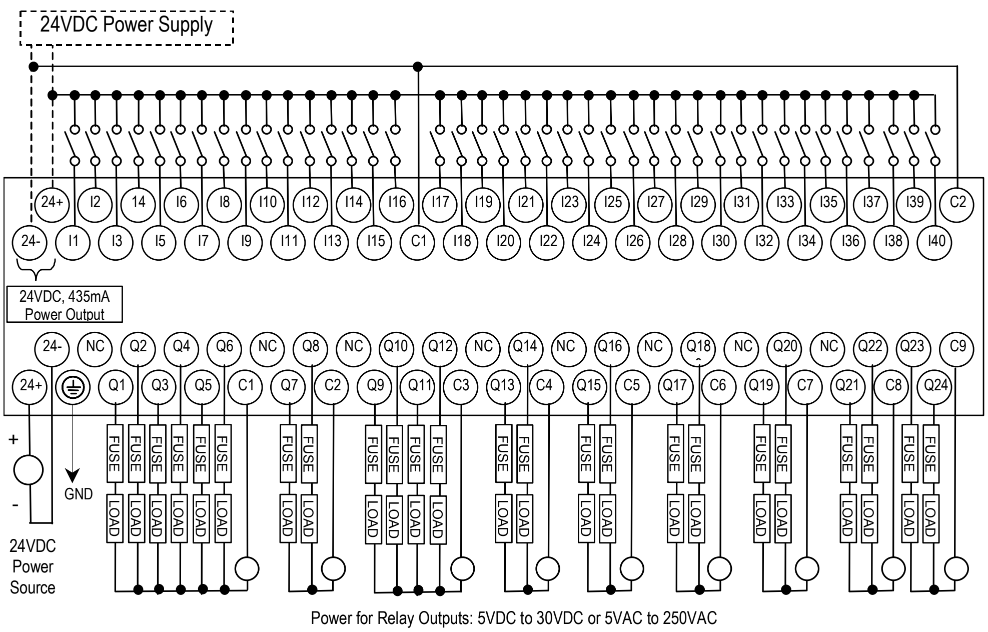
The relay outputs can be configured as up to three HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

Micro PLC IC200UDR064 Specifications

Weight	580 grams (1.28lbs)		
Inputs	Forty 24 VDC positive/negative logic input circuits		
Outputs	Twenty-four normally open 2 amp relay circuits		
High-speed Counters	Up to four Type A or one Type A and one Type B		
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)		
+5 VDC output of Serial Port	Serial Port 1, pin 7: 100mA maximum		
DC Power Specifications			
Range	19.2VDC to 30VDC		
Hold-up	10mS at 19.2 VDC		
Inrush Current	1 Amp maximum at 30VDC		
Inrush Time	10mS for 1 Amp		
Input Current	0.20 Amp typical at 24VDC		
Input Power Supply Rating	5W		
DC Input Specifications			
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current at 24VDC	8mA typical		
Input Impedance	2.7 Kohms		
Input Threshold Voltage	ON: 18VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.8mA minimum		
Response Time	1ms to 20ms configurable as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2.0A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

High-speed Counter Input and Output Specifications	
Maximum Counter Frequency	100kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16bits
Outputs	
Load Voltage	Q1: 5/12/24V, Q2-Q4: See relay output specifications
Type available	Up to three HSC outputs

Wiring Diagram, PLC IC200UDR064



IC200UDR164
64 Point Micro PLC, (40) 24VDC In, (24) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC IC200UDR164 accepts forty DC inputs and provides twenty-four normally-open 2 Amp relay outputs. It uses 100VAC to 240VAC nominal input power for PLC operation.

DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC's +24 VDC supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

Relay Outputs

The twenty-four normally-open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

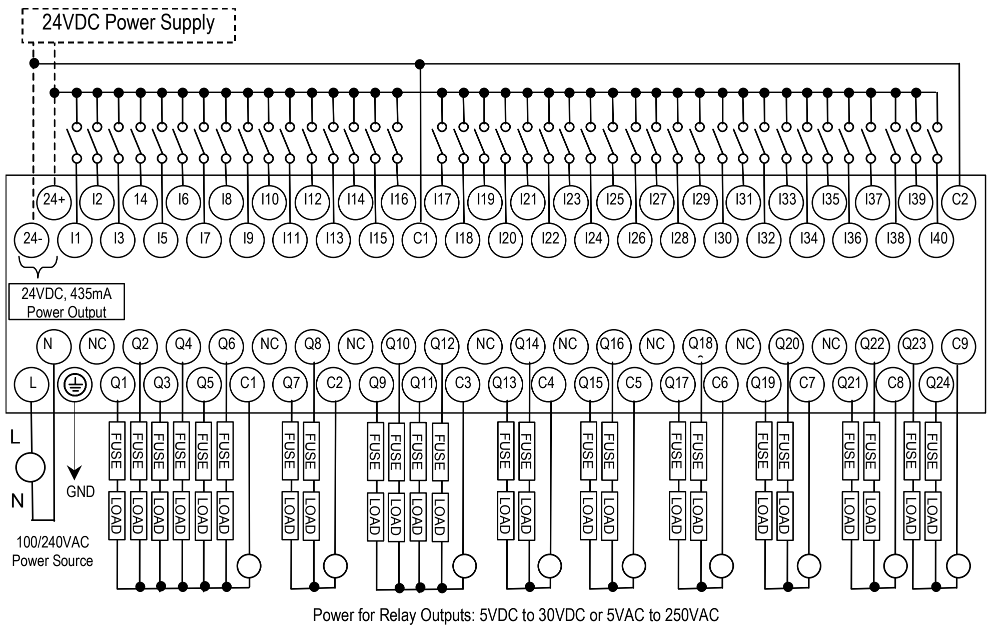
The relay outputs can be configured as up to three HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

Micro PLC IC200 UDD164, Specifications

Weight	580 grams (1.28lbs)
Inputs	Forty 24 VDC positive/negative logic input circuits
Outputs	Twenty-four normally open 2 amp relay circuits
High-speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
+5 VDC output of Serial Port	Serial Port 1, pin 7: 100mA maximum
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10mS at 85 to 100VAC, 20mS at 100 to 265VAC
Inrush Current	30 Amp maximum at 200 VAC, 40 Amp maximum at 265 VAC
Inrush Time	2 ms for 40Amp
Input Current	0.20 Amp typical at 200 VAC 0.10 Amp typical at 100 VAC
Input Power Supply Rating	26 VA

DC Input Specifications			
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current at 24VDC	8mA typical		
Input Impedance	2.7 Kohms		
Input Threshold Voltage	ON: 18VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.8mA minimum		
Response Time	1ms to 20ms configurable as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2.0A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Input and Output Specifications			
Maximum Counter Frequency	100kHz		
Input Voltage	ON: 15V, OFF: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16bits		
Outputs			
Load Voltage	Q1: 5/12/24V, Q2-Q4: See relay output specifications		
Type available	Up to three HSC outputs		

Wiring Diagram, IC200UDR164



Option Modules for 64-Point VersaMax Micro PLCs

Option Modules can be used to enhance the functionality of a 64-Point VersaMax Micro PLC. Four different Option Modules are available.

IC200USB001	RS232, Extra Port Option Module with 2 analog inputs
IC200USB002	RS485, Extra Port Option Module with 2 analog inputs
IC200UMB001	Memory Pack Module
IC200UUB001	USB / RS232 Conversion Option Module

These option modules install in the front of a 64-point Micro PLC. One Port module (USB001, USB002, or UUB001), and/or a Memory Pack module (UMB001) can be installed.

Option modules are configured using the Machine Edition software. If the configuration and installed option modules are different, the PLC logs a fault in the Fault Table.(System Configuration Mismatch).

IC200UMB001
Memory Pack Module

VersaMax Micro-64 PLC Memory Pack Module IC200UMB001 can be used to store and update the configuration, application program, and reference tables data of a 64-Point Micro PLC.

The Memory Pack Module plugs directly into port 2 on a Micro-64 PLC. Power for the device comes from port 2.

A programmer and PLC CPU are used to initially write data to the Memory Pack Module. In addition to writing data to the Memory Pack, the programmer can read data already stored on the Memory Pack and can compare that data with files already present in the programmer.

After the data is stored on the Memory Pack, the data can be copied to one or more other PLC CPUs of the same type, with no programmer needed. To do that, the Memory Pack Module is removed from the Micro PLC, and installed on another Micro PLC (Micro PLCs must be powered down to remove or install an option module). When the second Micro PLC is powered up, all of the data on the Memory Pack is written into the corresponding PLC reference addresses.

Features

- Store 128kB of data.
- Read the data at Power up.
- Read/Write/Verify the data through programmer command.

With the programmer present, the PLC CPU can read ,write, or verify a program, configuration and tables in the Memory Pack Module. When reading or verifying data, it is possible to select hardware configuration, logic, and/or reference tables data. However, when writing data to the Memory Pack Module, all the data (logic, configuration and reference tables) must be written. Individual data types cannot be selected to be written.

Reading Data from the Memory Pack Module at Startup

If the Memory Pack Module is connected to the port 2 when the PLC is switched on, the PLC automatically reads all the data (program, configuration, and tables) in the Memory Pack Module, The Micro PLC stores the data in its RAM/FLASH and flash based on the options that have been set in the hardware configuration.

The OK LED keeps blinking while the data is being transferred from the Memory Pack Module to the PLC. Wait until the OK LED stops blinking to do any further operations.

Data Read, Write, Verify Operations Using the Programming Software

Read/Write/Verify operations can be done on the Memory Pack Module using the programming software. The PLC must be placed in Stop mode.

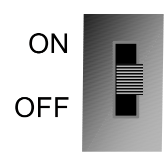
The path for write /read/ verify through programming software is:

Targets -> online commands -> Flash/EEProm

The popup window for write/read/verify appears. Select the memory storage board option from the two choices (memory storage board or flash memory) to transfer data between the Memory Pack module and the CPU. Then select the write/read/verify operation. The programming software shows the status of the data transfer.

The Memory Pack Module and PLC must both have either no OEM key password or the same OEM key password for the data to be transferred. The Memory Pack Module does not perform special processing for other type of passwords.

Write Protect Switch



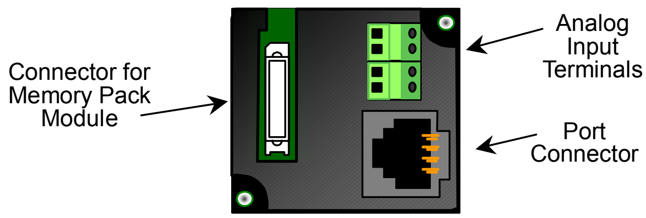
The Write Protect switch on the Memory Pack Module prevents writing data to the module when it is in the ON position.

Caution

If the Write Protect switch is in ON position and the programming software tries to write data to the Memory Pack Module, the data is NOT written to the module. However, no error message is generated, and there is no indication that the data has not been written. This should be considered before setting the Write Protect switch.

IC200USB001
RS232 Extra Port Option Module with 2 Analog Inputs

VersaMax Micro PLC Option Module IC200USB001 can be used with a 64-Point Micro PLC to provide an extra RS232 Port and two analog inputs.

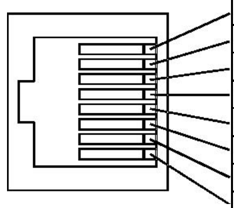


When installed on the 64-Point Micro PLC, the RS232 Port Option Module becomes port 2. It supports the following communications protocols:

- Modbus Master/Slave
- Serial Read/Write
- SNP/SNPX Master/Slave

Use of the Port Option module as port 2, and the protocol selection must be set up in the configuration software. After making those selections, the communications parameters can also be configured.

Pin assignments for Port 2 are



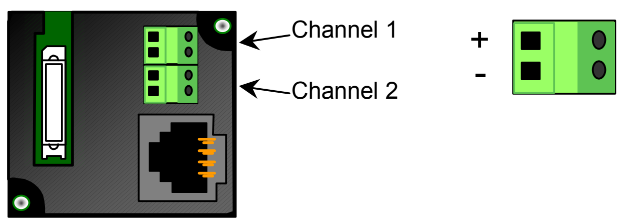
8	SG	Signal Ground
7	VCC	5VDC Output
6	10V	10VDC Output
5	NC	-
4	SD	Sent Data
3	RD	Received Data
2	NC	-
1	RS	Request to Send

An external device can obtain power from the 5VDC output pin if it requires 200mA or less at 5VDC.

Analog Inputs

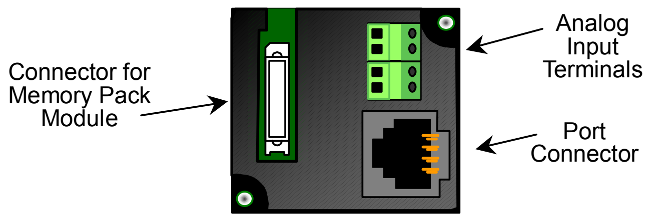
The terminals on the Port Option Module can be used for analog inputs with the following characteristics:

Input Ranges	0-10 V (10.24 V Max)
Resolution	0-10 V, 10 bits
Accuracy	+/-1%
Linearity	+/-3 LSB Maximum
Voltage Input Impedance	100KOhm
Isolation	Channel to channel: none CPU to analog signal: none
Analog Terminal Wiring	Solid wire: 0.14mm^2 to 1.5mm^2 Stranded wire: 0.14mm^2 to 0.10mm^2



IC200USB002
RS-422/485 Extra Port Option Module with 2 Analog Inputs

VersaMax Micro PLC Option Module IC200USB002 can be used with a 64-Point Micro PLC to provide an extra RS-422/485 Port and two analog inputs.

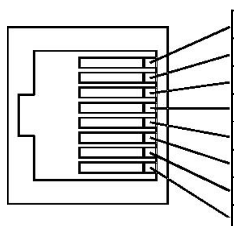


When installed on the 64-Point Micro PLC, the RS-422/485 Port Option Module becomes port 2. It supports the following communications protocols:

- Modbus Master/Slave
- Serial Read/Write
- SNP/SNPX Master/Slave

Use of the Port Option module as port 2, and the protocol selection must be set up in the configuration software. After making those selections, the communications parameters can also be configured.

Pin assignments for Port 2 are:



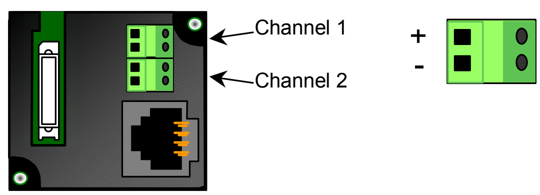
8	SG	Signal Ground
7	VCC	5VDC Output
6	NC	Not used
5	TX(+)	Send Data +
4	TX (-)	Send Data -
3	RX (-)	Received Data -
2	RX (+)	Received Data +
1	RT	Terminal Resistor

An external device can obtain power from the 5VDC output pin if it requires 200mA or less at 5VDC.

Analog Inputs

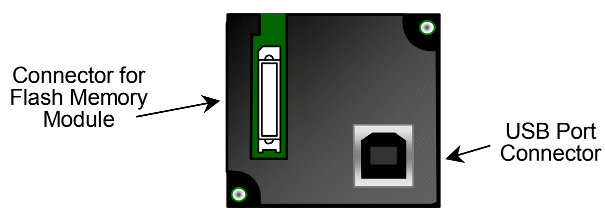
The terminals on the Port Option Module can be used for analog inputs with the following characteristics:

Input Ranges	0-10 V (10.24 V maximum
Resolution	0-10 V, 10 bits
Accuracy	+/-1%
Linearity	+/-3 LSB Maximum
Voltage Input Impedance	100KOhm
Isolation	Channel to channel: none CPU to analog signal: none
Analog Terminal Wiring	Solid wire: 0.14mm^2 to 1.5mm^2 Stranded wire: 0.14mm^2 to 0.10mm^2



IC200UUB001: USB / RS232 Conversion Option Module

VersaMax Micro PLC Option Module IC200UUB001 can be used with a 64-Point Micro PLC to provide a USB Port.



Characteristics of the USB Port are:

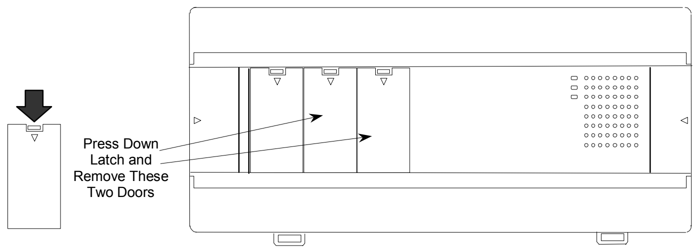
Connector	Straight B type
USB version	2.0
Power	Self power
Baud Rates Supported	4800 through 38400 only. Do not configure other baud rates for Port 2 when using the USB Conversion Option Module.

Connecting to the USB board from windows should automatically download the correct driver from Microsoft. To download directly, go to http://www.ftdichip.com/Drivers/FT232-FT245Drivers.htm

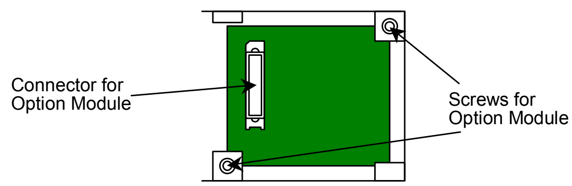
Installing Option Modules:

Power to the VersaMax Micro-64 PLC MUST BE TURNED OFF when installing or removing Option Modules.

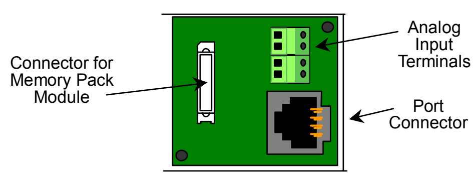
1. Remove the two doors show below, by pressing downward on the latches and lifting them away from the module.



2. If a port-type Option Module is being installed, orient the connector on the Option Module with the connector in the Micro PLC. Be careful to avoid contact with the exposed components in the module.



3. Press the Option Module downward until it clicks into place.
4. Install the screws provided with the Option Module into the corners as shown above.



5. If a Memory Pack Module is being installed, orient the connector on the back of the Memory Pack Module with the connector on the Micro PLC or port-type Option Module. Press the Memory Pack Module downward until it clicks into place.
6. Install the protective cover(s). If only the Memory Pack Module is used, both covers may be installed. If a port module is used, the righthand cover is not installed and the port connector remains accessible.

Chapter 7

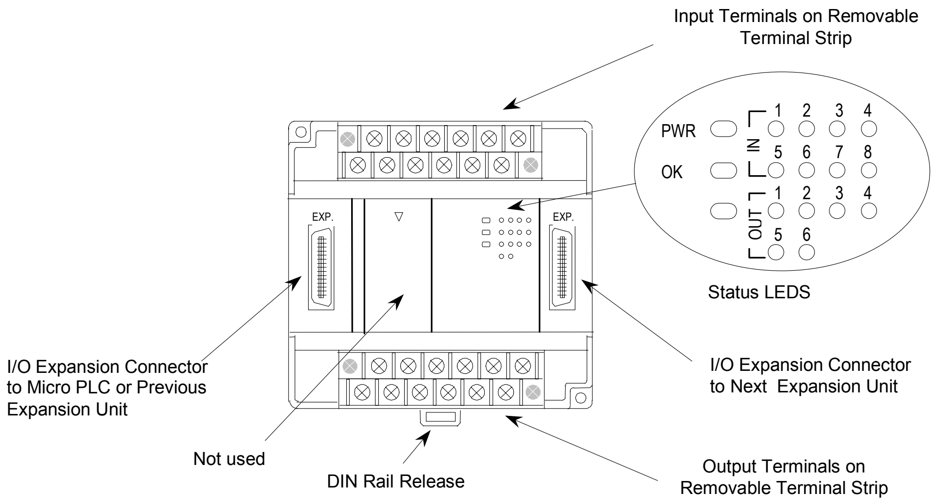
VersaMax Micro PLC 8, 14, and 16-Point Expansion Units

This chapter consists of module datasheets for the following VersaMax Micro PLC Expansion Units:

- IC200UEC008 8 Points, (4) 24VDC In, (4) 24VDC Out wirh ESCP, 24VDC Power Supply
- IC200UEC108 8 Points, (4) 24VDC In, (4) 24VDC Transistor Out, 24VDC Power Supply
- IC200UEC208 8 Points, (4) 24VDC In (4) Relay Out 24VDC Power Supply
- IC200UEI008 8 Points, (8) 24VDC In, 24VDC Power Supply
- IC200UEI016 16 Points, (16) 24VDC In, 24VDC Power Supply
- IC200UEO008 8 Points, (8) 24VDC Output with ESCP, 24VDC Power Supply
- IC200UEO108 8 Points, (8) 24VDC Transistor Out, 24VDC Power Supply
- IC200UEO016 16 Points, (16) 24VDC Output with ESCP, 24VDC Power Supply
- IC200UEO116 16 Points, (16) 24VDC Transistor Out, 24VDC Power Supply
- IC200UER008 8 Points, (8) Relay Outputs, 24VDC Power Supply
- IC200UER016 16 Points, Relay Outputs, 24VDC Power Supply
- IC200UEX009 14 Points, (8) 120 VAC In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240VAC Power Supply
- IC200UEX010 14 Points, (8) 120VAC In, (6) 120VAC Out, 120/240VAC Power Supply
- IC200UEX011 14 Points, (8) 24VDC In, (6) Relay Out, 120/240VAC Power Supply
- IC200UEX012 14 Points, (8) 24VDC In, (6) Relay Out, 24VDC Power Supply
- IC200UEX013 14 Points, (8) 12VDC In, (6) Relay Out, 12VDC Power Supply
- IC200UEX014 14 Points, (8) 24VDC In, (6) 24VDC Out, 24VDC Power Supply
- IC200UEX015 14 Points, (8) 12VDC In, (6) 12VDC Out, 12VDC Power Supply
- IC200UEX122 14 Points, (8) 24VDC In, (6) 24VDC Out with ESCP, 24VDC Power Supply

Features of VersaMax 8, 14, and 16-Point Expansion Units

Modular Expansion Units can be used to increase the total I/O count of a Micro PLC. Up to 4 Expansion Units in any combination can be used with any 14-point to 64-point Micro PLC. Expansion Units can be located up to 2 meters from the Micro PLC.



Removable Terminal Strips

VersaMax Expansion Units provide the wiring flexibility of removable terminal assemblies. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by loosening two screws.

Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. In addition to LEDs for Expansion Unit local Power and OK mode, there is an LED for each I/O point.

Cables

A 0.1 meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

IC200UEC008
8 Point Expansion Unit, (4) 24VDC Inputs, (4) 24VDC Outputs with ESCP, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC008 accepts four 24VDC inputs and provides four 24VDC source-type transistor outputs with Electronic Short Circuit Protection. The module requires +24VDC nominal input power.

DC Inputs

The four 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in +24 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Expansion Unit IC200UEC008 has four sink-type high-current transistor outputs. All outputs are isolated between field and logic and are switching positive voltage.

All outputs have electronic short-circuit protection, no fuses are needed to protect the outputs.

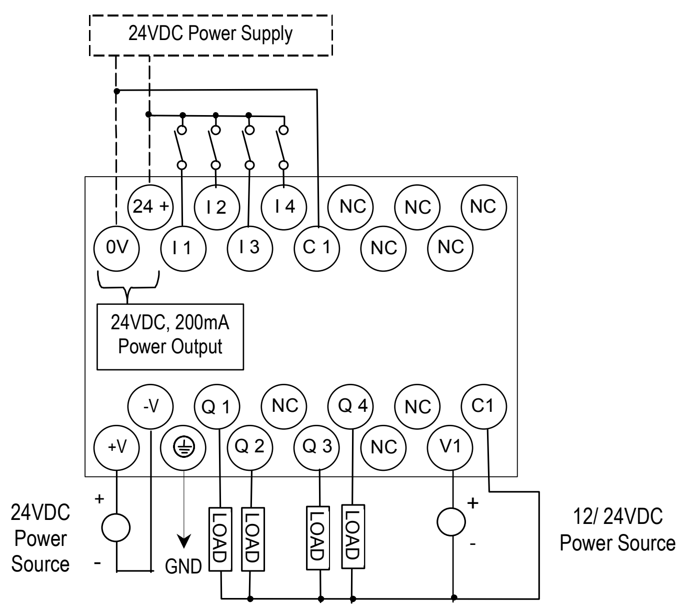
An external source of 12/24VDC power must be provided to power the outputs. The outputs share this common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Expansion Unit IC200UEC008 Specifications

Inputs	Four 24VDC input circuits
Outputs	Four 24VDC source-type transistor outputs with ESCP
+24 VDC Output Power Supply	200mA maximum(for input circuits and user devices)
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	3ms
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	OFF to ON or ON to OFF: 4ms typical
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load Current	0.7A per point , 3A per common
Maximum Inrush Current	
Output Voltage Drop	0.3V
OFF state Leakage Current	0.1mA
Response Time	OFF to ON or ON to OFF: 0.05ms maximum at 24VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12/24VDC –10%, +20%
Fuse	Not required
Minimum switching current	10mA

Wiring Diagram, IC200UEC008



IC200UEC108
16 Point Expansion Unit, (8) 24VDC Inputs, (8) 24VC Transistor Outputs, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC108 accepts eight 24VDC inputs and provides eight 24VDC sink-type transistor outputs. It requires +24VDC nominal input power.

DC Inputs

The eight 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in +24 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Expansion Unit IC200UEC108 has eight sink-type high-current transistor outputs. All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

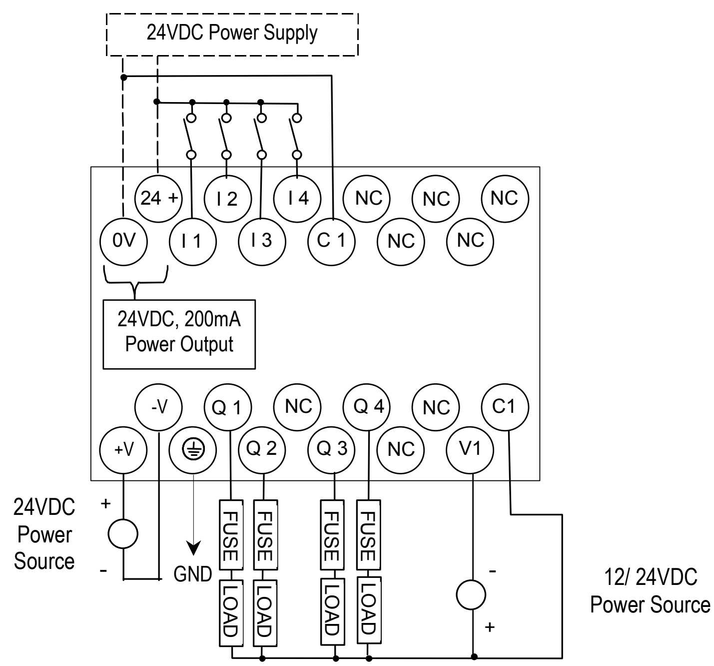
The outputs share one common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Expansion Unit IC200UEC108 Specifications

Inputs	Eight 24VDC input circuits
Outputs	Eight 24VDC source-type transistor outputs
+24 VDC Output Power Supply	200mA maximum(for input circuits and user devices)
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	10ms at 19.2VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	OFF to ON or ON to OFF: 4ms typical
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Transistor Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load	0.7A per point , 3A per common
Maximum Inrush Current	
Output Voltage Drop	0.3V
OFF state leakage	0.1mA
Response	OFF to ON or ON to OFF: 0.05ms maximum at 24VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12/24VDC –10%, +20%
Fuses	Not required
Minimum Switching Current	10mA

Wiring Diagram, IC200UEC108



IC200UEC208
8 Point Expansion Unit , (4) 24VDC Inputs, (4) Relay Outputs, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC208 accepts four 24VDC inputs and provides four normally-open 2 Amp relay outputs that can control 5 to 30 VDC or 5 to 250VAC output devices. It requires +24VDC nominal input power.

DC Inputs

The four DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

Four Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

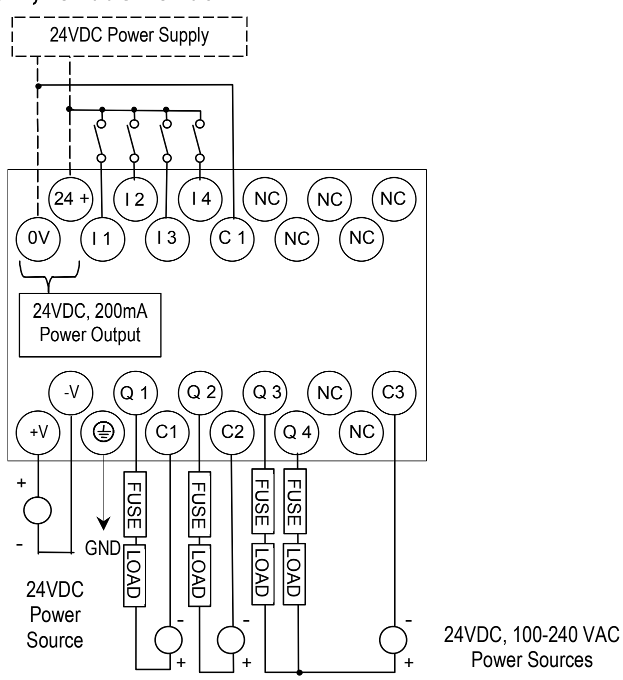
Expansion Unit IC200UEC208 Specifications

Inputs	Four 24 VDC positive/negative logic input circuits
Outputs	Four normally open 2 amp relay circuits
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24VDC –20% / +25%
Hold-up	10 ms at 19.2 VDC
Inrush Current	1 Amp maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 Amp typical at 24 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	OFF to ON or ON to OFF: 4ms typical
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum Load Current	2 Amps per point, 5 Amps per common		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Response Time	ON to OFF, or OFF to ON: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage, 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEC208



IC200UEI008
8 Point Expansion Unit, (8) 24VDC Inputs, 24VDC Power Supply
IC200UEI016
16 Point Expansion Unit, (16) 24VDC Inputs, 24VDC Power Supply

VersaMax Micro PLC Expansion Units IC200UEI008 and IC200UEI016 accept 24VDC inputs. The modules require +24VDC nominal input power.

DC Inputs

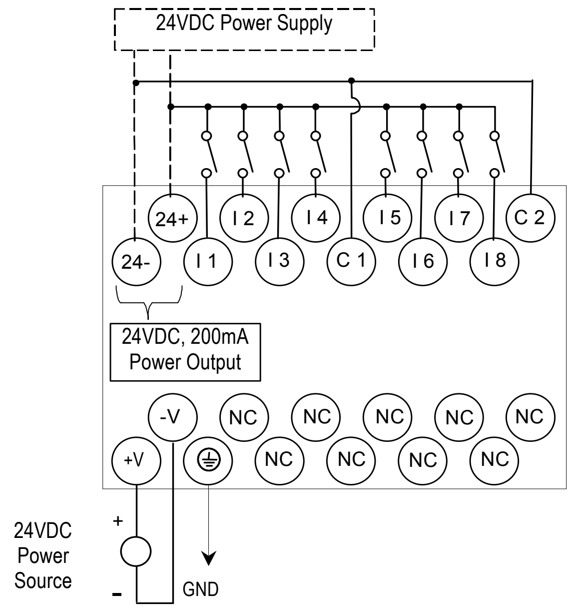
The DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

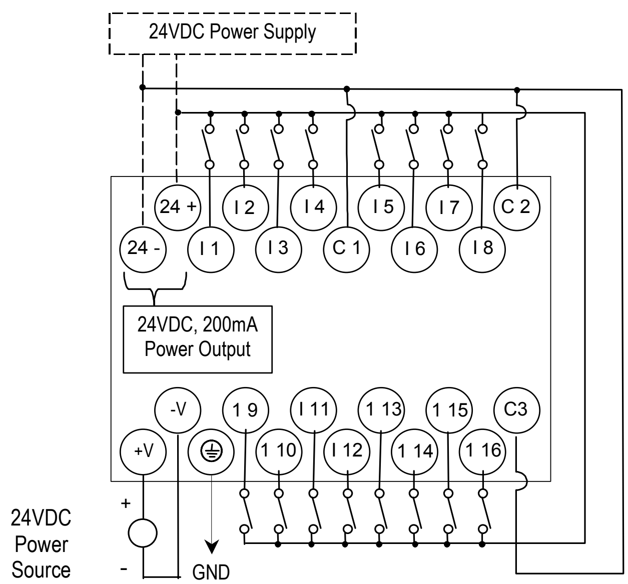
Expansion Units IC200UEI008 and IC200UEI016 Specifications

Inputs	IC200UEI008: Eight 24 VDC positive/negative logic input circuit IC200UEI016: Sixteen 24 VDC positive/negative logic input circuits
Outputs	None
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24VDC –20% / +25%
Hold-up	10 ms at 19.2 VDC
Inrush Current	1 Amp maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 Amp typical at 24 VDC
Input Power Supply Rating	4W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	4.8mA typical
Input Resistance	4.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 3.0mA maximum, OFF: 1.5mA minimum
Response Time	ON to OFF or OFF to ON: 2ms typical
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

Wiring Diagram, IC200UEI008



Wiring Diagram, IC200UEI016



IC200UEO008
8 Point Expansion Unit, (8) 24VDC Outputs with ESCP, 24VDC Power Supply
IC200UEO016
16 Point Expansion Unit, (16) 24VDC Outputs with ESCP, 24VDC Power Supply

VersaMax Micro PLC Expansion Units IC200UEO008 and IC200UEO016 provide 8 or 16 DC source-type high-current transistor outputs, respectively. Outputs have Electronic Short Circuit Protection. The modules require +24VDC nominal input power.

Transistor Outputs

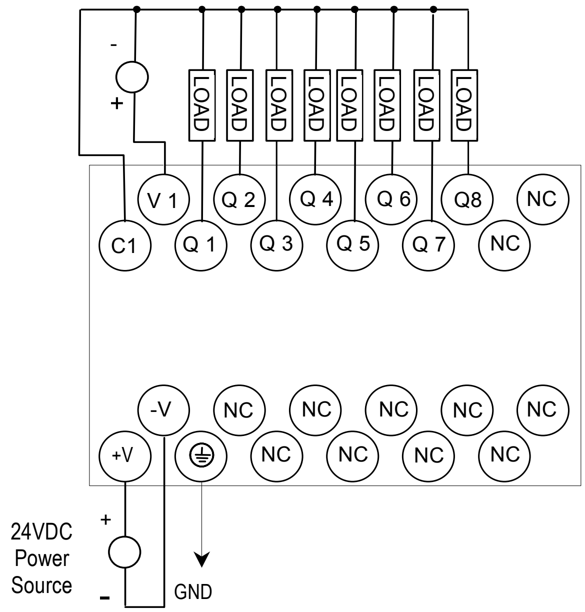
All outputs are isolated between field and logic and are switching positive voltage. Outputs have electronic short-circuit protection, no fuses are needed to protect the outputs.

An external source of 12/24VDC power must be provided to power the outputs. The outputs share one common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

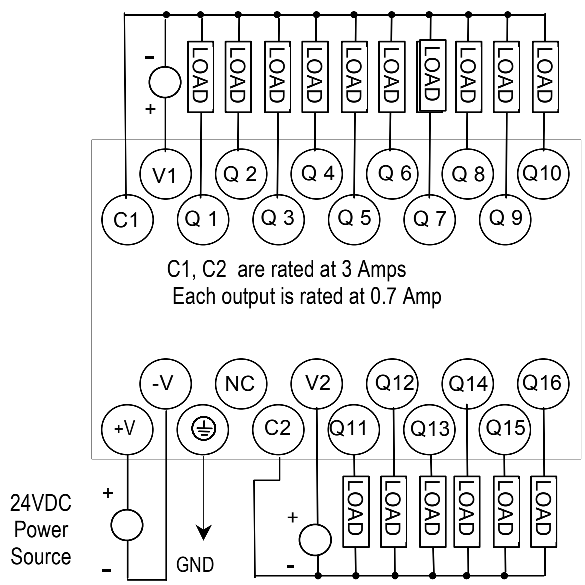
Expansion Units IC200UEO008 and IC200UEO016 Specifications

Inputs	None
Outputs	IC200UEO008: Eight source-type 24VDC transistor output circuits with ESCP IC200UEO016: Sixteen source-type 24VDC transistor output circuits with ESCP
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	10ms at 19.2VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W
Transistor Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load	0.7A per point , 3A per common
Maximum Inrush Current	
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA
Response	OFF to ON or ON to OFF: 0.05ms maximum at 24VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12/24VDC –10%, +20%
Fuses	Not required
Minimum switching current	10mA

Wiring Diagram, IC200UEO008



Wiring Diagram, IC200UEO016



IC200UEO108
8 Point Expansion Unit, (8) 24VDC Transistor Outputs, 24VDC Power Supply
IC200UEO116
16 Point Expansion Unit, (16) Transistor Outputs, 24VDC Power Supply

VersaMax Micro PLC Expansion Units IC200UEO108 and IC200UEO116 provide 8 and 16 DC sink-type outputs, respectively. These modules require +24VDC nominal input power.

Transistor Outputs

The sink-type transistor outputs are isolated between field and logic and are switching positive voltage.

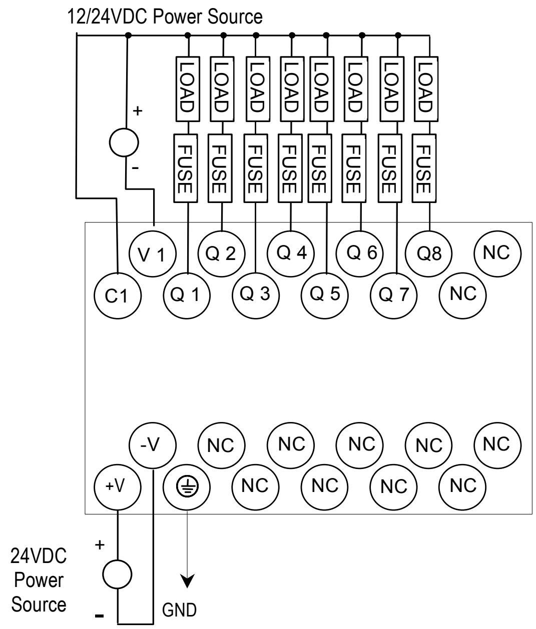
External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

The outputs share one common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

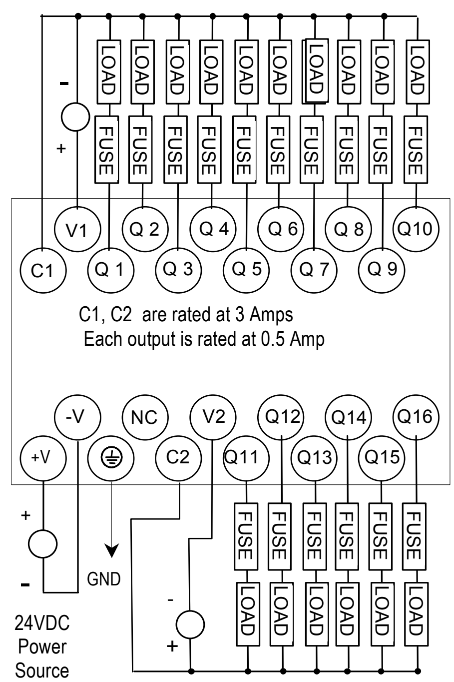
Expansion Units IC200UEO108 and IC200UEO116 Specifications

Inputs	None
Outputs	IC200UEO108: Eight sink-type DC transistor output circuits IC200UEO116: Sixteen sink-type DC transistor output circuits
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	10ms at 19.2VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W
Transistor Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load	0.5A per point, 3A per common
Maximum Inrush Current	
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA maximum
Response	OFF to ON or ON to OFF: 0.5ms
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	10-30VDC required to power the outputs.
Fuses	Outputs should be fused externally.
Minimum Switching Current	1mA

Wiring Diagram, IC200UEO108



Wiring Diagram, IC200UEO116



IC200UER008
8 Point Expansion Unit, (8) Relay Outputs, 24VDC Power Supply
IC200UER016
16 Point Expansion Unit, (16) Relay Outputs, 24VDC Power Supply

VersaMax Micro PLC Expansion Units IC200UER008 and IC200UER016 provide 8 or 16 normally-open 2 Amp relay outputs, respectively. The outputs can control 5 to 30 VDC or 5 to 250VAC output devices. The unit requires +24VDC nominal input power.

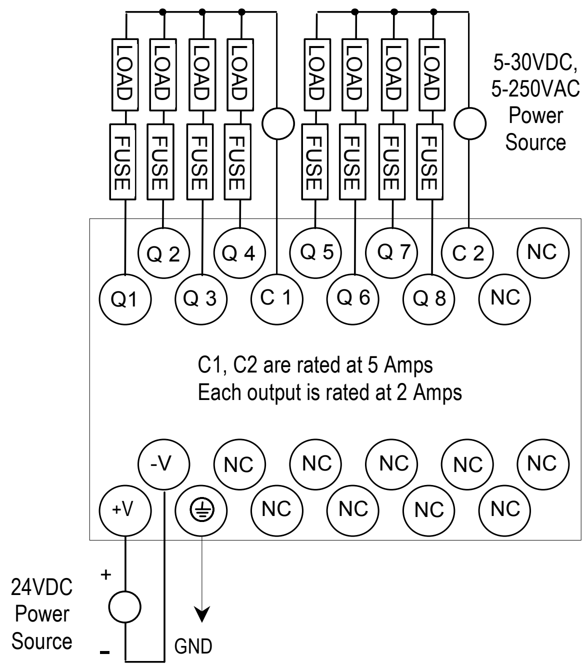
Relay Outputs

The Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

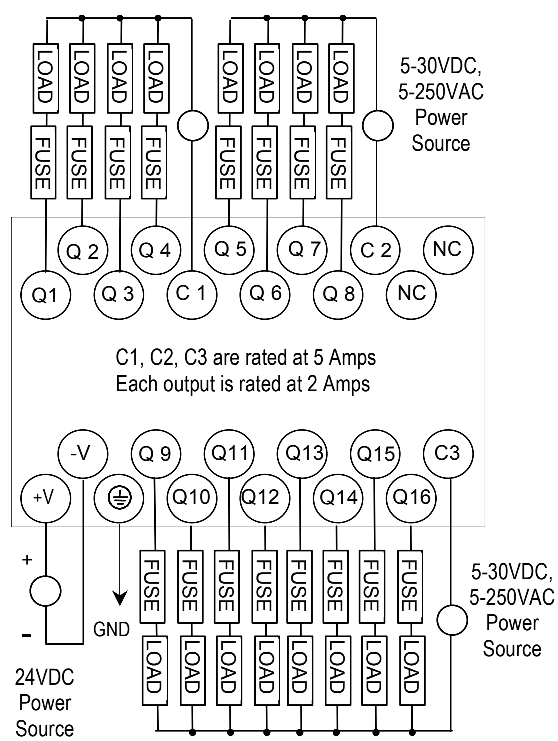
Expansion Units IC200UER008 and IC200UER016 Specifications

Inputs	None		
Outputs	IC200UER008: Eight normally open 2 amp relay circuits IC200UER016: Sixteen normally open 2 amp relay circuits		
DC Power Specifications			
Range	24 –20%/+25% VDC		
Hold-up	10ms at 19.2VDC		
Inrush Current	1 A maximum at 30 VDC		
Inrush Time	10 ms for 1 Amp		
Input Current	0.16 A typical at 24 VDC		
Input Power Supply Rating	4W		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum Load Current	2 Amps per point, 5 Amps per common		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Response Time	ON to OFF, or OFF to ON: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage, 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UER008



Wiring Diagram, IC200UER016



IC200UEX009
14 Point Expansion Unit, (8) 120VAC In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240VAC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX009 accepts eight AC inputs and provides six relay outputs: 2 at 10 Amps and 4 at 2 Amps. It requires 100VAC to 240VAC nominal input power.

AC Inputs

The 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

Relay Outputs

The six normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. There are two individual 10 Amp relay outputs and one group of four 2-Amp relay outputs. Power for the internal relay coils is provided by the internal supply. Separate external sources of AC or DC power must be supplied to operate field output devices.

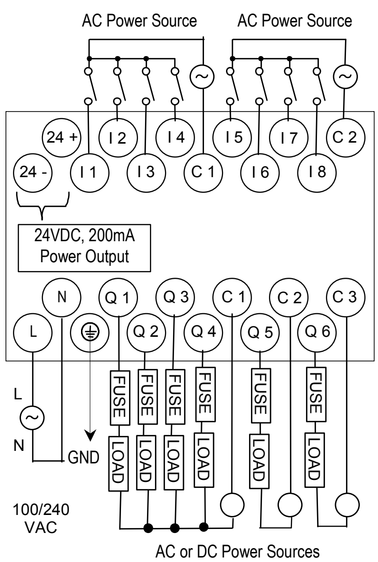
Expansion Unit IC200UEX009 Specifications

Inputs	Eight AC inputs
Outputs	Six relay outputs
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 to 100VAC
Inrush Time	2 ms for 40Amp
Inrush Current	18 A maximum at 120VAC, 30 A maximum at 200VAC, 40 A maximum at 265VAC
Input Current	0.05 A typical at 200 VAC, 0.10 A typical at 100 VAC
Input Power Supply Rating	11 VA

AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms
Response Time	OFF to ON: maximum 25mS, ON to OFF: maximum 30mS
Isolation	1500V rms field side to logic side, 500V rms between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC	10 amps at 24 VDC and 240 VAC	
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC	10 amps at 24 VDC and 240 VAC	
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Fuse	None		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
	2.0A	0.6A	200,000
	10.0A	4.0A	100,000
	4.0A	1.0A	200,000

Wiring Diagram, IC200UEX009



Outputs Q 1 – Q 4 are rated at 2.0 Amps each.
Outputs Q 5 and Q 6 are rated at 10.0 Amps each.

IC200UEX010
14 Point Expansion Unit, (8) 120VAC In, (6) 120VAC Out, 120/240VAC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX010 accepts eight AC inputs and provides six AC outputs. The module requires 100VAC to 240VAC nominal input power.

AC Inputs

The eight 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

AC Outputs

The six 120/240 VAC, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

AC power to operate loads connected to outputs must be supplied from an external source.

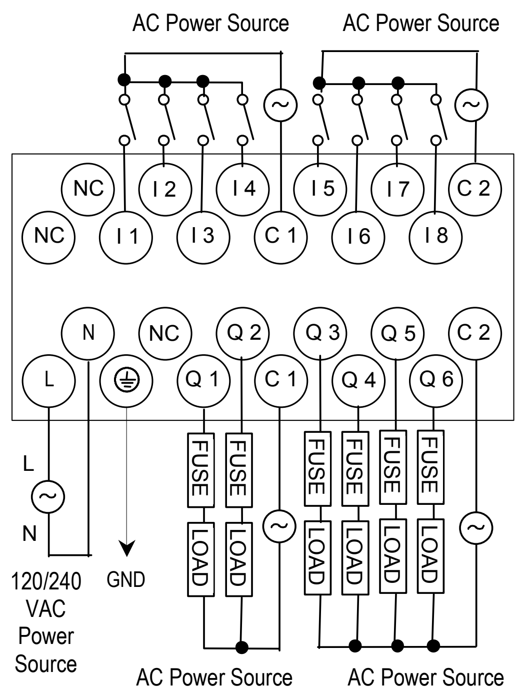
This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling a wide range of inductive and incandescent loads.

Expansion Unit IC200UEX010 Specifications

Inputs	Eight AC inputs
Outputs	Six AC outputs
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 to 100VAC, 20 ms at 100 to 264VAC
Inrush Time	2 ms for 40Amp
Inrush Current	18 A maximum at 120VAC, 30 A maximum at 200VAC, 40 A maximum at 265VAC
Input Current	0.05 A typical at 200 VAC, 0.10 A typical at 100 VAC
Input Power Supply Rating	11 VA

AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80VAC rms, 4.5 mA rms, OFF: maximum 30VAC rms, 2 mA rms
Response Time	OFF to ON: maximum 25mS, ON to OFF maximum 30mS
Isolation	1500V rms field side to logic side, 500V rms between groups
AC Output Specifications	
Rated Load Voltage	100 -15% to 240 +10% VAC, 50 -5% to 60 +5% Hz
Maximum Resistive Load Current	0.5 Amp per point
Maximum UL Pilot Duty Rating	0.5 Amp per point at 240 VAC, 0.6 Amp maximum on C1, 1.2 Amps maximum on C2
Maximum Inrush Current	5A (1 period)/point, 10A (1 period)/common
Maximum voltage drop when ON	1.5 V RMS
Maximum leak current when OFF	1.8 mA RMS (115 VAC), 3.5 mA RMS (230 VAC)
Response Time (Maximum)	OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 mS
Isolation	1500V RMS field side to logic side, 500V RMS between groups

Wiring Diagram, IC200UEX010



IC200UEX011
14-Point Expansion Unit with AC Power, (8) 24DC Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEX011 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5-30VDC or 5-250VAC output devices. The module requires 100VAC to 240VAC nominal input power.

DC Inputs

The eight DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

Isolated +24VDC output power is available for field devices, up to 200mA maximum.

Relay Outputs

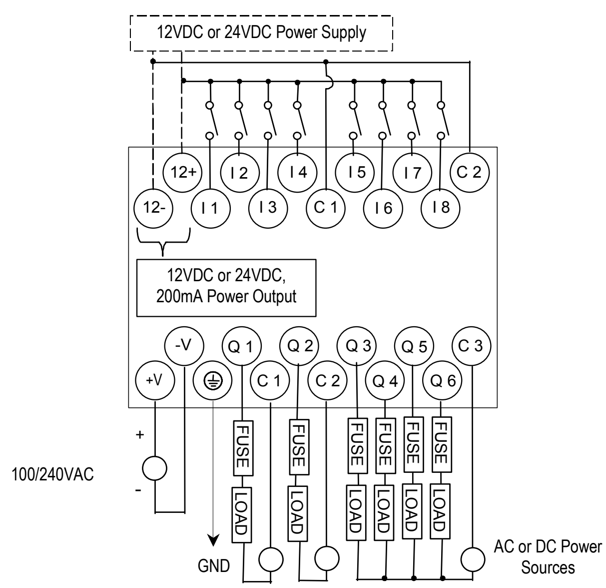
The six Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the 24VDC internal supply. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX011 Specifications

Inputs	Eight 24 VDC positive/negative logic input circuits
Outputs	Six normally open 2 Amp relay circuits
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
Relay Output Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 to 100VAC
Inrush Time	2 ms for 40Amp
Inrush Current	18 A maximum at 120VAC, 30 A maximum at 200VAC, 40 A maximum at 265VAC
Input Current	0.05 A typical at 200 VAC, 0.10 A typical at 100 VAC
Input Power Supply Rating	13 VA

DC Input Specifications			
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current	7.5mA typical		
Input Resistance	2.8 Kohms		
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum		
Response Time	0.5 to 20ms		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups, if one group is powered by an external 24V power supply.		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
240VAC, 120VAC, 24VDC	2A	0.6A	200,000

Wiring Diagram, IC200UEX011



IC200UEX012
14-Point Expansion Unit with 24DC Power, (8) 24DC Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEX012 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5 to 30 VDC or 5 to 250VAC output devices. The module requires +24VDC nominal input power.

DC Inputs

The eight DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's isolated +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

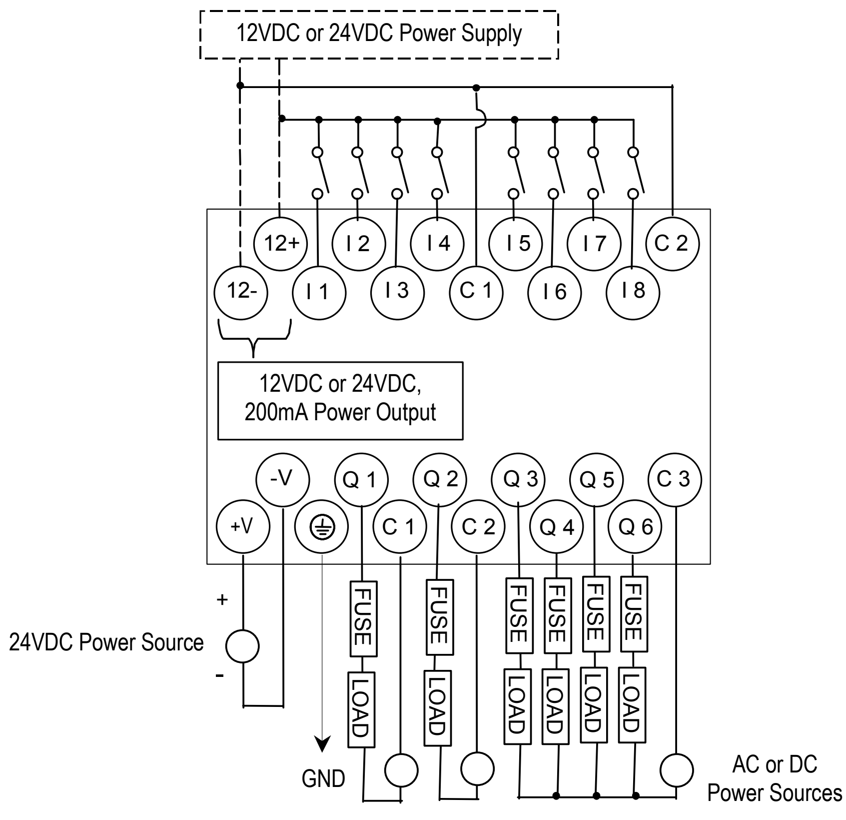
The six Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX012 Specifications

Inputs	Eight 24 VDC positive/negative logic input circuits
Outputs	Six normally open 2 amp relay circuits
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24VDC –20% / +25%
Hold-up	10 ms at 19.2 VDC
Inrush Current	1 Amp maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 Amp typical at 24 VDC
Input Power Supply Rating	4W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage, 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEX012



IC200UEX013
14-Point Expansion Unit with 12VDC Power, (8) 12VDC Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEX013 accepts eight 12VDC inputs and provides six normally-open 2 Amp relay outputs that can control 5 to 30 VDC or 5 to 250VAC output devices. The module requires +12VDC nominal input power.

DC Inputs

The eight 12 VDC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's isolated +12 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs

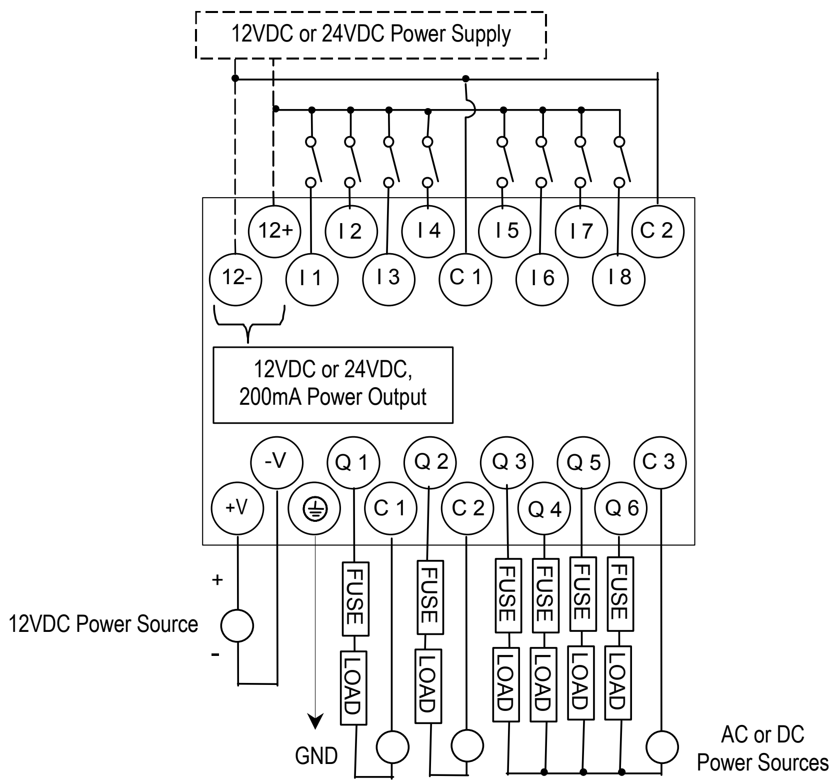
The six Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX013 Specifications

Inputs	Eight 12 VDC positive/negative logic input circuits
Outputs	Six normally open 2 amp relay circuits
+12 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	9.2A typical at 12 VDC
Inrush Time	200ms typical
Input Current	300mA typical at 12 VDC
Input Power Supply Rating	4W
DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Impedance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable)
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20×10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEX013



IC200UEX014
14-Point Expansion Unit with 24DC Power, (8) 24DC Inputs, (2) High-Current and (4) Low-Current Transistor Outputs

VersaMax Micro PLC Expansion Unit IC200UEX014 accepts eight DC inputs and provides two low-current and four high-current DC transistor outputs. It requires +24VDC nominal input power.

DC Inputs

The eight 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +24 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Expansion Unit UEX014 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

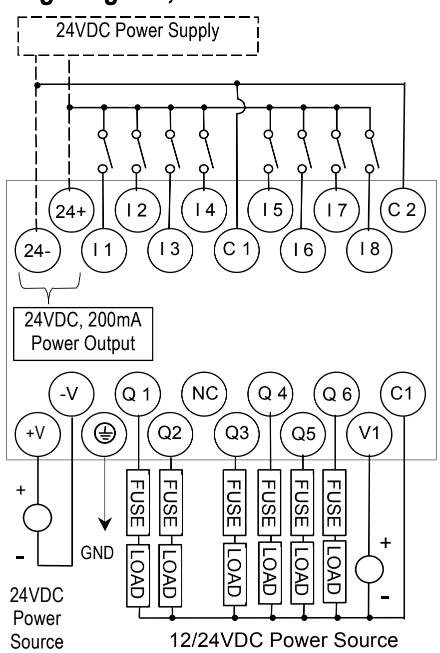
The outputs share one common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Expansion Unit IC200UEX014 Specifications

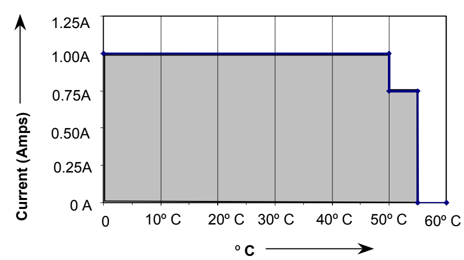
Inputs	Eight 24VDC positive/negative logic input circuits
Outputs	Four low-current and two high-current DC transistor output circuits
+24 VDC Output Power Supply	200mA maximum, (for input circuits and user devices)
DC Power Specifications	
Range	24 –20%/+25% VDC
Hold-up	10ms at 19.2VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Transistor Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load (see below)	1A per point (Q1 - Q2) at 100 % ON duration at 24VDC 0.5A per point (Q3 - Q6) at 100 % ON duration at 12VDC 0.75A per point (Q3 - Q6) at 100 % ON duration at 24VDC
Maximum Inrush Current	Q1, Q2: 8A for 20ms, 1 pulse, Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse
Output Voltage Drop	0.5V maximum
OFF state leakage	100µA maximum
Response	OFF to ON or ON to OFF: 0.1ms maximum at 24VDC, 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	10-30VDC required to power the outputs.
Fuses	Outputs should be fused externally..

Wiring Diagram, IC200UEX014



The maximum current that can be used for output points Q1 and Q2 is lower for ambient temperatures above 50 degrees C.



IC200UEX015
14-Point Expansion Unit with 12DC Power, (8) 12DC Inputs, (6) 12VDC Outputs

VersaMax Micro PLC Expansion Unit IC200UEX015 accepts eight DC inputs and provides six DC transistor outputs. It requires +12VDC nominal input power.

DC Inputs

The eight 12 volt DC inputs can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +12 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

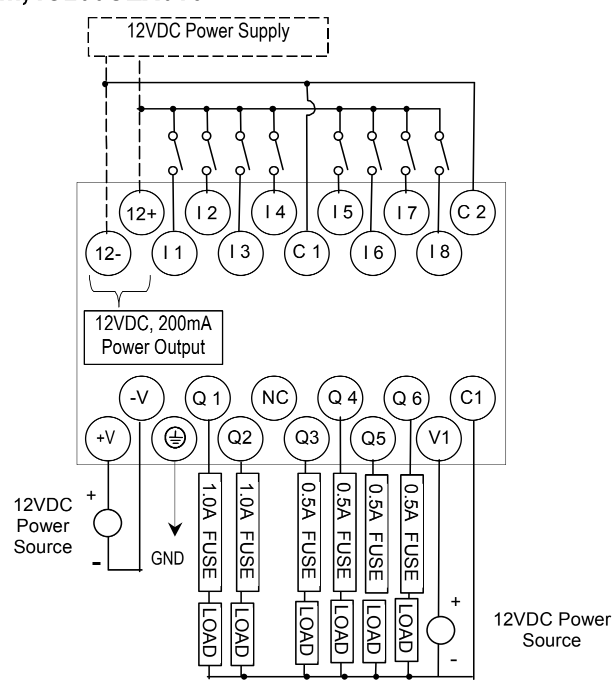
The outputs share one common incoming 12VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Expansion Unit IC200UEX015 Specifications

Inputs	Eight 12VDC positive/negative logic input circuits
Outputs	Six 12VDC output circuits
+12 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	9.6VDC to 15 VDC
Hold-up	3.0mS
Inrush Current	9.2A typical at 12 VDC
Inrush Time	200ms typical
Input Current	300mA typical at 12 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Number of Inputs	8
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Impedance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable)
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Transistor Output Specifications	
Voltage Range	12VDC +20%, -20%
Maximum Load	0.7A per circuit, 4A per common
Maximum Inrush Current	4A for 20mS
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA
Response	OFF to ON or ON to OFF: 0.1ms maximum 12VDC 0.2A
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12VDC required to power the outputs.
Fuse	Outputs should be fused externally.

Wiring Diagram, IC200UEX015



IC200UEX122
14-Point Expansion Unit with 24DC Power, (8) 24DC Inputs, (2) High-Current and (4) Low-Current Transistor Outputs with ESCP

VersaMax Micro PLC Expansion Unit IC200UEX122 accepts eight DC inputs and provides two low-current and four high-current DC transistor outputs. The outputs have electronic short circuit protection. The module requires +24VDC nominal input power.

DC Inputs

The 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +24 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Outputs

Expansion Unit UEX122 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). They can be used as positive or negative logic standard inputs.

All outputs are isolated between field and logic and are switching positive voltage.

All six outputs have electronic short-circuit protection, no fuses are needed to protect the outputs.

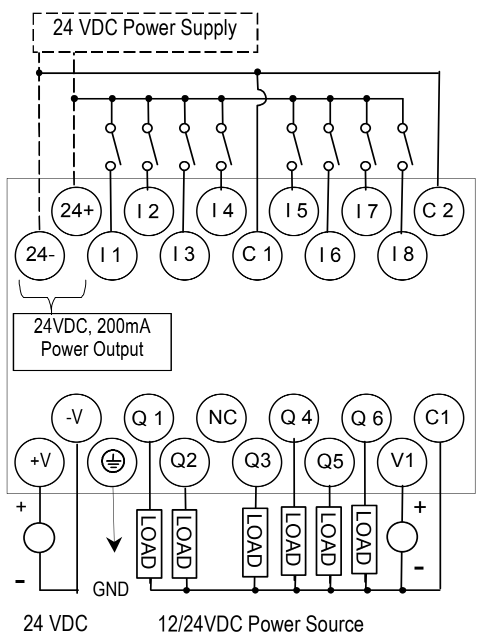
An external source of 12/24VDC power must be provided to power the outputs. The outputs share this common incoming 24VDC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

Expansion Unit IC200UEX122 Specifications

Inputs	Eight 24VDC positive/negative logic input circuits
Outputs	Four low-current and two high-current DC transistor output circuits with ESCP
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10ms at 19.2VDC
Inrush Current	1 A maximum at 30 VDC
Inrush Time	10 ms for 1 Amp
Input Current	0.16 A typical at 24 VDC
Input Power Supply Rating	4W

DC Input Specifications	
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Impedance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
sResponse Time	0.5 to 20ms
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	12/24VDC +10%/-15% (at VC)
Maximum Load Current	Q1 and Q2: 1A, 3.4A per common, Q3 to Q6: 0.7A per point , 3.4A per common
Maximum Inrush Current	Q1, Q2: 8A for 20ms, 1 pulse, Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse
Output Voltage Drop	0.3V
OFF state Leakage Current	0.1mA
Response Time	OFF to ON or ON to OFF: 0.05ms maximum at 24VDC
Isolation Voltage	1500V RMS field side to logic side, 500VAC between field side and logic side
External power supply	12/24VDC –10%, +20%
Fuse	Not required
Minimum switching current	10mA

Wiring Diagram, IC200UEX122



Chapter 8

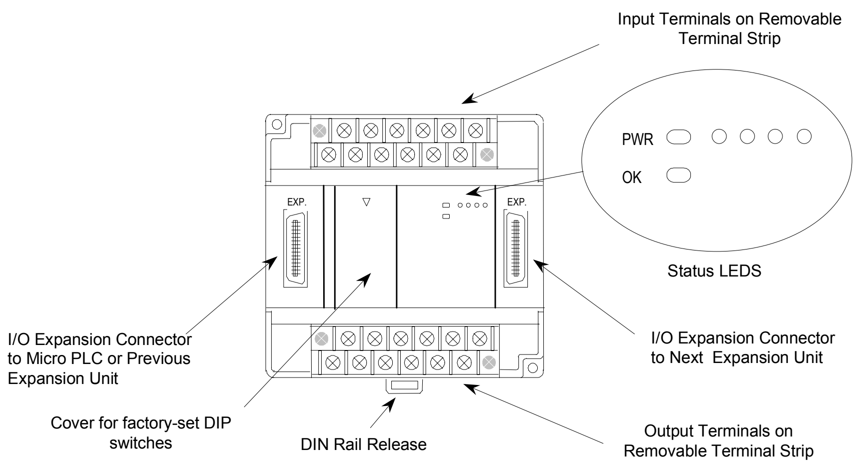
Analog and RTD Expansion Units

This chapter describes the following VersaMax Micro PLC Analog Expansion Units:

- IC200UEX616 6 Point Analog Expansion Unit, 4) Analog In and (2) Analog Out, 12 VDC Power Supply
- IC200UEX626 6 Point Analog Expansion Unit, (4) Analog In and (2) Analog Out, 24 VDC Power Supply
- IC200UEX636 6 Point Analog Expansion Unit, (4) Analog In and (2) Analog Out, 100/240 VAC Power Supply
- IC200UEX724 4 RTD, Pt 100 In, 24VDC Power Supply
- IC200UEX726 4 RTD, Pt 100 In and 2 Analog Out, 0 – 20mA, 4 – 20mA, or 0 – 10VDC, 24VDC Power Supply
- IC200UEX734 4 RTD, Pt 100 In, 100/240VAC Power Supply
- IC200UEX736 4 RTD, Pt 100 In and 2 Analog Out, 0 – 20mA, 4 – 20mA, or 0 – 10VDC, 100/240VDC Power Supply

Features of Analog and RTD Expansion Units

Analog and RTD Expansion Units have the features shown below. Expansion Units can be located up to 2 meters from the Micro PLC.



Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.

Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. Expansion Unit LEDs indicate local Power and OK mode.

On an RTD Expansion Unit, the input channel LEDs should be OFF during proper operation. Flashing channel LED indicates temperature out of range, open or shorted wire, or no RTD attached.

Cables

A 0.1 meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

Expansion Unit Specifications

Module Dimensions	Height: 90mm (3.6 inches) Depth: 76mm (3.0 inches) Width: 150mm (6.0 inches)
Inputs	4 analog or RTD inputs
Outputs	2 analog outputs (all models except UEX724 and UEX734)

DC Power Specifications for Expansion Units IC200EUX616, UEX626, UEX724, UEX726

	IC200UEX616	*IC200UEX626, UEX724, UEX726*
Power voltage	12VDC	24VDC
Range	9.6VDC - 15VDC	19.2VDC to 30VDC
Hold-up	10.1ms at 9.6V	24.5ms at 19.2V
Inrush Current/Time	0.9A / 1ms at 15V	2.5V / 1ms at 30V
Input Current	0.15A at 15V	0.1A at 30V
Input Power Supply Rating	2.25W	3W

The DC power source must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level.

AC Power Specifications for Expansion Unit IC200UEX636, UEX734, UEX736

Power voltage	100/110/120/200/210/220V (50/60Hz)
Range	85 to 264VAC
Hold-up	223ms at 85V
Inrush Current/time	4A / 5ms at 264V
Input Current	0.06A at 264V
Input Power Supply Rating	15VA

RTD Expansion Units Applications and Compatibility

VersaMax Micro PLC RTD Expansion Units are used for application that require temperature monitoring and control. Typical applications include oven control, motor monitoring, refrigerant control, environmental control. One RTD Expansion Unit can monitor up to 16 RTDs. RTD Expansion Units are compatible with Micro PLCs having a firmware version of 2.0 or greater.

They are compatible with Machine Edition Logic Developer 2.06 or above and with VersaPro software 2.03 and above. Some compatible software versions do not list these modules separately, but allow them to be configured as analog expansion units. Current software versions list these modules by number and description.

Input and Output Specifications

*Analog Input Channels (IC200UEX6**)*	4, differential
Input ranges	0 to 10V (10.23V maximum) -10V to +10V (-10.23V min. and +10.23V max.) 0 to 20mA (20.47mA maximum) 4 to 20mA (20.47mA maximum)
Resolution	12 bits
Accuracy	±1% of full scale over full operating temperature range
Linearity	±3 LSB maximum
Isolation	non-isolated
Common mode voltage	±40 V maximum
Current input impedance	249 ohms
Voltage input impedance	200 Kohms
Input filter time	20ms to reach 1% error for step input
*RTD Input Channels (IC200UEX7**)*	4, differential
Input Sensor Types	2- and 3-wire types, PT 100
Input ranges	-100 to +600C / -150 to +1050F
Resolution	0.2C / 0.3F
Accuracy	±0.5% of full scale over operating temperature range
Data Format	0 to 32000 for F, or 0 to 28000 for C
Constant Current	Approximately 1mA
Channel Update Time	141/563ms (selectable) for all channels
Diagnostics	LED on module blinks when inputs values at –100C (-150F) or less, or 600C (+1050F) or more (includes cable disconnection)
Digital Resolution	15 bits + sign
Open Circuit Detection Time	141ms or 563ms, excluding logic execution
Channel to Channel Isolation	None
Maximum Lead Resistance	100Ohms
Converter Type	Successive approximation
Excitation	Current Source 1.0mA
Analog Output Channels	2, single-ended, non isolated
Output ranges	0 to 10V (10.23V maximum) 0 to 20mA (20.47mA maximum) 4 to 20mA (20.47mA maximum)
Resolution	12 bits
Accuracy	±1% of full scale over operating temperature range
Current: maximum terminal voltage user load range output load capacitance output load inductance	10V (at 20mA output) 10 to 500 ohms 2000 pF maximum 1 Henry maximum
Voltage: output loading output load capacitance	10 kOhm minimum at 10 volts 1 μF maximum

Analog Operation

This section explains how a VersaMax Micro PLC Expansion Unit with analog channels processes analog data. Unlike discrete expansion units, if one analog unit fails all subsequent analog expansion units will stop communicating. However, expansion units before the failed unit continue to be available. If an analog expansion fails at power up, no expansion units (discrete or analog) will be functional.

Analog I/O Parameters

Each analog channel can be configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA. If voltage mode operation is selected (inputs only), the range can then be configured as either 0-10V or –10V to +10V.

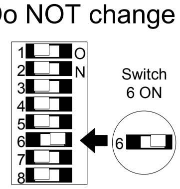
Parameter	***Choices***	***Default Value***
Voltage or current mode	Voltage, Current	Voltage
Current range selection	4–20mA, 0–20mA	4–20mA
Voltage range selection (Inputs Only)	0-10V, -10-+10V	0-10V

Input/Output Values Compared to Process Data

The Expansion Unit processes analog channels using fixed conversion values for both current and voltage mode operation. The table below shows the relationship between the analog input and output values used by the application program, and the actual analog input or output for each mode. These values include the automatic adjustments for gain.

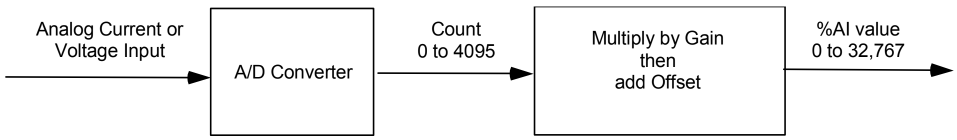
In this Configured Mode:	***This is the Analog Signal Range***	***This is the Equivalent Process Data %AI or %AQ Range***	***For the Default Calibration, the Value in the %AI or %AQ Reference Equals:***
Voltage 0 to +10V	0 to 10,000mV	0 to 32000	3.2 x mV
Voltage –10 to +10V (Inputs Only)	-10,000mv to +10,0000mV	-32000 to 32000	3.2 x mV
Current 0 to 20mA	0 to 20,000µA	0 to 32000	1.6 x µA
Current 4 to 20mA	4,000 to 20,000µA	0 to 32000	2 x µA –8000

For analog expansion units, count resolution is controlled by a dip switch setting on the module. Switch 6 should be set to ON by default. If unexpected results are observed, check the position of switch 6. If switch 6 is not ON, power down the system and set switch 6 to ON. Do NOT change any of the other switches.



Analog Input Processing

The Expansion Unit processes analog input channels with a 12-bit successive-approximation A/D converter. It converts the analog value into a digital count, calculates the %AI value as described below, then places the result into the appropriate %AI input reference (these references are described in chapter 16).



Automatic Conversion of Analog Voltage or Current to Counts

In voltage mode, the Expansion Unit first converts the 0 to 10,000mV input signal to a count in the range of 0 to 4,000 (or –10,000mV to 10,000mV signal to a range of –4,000 to 4,000). The fixed multiplier for this conversion is 2.5.

In current mode, the Expansion Unit first converts the 0 to 20,000µA input signal to a count value in the range of 0 to 4,000. The fixed multiplier for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Automatic Gain and Offset Adjustment for Analog Inputs

The Expansion Unit then converts the A/D converter's input count value from the range of 0 to 4000 to a final %AI input value in the range of 0 to 32,000. It multiplies the count value by 8 (32000 / 4000) to get the final analog input ($AI):

(input count X 8) = %AI value

Any calculated value above 32,767 is clamped at that maximum value. Any calculated value less than 0 is clamped at 0.

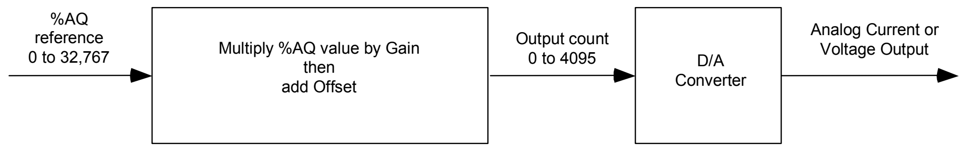
Analog Input Conversion Summary

The table below summarizes the conversion of voltage or current inputs to counts and then to %AI values.

Input Signal	Conversion Factor	A/D Converter VAlue	Gain Factor	%AI Range
Voltage Mode (0 to 10,000mV)	2.5	0–4000 counts	8	0–32,000
Voltage Mode (-10,000 to 10,000mV)	2.5	-4000 to 4000 counts	8	-32,000 to 32,000
Current Mode (0–20mA) or (4–20mA)	5	0–4000 counts	8	0–32,000

Analog Output Processing

To generate the analog output signal, the Expansion Unit converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.



Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Expansion Unit first multiplies the %AQ value from the program by .125 (4000 / 32000) to produce the count value for the D/A converter:

(%AQ X .125) = D/A count

Any calculated value that exceeds 4095 (2^{12}-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,767.

Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000μA. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Analog Output Data Conversion Summary

The table below summarizes the conversion of %AQ values to counts and then to voltage or current levels.

%AQ Range	Gain, Factor	D/A Converter Range	Conversion Factor	Output Signal
0– 32,000	0.125	0–4,000 counts	2.5	Voltage Mode (0–10,000mV)
0–32,000	0.125	0–4,000 counts	5	Current Mode (0–20mA) or (4–20mA)

Data Conversion for RTD Expansion Units

Individual channels on an RTD Expansion Units can be individually configured for either Celsius or Fahrenheit (see chapter 10 for configuration information).

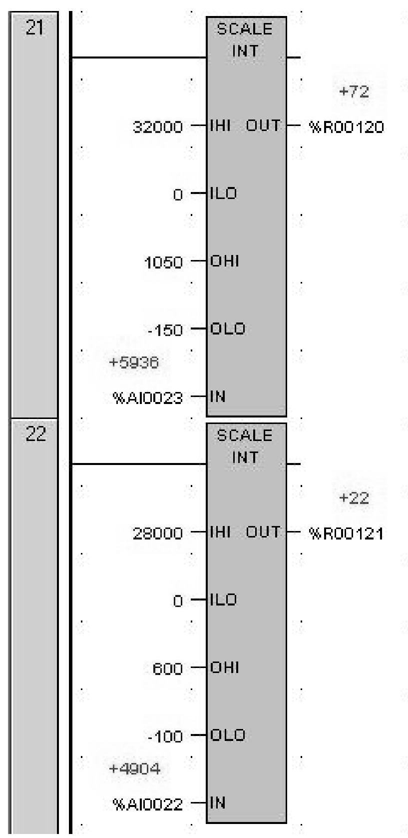
If Celsius is configured, the range of data for a channel is 0 to 28,000.

If Fahrenheit is configured, the range of data for the channel is 0 to 32,000.

- Values below 0 indicate shorted cable.
- Values above 28,000 C or 32,000 F indicate disconnected (open) or shorted cable.

Basic Temperature Conversion Logic

The Scaling function (see chapter 16) can be use in the application program to convert the raw counts value for a channel to a temperature measurement in degrees. The ranges are -100 to +600 degrees C and -150 to +1050 degrees F.



High-Resolution Temperature Conversion Logic

For accuracy in tenths of degrees, the Data Type Conversion functions (see chapter 16) can be added to the program logic. See the examples below.

Celsius Conversion

Line 15: Converts RTD to Real Value. Data will be stored in two consecutive Registers 100 and 101

Line 16: Divides the raw value by 40.0 (28000/700) 700 comes from the full temperature range of 600 to –100 C. Result is placed in R102 and R103

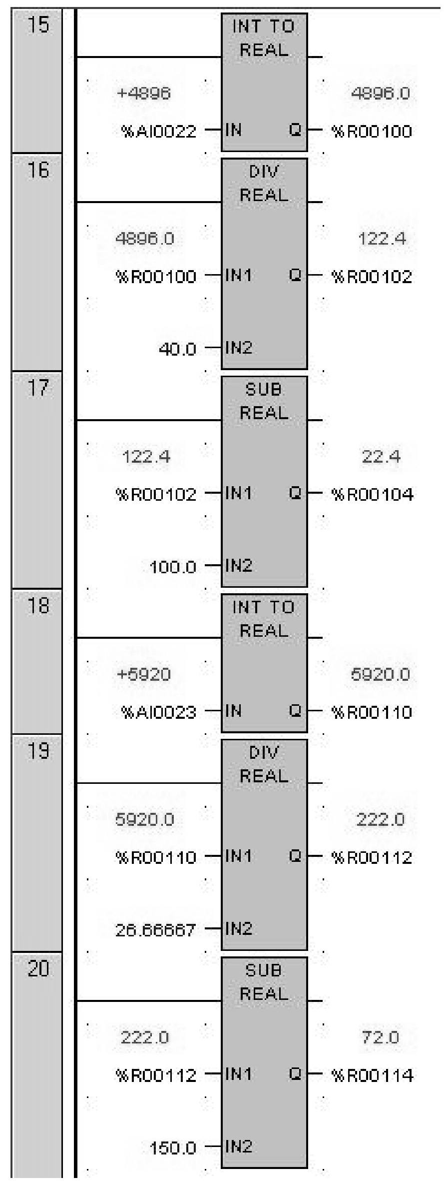
Line 17: Subtracts 100 for conversion. This is to offset the –100 and the result is in R104 and R105

Fahrenheit Conversion

Line 18: Converts RTD to Real Value. Data will be stored in two consecutive Registers 110 and 111

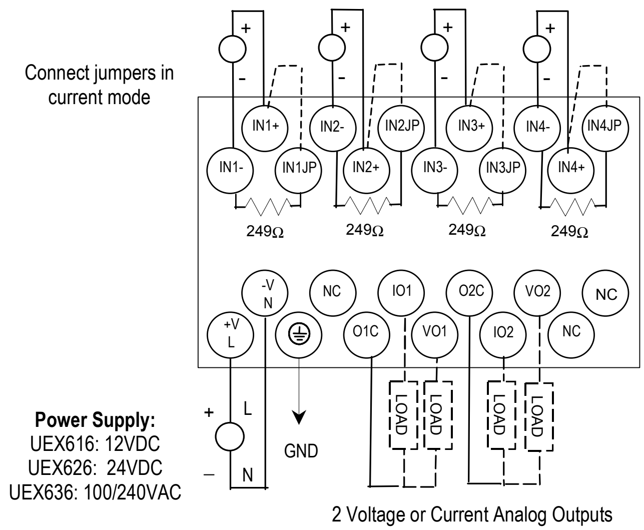
Line 19: Divides the raw value by 26.66667 (32,000/1200) 1200 comes from the full temperature range of 1050 to –150 F. Result is placed in R112 and R113

Line 20: Subtracts 150 for conversion. This is to offset the –150 and the result is in R114 and R115



Wiring Diagrams

Analog Expansion Units

IC200UEX616 ***IC200UEX626*** ***IC200UEX636*** ***Expansion Units*** The resistors illustrated are internal.	

RTD Expansion Units

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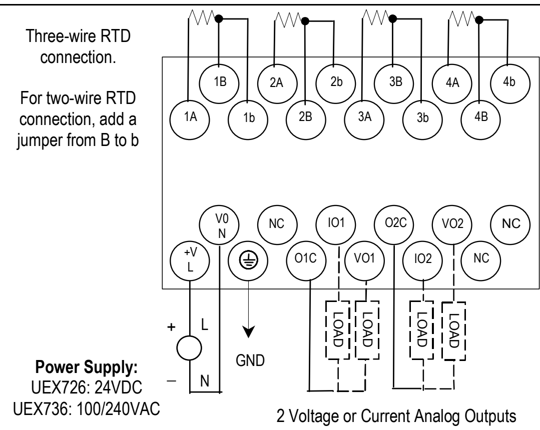
IC200UEX736

Expansion Units</td>
<td>
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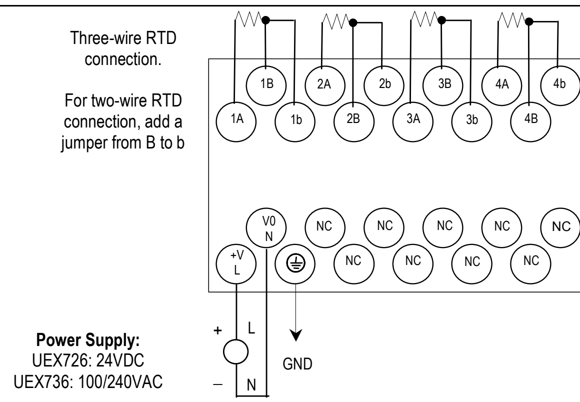
<tr>
<td>IC200UEX724
IC200UEX734

Expansion Units</td>
<td>
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</table>

1. To avoid risk of electric shock, turn off power to the Micro PLC and disconnect the main power before connecting the RTD expansion modules.
2. Loosen the screws on the terminal block and attach unit power, RTD wires and analog outputs. Tighten all screws securely. The RTD wires should be the same type and length (except for the jumper used in a two-wire RTD) to ensure accuracy. Do not use the shield or drain wire for the third connection.
3. If all RTD channels are not used, a 100 to 300 Ohm resistor can be connected across terminal A to B with a jumper connected from B to b. The resistor will disable the diagnostics and stop the channel LED from flashing.
4. Connect the expansion cable to the Micro PLC or expansion unit to the left of the RTD Expansion Unit.

Check the DIP switch settings as shown on page 9-32. Turn power on. The Power and OK LEDs should be ON. The LEDs for channels 1 to 4 should be OFF during normal operation if the RTDs are connected properly.

Chapter 9

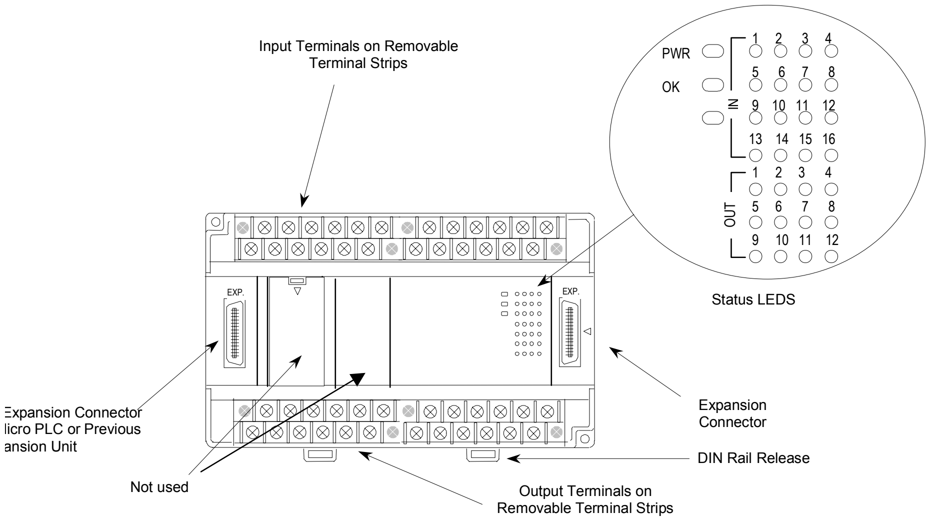
VersaMax Micro PLC 28-Point Expansion Units

This chapter consists of module datasheets for the following VersaMax Micro PLC Expansion Units:

▪ IC200UEX209	28 Point Expansion Unit, (16) 120VAC In, (2) Relay Out at 10 Amps, (10) Relay Out at 2 Amps, 120/240VAC Power Supply
▪ IC200UEX210	28 Point Expansion Unit, (16) 120VAC In, (12) 120VAC Out, 120/240VAC Power Supply
▪ IC200UEX211	28 Point Expansion Unit, (16) 24VDC In, (12) Relay Out, 120/240VAC Power Supply
▪ IC200UEX212	28 Point Expansion Unit, (16) 24VDC In, (12) Relay Out, 24VDC Power Supply
▪ IC200UEX213	28 Point Expansion Unit, (16) 12VDC In, (12) Relay Out, 12VDC Power Supply
▪ IC200UEX214	28 Point Expansion Unit, (16) 24VDC In, (12) 24VDC Out, 24VDC Power Supply
▪ IC200UEX215	28 Point Expansion Unit, (16) 12VDC In, (12) 12VDC Out, 12VDC Power Supply
▪ IC200UEX222	28 Point Expansion Unit, (16) 24VDC In, (12) 24VDC Out with ESCP, 24VDC Power Supply

Features of VersaMax 28-Point Micro PLC Expansion Units

Modular 28-point Expansion Units can be used to increase the total I/O count of a Micro PLC. Expansion Units can be used with any 14- to 64-point Micro PLC. Expansion Units can be located up to 2 meters from the Micro PLC.



Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.

Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. In addition to LEDs Expansion Unit local Power and OK mode, there is an LED for each I/O point.

Cables

A 0.1 meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

IC200UEX209
28 Point Micro PLC Expansion Unit, (16) 120VAC In, (2/10) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX209 accepts sixteen AC inputs and provides two relay outputs at 10 Amps and ten relay outputs at 2 Amps. It uses 100VAC to 240VAC nominal input power.

AC Inputs

The 120 VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

Relay Outputs

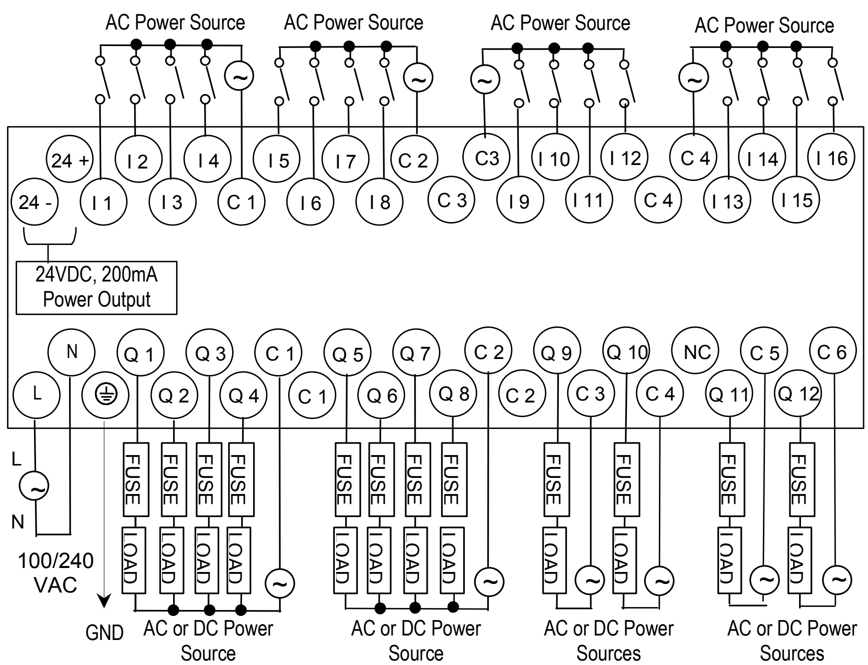
The relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX209 Specifications

Inputs	16 AC inputs
Outputs	2 relay outputs at 10 Amps, 10 relay outputs at 2 Amps
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
AC Power Specifications	
Range	100 –15% to 240 +10% VAC
Frequency	50 –5% to 60 +5% Hz
Hold-up	10ms at 85-100 VAC, 20ms at 100-264 VAC
Inrush Time	2ms for 40 Amp
Inrush Current	30 Amp maximum at 200VAC, 40 Amp maximum at 265VAC
Input Current	0.10 Amp typical at 100VAC, 0.06 Amp typical at 200VAC
Input Power Supply Rating	16 VA
AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms
Response Time	OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms
Isolation	1500V rms field side to logic side, 500V rms between groups

Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24VDC and 240VAC		10 amps at 24VDC and 240VAC
Maximum Resistive Load Rating	2 amps at 24VDC and 240VAC		10 amps at24 VDC and 240VAC
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		14 amps per half cycle
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2.0A 10.0A 4.0A	Current: Lamp and Solenoid 0.6A 4.0A 1.0A	Typical Operations 100,000 100,000 200,000

Wiring Diagram, IC200UEX209



Outputs Q 1 – Q 10 are rated at 2.0 Amps each. Outputs Q 11 and Q 12 are rated at 10.0 Amps each.

IC200UEX210
28 Point Micro PLC Expansion Unit, (16) 120VAC In, (12) 120VAC Out, 120/240VAC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX210 accepts sixteen AC inputs and provides twelve AC outputs. It uses 100VAC to 240VAC nominal input power.

AC Inputs

The 120VAC input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

AC Outputs

The 120/240 VAC, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

AC power to operate loads connected to outputs must be supplied from an external source.

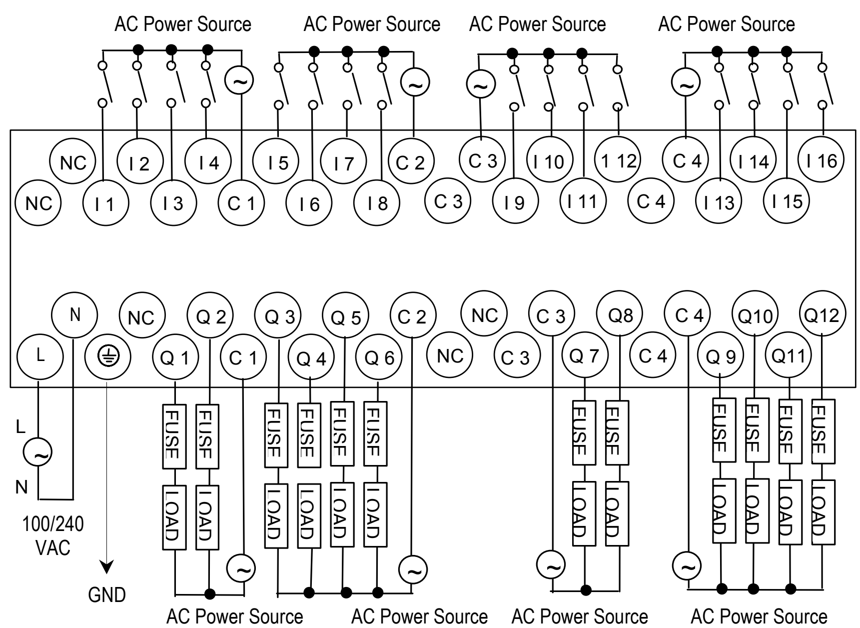
This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling a wide range of inductive and incandescent loads.

Expansion Unit IC200UEX210 Specifications

Inputs	16 AC inputs
Outputs	12 AC outputs
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10ms at 85-100 VAC, 20ms at 100-264 VAC
Inrush Time	2ms for 40 Amp
Inrush Current	30 Amp maximum at 200VAC, 40 Amp maximum at 265VAC
Input Current	0.10 Amp typical at 100VAC, 0.06 Amp typical at 200VAC
Input Power Supply Rating	16 VA

AC Input Specifications	
Points/Common	4 (I1–I4) and (I5–I8)
Rated Load Voltage	85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage	132V rms, 50/60 Hz
Input Current	8 mA rms (100 VAC, 60 Hz)
Voltage	ON minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms
Response Time	OFF to ON: maximum 25 ms< ON to OFF: maximum 30 ms
Isolation	1500V rms field side to logic side, 500V rms between groups
AC Output Specifications	
Rated Load Voltage	100 -15% to 240 +10% VAC, 50 -5% to 60 +5% Hz
Maximum Resistive Load Current	0.5 Amp per point
Maximum UL Pilot Duty Rating	0.5 Amp per point at 240 VAC 0.6 Amp maximum on C1 and C3 1.2 Amps maximum on C2 and C4
Maximum Inrush Current	5A (1 period)/point, 10A (1 period)/common
Maximum voltage drop when ON	1.5 V RMS
Maximum leak current when OFF	1.8 mA RMS (115 VAC), 3.5 mA RMS (230 VAC)
Response Time (Maximum)	OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 ms
Isolation	1500V RMS field side to logic side, 500V RMS between groups

Wiring Diagram, IC200UEX210



IC200UEX211
28 Point Micro PLC Expansion Unit, (16) 24VDC In, (12) Relay Out, 120/240VAC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX211 accepts sixteen DC inputs and provides twelve normally-open 2 Amp relay outputs. It uses 100VAC to 240VAC nominal input power.

DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. The +24 VDC supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs (Q1 – Q12)

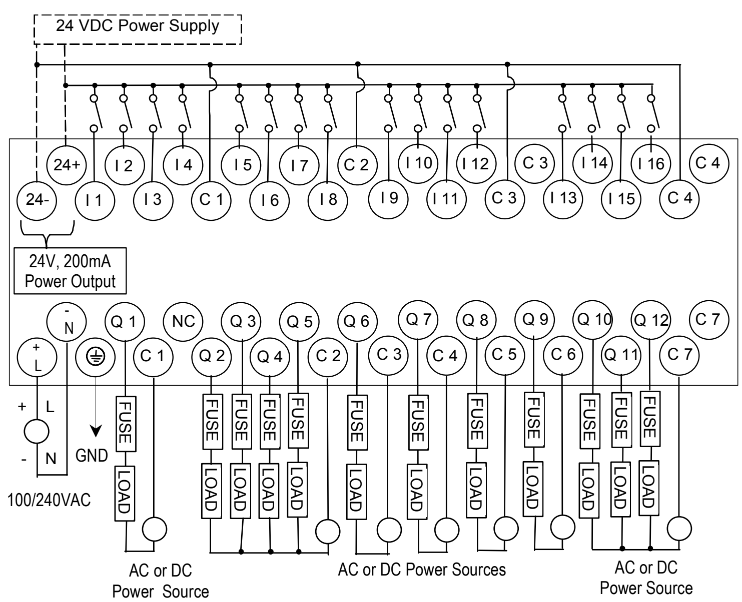
The twelve Form A (SPST-single pole single throw) normally-open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX211 Specifications

Inputs	Sixteen 24 VDC positive/negative logic input circuits
Outputs	Twelve normally open 2 amp relay circuits
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10ms at 85 to 100VAC, 20ms at 100 to 265VAC
Inrush Current	30 Amp maximum at 200 VAC, 40 Amp maximum at 265 VAC
Inrush Time	2 ms for 40Amp
Input Current	0.20 Amp typical at 200 VAC, 0.10 Amp typical at 100 VAC
Input Power Supply Rating	26 VA

DC Input Specifications			
Number of Inputs	16		
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current	7.5mA typical		
Input Resistance	2.8 Kohms		
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum		
Response Time	0.5 to 20ms configurable		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2.0A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEX211



IC200UEX212
28 Point Micro PLC Expansion Unit, (16) 24VDC In, (12) Relay Out, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX212 accepts sixteen DC inputs and provides twelve normally-open 2 Amp relay outputs. It uses +24VDC nominal input power.

DC Power

The 24VDC power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage. The +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Relay Outputs (Q1 – Q12)

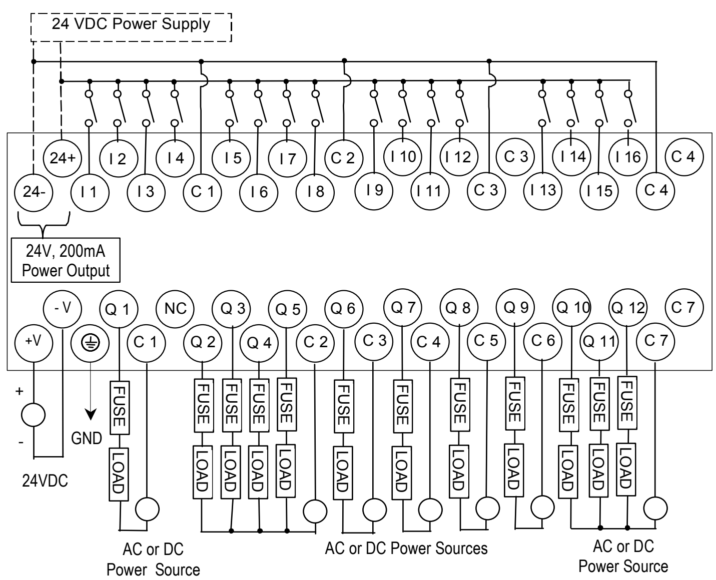
Twelve Form A (SPST-single pole single throw) normally-open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2A. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX212 Specifications

Inputs	Sixteen 24 VDC positive/negative logic input circuits
Outputs	Twelve normally open 2 amp relay circuits
DC Power Specifications	
Range	24 -20%, +25% VDC
Hold-up	10ms at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10ms for 1 A
Input Current	0.30 Amp typical at 24VDC
Input Power Supply Rating	8W
+24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)

DC Input Specifications			
Number of Inputs	16		
Rated Input Voltage	24 volts DC		
Input Voltage Range	0 to 30 volts DC		
Input Current	7.5mA typical		
Input Resistance	2.8 Kohms		
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum		
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum		
Response Time	0.5 to 20ms configurable		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEX212



IC200UEX213
28 Point Micro PLC Expansion Unit, (16) 12VDC In, (12) Relay Out, 12VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX213 accepts sixteen 12VDC inputs and provides twelve normally-open 2 Amp relay outputs. It uses +12VDC nominal input power.

DC Power

The 12VDC power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level.

DC Inputs

Sixteen configurable 12VDC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 12 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Relay Outputs (Q1 – Q12)

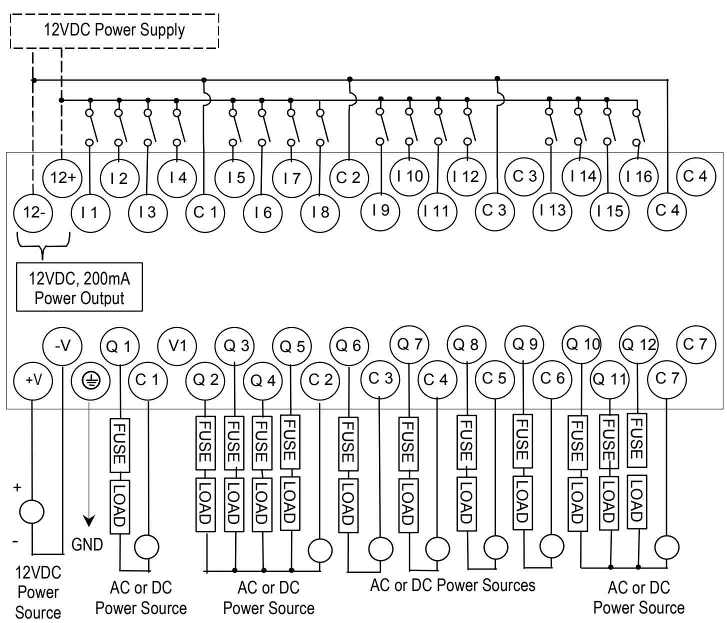
Twelve Form A (SPST-single pole single throw) normally-open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

Expansion Unit IC200UEX213 Specifications

Inputs	Sixteen 12 VDC positive/negative logic input circuits
Outputs	Twelve normally open 2 amp relay circuits
DC Power Specifications	
Range	9.6VDC - 15VDC
+12 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200ms typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W

DC Input Specifications			
Number of Inputs	16		
Rated Input Voltage	12 volts DC		
Input Voltage Range	0 to 15 volts DC		
Input Current	9.0mA typical		
Input Impedance	1.3 kOhms		
Input Threshold Voltage	ON : 9.5VDC minimum, OFF: 2.5VDC maximum		
Input Threshold Current	ON: 6.5mA maximum , OFF: 1.6mA minimum		
Response Time	0.5 to 20ms (user configurable)		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000

Wiring Diagram, IC200UEX213



IC200UEX214
28 Point Micro PLC Expansion Unit, (16) 24VDC In, (12) 24VDC Out, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX214 accepts sixteen DC inputs and provides four low-current and eight high-current DC transistor outputs. It uses +24VDC nominal input power.

DC Power

The 24VDC power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level.

DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Twelve positive-logic transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Otherwise, a load short could damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

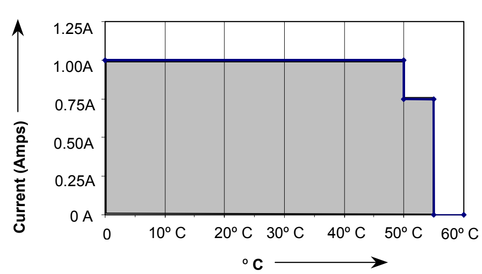
Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A.

All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

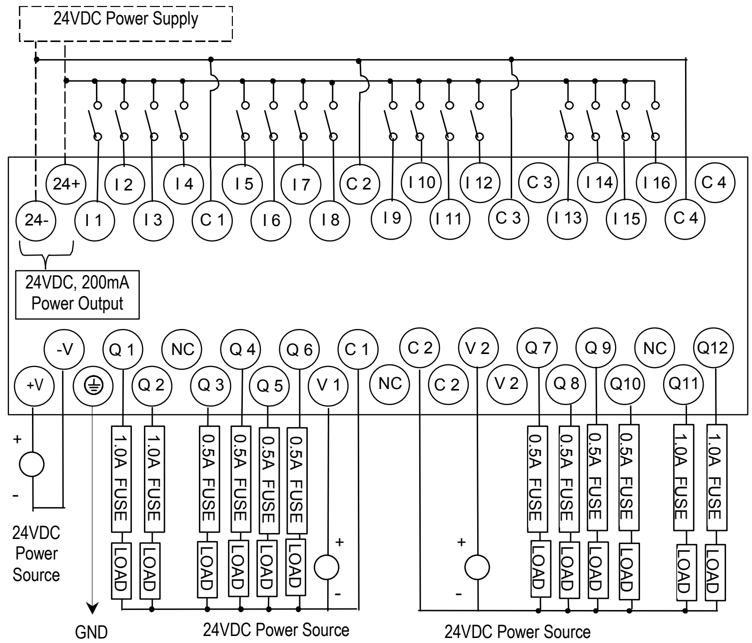
Expansion Unit IC200UEX214 Specifications

Inputs	Sixteen 24 VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 24 VDC.
DC Power Specifications	
Range	24 -20%, +25% VDC
Hold-up	10ms at 19.2 VDC
+24 VDC Output Power Supply	200mA maximum (for input circuits an user devices)
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10ms for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W
DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
Transistor Output Specifications	
Voltage Range	12VDC/24VDC (24VDC +10% / -43% input at V1,C1)
Maximum Load (See below)	1.0A per point (Q1, Q2, Q11, Q12) at 24VDC at 100% ON duration 0.75A per point (Q3 - Q10) at 24VDC at 100 % ON duration 0.5A per point (Q3 - Q10) at 12VDC at 100 % ON duration
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	0.3V maximum
OFF state leakage	100µA maximum
Response Time	OFF to ON : 0.1ms maximum (24 VDC, 0.2A) ON to OFF : 0.1ms maximum (24 VDC, 0.2A)
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
External Fuse	Recommended

The maximum current that can be used for output points Q1, Q2, Q11 and Q12 is lower for ambient temperatures above 50 degrees C



Wiring Diagram, IC200UEX214



IC200UEX215
28 Point Micro PLC Expansion Unit, (16) 12VDC In, (12) 12VDC Out, 12VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX215 accepts sixteen 12VDC inputs and provides twelve DC transistor outputs. It requires +12VDC nominal input power.

DC Power

The 12VDC power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level.

DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 12 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Expansion Unit IC200UEX215 has four high-current transistor outputs (Q1, Q2, Q11, and Q12) and eight low-current transistor outputs (Q3 to Q10). All outputs are isolated between field and logic and are switching positive voltage.

Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A. Each group of 6 outputs has one common incoming supply (V1, V2) and one common ground (C1, C2). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

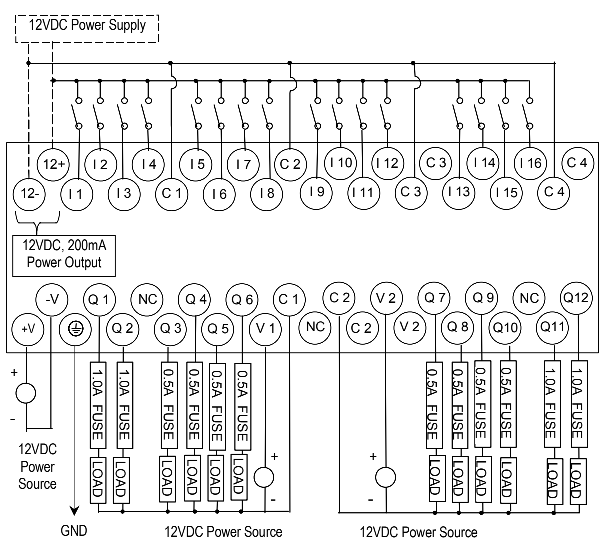
Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

Expansion Unit IC200UEX215 Specifications

Inputs	Sixteen 12VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 12 VDC.
+12 VDC Output Power Supply	200mA maximum (for input circuits and user devices)

DC Power Specifications	
Range	9.6VDC to 15 VDC
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200ms typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W
DC Input Specifications	
Number of Inputs	16
Rated Input Voltage	12 volts DC
Input Voltage Range	0 to 15 volts DC
Input Current	9.0mA typical
Input Resistance	1.3 kOhms
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum
Input Threshold Current	ON: 6.5mA maximum , OFF: 1.6mA minimum
Response Time	0.5 to 20ms (user configurable)
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	12VDC (+20%, -20%)
Maximum Load	0.7A per point (Q1 - Q12) at 24VDC at 100 % ON duration, 4A per common
Maximum Inrush Current	4A for 20mS
Output Voltage Drop	0.3V maximum
OFF state leakage	0.1mA maximum
Response Time	OFF to ON or ON to OFF : 0.1ms maximum (12 VDC)
Isolation Voltage	1500V RMS between field side and logic side, 500V RMS between groups
Fuse	Outputs should be fused externally.

Wiring Diagram, IC200UEX215



IC200UEX222
28 Point Micro PLC Expansion Unit, (16) 24VDC In, (12) 24VDC Out with ESCP, 24VDC Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX222 accepts sixteen DC inputs and provides twelve 24VDC outputs. The outputs have electronic short circuit protection. The module uses +24VDC nominal input power.

DC Power

The 24VDC power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level. 24VDC output power is available for field devices, up to 200mA maximum.

DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The +24 VDC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

Transistor Outputs

Twelve positive-logic DC outputs can be used to switch devices like valves, lamps or contactors. Outputs provide electronic short-circuit protection.

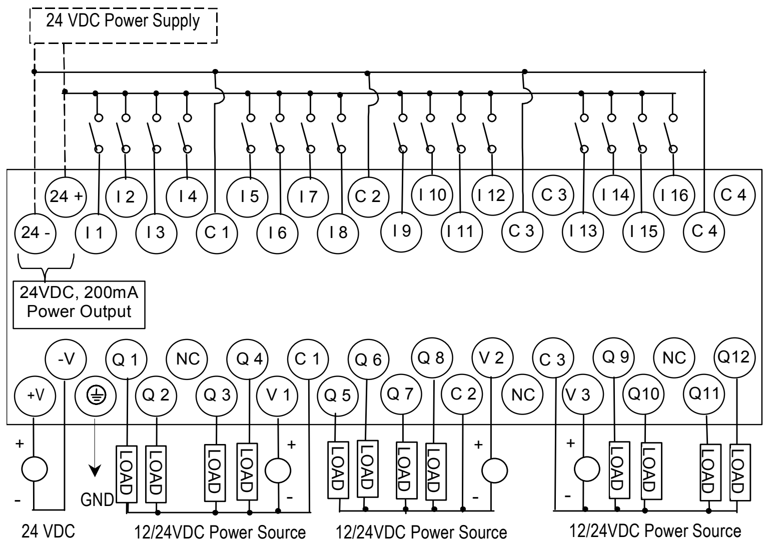
Outputs are grouped in three groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 4 outputs with a maximum load of 1A.

Expansion Unit IC200UEX222 Specifications

Inputs	Sixteen 24 VDC positive logic inputs in four groups of four
Outputs	Twelve transistor outputs, 24 VDC.
DC Power Specifications	
Range	19.2VDC to 30VDC
Hold-up	10ms at 19.2 VDC
24 VDC Output Power Supply	200mA maximum (for input circuits and user devices)
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10ms for 1 Amp
Input Current	0.20 Amp typical at 24VDC
Input Power Supply Rating	5W

DC Input Specifications	
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms.
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Voltage Range	Q1 – Q12: 12/24VDC +10%, -15%
External Power Supply (for supplying power to the V terminal)	12/24V -10%, +20%
Maximum Load Current	Q1 and Q2: 1A per point, Q3 - Q12: 0.7A per point
Minimum Switching Current	10mA
Maximum Inrush Current	Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse
Output Voltage Drop	Q1– Q12: 0.3V maximum
OFF state leakage current	0.1mA
Response Time	OFF to ON or ON to OFF: 0.05ms maximum @ 24VDC
Isolation Voltage	1500V RMS between field side and logic side 500V RMS between groups
Fuses	Not required
Undervoltage shutdown	Q1 - Q12: 5V minimum, 8V maximum
DC short circuit current	Q1 – Q12: 0.7A minimum, 2A maximum
Peak short circuit current	4A maximum
Delay time of peak short circuit current	100μS
Delay time of current limit	100μS

Wiring Diagram, IC200UEX222



Chapter 10

Installation Instructions

This chapter describes the procedures for installing a VersaMax Nano PLC or VersaMax Micro PLC and preparing the system for use. Included in this chapter are instructions for unpacking, inspecting, and installing the PLC. Instructions are also provided for connecting cables to programming devices.

- Preinstallation check
- Agency Approvals, Standards, and General Specifications
- Immunity and Emission Specifications, Relevant Standards, and Level Passed
- Installation Guidelines
- Mounting Dimensions
- Grounding the Equipment
- Installing a PLC or Expansion Unit on a DIN Rail
- Connecting an Expansion Unit to a Micro PLC
- System Wiring Guidelines
- Starting Up the PLC
- Adjusting the Analog Potentiometers
- DIP Switches
- Installing/Replacing a Backup Battery
- Serial Port Connections
- RS485 Port Isolator
- RS-232 to RS-485 Adapter
- Replacing AC Output Module Fuses

Preinstallation Check

Carefully inspect all shipping containers for damage during shipping. If any part of the system is damaged, notify the delivery service immediately. The damaged shipping container should be saved as evidence for inspection by the delivery service. As the consignee, it is your responsibility to register a claim with the delivery service for damage incurred during shipment. However, GE Fanuc will fully cooperate with you, should such action be necessary. After unpacking the equipment, record all serial numbers. Serial numbers are required if you should need to contact Product Service during the warranty period of the equipment. All shipping containers and all packing material should be saved should it be necessary to transport or ship any part of the system.

Keep Micro PLC modules in their boxes during storage and transport.

Agency Approvals, Standards, and General Specifications

The Micro PLC products supplied by GE Fanuc are global products designed and manufactured for use throughout the world. They should be installed and used in conformance with product-specific guidelines as well as the following agency approvals, standards and general specifications:

Agency Approvals		***Comments***
Industrial Control Equipment [Safety]	UL508, CSA C22.2 No 142-M1987	Certification by Underwriters Laboratories for Revision B and later models
Hazardous Locations [Safety] Class I, Div II, A, B, C, D	UL1604 CSA C22.2 No 142-M1987	Certification by Underwriters Laboratories for Revision B and later models
European EMC & LVD Directives	CE Mark	All models

Environmental		***Conditions***
Vibration	IEC68-2-6, JISC0911	1G @57-500Hz, 0.15mm p-p @10-57Hz
Shock	IEC68-2-27, JISC0912	15G, 11ms
Operating Temperature		0deg C to 55deg C [ambient]
Storage Temperature		–10deg C to +75deg C
Humidity		5% to 95%, non-condensing
Enclosure Protection	IEC529	Enclosure per IP54; protection from dust & splashing water
Isolation: Dielectric Withstand	UL508, UL840, IEC664	1.5KV for modules rated from 51V to 250V

Immunity and Emission Specifications, Relevant Standards, and Level Passed

Description	***Standards***	***Specifications***
Electrostatic Discharge	EN 61000-4-2	± 4.0 kV (Contact) ± 8.0 kV (Air)
RF Susceptibility	EN 61000-4-3	10 V/m (unmodulated), 80-1000 MHz, 80% AM, 1 kHz sine wave
RF Susceptibility from Digital Radio Telephones	ENV 50204	10 V/m (unmodulated), 900±5Mhz, 100% AM (200 Hz square wave, 50% duty cycle)
Fast Transient	EN 61000-4-4	± 2.2 kV (PS) ± 1.1 kV (I/O)
Voltage Surge	EN 61000-4-5	± 2.2 kV, common mode (PS) ± 1.1 kV, differential (PS)
Conducted RF	EN 61000-4-6	10 V_{rms}, 0.15-80 MHz, 80% AM, 1 kHz sine wave (PS, I/O)
Voltage Dip Voltage Interrupt Voltage Variation	EN 61000-4-11	30% Nom., 10 ms >95% Nom., 10ms 20% Nom. 10 sec.
Radiated Emissions	EN 55011*	30 dBμV/m, 30 – 230 MHz (measured @ 30m) 37 dBμV/m, 230 – 1000 MHz (measured @ 30m)
Conducted Emissions	EN 55011*	79/66 dBμV, 0.15 – 0.5 MHz 73/60 dBμV, 0.5 – 30 MHz

* EN 55011 limits are equivalent to limits specified in EN 55022, CISPR 11, CISPR 22, and 47 CFR 15.

Installation Guidelines

- This equipment is intended for use in typical industrial environments that utilize anti-static materials such as concrete or wood flooring. If the equipment is used in an environment that contains static material such as carpets, personnel should discharge themselves by touching a safely-grounded surface before accessing the equipment.
- If the AC mains are used to provide power for I/O, these lines should be suppressed prior to distribution to the I/O so that immunity levels for the I/O are not exceeded. Suppression for the AC I/O power can be made using line-rated MOVs that are connected line-to-line, as well as line-to-ground. A good high-frequency ground connection must be made to the line-to-ground MOVs.
- Installation should be indoors with primary facility surge protection on the incoming AC power lines.

CE Mark Installation Requirement

For compliance to the Low Voltage Directive, VersaMax Nano and VersaMax Micro systems are considered ‘open equipment’ (i.e. live electrical parts may be accessible to users) and must be installed in an enclosure. IEC 1131-2:1991 (sect. 4.2, item 2) states: “Open equipment is not required to meet IP2x requirement…. Opening of the enclosure shall only be possible by means of a key or tool.” The PLC equipment should be installed in a location that meets the specifications listed on the previous page.

UL Requirements for Class I Div 2 Installations

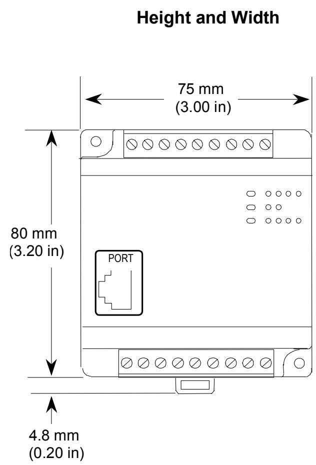
- Equipment labeled with reference to Class 1 Div. 2 Groups A, B, C & D, hazardous locations is suitable for use in Class 1, Division 2, Groups A, B, C, D or non-hazardous locations only.
- Equipment labeled with reference to Class 1 Zone 2 Groups A, B, C & D, hazardous locations is suitable for use in Class 1, Zone 2, Groups A, B, C, D or non-hazardous locations only.
- Warning - explosion hazard - substitution of components may impair suitability for Class 1, Division 2.
- Warning - explosion hazard - do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

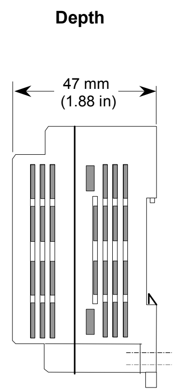
Additional Environmental Guidelines

- The temperature must not change so rapidly that condensation could form on or inside the unit.
- There should be no combustible, corrosive or flammable gases.
- The environment should not have excessive dust, salty air, or conductive materials (iron powder, etc.) that could cause internal shorts.
- The PLC should not be installed where it will be exposed to direct sunlight.
- The PLC should not be exposed to water, oil or chemicals.
- Provide adequate ventilation space. Recommended minimum space allowances are approximately: 50mm (2 inches) top, sides and bottom.
- The PLC should not be installed above equipment that generates a large amount of heat.
- If the ambient temperature exceeds 55°C, provide a ventilation fan or air conditioner.
- The equipment should not be installed within 200mm (8 inches) of any high voltage (more than 1000V) or high current (more than 1A) line (except for outputs controlled by the PLC).
- For ease of maintenance and safety, locate the PLC equipment as far away from high voltage equipment and power generation equipment as possible.
- Take appropriate measures when installing systems in locations:
  - subject to static electricity or other forms of noise.
  - subject to strong electromagnetic fields.
  - close to power supplies.

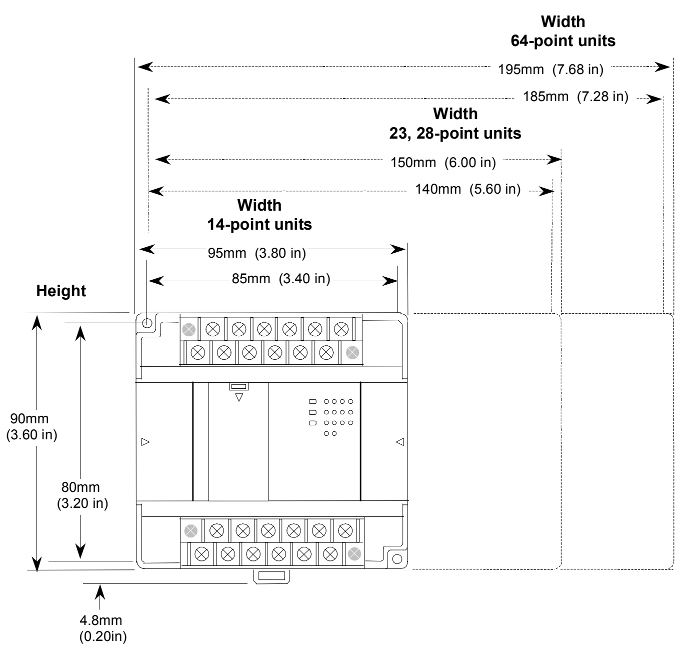
Mounting Dimensions

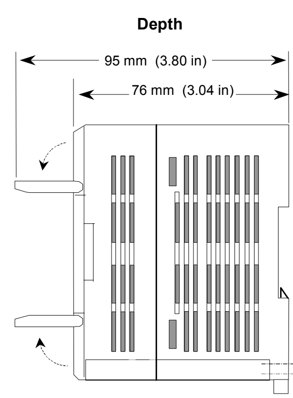
Dimensions of Nano PLCs





Dimensions of 14, 23, 28, and 64-Point Micro PLCs and Expansion Units



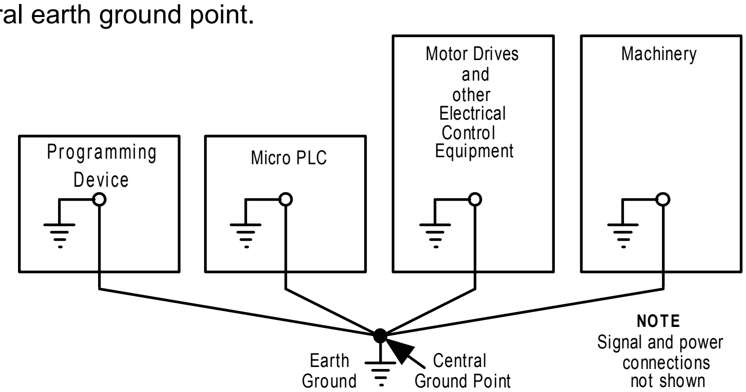


Grounding the Equipment

Equipment grounding procedures must be properly followed for safe operation of your PLC equipment.

The maximum recommended resistance to ground is 200mΩ (equivalent to 100 feet of AWG #12 – 3.29mm^2 – copper cable).

- Grounding installation must conform to National Electrical Code (NEC) standards.
- Ground conductors should be connected with separate branches routed to a central earth ground point.



- Ground conductors should be as short and as large in size as possible. Braided straps or ground cables – AWG #12 (3.29mm^2) or larger – can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.
- Install an external earth leakage breaker and take other safety measures according to external wiring standards.

Grounding the Programmer

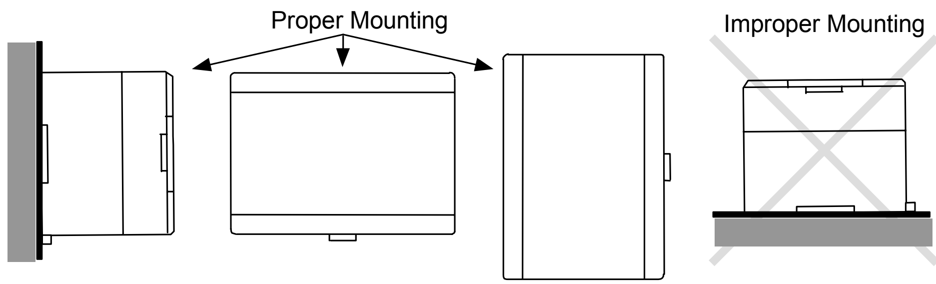
For proper operation, the computer for the programming software must have a ground connection in common with the PLC. Normally, this common ground connection is provided by connecting the programmer's power cord to the same power source (with the same ground reference point) as the PLC. If that is not possible, use a port isolator (IC690ACC903) between the programmer PLC serial connection. If the programmer ground is at a different potential than the PLC ground, a shock hazard could exist. Also, damage to the ports or converter (if used) could occur when the programmer serial cable is connected between the two.

Warning

Failure to follow programmer grounding recommendations could result in personal injury, equipment damage, or both.

Installing a PLC or Expansion Unit on a DIN Rail

VersaMax Nano PLC and Micro PLC equipment can be mounted on a 35 mm DIN rail as described below, or mounted on a metal panel using screws as described on the next page. The equipment must be mounted on a vertical surface. Do not mount it on a horizontal surface.

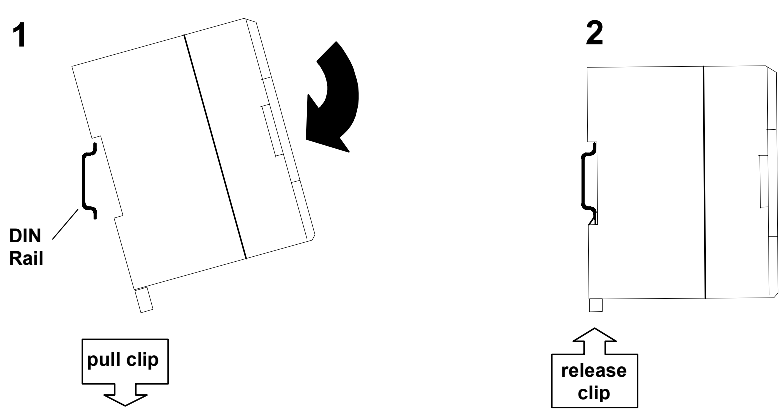


The DIN rail must be electrically grounded to provide EMC protection as described on the next page. DIN rails compliant with DIN EN50032 are preferred.

For vibration resistance, the DIN rail should be installed on a panel using screws spaced approximately 5.24cm (6 inches) apart.

Mounting the PLC on a DIN Rail

Units mount on a 35 mm DIN rail as shown below. Using a small flat screwdriver or similar tool, pull out the retaining clip on the bottom of the unit. Press the unit back and release the retaining clip. Be sure the clip is holding the unit securely.



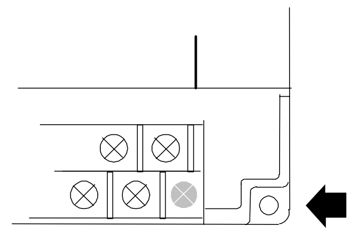
Removing the PLC from a DIN Rail

Pull down the retaining clip on the bottom of the module then pull the unit away from the DIN rail.

Panel-Mounting

For greatest resistance to mechanical vibration and shock, units should installed on a metal panel.

Following the dimensions shown in this chapter or using the module itself as a template, mark the location of the module's panel-mount holes on the panel. Drill the hole in the panel. Install the module using 65x70 M4 (#8-32) screws at least 20mm (0.79 in.) long in the panel-mount holes.



1.1 to 1.4Nm (10 to 12 in/lbs) of torque should be applied to M4 (#8-32) steel screws threaded into material containing internal threads and having a minimum thickness of 2.4mm (0.093in).

Grounding the Metal Panel or DIN Rail

To prevent the risk of electric shock, the metal panel on which the PLC is installed must be properly grounded to protective earth.

Connect the ground wire to the metal panel using a star washer. Where connections are made to a painted panel, the paint should be removed so clean, bare metal is exposed.

Connect the metal plate, duct, pipe, door and side board etc. to protective earth.

Connecting an Expansion Unit to a Micro PLC

Up to four expansion units can be connected in series to a Micro PLC.

Caution

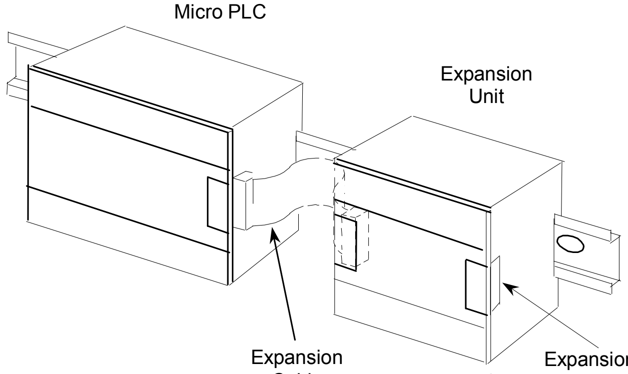
Power down the Micro PLC before connecting an Expansion Unit. Connecting an Expansion Unit with the Micro PLC powered up will damage the unit.

NOTE

The Micro PLC and Expansion Unit(s) should be wired to a common power source and powered up together. If an attached Expansion Unit is left unpowered, the Micro PLC may not power up properly.

The Expansion Cable

A 0.1-meter ribbon cable (IC200CBL501) is provided with each expansion unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths. The maximum total overall length is 2 meters. This cable has keyed connectors to prevent incorrect installation. Powering up the system with the cable improperly installed can damage the Expansion Unit. Do not substitute a different cable. If you need to order replacements, expansion cables are available in various lengths. Connect the units as shown below.



The Expansion Unit(s) and Micro PLC must be connected in the same orientation. Connecting an Expansion Unit “upside down” will damage the DC input circuit when the system is powered up.

After installing the ribbon cable on a unit, close the hinged door.

System Wiring Guidelines

In addition to the following wiring suggestions, we strongly urge that you follow all wiring and safety codes that apply to your area or to your type of equipment. Failure to do so could lead to personal injury or death, property damage or destruction, or both.

Four types of wiring may be encountered in a typical factory installation:

- Power wiring – the plant power distribution, and high power loads such as high horsepower motors. These circuits may be rated from tens to thousands of KVA at 220 VAC or higher.
- Control wiring – usually either low voltage DC or 120 VAC of limited energy rating. Examples are wiring to start/stop switches, contactor coils, and machine limit switches. This is generally the interface level of discrete I/O.
- Analog wiring – transducer outputs and analog control voltages. This is the interface level to I/O analog blocks.
- Communications and signal wiring – the communications network that ties everything together, including computer LANs, MAP, and field busses.

These four types of wiring should be separated as much as possible to reduce the hazards from insulation failure, miswiring, and interaction (noise) between signals. A typical control system may require some mixing of the latter three types of wiring, particularly in cramped areas inside motor control centers and on control panels.

Wiring which is external to equipment and in cable trays should be separated following National Electrical Code practices.

Safety Measures

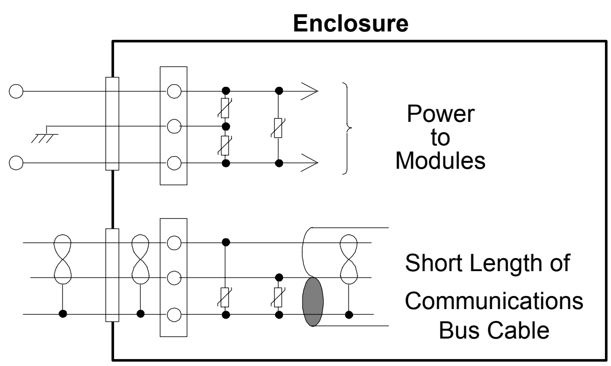
Appropriate emergency stop circuitry, interlock circuitry and similar safety measures should be added to the system in accordance with accepted practices.

Appropriate safety measures should be included in the design of the overall system to ensure safety in the event of incorrect, missing or abnormal signals caused by broken signal lines, momentary power interruptions or other causes.

Installing Additional Suppression

External MOV suppression can be installed at the power line input of a system enclosure (see below). The axial-leaded ZA series of MOVs from Harris is often used. The MOV should be able to handle most line transients. Measurement of actual transients may be required in extreme cases to decide what MOV is best.

Ideally, MOVs should be used at each cabinet in the system for maximum protection. The following illustration shows suppression on both power lines and a communications bus entering an enclosure.



Periodic Inspection and Replacement of MOVs

MOVs do a good job of absorbing transients on communications, control, and power lines, provided the total energy of those transients does not exceed the rating of the device. However, if the energy of the transient exceeds the rating of the device, the MOV may be either damaged or destroyed. *This failure may not be visibly or electrically evident.* MOVs should be regularly inspected for signs of damage to assure continued protection against transients. For some applications, periodic replacement of critical MOVs is recommended, even if they do not show signs of damage.

I/O Installation and Wiring

Wiring diagrams are located in the individual module sections of this manual.

Warning

The PLC must be grounded to minimize electrical shock hazard. Failure to do so could result in injury to personnel.

Warning

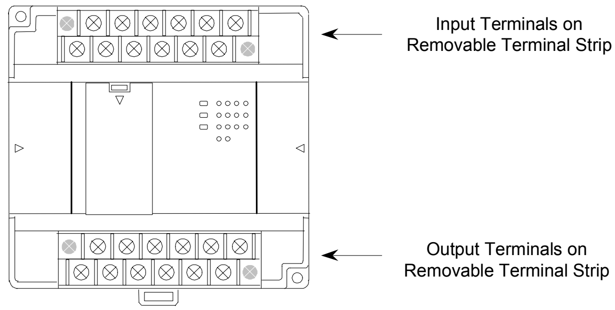
You should calculate the maximum current for each wire and observe proper wiring practices. Failure to do so could cause injury to personnel or damage to equipment.

Caution

When connecting stranded conductors, ensure that there are no projecting strands of wire. These could cause a short circuit, thereby damaging equipment or causing it to malfunction.

- ***Wiring for Power Supply and I/O Connections***
- Each terminal can accept solid or stranded wires, but the wires into any given terminal must be of the same type and size.
- Use copper conductors rated for 75 °C (167 °F) for all wiring.
- Micro PLC wire sizes: one AWG #14 (2.1 mm^2) conductor or two smaller conductors – AWG #16 (1.3 mm^2) through AWG #20 (0.36mm^2) per terminal. The suggested torque for the terminal connections is 5 in-lbs (5.76 kg-cm).
- Nano PLC wire sizes: each terminal accommodates one AWG #14 (avg 2.1mm^2 cross section) to AWG #22 wire (avg 0.36mm^2 cross section), or two wires up to AWG #18 (avg. 0.86mm^2 cross section). The suggested torque for the terminal connections is 3 in-lbs (3.75 kg-cm).

Removable Wiring Terminals

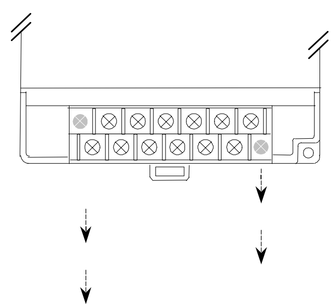


The terminal block assembly of a Micro PLC can be removed to perform wiring. A 14-point unit (shown above) has two removable terminal assemblies. A 23-point or 28-point Micro PLC unit has four.

Caution

Do not insert or remove a terminal assembly with power applied to the PLC/Expansion Unit OR TO FIELD DEVICES. Injury to personnel and damage to the equipment may result. Potentially dangerous voltages from field devices may be present on the screw terminals even though power to the PLC or Expansion Unit is turned off. Care must be taken any time you handle the removable terminal assembly or any wires connected to it

A new Micro PLC or Expansion Unit is shipped with its terminal block assemblies firmly installed. To remove a terminal assembly, use a small Phillips or flat screwdriver to alternately loosen the two captive retaining screws. Hold onto the terminal assembly; when the screws have been backed out of the holes, the terminal assembly is completely detached from the module.



Loosen alternately

When re-installing terminal assemblies, be sure to place each one in the correct location to avoid mis-wiring the module. The terminal assemblies are not keyed or labeled.

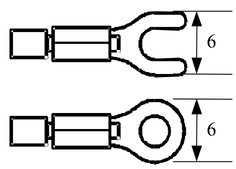
General Wiring Procedures

Follow the procedures below when routing and connecting field wiring from user devices to the PLC inputs and outputs. The individual PLC and Expansion Unit sections of this manual provide detailed wiring information for connecting input and output devices and power sources.

- Turn off power to the PLC before connecting field wiring.
- All low-level signal wires should be run separately from other field wiring.
- All channels must be fed from the same phase for AC power lines.
- Install AC power cables and signal or data lines in separate cable trays or bunches from DC field wiring.
- Field wiring should not be routed close to any device that could be a potential source of electrical interference.
- Route the signal and data lines as close as possible to grounded surfaces such as cabinet elements, metal bars and cabinets panels.
- If severe noise problems are present, additional power supply filtering or an isolation transformer may be required.
- Ensure that proper grounding procedures are followed to minimize potential safety hazards to personnel.
- Label all wires to and from I/O devices.
- Do not attempt to disassemble, repair or modify any part of the PLC.
- Do not pull on cables or bend cables beyond their natural limit. The lines may break.
- Always use the power supply voltage listed in the module specifications. Using other voltages may damage the equipment.
- Do not apply voltages to the inputs in excess of the rated input voltage. The equipment may be damaged if the rated voltage is exceeded.
- Do not use voltages with outputs in excess of the maximum switching capacity. The PLC may be damaged if the maximum switching capacity is exceeded.
- Use shielded cable for analog inputs and outputs, and connect shields to a functional earth ground.

Wiring Connections

The following types of wiring terminals are recommended for use with VersaMax Micro PLC modules:



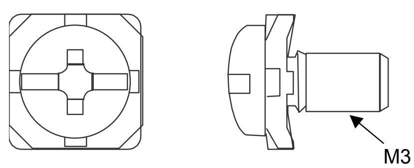
When using wiring terminals, be sure to tighten screws adequately, so the wiring terminals will not become loose.

Alternatively, each module screw can accept:

- One wire, size AWG14 to AWG22 (2.1 to 0.36 mm^2) or:
- Two wires, size AWG16 to AWG22 (1.3 to 0.36 mm^2)

Terminal Screws

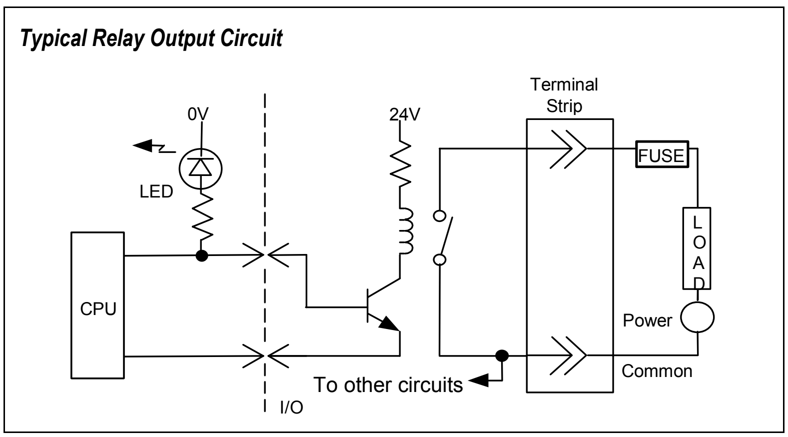
Should any of the terminal screws be lost or damaged, they can be replaced with M3 x 0.6mm pitch screws of the type shown below.



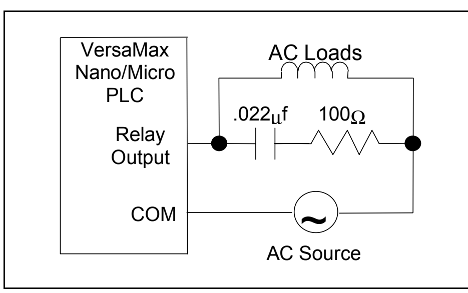
Providing Fusing for Outputs

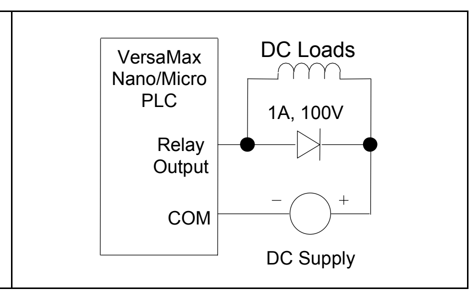
Outputs with electronic short-circuit protection are available on several Micro PLCs and Expansion Units, including IC200UDD120 (outputs 5-12), IC200UEX122 (all outputs), IC200UDD064 (outputs 5-24), IC200UEO008, IC200UEO016 and IC200UEC008. All other module outputs should be externally-fused (1 Amp to 2 Amp fuse) to protect the output point contacts. For lighter loads, the internal common fuse (3.15 amp) can be replaced with a 1 amp fuse to protect the output point without adding the external fusing.

Providing Suppression Circuits for Inductive Loads



Installing suitable suppression across inductive loads enhances reliability of relay contacts. When switching inductive loads, relay contact life approaches resistive load contact life if suppression circuits are used. The 1A, 100V diode shown in the typical DC load suppression circuit is an industry standard 1N4934.

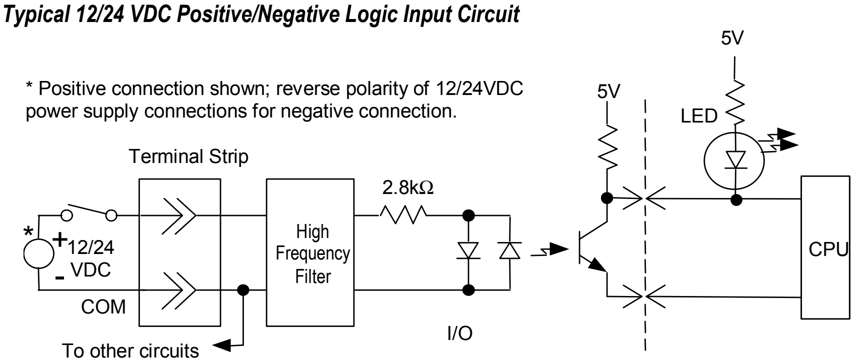




Typical DC Input Circuits

All DC inputs can be connected as either positive or negative logic.

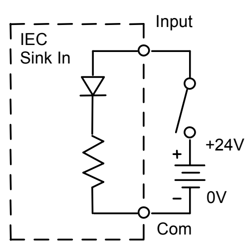
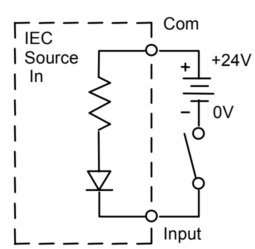
Typical 12/24 VDC Positive/Negative Logic Input Circuit



In the wiring diagrams in this section, inputs I1 through I8 are shown as positive and inputs I9 through I13 are shown as negative.

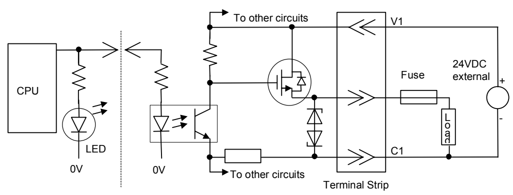
Positive and Negative Logic Definitions

The IEC definitions for positive logic and negative logic, as applied to the PLC I/O circuits, are shown below.

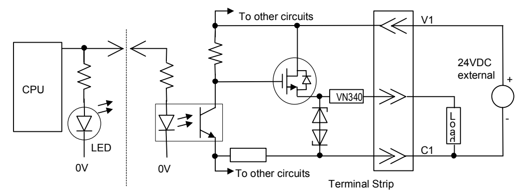
Input Points– Positive Logic	**Input Points – Negative Logic**
	
▪ Equivalent to IEC sink input points. ▪ Sink current from the input device to the user common or negative power bus. The input device is connected between the positive power bus and the input terminal. The negative bus is connected to the input circuit common.	▪ Equivalent to IEC source inputs. ▪ Source current through the input device to the user common or positive power bus. The input device is connected between the negative power bus and the input terminal. The positive bus is connected to the input circuit common.

Typical DC Output Circuits

Typical Transistor Output Circuit 12 VDC

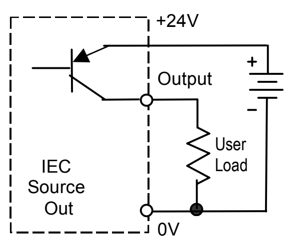


Typical Transistor Output Circuit 24 VDC



When using the outputs as PWM or Pulse Train Outputs, and for duty cycles in the lower ranges (5% and lower), a pulldown resistor must be connected between the output point (Q1-Q3) and the common terminal (C1). A 1.5 Kohm, 0.5 watt resistor is recommended.

Output Points – Positive Logic

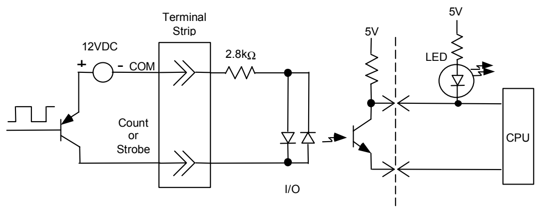


- Equivalent to IEC source output points.
- Source current to the loads from the user common or positive power bus.

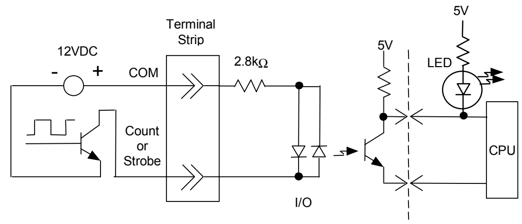
The load is connected between the negative power bus and the module output.

Typical High-Speed Counter Connections

High Speed Counter Circuit – Positive Logic Connection



High Speed Counter Circuit – Negative Logic Connection

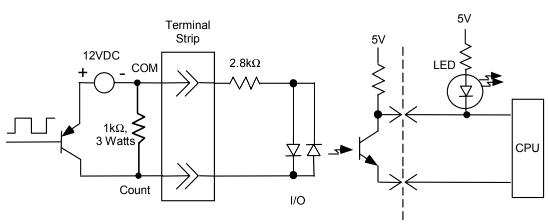


When I1-I6 on a Micro PLC are used as High-speed Counter inputs, the input switches should be solid state to prevent switch bouncing, which could cause unintended high speed counter counts or strobe input signals.

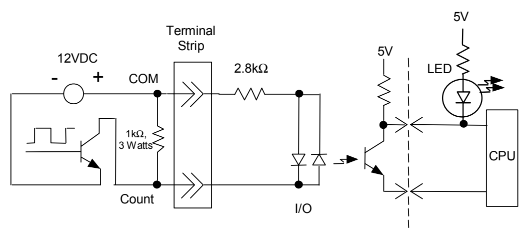
Added Resistance for 64-Point Micro PLCS at Higher Count Rates

When using count rates about 30KHz on a 64-Point Micro PLC, a 1kOhm, 3Watt resistor should added between the common and the Count input as shown below.

High Speed Counter Circuit – Positive Logic Connection

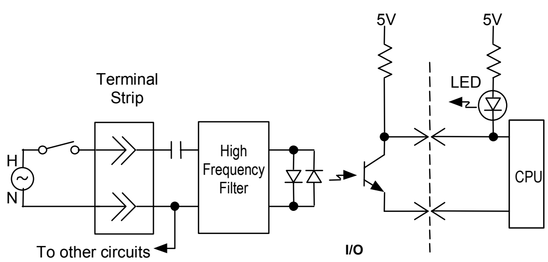


High Speed Counter Circuit – Negative Logic Connection

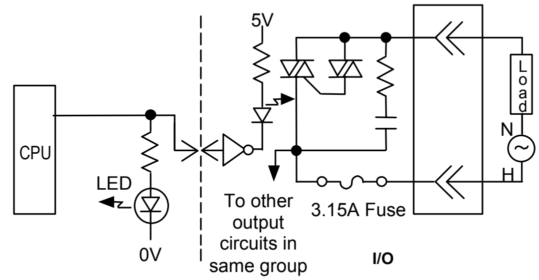


Typical AC Input and Output Circuits

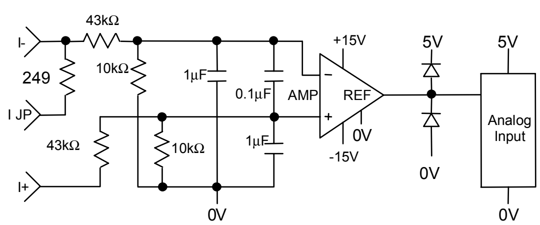
Typical 120 VAC Input Circuit



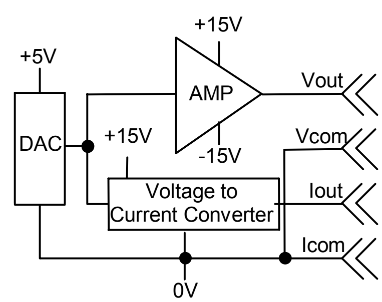
Typical 120/240 VAC Triac Output Circuit



Typical Analog Input and Output Circuits



Analog Output Circuit



Starting Up the PLC

Before applying power to the PLC:

- Be sure all mounting screws, terminal screws, cables and other items are properly tightened and secured.

Warning

- On a Micro PLC CPU or Expansion Unit, be sure the protective covers are installed over terminals when power is applied to the unit. The covers protect against accidental shock hazard that could cause severe or fatal injury.
- Double-check all wiring. Faulty wiring may damage the PLC.
- Do not turn on the power supply to a broken PLC.
- Be sure that Expansion Units connected to the Micro PLC are wired to the same power source and that the PLC and Expansion Units will power up together. If an attached Expansion Unit is left unpowered, the Micro PLC may not power up properly.

Warning

Always turn off the power supply to the PLC before attempting any of the following. Performing any of these acts may result in electrical shock, damage to the PLC or faulty operation.

A. Assembling the PLC.
B. Connecting or disconnecting cables or wiring.
C. Connecting a Frame Ground (earth) terminal to the metal plate or metal case.

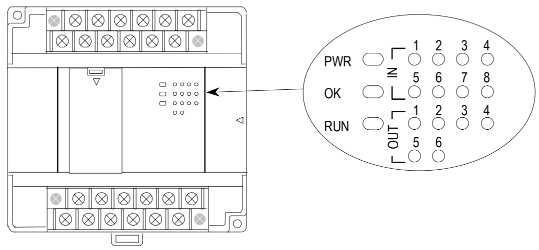
Turning off Power to the PLC

Caution

During a gradual power down, when the input power supply voltage is below the minimum operating voltage, the PLC may power off and then power on again until the input voltage drops low enough to prevent power on again. You should take precautions if this type of behavior cannot be tolerated in your application.

Normal Powerup Sequence

Apply the required power to the power inputs and observe the LEDs. A 14-point Micro PLC is shown below. Other PLC models and expansion units have different LEDs.



- The PWR LED should light.
- The OK LED blinks during power-up diagnostics. (Micro PLCs that do not have expansion units can be configured to skip powerup diagnostics, as explained in chapter 11.) When diagnostics have successfully completed, the OK LED changes to a steady on state. The RUN LED goes ON if the unit is configured to run on power-up. If the Run LED does not light when you go to Run mode, the cause could be invalid configuration or a fatal error in the CPU fault table.
- If any input points have been wired to field devices that energize those circuits, the corresponding input LEDs should also be ON. (On an RTD Expansion Unit, the input 1-4 LEDs should be OFF during normal operation. A flashing channel LED on an RTD expansion unit indicates an error such as temperature out of range, open wire, shorted wire or no RTD attached.) If the OK LED on an RTD expansion unit continues to flash or remains OFF, cycle power to the unit. If the expansion unit does not recover, replace the unit.
- If the RUN LED on the Micro PLC CPU is not ON, all output LEDs should be OFF (in STOP with I/O Disabled mode).
- After powerup and program download, check the program for proper execution.

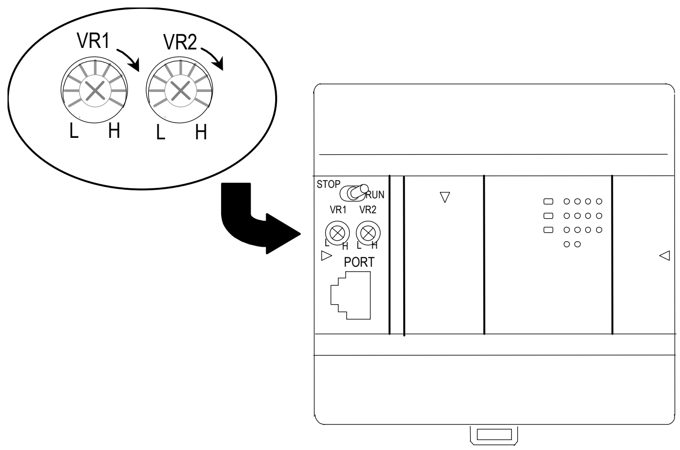
Micro PLC LEDs

Symptom	*Action*
PWR LED does not light.	1. Check that the proper power source is provided and is on. 2. With power supply off, check wiring to the module unit to be sure it is connected correctly.
PWR LED is ON OK LED is OFF	(This indicates that the power source is good and that the CPU has detected an internal fault. Be sure all the DIP switches are in the “OFF” position (down).
PWR LED is ON. OK and RUN blink together.	The PLC is in system bootloader mode and is awaiting a system firmware download from the Winloader tool.
PWR LED is ON. OK is blinking.	The PLC features built-in blink codes to assist in troubleshooting.

Adjusting the Analog Potentiometers

Two potentiometers located behind the left door of a Micro PLC can be adjusted to lower or raise the values in analog registers %AI16 and %AI17. The left potentiometer, labeled VR1, adjusts the value in register %AI16. The right potentiometer, VR2, adjusts the value in %AI17.

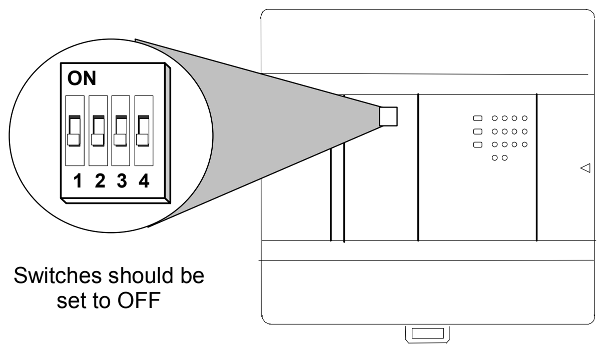
To adjust the potentiometers, use a small screwdriver. Turning a potentiometer clockwise increases the value.



DIP Switches

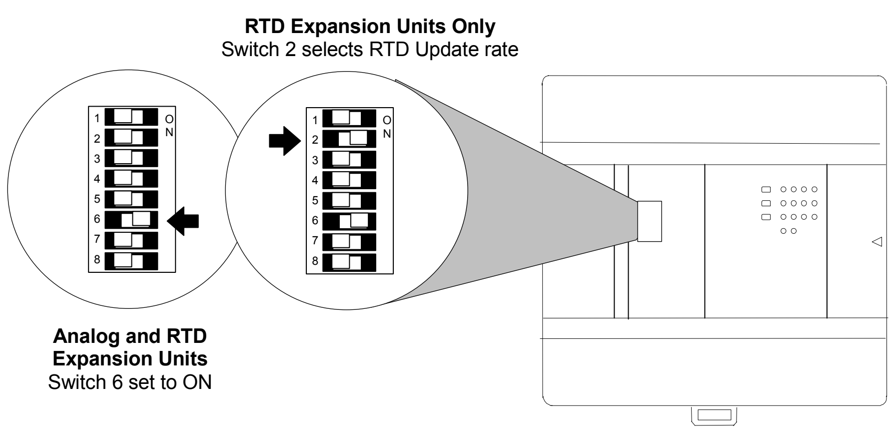
4-Position DIP Switches on Micro PLC CPUs

The DIP switches located behind the removable door on the front of a 14-, 23-, 28-, or 64-point Micro PLC are factory-set to OFF (down position) as shown below, and should not be changed.



DIP Switches on an Analog Expansion Unit Select Count Resolution

For analog expansion units, count resolution is controlled by the DIP switch setting shown below. Switch 6 should be set to ON by default. If unexpected results are observed, check the position of switch 6. If switch 6 is not ON, power down the system and set switch 6 to ON. Do NOT change any of the other switches.



DIP Switches on an RTD Expansion Unit Select Update Rate

For RTD expansion units, DIP switch 2 selects the RTD channels update rate. In the factory default OFF position, switch 2 selects a 562ms update rate. The update rate can be changed to 141ms by moving switch 2 to the ON position. Switch 6 should always be in the ON position as shown.

Installing/Replacing a Backup Battery

For the 23 and 28 point Micro PLCs, a backup battery can be installed to protect the RAM memory contents of the PLC when the PLC power supply is removed or turned off. It also backs up the CPU's real-time clock. Note: Use of another battery type may present a risk of fire or explosion.

Important: The Micro PLC power must be OFF when installing/replacing the battery.

IC200ACC414	Nominal Voltage 3.6 vdc @ 790 mAh	
Battery shelf life, not installed	Up to 5 years typical at 30 °C Up to 3 years typical at 55 °C	
Backup time with battery installed, Micro PLC continuously powered down	For units with serial number before 07000069274 13 months minimum at 70 °C 30 months minimum at 20 °C	For units with serial number after 07000069274 19 months minimum at 70 °C 121 months minimum at 20 °C

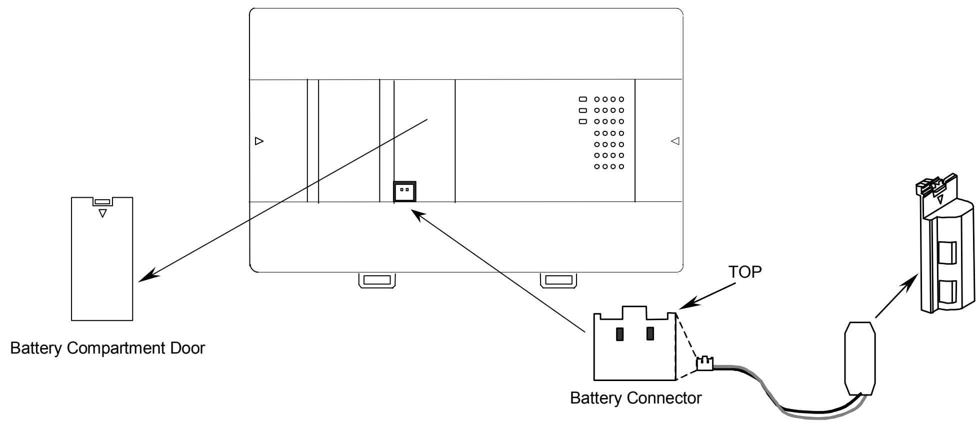
This battery replaces an earlier coin-type battery, IC200ACC403.

CPU Battery Consumption Data

	Battery Consumption Per hour (Micro PLC with a serial number before 07000069274)	Battery Consumption Per hour (Micro PLC with a serial number after 07000069274)	Battery Consumption Per hour (64-Point Micro PLCs)
Power ON	30 micro Amps	3 micro Amps	0 micro Amps
Power OFF	83 micro Amps @ 70C 36 micro Amps @ 20C	56 micro Amps @ 70C 9 micro Amps @ 20C	31 micro Amps @ 55C 3 micro Amps @ 25C

To replace a previously-installed battery, open the battery compartment door and remove the old battery assembly.

Insert the battery plug into the connector at the bottom of the battery compartment. Press it in until it clicks. Do not force the connection – the plug is keyed to prevent accidentally installing the battery in a reverse polarity.



For a cylinder-type battery, tuck in the wires and snap the battery holder (see the illustration above) onto the VersaMax Micro PLC. The original battery compartment door is no longer needed.

For a coin-type battery, place the battery into the holder on the left side of the battery compartment and tuck in the wires. Close the battery compartment door securely.

Caution

Battery may explode if mistreated.

Do not recharge, disassemble, heat above 100 deg.C (212 deg.F) or incinerate.

Serial Port Connections

Providing Power to an External Device from Port 1 or 2

If either port is set up for communications with a serial device that requires 100mA or less at 5VDC, the device can obtain power from either Port 1 or Port 2. The total current drawn from both ports added together cannot exceed 100mA.

Short Circuit Protection on 5VDC for Units Later than June 2005

In the event that a short occurs across 5VDC on any serial port on a VersaMax Micro or Nano PLC manufactured after June 2005, date code 523 (the date code is a three-digit code located on side of unit) the unit will power down until the short is removed. By removing the short, the unit will recover fully.

Micro and Nano PLCs prior to date code 523 have a non-replacable internal fuse for 5VDC. On those units, if the fuse blows, the RS-232 continues to function but the port no longer provides 5VDC to external devices. The 5VDC is also lost on the RS-485 port.

Cable Lengths and Baud Rates

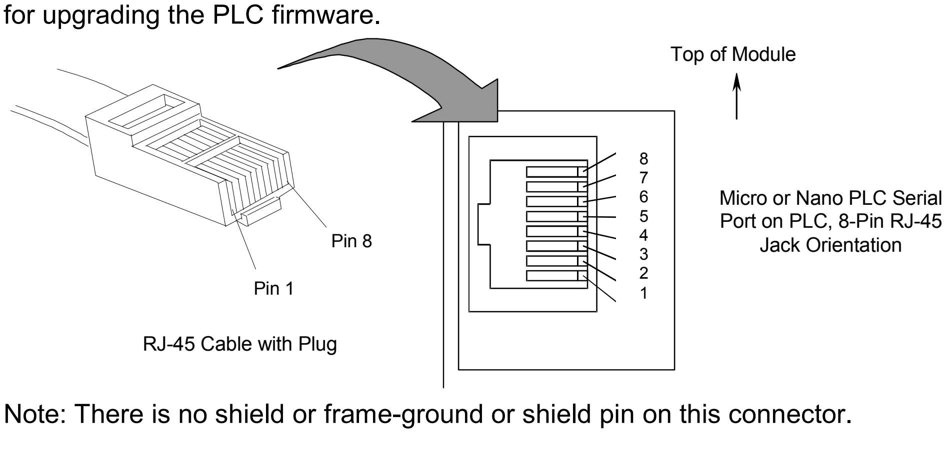
Maximum cable lengths (the total number of feet from the CPU to the last device attached to the cable) are:

Port 1 (RS-232) = 15 meters (50 ft.)
Port 2 (RS-485) = 1200 meters (4000 ft.)

Both ports support configurable baud rates from 300 to 19.2k bps.

Port 1: RS-232

Port 1 is an RS-232 port with a 8-pin RJ-45 vertical jack. In addition to being a general serial communications port, this port is also used as the boot loader port for upgrading the PLC firmware.

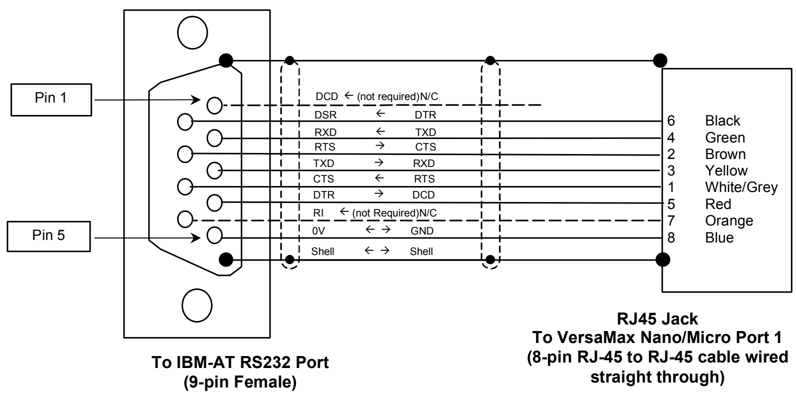


Note: There is no shield or frame-ground or shield pin on this connector.

Pin	Signal	Direction	Function
1	RTS	Output	Request to Send output
2	CTS	Input	Clear to Send input
3	RXD	Input	Receive Data input
4	TXD	Output	Transmit Data output
5	DCD	Input	Data Carrier Detect input
6	DTR	Output	Data Terminal Ready output
7	+5V	Output	+5VDC output to power external protocol converters
8	GND	--	0V/Gnd signal reference

Port 1 Cable Wiring to a 9-pin D-sub PC-style RS-232 Port

An RJ-45 to DB9F adapter can be used to connect Port 1 to the standard 9-pin D-Sub port found on most PCs. Programmer wiring to an RJ-45 to DB9F adapter is shown below. For a PC that is not used as a programmer, only the Transmit, Receive, and Ground wires are needed on port 1 and Port 2.



** Dotted lines are optional wires and not required*

RJ45 to DB9F Adapter Wiring

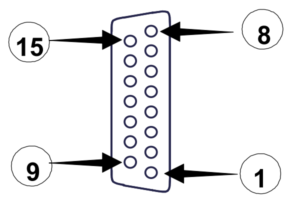
The color codes shown below are standard for most RJ-45 to DB9F adapter kits, but be sure to review your kit's particular documentation. Wire the adapter kit following the pin numbers as shown.

Adapter Wire Color	DB9F pin	RJ45 pin	Micro PLC signal	DB9F (PC Serial Port) signal
n/c	1	-	n/c	DCD (in)
Green	2	4	TxD (out)	RxD (in)
Yellow	3	3	RxD (in)	TxD (out)
Red	4	5	DCD (in)	DTR (out)
Blue	5	8	Ground	Ground
Black	6	6	DTR (out)	DSR (in)
Brown	7	2	CTS (in)	RTS (out)
White	8	1	RTS (out)	CTS (in)
Orange	9	7	+5V (out)	RI (in)

Port 2 on 23-Point and 28-Point Micro PLCs: RS-485

Pin Assignments for Port 2

Port 2 on 23-point and 28 point VersaMax Micro PLCs is an RS-485 port with a 15-pin female D-sub connector.



This can be attached directly to an RS-485 to RS-232 adapter (IC693ACC901 or similar).

Pin	Signal	Direction	Function
1	SHLD	--	Cable Shield Drain wire connection
2, 3, 4	n/c		
5	P5V	Output	+5VDC to power external devices (100mA max.)
6	RTSA	Output	Request to Send (A) output
7	GND	--	0V/GND reference signal
8	CTSB'	Input	Clear to Send (B) input
9	RT	--	Resistor Termination (120 ohm) for RDA'
10	RDA'	Input	Receive Data (A) input
11	RDB'	Input	Receive Data (B) input
12	SDA	Output	Transmit Data (A) output
13	SDB	Output	Transmit Data (B) output
14	RTSB	Output	Request to Send (B) output
15	CTSA'	Input	Clear to Send (A) input
Shell	SHLD	--	Cable Shield wire connection / 100% (Continuous) shielding cable shield connection

Connector and Cable Specifications for Port 2 on 23-Point and 28-Point Micro PLCs

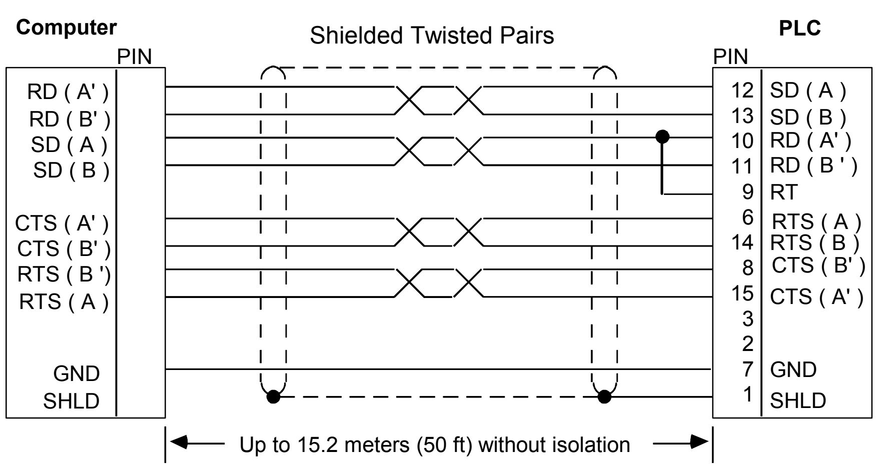
Vendor Part numbers below are provided for reference only. Any part that meets the same specification can be used.

Cable: Belden 8105	Low Capacitance Computer cable, overall braid over foil shield 5 Twisted-pairs † Shield Drain Wire † 30 Volt / 80°C (176°F) 24 AWG tinned copper, 7x32 stranding Velocity of Propagation = 78% Nominal Impedance = 100Ω †			
15 Pin Male Connector:	Type: Crimp	Vendor: ITT/Cannon AMP	Plug: DAA15PK87F0 205206-1	Pin: 030-2487-017 66506-9
	Solder	ITT/Cannon AMP	ZDA15P 747908-2	-- --
Connector Shell:	Kit* – ITT Cannon DA121073-50 [15-pin size backshell kit]: Metal-Plated Plastic (Plastic with Nickel over Copper) † Cable Grounding Clamp (included) 40° cable exit design to maintain low-profile installation Plus – ITT Cannon 250-8501-009 [Extended Jackscrew]: Threaded with (metric) M3x0.5 for secure attachment † Order Qty 2 for each cable shell ordered			

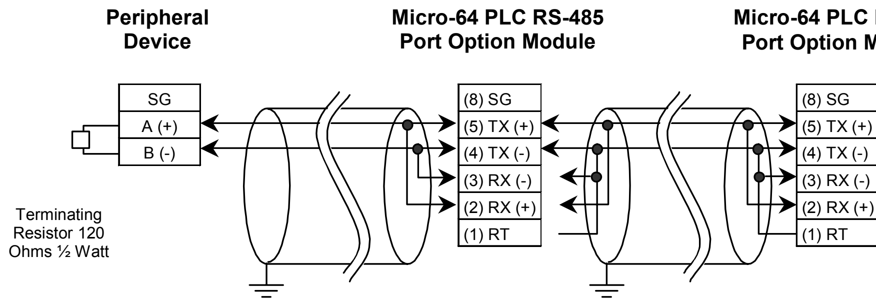
† Critical Information – any other part selected should meet or exceed this criteria.

RS-485 Point to Point Connection with Handshaking

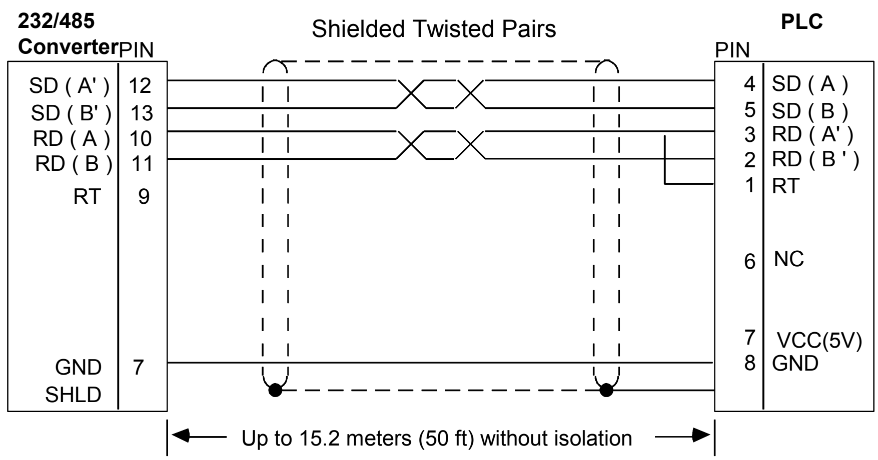
In point-to-point configuration, two devices are connected to the same communication line. For RS-485, the maximum cable length is 1200 meters (4000 feet). Modems can be used for longer distances.



Port 2 RS-485 Option Module on 64-Point Micro PLCs



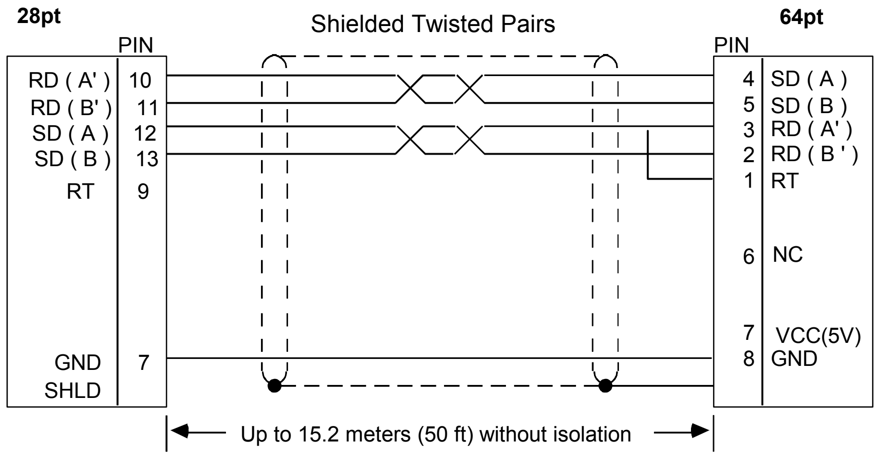
Connections: Peripheral Device to Micro-64 PLC RS-485 Option Module



Note : The connection to peripheral device is through 232/485 converter . Diagram gives the RS485 communication part of the PLC with the converter.

On the 232 side of the converter peripheral device needs to be connected.

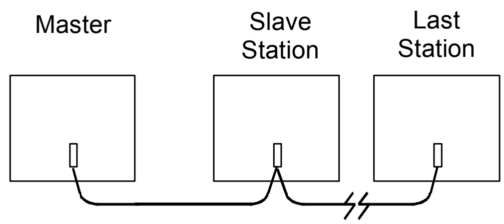
Connections, Micro-28 PLC to Micro-64 PLC Master/Slave



RS-485 Multidrop Serial Connections

The Micro PLC supports a maximum of eight devices on a single serial link per network. This number can be increased with the use of a repeater. For additional information on serial communications, refer to the *Series 90 PLC Serial Communications User's Manual*, GFK-0582.

In the multidrop configuration, the host device is configured as the master and one or more PLCs are configured as slaves. The maximum distance between the master and any slave may not exceed 4000 feet (1200 meters). Any installation with PLCs over 50 feet (15.2 meters) apart must include optical isolation.



The RS-485 line must include handshaking and use wire type specified earlier. Reflections on the transmission line can be reduced by daisy-chaining the cable as shown. Make connections inside the connector to be attached to the PLC. Avoid using terminal strips to other types of connectors along the length of the transmission line.

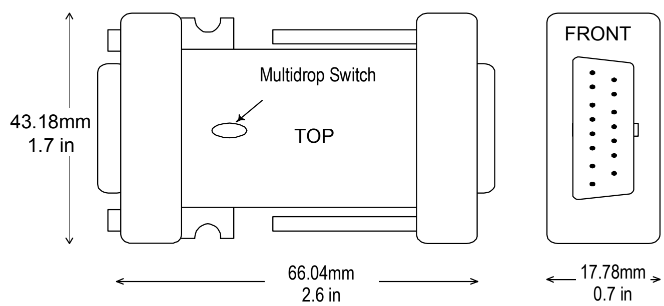
Termination resistance for the Receive Data (RD) signal must be connected only on units at the ends of lines. This termination is made at the CPU by connecting a jumper between pin 9 and pin 10 inside the D-shell connector.

Ground Potential: Multiple units not connected to the same power source must have common ground potential or ground isolation for proper operation of the system.

RS485 Port Isolator

The IC690ACC903 RS-485 Port Isolator can be connected directly to the Micro PLC's RS-485 serial port, or panel-mounted and connected to the Micro PLC using a short extender cable. The extender cable is intended for use in applications where direct connection to the port is obstructed by surrounding equipment or where it is not acceptable for the device to protrude from the Micro PLC. The Port Isolator can operate in either single- or multi-drop mode, which is selected by a slide switch on the top of the module. The Port Isolator provides the following features:

- Four opto-isolated signal channels: SD, RD, RTS, and CTS
- Electrical compatibility with RS-485
- Single- or multi-drop operation
- Input termination consistent with standard for serial channels
- A 5V DC/DC converter for power isolation
- Hot insertion is supported



Port Isolator Specifications

Mechanical	
RS-485	15-pin D shell male for direct mounting to serial port on the programmable controller 15-pin D shell female for communication cable
Installation Hardware	Two M3 thread connector thumbscrews. Recommended torque: 8 in./lbs. (supplied with Isolator). Two #6/32 thread panel mounting screws. Recommended torque: 12 in./lbs. (user supplied)
Electrical	
Voltage Supply Typical Current	+5VDC (supplied by port) 25 mA 100 mA available for external equipment
Ground Isolation Conformance	500 Volts EIA-422/485 Balanced Line
Operating Temperature	0° - 70°C (32° - 158° F)

Baud Rate	Those supported by PLC

Port Isolator Connectors

The Isolator has two connectors, one 15 pin male D-type (PL1) and one 15 pin female D-type (PL2). The pin assignments are identical, except that pin 4 on PL2 is connected to the module ID resistor.

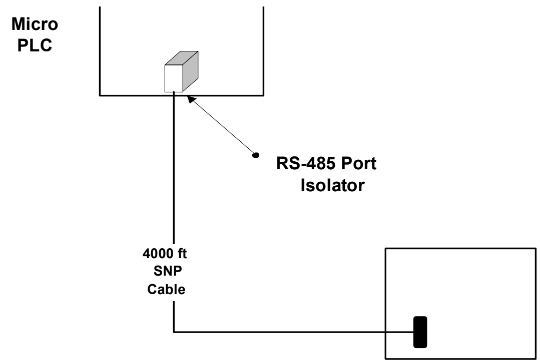
RS-485 Connector Pin Assignments

	Pin	Pin Name	Pin Type	Description
PL1	1	SHLD	-	Chassis Ground
	2	NC	-	
	3	NC	-	
	4	NC	-	
	5	5V	-	+5V power
	6	RTS (A)	In	Request to send -
	7	0V	-	Signal Ground
	8	CTS (B')	Out	Clear to send +
	9	NC	-	
	10	RD (A')	Out	Read data -
	11	RD (B')	Out	Read data +
	12	SD (A)	In	Send data -
	13	SD (B)	In	Send data +
	14	RTS (B)	In	Request to send +
	15	CTS (A')	Out	Clear to send -
PL2	1	NC	-	
	2	NC	-	
	3	NC	-	
	4	TESTID	-	ID resistor
	5	5V	-	+5V power
	6	RTS (A)	Out	Request to send -
	7	0V	-	Signal Ground
	8	CTS (B')	In	Clear to send +
	9	RT	-	Terminating Resistor*
	10	RD (A')	In	Read data -
	11	RD (B')	In	Read data +
	12	SD (A)	Out	Send data -
	13	SD (B)	Out	Send data +
	14	RTS (B)	Out	Request to send +
	15	CTS (A')	In	Clear to send -

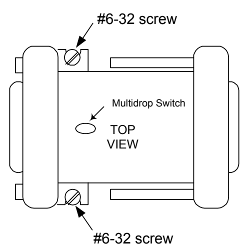
- Use the terminating resistor if the Port Isolator is used in port-to-port mode or at the end of a multi-drop configuration. To terminate the RD balanced line, place a jumper wire from pin 9 to pin 10.
- A denotes – and B denotes +. A and B denote outputs and A' and B' denote inputs.

Installing the Port Isolator

The Isolator is packaged in a contoured plastic enclosure designed for either direct attachment to a serial port or through a 12” extender cable for panel-mounted equipment. Two M3 thumbscrews secure the device to its mating connector. It can be easily inserted into an existing communication channel with no additional hardware.



When installing the Port Isolator on a panel, you will need to provide two #6-32 mounting screws.

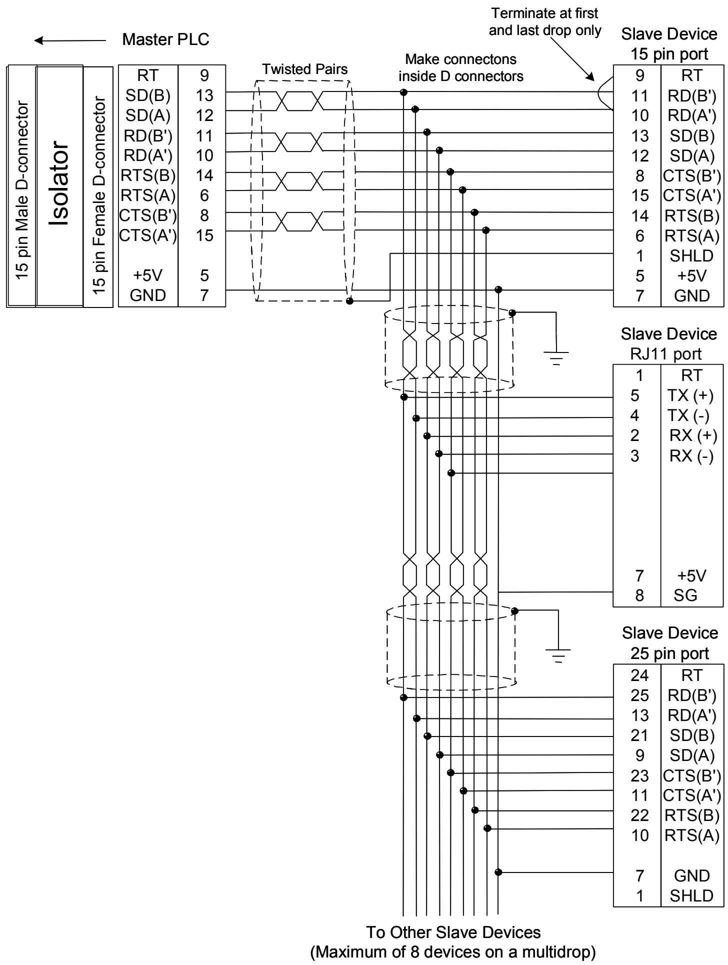


When installing the Isolator, tighten the connector screws and panel mounting screws (if used) to the following torque values:

Screws	Type	Torque
Connector Thumbscrews (supplied with Isolator)	M3	8 in/lbs
Panel Mounting Screws (user-supplied)	#6/32	12 in/lbs

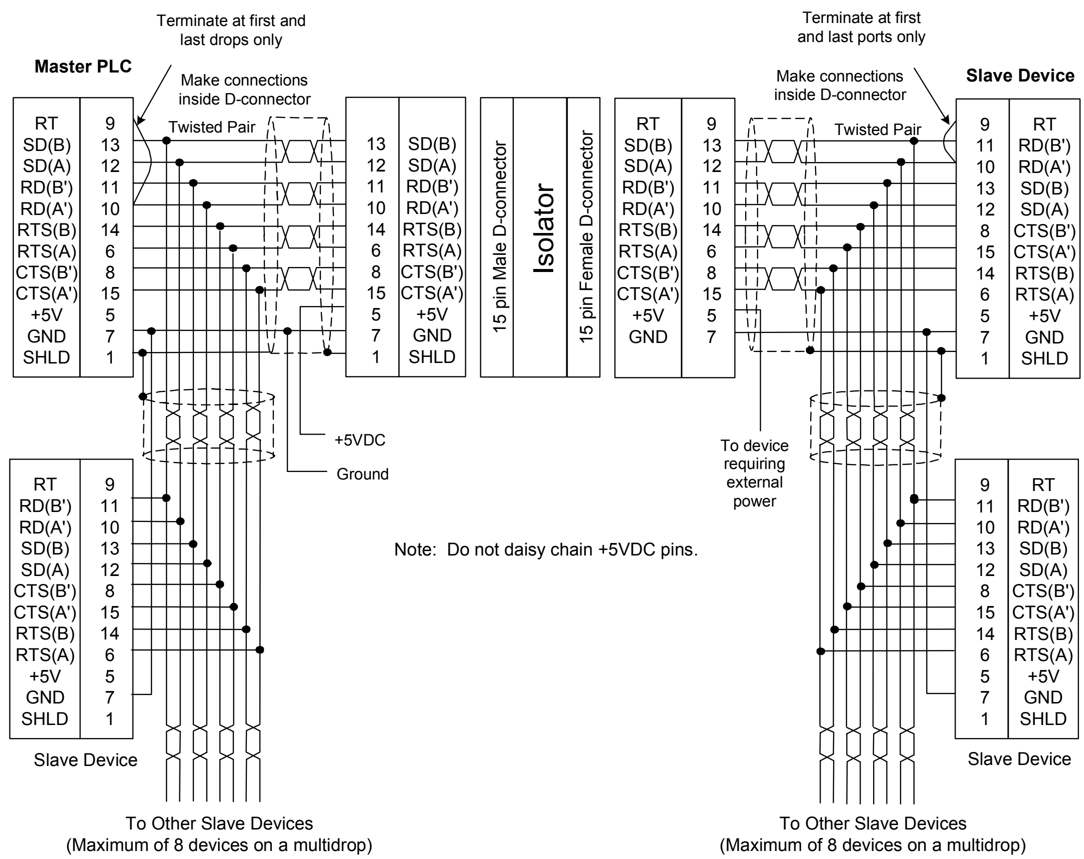
The RS485 Port Isolator supports both port-to-port and multi-drop configurations.

Multidrop Cable Connecting Devices with 15-Pin Ports and 25-Pin Ports

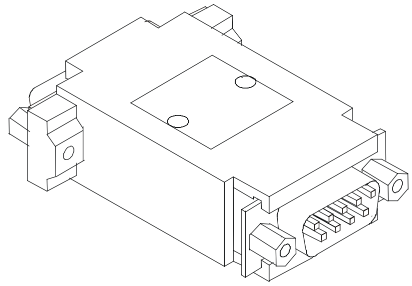


Cable for Supplying External Power Through the Port Isolator

If the Isolator is powered by a source other than the host port, you will need to build a custom cable as shown below.



RS-232 to RS-485 Adapter



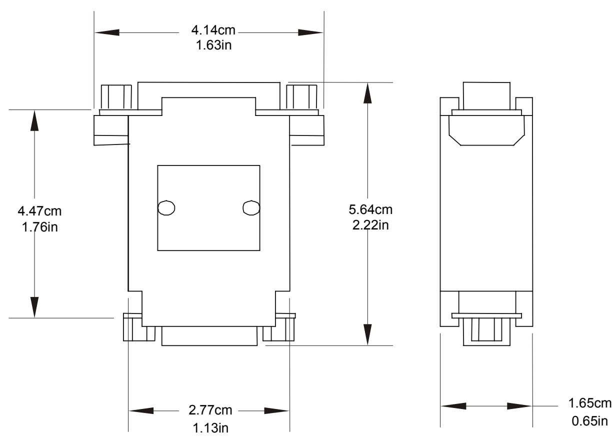
The RS-232 to RS-485 Adapter (IC200ACC415) connects a VersaMax Nano PLC or VersaMax Micro PLC to an RS-485 communications bus. It supports RS-485 multi-drop connections.

In conjunction with an RJ45 to DB9 Female cable (IC200CBL500), the adapter converts from the RS-232 (9-pin D-sub male) connector on the Nano/Micro PLC to an RS-485 (15-pin D-sub female) connector.

Two LEDs on the adapter indicate activity on the transmit and receive lines.

Power for this adapter is provided by the Micro/Nano PLC.

Dimensions of the Adapter are shown below.

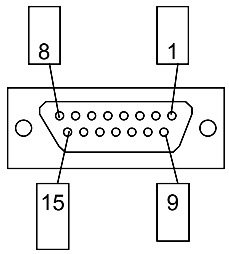


Specifications

Temperature Rating	0 to 55ºC
Storage Temp. Rating	-10 to 75ºC
Humidity	5 to 95%
Shock	MIL-STD 810C, 15G
Noise Immunity	Ansi/EE C37.90A, 801.2 ESD L3, 801.3 L3, 801.6 RF, 801.4 Fast Transient L3, 801.5 Surge, EN55011 Emissions
Agency Approvals	UL (Class 1, Div 2) for Nano/Micro PLC version B and higher , CUL and CE

Adapter 15-pin RS-485 Port Connector

The adapter's RS-485 port is a standard SNP Port (15-pin D-sub female) connector. It supports EIA/TIA-485 (RS-485) compatible signal levels. The pin assignments of the RS-485 connector are shown below.



Adapter RS485 Port Pin Assignments

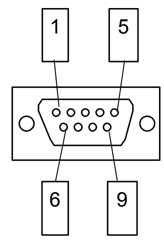
Pin	Function	Dir.
1	Shield / Frame GND	-
2	N/C	
3	N/C	
4	N/C	
5	+5VDC	Out
6	RTS(A)	Out
7	GND	-
8	CTS(B')	In

Pin	Function	Dir.
9	RT (RD Term)*	-
10	RD(A')	In
11	RD(B')	In
12	SD(A)	Out
13	SD(B)	Out
14	RTS(B)	Out
15	CTS(A')	In
[Shell]	Frame GND	

* RT pin is connected with a 120 ohm resistor to pin 11: RD(B') to provide a simple end-of-line termination through a jumper in the backshell between pin 10 and pin 9.

Adapter 9-pin RS-232 (D-sub Male) Port Connector

The Adapter's RS-232 port matches the industry standard PC 9-pin male serial port. This port accepts the same cable (IC200CBL500) used to communicate directly from the Micro/Nano's RJ-45 jack to a PC. This port supports EIA/TIA-232 (RS-232) compatible signal levels. The +5VDC output from the Nano/Micro PLC is routed to pin 9 on this cable and is used to power the converter.



Adapter RS-232 Port Pin Assignments

Pin	Signal	Dir.	Function
1	DCD	Input	(No Connect)
2	RXD	Input	Receive Data
3	TXD	Output	Transmit Data
4	DTR	Output	(No Connect)
5	GND	--	0V/Gnd signal
6	DSR	Input	(No Connect)
7	RTS	Output	Request to Send
8	CTS	Input	Clear to Send
9	+5V	Input	+5VDC power in
SHELL	SHLD	--	Cable Shield wire connection

Replacing AC Output Module Fuses

Caution

There are *no* user-replaceable parts in the DC In/Relay Out or DC In/DC Out Micro PLCs.

The AC In/AC Out model Micro PLCs (IC200UAA003/IC200UAA007) provide user-replacable fuses for their AC output points. Because each output fuse is on the common of several circuits, a blown fuse will prevent the entire group associated with it from working.

Warning

Remove power from the unit before removing field wiring or removing the front cover. Failure to remove power from the unit before disassembling it could cause severe or fatal injury to personnel.

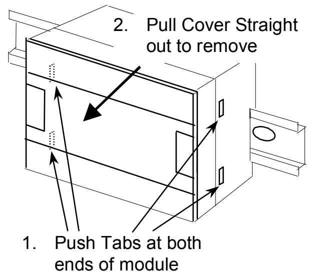
Caution

Do not attempt to remove the circuit boards from the Micro PLC assembly, or to replace fuses on the power supply board. Any disassembly beyond removing the front cover and replacing AC output fuses could damage the unit and will invalidate the warranty.

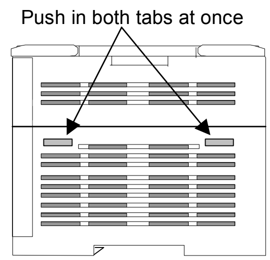
Fuse replacement should only be performed by qualified service personnel.

The plug-in fuses are located on the I/O circuit board, which is accessible after removing the Micro PLC front cover. To replace these fuses:

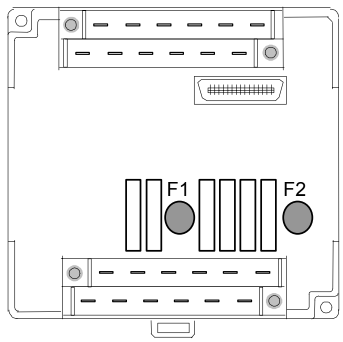
1. Remove power from the unit and I/O devices.
2. Remove terminal blocks with attached field wiring from the module
3. Remove front cover from the unit. (Gently press inward on both of the tabs located on the sides of the unit and pull the cover straight off. Note: The CPU board assembly should remain captive inside the front cover as you remove it.)



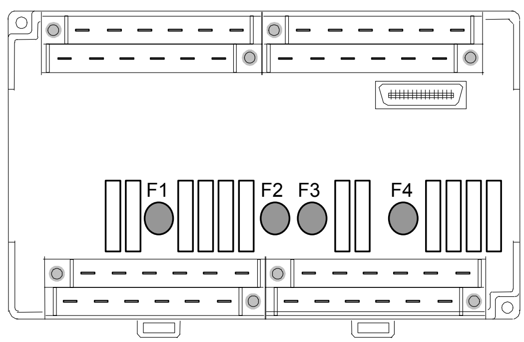
Side View



4. Replace each blown fuse with the appropriate fuse type.



14-point Micro PLC (IC200UAA003)



28-point Micro PLC (IC200UAA007)

Note

The fuses listed below are only for the output points on the AC In/AC Out Micro PLCs (IC200UAA003/IC200UAA007). Do not attempt to replace any other parts in any other Micro PLC unit.

AC Output Fuse Specifications

IC200UAA003 007	F1 F2	Q1-Q2 Q3-Q6
IC200UAA007	F3 F4	Q7-Q8 Q9-Q12
Rated Load Voltage		250 V
Current Rating		3.15 A
Manufacturer		WICKMANN USA, Inc. http://www.wickmannusa.com/
Manufacturer Part Number		TR5-F-373 series, 3.15A / 250V, Short Leads

Chapter 11 Configuration

This chapter explains how a VersaMax Nano PLC or Micro PLC is configured.

- Autoconfiguration
- Storing a Configuration from a Programmer
- CPU Configuration
- Port 1 Configuration
- Port 2 Configuration
- Configuring Reference Addresses
- Configuring Analog I/O Parameters
- Configuring RTD Expansion Unit Channels
- Configuring High-speed Counter, PWM or Pulse Output Operation

Configuration selects the characteristics of module operation. It also establishes program references that will used for each I/O point.

The PLC supports either autoconfiguration or storing a configuration from a programmer.

Autoconfiguration

A VersaMax Nano or Micro PLC automatically configures its default parameters the first time it is powered up. It will continue to autoconfigure at power up until it receives a valid configuration from the programmer. Once that has been done, the PLC stops autoconfiguring at powerup, so the desired configuration will be retained.

Software Configuration

Most PLC systems use a customized configuration that is created using configuration software and stored to the CPU from a programmer.

The CPU retains a software configuration across power cycles. After a software configuration is stored to the CPU, the CPU will not autoconfigure when power-cycled.

The configuration software can be used to:

- Create a new configuration
- Store (write) a configuration to the CPU
- Load (read) an existing configuration from a CPU
- Compare the configuration in a CPU with a configuration file stored in the programmer
- Clear a configuration that was previously stored to the CPU

The CPU stores a software configuration in its non-volatile RAM. Storing a configuration disables autoconfiguration, so the PLC will not overwrite the configuration during subsequent startups.

However, actually clearing a configuration from the programmer does cause a new autoconfiguration to be generated. In that case, autoconfiguration is enabled until a configuration is stored from the programmer again.

For a Nano or Micro PLC, one of the parameters that can be controlled by the software configuration is whether the CPU reads the configuration and program from Flash at powerup, or from RAM. If Flash is the configured choice, the CPU will read a previously-stored configuration from its Flash memory at powerup. If RAM is the choice, the CPU will read a configuration and application program from its RAM memory at powerup.

Storing a Configuration from a Programmer

A configuration can be stored from a programmer via the CPU port. The configuration takes place whether I/O scanning is enabled or not.

Storing a configuration disables autoconfiguration.

Note: If a hardware configuration is stored to the CPU, the configuration for the serial port to which the programmer is connected is not actually installed until the programmer is removed. After removal of the programmer, there is a delay before the new protocol begins operating. This delay is equal to the configured T3' time.

Clearing a configuration from the programmer causes a new autoconfiguration to be generated. Autoconfiguration will be enabled until the configuration is stored from the programmer again.

When a programmer is first connected to a Nano or Micro PLC, the PLC communicates using the default communications parameters: 19,200 baud, odd parity, one start bit, one stop bit, and eight data bits. If these parameters are re-configured, the new settings will be used at powerup instead.

CPU Configuration

CPU configuration establishes the basic operating characteristics of the PLC, such as whether it scans I/O while in Stop mode and how it behaves at powerup.

Feature	***Description***	***Default***	***Choices***
I/O Scan-Stop	Determines whether I/O is to be scanned while the PLC is in STOP mode.	No	Yes, No
Powerup Mode	Powerup mode for Nano PLC Powerup mode for Micro PLC	Stop Last	Stop, Run Last, Stop, Run
Logic/ Configuration from	Source of program and configuration when the a Micro PLC is powered up.	Flash for Nano, RAM for others	RAM, Flash
Registers	Selects source of register data when PLC is powered up.	Flash for Nano, RAM for others	RAM, Flash
Passwords	Determines whether passwords are enabled or disabled. (If passwords are disabled, the only way to enable them is to clear the Micro PLC memory.)	Enabled	Enabled, Disabled
Checksum Words	The number of words in the program to be checksummed each sweep. Entering 0 disables the checksum function.	8	8 to 32
Default Modem Turnaround Time	Modem turnaround time (10ms/unit) This is the time required for the modem to start data transmission after receiving the transmit request.	0mS	0–255mS
Default Idle Time	Time (in seconds) the CPU waits to receive the next message from the programming device before it assumes that the programming device has failed and proceeds to its base state. Communication with the programmer is terminated and will have to be reestablished.	10	1–60
SNP ID	The ID used for SNP communications if a serial port is configured for RTU Slave or Serial I/O. SNP communications will occur between the programmer and the CPU when the CPU is in Stop mode.		Editable value
Switch Run/Stop	Determines whether the switch will control Run/Stop mode operation. See chapter 12 for more information about configuring switch operation.	Enabled	Enabled, Disabled
Switch Memory Protect	Determines whether the switch will control RAM memory protection. See chapter 12 for more information about configuring switch operation.	Disabled	Enabled, Disabled

Feature	*Description*	*Default*	*Choices*
Diagnostics	Micro PLCs can be configured to power up more quickly by turning off the normal powerup diagnostics. However, unless your application requires unusually fast power up, leave this setting ENABLED. The DISABLED setting causes the Micro PLC to power up without running diagnostics. If powerup diagnostics are disabled, no expansion units can be used. (If expansion units are connected while powerup diagnostics are disabled, faults are logged in the I/O tables.) Micro PLC IC200UDR010 is guaranteed to power up within 100mS when powerup diagnostics is disabled.	Enabled	Enabled, Disabled
Fatal Fault Override	If the PLC powers up with fatal faults, it automatically sets fault references. If this parameter is set to Disabled, the CPU will then go to Stop mode. If this parameter is set to Enabled, the CPU can then be power cycled from Stop/Fault mode and it will go to Run/Stop mode.	Disabled	Enabled, Disabled
Memory Board	(for 64-Point Micro PLCs only) Sets up use of an optional memory module in the 64 Point Micro PLC.	RAM Only	RAM and Flash
Port 2 Configuration	(for 64-Point Micro PLCs only) Sets up the use of a Port 2 option module in the PLC. The port 2 options can then be configured.	None	RS232/ USB, RS485. None
Sweep Mode	Normal: sweep runs until it is complete. Constant: sweep runs for time specified in Sweep Tmr.	Normal	Normal, Constant
Constant Sweep Time	If Constant Sweep mode was selected, a Constant Sweep Time (in milliseconds) can be specified.	100mS	5–200mS

Port 1 Configuration

Port 1, an RS-232 compatible serial port, is used to communicate with the programmer or for other communications. Configuration options for Port 1 are described below. See chapter 19 for more information about port protocols for the Micro PLC. Note that VersaMax Micro PLC and Nano PLC models prior to Release 3.0 do not support all port modes.

Feature	Description	Default	Choices
Port Mode	Defines the protocol for Port 1. This selection determines which of the additional parameters below are configurable.	SNP	SNP, RTU only, Serial I/O
Port Type	*SNP, RTU:* Configures the serial port as the slave or master device.	Slave	Master, Slave
Data Rate (bps)	Data transmission rate (in bits per second).	19200	300, 600, 1200, 2400, 4800, 9600, 19200, 38400
Flow Control	The type of flow control used on the port. Not editable.	None	None
Parity	Determines whether parity is added to words	Odd	Odd, Even, None
Stop Bits	Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1	1, 2
Bits / Character	Determines whether the CPU recognizes 8-bit or 7-bit characters.	8 bits	7 bits, 8 bits
Timeout	*SNP only:* Specifies the timeout value used by the protocol.	Long	Long, Medium, Short, None
Turn Around Delay	*SNP* only: Turnaround delay time in ms	0	0-255
SNP ID	*SNP only:* 8-byte network identifier for Port 1.	(none)	(none)
Station Address	*RTU:* Station address of the slave on the RTU network	1	1 to 247
	Serial I/O: A hexadecimal identifier used for Serial I/O protocol.	0	0 to FF hex

Timing Note for RTU Communications

When using RTU communications, it may be necessary to increase the RTU timeout configured on the master device as the PLC slave scan time increases. It is not necessary to change the configuration of the VersaMax CPU when the port is used in RTU slave mode.

Port 2 Configuration

On 23 and 28-point Micro PLCs, the built-in Port 2 provides general-purpose communications using SNP, SNPX, RTU slave and Serial I/O protocols. Port 2 can also be configured as an SNP/SNPX master. On 64-Point Micro PLCs, an optional RS-232, RS-485, or USB port module can be installed and configured as Port 2.

Port 2 configuration can be changed through the configuration utility, or by using the COMMREQ (communications request) function block within a ladder logic program as explained in chapter 12.

Feature	Description	Default	Choices
Port Mode	Defines the protocol for Port 2. This selection determines which of the additional parameters below are configurable.	SNP	*RS232/USB:* SNP, Serial I/O, RTU Only
			RS485: SNP, Serial I/O, RTU Only
Port Type	*For Port Modes SNP and RTU Only:* Configures the serial port as a slave (the responding device) or a master (the initiating device) in a master/slave system.	Slave	Slave, Master
Data Rate (bps)	Data transmission rate (in bits per second).	19200	300, 600, 1200, 2400, 4800, 9600, 19200, 38400
Flow Control	The type of flow control used on the port. Not editable.	None	None
Parity	Determines whether parity is added to words	Odd	Odd, Even, None
Stop Bits	*For SNP and Serial I/O:* Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1	1, 2
Bits / Character	*For Serial I/O:* Determines whether the CPU recognizes 8-bit or 7-bit characters.	8 bits	7 bits, 8 bits
Timeout	*For SNP:* Specifies the timeout value used by the protocol.	Long	Long, Medium, Short, None
Turn Around Delay	*For SNP:* Turnaround delay time in ms	0	0-255
SNP ID	*For SNP and RTU only:* 8-byte network identifier for Port 2.	(none)	1 to 247
Station Address	*For Serial I/O:* A hexadecimal identifier used for Serial I/O protocol.	0	0 to FF
Duplex Mode	*For RS485 RTU*	2-Wire	2-Wire 4-Wire
	For RS485 Serial I/O	Point to Point	2-Wire 4-Wire, Point to Point

Configuring Reference Addresses

Default I/O reference addresses for a Micro PLC and for each expansion unit are automatically established by the configuration software.

	Address				Function
	10-Point Nano PLCs	14-Point Micro PLCs	23 and 28-Point Micro PLCs	64-Point Micro PLCs	
%I			I0009-I0016	I0019-I0040	Discrete Inputs
	N/A	I0009	I0017	I0041	Default first discrete input from expansion unit, can be reconfigured.
%Q			Q0007-Q0016	Q0007-Q0024	Discrete Outputs
	N/A	Q0009	Q0017	Q0025	Default first discrete output for expansion unit, can be reconfigured
%AI	N/A	AI016-AI017			Optional analog values
%AI	N/A		AI018	N/A	Analog input channel 1 for 23 pt Micro and analog Nano.
	N/A		AI019	N/A	Analog input channel 2 for 23pt micro only.
	N/A	AI0020-0023			Inputs 1 - 4 from 1st analog expansion unit, can be reconfigured
%AQ	N/A		AQ012	N/A	Analog output channel for 23-point Micro only.
	N/A	AQ0013, 0014			Outputs 1, 2 for 1st analog expansion unit, can be reconfigured

The default addresses for expansion units can be changed if other addresses are preferred. Please see chapter 16 for a complete listing of I/O reference address usage in the VersaMax Nano and Micro PLCs.

Configuring Analog I/O Parameters

For Micro PLC and Expansion Units with analog I/O, each analog channel can be individually configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA. For Nano PLCs with one analog input, the mode is always voltage. Reference addresses can also be selected as described above.

Mode	Parameters	Default
Voltage or current mode	Voltage, Current	Voltage
Current range selection	4–20mA 0–20mA	4–20mA
Voltage range selection (Expansion Inputs Only)	0 to 10,000mV -10,000 to 10,000mV	0 to 10,000mV

Configuring High-speed Counter, PWM or Pulse Train

For Nano and Micro PLCs that offer high-speed counter features, the high-speed DC outputs can be configured as High-speed Counter, PWM, Pulse Train or Pulse Train with Ramp outputs. Configuration selections are summarized below. Chapter 13 provides details of configuring and using these features.

Parameter	***Description***	***Default***	***Setting/Value Range***
Counter Type	Selects the type if High-speed Counters that will be used.	4 Type A	4 Type A, 1 Type A and 1 Type B, 1 Type B2
Output Stop Mode	Defines what outputs do if the system is in stop mode. Normal means that HSC outputs continue to respond to the counter inputs and standard outputs turn off. Preset outputs, continue to operate as if the CPU were present, changing state to reflect the counter Accumulators. Force Off means all Preset outputs are turned off and remain off until the CPU returns to normal operation. Hold Last means Preset outputs retain current levels and do not reflect the counter Accumulators.	Normal	Normal, Force All Outputs Off, Hold
Reference Address, Length	Assigns the CPU memory references that will be used by the HSC outputs.		
Channel #1/2/3/4 Function	Specifies channel function.	HSC	Counter, PWM, Pulse Train, Standard, B2 Counter, Pulse Train with Ramp
Counter #1/2/3/4 Status	Specifies if the counter output is enabled. If disabled, the output is used as a standard output.	Disabled	Enabled, Disabled
Counter #1/2/3/4 Direction	(Type A only). Specifies whether count inputs increment or decrement the accumulator.	Up	Up, Down
Counter #1/2/3/4 Mode	Defines whether the counter wraps if the count limit is reached (continuous) or if it stops at the counter limit.	Continuous	Continuous , Single Shot
Counter #1/2/3/4 Preload/Strobe Selection	Specifies the function of the Preload/Strobe Input.	Preload	Preload, Strobe
Counter #1/2/3/4 Preload/Strobe Input Edge	For Type A counters only, specifies which transition of this input is used. Zero to positive is a low-to-high transition.	Zero to Positive	Not editable
Counter #1/2/3/4 Count Input Edge	For Type A counters only, specifies which transition of this input is used. Positive is a low-to-high transition.	Zero to Positive	Zero to Positive, Positive to Zero
Time Base #1/2/3/4	Specifies the timebase for the Counts-per-Timebase register.	1000mS	10mS to 65530mS
High Limit #1/2/3/4	Defines the counter's upper limit. It must be greater than the low limit	+32,767	-32,767 to +32,767
Low Limit #1/2/3/4	Defines the counter's lower limit.	0	-32,768 to +32,766
ON Preset #1/2/3/4	Defines the counter's ON preset.	+32,767	-32,768 to +32,767
OFF Preset #1/2/3/4	Defines the counter's OFF preset.	0	-32,768 to +32,767
Preload Register #1/2/3/4	This register value is the Preload value for the counter.	0	-32,768 to +32,767
Acceleration	Pulse Train acceleration rate from stop to full speed	1000000	For Channel 1,2,3: 10 to 1000000 . For channel 4: 90 to 1000000
Deceleration	Pulse Train deceleration rate from full speed to stop	1000000	For Channel 1,2,3: 10 to 1000000, For channel 4: 90 to 1000000

Chapter 12 PLC Operation

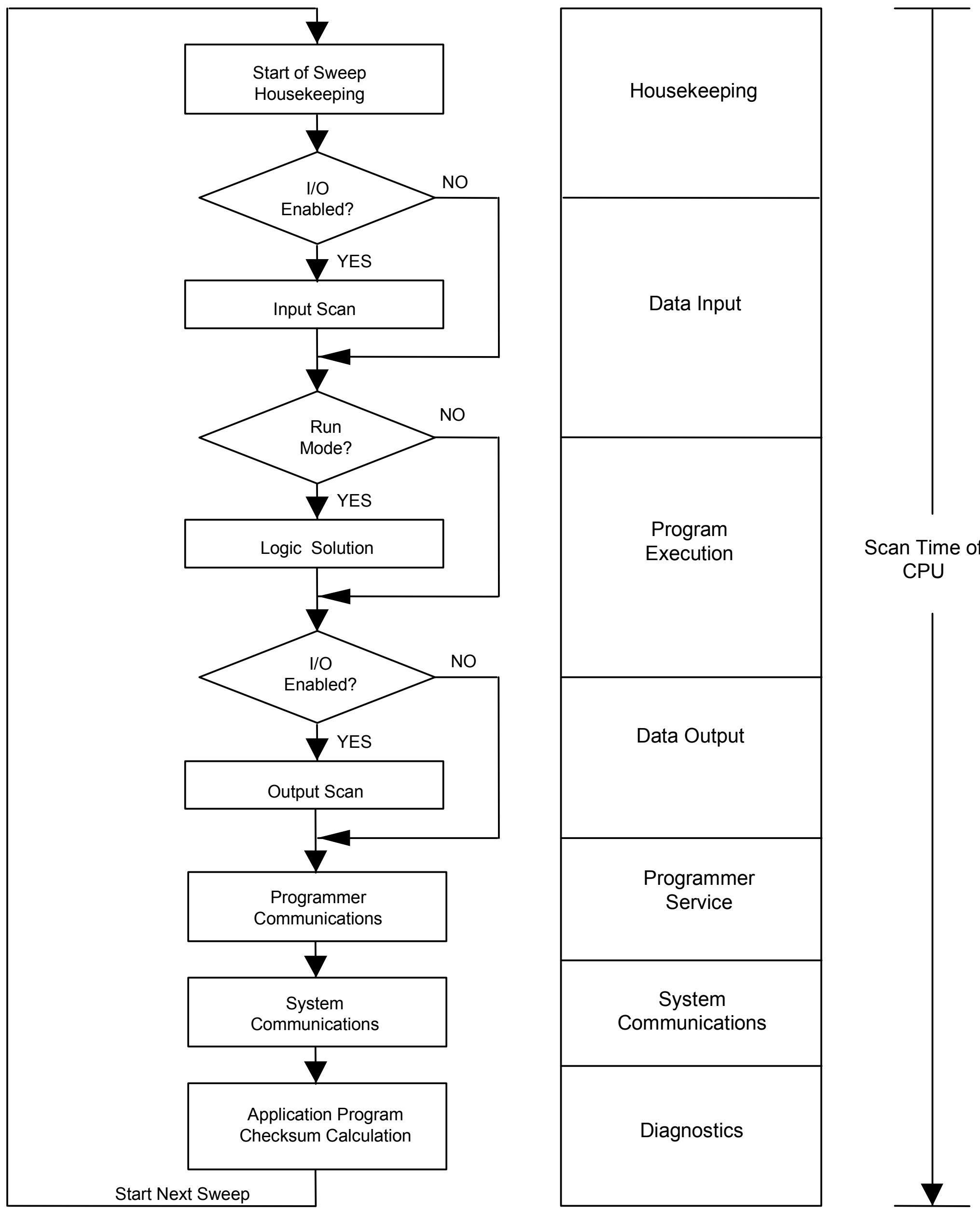
This chapter describes the operating modes of the VersaMax Nano and Micro PLCs and shows the relationship between the application program execution and other tasks performed by the PLC CPU.

Operating Modes

The application program in a PLC executes repeatedly. In addition to executing the application program, the PLC regularly obtains data from input devices, sends data to output devices, performs internal housekeeping, and performs communications tasks. This sequence of operations is called the **sweep**.

- The basic operating mode of the PLC is called **Standard Sweep** mode. In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.
- The PLC may instead operate in **Constant Sweep Time** mode. In this mode, the CPU performs the same series of actions but each sweep takes the same amount of time.
- The PLC may also be in either of two Stop modes:
  - Stop with I/O Disabled mode
  - Stop with I/O Enabled mode

Parts of the CPU Sweep



Parts of the CPU Sweep

Start of Sweep Housekeeping	Housekeeping includes the tasks necessary to prepare for the start of the sweep. Before starting the actual sweep, the CPU: Calculates the sweep time Schedules the start of the next sweep Determines the mode of the next sweep Updates the fault reference tables Resets the Watchdog timer If the PLC is in Constant Sweep Time mode, the sweep is delayed until the required sweep time elapses. If the required time has already elapsed, the OV_SWP %SA0002 contact is set, and the sweep continues without delay. Next, the CPU updates timer values (hundredths, tenths, and seconds).
Input Scan	When the sweep starts, the CPU first scans inputs in ascending reference address order. The CPU stores this new input data in the appropriate memories. If the CPU has been configured to not scan I/O in Stop mode, the input scan is skipped when the CPU is in Stop mode.
Application Program Logic Scan	Next, the CPU solves the application program logic. It always starts with the first instruction in the program. It ends when the END instruction is executed. Solving the logic creates a new set of output data.
Output Scan	Immediately after the logic solution, the CPU scans all outputs in ascending reference address order. The output scan is completed when all output data has written. If the CPU has been configured to not scan I/O in Stop mode, the output scan is also skipped when the CPU is in Stop mode.
Programmer Communications Window	If there is a programming device attached, the CPU next executes the programmer communications window. In the default limited window mode, each sweep the CPU honors one service request. The time limit for programmer communications is 6 milliseconds. If the programmer makes a request that requires more than 6 milliseconds to process, the processing is spread out over multiple sweeps. In Run to Completion mode, the length of the system communications window is limited to 50 milliseconds. If a module makes a request that requires more than 50 milliseconds to process, the request is spread out over multiple sweeps
System Communications Window	Next, the CPU processes communications requests. In default (“Run to Completion”) mode, the length of the system communications window is limited to 200 milliseconds. If a request requires more than 200 milliseconds to process, the request is spread out over multiple sweeps. In Limited mode, if a request requires more than 6 milliseconds to process, the processing is spread out over multiple sweeps. The result is that communications using the system window have less impact on sweep time, but response is slower.
Logic Program Checksum Calculation	A checksum calculation is performed on the application program at the end of every sweep. You can specify the number of words from 8 to 32 to be checksummed. If the calculated checksum does not match the reference checksum, the program checksum failure exception flag is raised. This causes a fault entry to be inserted into the PLC fault table and the PLC mode to be changed to Stop. If the checksum calculation fails, the programmer communications window is not affected.

Standard CPU Sweep Operation

Standard Sweep operation is the normal operating mode of the PLC CPU. In Standard Sweep operation, the CPU repeatedly executes the application program, updates I/O, and performs communications and other tasks shown in the diagram:

1. The CPU performs its start-of-sweep housekeeping tasks.
2. It reads inputs.
3. It executes the application program.
4. It updates outputs
5. If a programming device is present, the CPU communicates with it.
6. It communicates with other devices.
7. It performs diagnostics

Except for communicating with a programmer, all these steps execute every sweep. Programmer communications occur only when needed.

In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.

The Sweep Windows

The programmer communications window and the system communications window have two operating modes:

Limited Mode	The execution time of the window is 6ms. The window terminates when it has no more tasks to complete or when 6ms has elapsed.
Run to Completion Mode	Regardless of the time assigned to a particular window, the window runs until all tasks within that window are completed (up to 200ms for the System Communications Window and up to 50ms for the Programmer Communications Window).

SVCREQ 2 can be used in the application program to obtain the current times for each window.

The Watchdog Timer

When the CPU is in **Standard Sweep** mode, the Watchdog Timer catches failure conditions that could cause an unusually long sweep. The length of the Watchdog Timer is 200 milliseconds. It restarts from zero at the beginning of each sweep.

If the sweep takes longer than 200mS, the OK LED on the CPU module goes off. The CPU resets, executes its powerup logic, generates a watchdog failure fault, and goes to Stop mode. Communications are temporarily interrupted.

Constant Sweep Time Operation

If the application requires that each CPU sweep take the same amount of time, the CPU can be configured to operate in Constant Sweep Time mode. This operating mode assures that the inputs and outputs in the system are updated at constant intervals. This mode can also be used to implement a longer sweep time.

Changing the Configured Default for Constant Sweep Mode

If the PLC is in STOP mode, its Configured Constant Sweep mode can be edited. After this is done, the configuration must be stored to the CPU for the change to take effect. Once stored, Constant Sweep Time mode becomes the default sweep mode.

The Constant Sweep Timer

During operation in Constant Sweep Time mode, the CPU's Constant Sweep Timer controls the length of the sweep. The timer length can be 5 to 200 milliseconds. The time should be at least 10 milliseconds longer than the CPU's sweep time when it is in Standard Sweep mode, to prevent extraneous oversweep faults.

If the Constant Sweep Timer expires before the sweep completes, the CPU still completes the entire sweep, including the windows. However, it automatically provides notice than a too-long sweep has occurred. On the next sweep after the oversweep, the CPU places an oversweep alarm in the PLC fault table. Then, at the beginning of the following sweep, the CPU sets the OV_SWP fault contact (%SA0002). The CPU automatically resets the OV_SWP contact when the sweep time no longer exceeds the Constant Sweep Timer. The CPU also resets the OV_SWP contact if it is not in Constant Sweep Time mode.

As with other fault contacts, the application program can monitor this contact to keep informed about the occurrence of oversweep conditions.

Enabling/Disabling Constant Sweep Time, Reading or Setting the Length of the Timer

SVCREQ 1 can be included in the application program to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

CPU Stop Modes

The Nano or Micro PLC may be in either of two Stop modes:

- Stop with I/O Disabled mode
- Stop with I/O Enabled mode

When the PLC is in Stop mode, the CPU does not execute the application program logic. You can configure whether or not the I/O will scanned during Stop mode. Communications with the programmer and intelligent option modules continue in Stop mode. In addition, faulted board polling and board reconfiguration execution continue in Stop mode.

SVCREQ 13 can be used in the application program to stop the PLC at the end of the next sweep. All I/O will go to the OFF state and a diagnostic message will be placed in the PLC Fault Table.

Controlling the Execution of a Program

The VersaMax CPU Instruction Set contains several powerful Control functions that can be included in an application program to limit or change the way the CPU executes the program and scans I/O.

Calling a Subroutine Block

The CALL function can be used to cause program execution to go to a specific subroutine. Conditional logic placed before the Call function controls the circumstances under which the CPU performs the subroutine logic. After the subroutine is finished, program execution resumes at the point in the logic directly after the CALL instruction.

Creating a Temporary End of Logic

The END function can be used to provide a temporary end of logic. It can be placed anywhere in a program. No logic beyond the END function is executed, and program execution goes directly back to the beginning. This ability makes the END function useful for debugging a program.

The END function should not be placed in logic associated with or called by a Sequential Function Chart control structure. If this occurs, the PLC will be placed in STOP/FAULT mode at the end of the current sweep and an SFC_END fault will be logged.

Executing Rungs of Logic without Logical Power Flow

The nested Master Control Relay can be used to execute a portion of the program logic with no logical power flow. Logic is executed in a forward direction and coils in that part of the program are executed with negative power flow. Master Control Relay functions can be nested to 8 levels deep.

Jumping to Another Part of the Program

The Jump function can be used to cause program execution to move either forward or backward in the logic. When a nested Jump function is active, the coils in the part of the program that is skipped are left in their previous states (not executed with negative power flow, as they are with a Master Control Relay). Jump functions can also be nested.

Jumps cannot span blocks, SFC actions, SCF transitions, or SFC pre- or post-processing logic.

Privilege Levels and Passwords

Passwords are an optional configurable feature of the Micro PLC (passwords are not available on Nano PLCs). Passwords provide different levels of access privilege to the PLC when the programmer is in Online or Monitor mode. Passwords are not used if the programmer is in Offline mode. Passwords can restrict:

- Changing I/O and PLC configuration data
- Changing programs
- Reading PLC data
- Reading programs

There is one password for each privilege level in the PLC. Each password may be unique or the same password can be used for more than one level. Passwords are one to seven ASCII characters in length.

By default, there is no password protection. Passwords are set up, changed, or removed using the programming software. After passwords have been set up, access to the PLC is restricted unless the proper password is entered. Entering a correct password allows access to the requested level and to all lower levels. For example, the password for level 3 allows access to levels 1, 2, and 3. If PLC communications are suspended, protection automatically returns to the highest unprotected level. For example: If a password is set at levels 2 & 3, but none at level 4, if the software disconnects and reconnects, the access level is 4. Privilege level 1 is always available because no password can be set for this level.

Level	***Access Description***
4 Least Protected	▪ Write to all configuration or logic. Configuration may only be written in Stop mode; logic may be written in Stop or Run mode (if run-mode store is supported). ▪ Set or delete passwords for any level. ▪ Plus all access from levels 3,2 and 1 ▪ NOTE: This is the default if no passwords are defined.
3	▪ Write to all configuration and logic when the CPU is in Stop mode, including word-for-word changes (when supported), the addition/deletion of program logic, and the overriding of discrete I/O. ▪ Read/Write/Verify user flash. ▪ Store reference/override tables. ▪ Change sweep mode. ▪ Plus all access from levels 2 and 1
2	▪ Write to any data memory, but this does not include storing tables. ▪ This includes the toggle/force of reference values but does not include overriding discrete I/O. ▪ The PLC can be started or stopped. ▪ PLC and I/O fault tables can be cleared. ▪ Plus all access from level 1
1 Most Protected	Read any PLC data except for passwords. This includes reading fault tables, current status, performing datagrams, verifying logic/config, and loading program and configuration from the PLC. No PLC memory may be changed.

Protection Level Request from Programmer

Upon connection to the CPU, the programming software automatically requests the CPU to move to the highest unprotected level. That gives the programmer access to the highest unprotected level without having to specifically request a particular level.

A privilege change may be to a lower level or to a higher level. The privilege level is changed from the programmer by entering the new level and the correct password for that level. If the wrong password is entered, the change is denied and a fault is logged in the PLC fault table. A request to change to a privilege level that is not password-protected is made by supplying the new level and an empty password.

Notes on Using Passwords

- To re-enable passwords after passwords have been disabled, the PLC must be power-cycled with the battery removed for long enough to completely discharge the super-capacitor and erase the PLC's memory.
- If the passwords prevent changing the run/stop mode, firmware upgrades cannot be performed if the PLC is in run mode.
- The Run/Stop switch (if configured) will place the PLC in run or stop mode regardless of the passwords.

The OEM Protection Feature

The OEM protection feature is similar to the passwords and privilege levels and provides an even higher level of security. The feature is enabled or disabled using a 1 to 7 character password called the *OEM key*. When OEM protection is enabled, no write-access to the PLC program and configuration is permitted. Reading the configuration from the PLC is permitted. In this mode, no user flash operations are allowed.

When the OEM key password has been created, the OEM key can be locked in two ways: by choosing the locked setting from the programming software or by power-cycling the PLC. (The OEM key locked status does not change when PLC communications are suspended.)

Clearing All Memory

It is possible to Clear All memory from the programmer with the CPU at any privilege level, even with the OEM key locked. Operators can clear CPU memory and store a new application program to the CPU without knowing passwords.

If passwords and/or the OEM key have been set and written to flash, a read from flash updates the protection level. In this case, it is not necessary to reenter the password to gain access to a particular level. A Clear All does not clear user flash.

Run/Stop Mode Switch Operation

The CPU Run/Stop mode switch on a VersaMax Micro PLC can be used as a Run/Stop switch, as a memory protect switch, and for clearing faults when a fatal fault exists. A 10-Point VersaMax Nano PLC can provide the same functionality by adding a Single Pole, Single Throw (SPST) switch. An external switch on a Nano PLC is read as a normal 24VDC input. The specifications for the RUN input are the same as the other DC inputs on the Nano PLC.

Run/Stop Mode Operation

If Run/Stop operation is enabled, the Run/Stop switch is use to control the operating mode of the PLC. The PLC monitors the state of the Run/Stop switch and stores the current state in status bit %S0022. The application program can check the state of this bit if necessary, and activate logic based on its setting (in Run mode, the bit is =1, and in Stop mode, it is =0).

If Run/Stop mode switch operation is enabled, the switch can be used to place the Micro PLC CPU in Run mode if a fatal fault condition exists in the CPU. Note that the switch overrides any restrictions on mode selection that have been set up using password protection.

- If the CPU has non-fatal faults and is not in Stop/Fault mode, placing the switch in Run position causes the CPU to go to Run mode. Faults are NOT cleared.
- If the CPU has fatal faults and is in Stop/Fault mode and Run/Stop Enabled is configured, placing the switch in Run position causes the Run LED to blink for 5 seconds. While the Run LED is blinking, the CPU switch can be used to clear the fault table and put the CPU in Run mode. After the switch has been in Run position for at least ½ second, move it to Stop position for at least ½ second. Then move it back to Run position. The faults are cleared and the CPU goes to Run mode. The LED stops blinking and stays on. This can be repeated if necessary.
- If the switch is not toggled as described, after 5 seconds the Run LED goes off and the CPU remains in Stop/Fault mode. Faults stay in the fault table.
- If Run/Stop operation is NOT enabled by configuration and a fatal fault occurs, it is not possible to restore operation using the switch as described above. The CPU remains in Stop/Fault mode and faults stay in the fault table.

Configurable Memory Protection

Operation of the Micro PLC Run/Stop switch (or Nano Run/Stop input) can be configured to prevent writing to program memory and configuration, and to prevent forcing or overriding discrete data.

Configuration Parameters and Switch Position for Run/Stop Modes

Switch Run/Stop Enabled Configuration	I/O Scan Stop Configuration	Switch Position	Allowed Mode	PLC Operation
Disabled	has no effect	has no effect	All	PLC Programmer modes operate the same
Enabled	has no effect	Run/On	All	PLC Programmer modes operate the same
Enabled	No	Stop/Off	Stop/ No I/O	PLC not allowed to go to Run mode.
Enabled	Yes	Stop/Off	Stop/No I/O, Stop I/O	PLC not allowed to go to Run mode.
Enabled	has no effect	Toggle Switch from Stop to Run	n/a	PLC goes to Run mode
Enabled	No	Toggle switch from Run to Stop	n/a	PLC goes to STOP–NO IO
Enabled	Yes	Toggle switch from Run to Stop	n/a	PLC goes to STOP–IO

Configuration Parameters and Switch Position for Memory Protection

Memory Protect Enabled Configuration	Switch Position	PLC Operation
Off	n/a	Normal PLC operation
On	Protect/On	No storing/clearing/loading of PLC allowed
On	Protect/Off	Normal PLC operation

Configuration Parameters and Switch Position for Simultaneous Run/Stop Operation and Memory Protection

Memory Protect Configuration	Run/Stop Configuration	Switch Position	PLC Operation
Enabled	Disabled	Toggled From OFF to ON	Memory Protected
Enabled	Enabled	Toggled From OFF to ON	Memory Protected PLC is in Run Mode
Enabled	Enabled	Toggled From ON to OFF	Memory Protected PLC is in Stop Mode PLC cannot be put in Run Mode with Programmer

Configuration Parameters and Switch Position for Fault Operations

Run/Stop Enabled Configuration	Switch Position	Faults Present in the PLC	PLC Operation
Disabled	n/a	n/a	Normal PLC operation
Enabled	Toggle Switch from Stop to Run	Non-fatal	Places PLC in Run mode Faults are NOT cleared
Enabled	Toggle Switch from Stop to Run	Fatal	Run LED blinks for 5 sec
Enabled	While the Run LED is blinking and ON for at least ½ second, toggled from Run to Stop, then after another ½ second, toggled from Stop to Run	Fatal	PLC goes to Run mode and all faults are cleared

Powerup and Power-Down Sequence

Powerup Sequence

The powerup sequence for the Nano/Micro PLC consists of the following events:

1. The CPU runs self-diagnostics. This includes checking a portion of RAM to determine whether or not the RAM is functional. (For DC Micro PLCs, powerup diagnostics can be disabled by configuration. It is recommended that you not use this feature unless your application requires unusually rapid powerup. For details, see “Installation Instructions”.)
2. The hardware configuration is compared with the software configuration. Any mismatches detected constitute faults and are alarmed.
3. If there is no software configuration, the CPU uses the default configuration.
4. The mode of the first sweep is determined based on CPU configuration. The PLC can either copy the program from flash memory into RAM (see below), or power up in Stop or Run mode. See “Flash Memory”.

	Nano PLC or 14-Point Micro PLC	23-Point or 28-Point Micro PLC	
		No Backup Battery	Backup Battery
Default Powerup Mode	Stop Mode	Stop Mode	Last Mode
Configurable Powerup Modes	Run Mode or Stop Mode	Run Mode or Stop Mode	Run, Stop, or Last Mode

Flash Memory

A VersaMax Nano or Micro PLC provides non-volatile flash memory to store the application program and system firmware.

Only one application program at a time can be present in non-volatile flash memory. Separate copies of the user data (program, configuration, and retentive data) are maintained in FLASH memory.

During configuration of a Nano or Micro PLC, you can choose whether, in the future, the PLC will read its user data from flash or from RAM.

In addition, Micro PLCs that use the optional backup battery can read their user data from RAM if the unit has been powered down for an extended period of time. If there is no battery backup, RAM may be invalid on powerup. In that case, the default program is installed or the user data must be read from flash.

	User Data		
	Configuration	**Program**	**Retentive Data**
Default Settings			
Read From RAM	X	X	X
Read From FLASH	–	--	–
Recommended Settings			
Read From RAM	–	--	X
Read From FLASH	X	X	X (If battery is not used)

If the application uses svc_req 53 to write additional data to flash memory (supported in firmware rev 3.0), retentive data will be updated. If the retentive data is read from flash on powerup, these updated values will be used instead of the original data values.

Default Conditions for Micro PLC Output Points

At power-up, output points default to off. They stay off until the first output scan.

Power-Down Conditions

System power-down occurs automatically if the power supply detects that incoming AC power has dropped. The minimum hold time is one half cycle.

Note: During a gradual power down, when the input power supply voltage drops below the minimum operating voltage, the PLC will transition to a state where all outputs are disabled. In this state, the Run LED and the OK LED are also turned off. The PLC remains in this state until power is lost completely (the PLC shuts off), or until power is restored (above the minimum operating voltage). In the latter case, the PLC will reset itself and start the normal powerup sequence.

Power Cycle

The table below lists the effects that a power cycle can have on Micro PLC operation under specific conditions.

Condition	Effects
PLC loses power while storing a program to RAM from either the programming software or flash memory.	On the ensuing powerup the program will be deleted from RAM. You will need to store the program again from the programmer.
PLC loses power while storing a configuration to RAM from either the programming software or flash memory.	On the ensuing powerup, the configuration will be deleted from RAM. You will need to store the configuration again from the programmer.
PLC loses power while storing the reference tables to RAM from either the programming software or flash memory.	On the ensuing powerup, the reference table data will be deleted from RAM. You will need to store the data again from the programmer.
PLC loses power while storing a program. configuration, or reference table data to flash memory.	The flash memory area used to store the program, configuration, or reference table data will be considered invalid. You will need to store the program, configuration, or reference tables to flash memory again.
If system includes expansion unit(s):	
Micro PLC base unit loses power before the expansion unit(s)	Expansion units will be reset (all outputs will be set to zero)
Expansion unit(s) lose power before the Micro PLC base unit while Micro PLC is scanning I/O	A *Loss of Expansion Module* fault may be logged.
Micro PLC base unit powers up before the expansion unit(s)	If expansion units do not power up at the same time as the Micro PLC, a *Loss of Expansion Module* fault may be logged.
Expansion unit(s) power up before the Micro PLC base unit	Expansion unit outputs remain off until the Micro base unit completes powerup and begins scanning I/O.

If the application uses svc_req 53 to write additional data to flash memory (supported in firmware rev 3.0), retentive data will be updated. If the retentive data is read from flash on powerup, these updated values will be used instead of the original data values.

Input Filters

Discrete Input Filtering

Nano and Micro PLCs with DC inputs can provide discrete input filtering, to compensate for switch bounce and other application conditions. This input filtering also applies to discrete expansion units connected to the PLC.

Filter Control Reference

Discrete input filter time can be changed on the fly by simply adjusting the value in reserved reference %AQ11. The filter time can be 0.5mS to 20mS in 0.5mS increments. The value in %AQ11 represents the number of 0.5mS increments in the total filter time.

For 64-point Micro PLCs, input filtering is configurable in 1ms increments only. Use the values shown below (1ms = 2, 2ms = 4, 3ms = 6 and so on).

Filter Time in mS	Value to Put in %AQ11	Filter Time in mS	Value to Put in %AQ11	Filter Time in mS	Value to Put in %AQ11	Filter Time in mS	Value to Put in %AQ11
0.5mS	1	5.5mS	11	10.5mS	21	15.5mS	31
1.0mS	2	6.0mS	12	11.0mS	22	16.0mS	32
1.5mS	3	6.5mS	13	11.5mS	23	16.5mS	33
2.0mS	4	7.0mS	14	12.0mS	24	17.0mS	34
2.5mS	5	7.5mS	15	12.5mS	25	17.5mS	35
3.0mS	6	8.0mS	16	13.0mS	26	18.0mS	36
3.5mS	7	8.5mS	17	13.5mS	27	18.5mS	37
4.0mS	8	9.0mS	18	14.0mS	28	19.0mS	38
4.5mS	9	9.5mS	19	14.5mS	29	19.5mS	39
5.0mS	10	10.0mS	20	15.0mS	20	20.0mS	40

The input filter recognizes signals that have a duration within ±0.5mS (±1.0mS for 64-point Micro PLCs) of the filter time. For example, if the filtering time is 5mS, any input that lasts more than 4.5mS (5.0mS for 64-point Micro PLCs) is recognized. What will be read on an input is not only based on the input filter setting. It is also based on the scan time. An input will always be seen if it is longer than both the scan time and the filter time.

Because %AQ11 is used to control the discrete input filtering time, it should not be used for any other purpose.

Analog Potentiometer Input Filtering

Input Settings

VersaMax Micro-14, Micro-23, and Micro-28 PLCs have two potentiometers, located below the Run/Stop switch, that can be used to manually set input values that are stored in %AI16 and %AI17. The left potentiometer controls %AI16, and the right one controls %AI17.

Filter Control Reference

Due to the nature of analog input, the values seen in %AI16 and %AI17 will have some fluctuation. This variation could make these inputs less suitable for certain applications. The Micro PLC uses an averaging filter that samples the values of these inputs once per sweep. When a selected number of samples has been read, it averages them and stores the result in %AI16 and %AI17.

The value in memory reference %AQ1 controls the number of samples to be averaged, calculated as follows:

$$\text{Number of samples} = 2^{\%AQ1}$$

The value in %AQ1 can be from 0 to 7 (for 0 through 128 samples). For example, if 4 is placed in %AQ1, 16 samples are averaged to determine the values to place in %AI16 and %AI17. If 5 is placed in %AQ1, 32 samples are averaged.

The analog value from the potentiometer is not reported until the number of sweeps determined by the value in AQ1 has occurred. If you want to receive a value from the potentiometer on every sweep, including the first sweep, %AQ1 must contain 0.

Default Filter Time

The default value in %AQ1 is 4, meaning that 16 samples will be averaged.

Limitations of Analog Potentiometer Input Filtering

As with any filter, the longer the filter time (i.e., the more samples that are taken), the longer the response time. Although the maximum value of 7 could be used in %AQ1, this value might cause a long response time on larger programs. For example, if the sweep time of a program is 100ms, and if the potentiometer value is changed, the new value would not show up for 12.8 seconds.

Chapter 13

High-speed Counter, PWM, and Pulse Train Operation

All Nano PLCs and Micro PLCs with DC inputs are configurable for a mix of High-speed Counting features. Nano PLCs and Micro PLCs with DC outputs can also be configured with Pulse-Width Modulation and Pulse Train/Ramping Pulse Train features. For added flexibility, the operating parameters of these features can be fine-tuned during operation by including special function blocks in the application program.

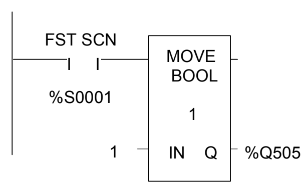
The mix of features available depends on the type of Nano/Micro PLC model being used, as explained on the following pages.

Setting Up HSC, PWM, and Pulse Train Features

There are three basic steps to setting up a High Speed Counter, PWM, and PT features.

- With the VersaPro configuration software, enable each feature you want to use. See the Configuration chapter of this manual for configuration details.
- If you want a counter to control an output you must enable the output, also using the configuration software.
- Finally, you can provide application program control over operation of the output by setting or clearing its associated Enable Output bit from the program or in the data tables. For example, if a High-speed Counter is configured with its output enabled and its Output Enable bit is set, it will control the output. The Output Enable bits are assigned to fixed reference addresses: Q505 through Q508.

A sample ladder logic rung that sets the Output Enable bit for a High-speed Counter is shown below.



Operation at Powerup and Mode Change

High-speed Counters run independently of the PLC program. When the PLC goes from Run to Stop mode, the High-speed Counters continue to operate (as specified in the configuration). High-speed Counters remain in running mode through a power cycle. If a High-speed Counter is running when power is lost, it will start again as soon as power is restored. When power is cycled or the PLC is placed in Run mode, the Accumulator register is loaded with the configured Preload value.

If a new configuration has been stored to the PLC, the PLC continues with the existing HSC/PTO/PWM configuration. When the PLC is switched to Run mode, the HSC begins using the new configuration and the Preload value is placed in the Accumulator register.

Combining HSC, PWM, and Pulse Train Features

The HSC, PWM and Pulse Train features use the same input and output points. HSC, PWM and PTO operation can be set up for each channel individually.

- Each channel can be configured as a High-speed Counter, PWM, or Pulse Train channel. (High-speed Counter inputs cannot be mixed with PWM or PTO outputs on the same channel.)
- A channel that uses High-speed Counter inputs can use its associated output(s) as either High-speed Counter or standard output(s).
- A channel that uses PWM or Pulse Train outputs can use its associated inputs as standard inputs.

Micro PLCs

A Micro PLC can be set up to have either four channels (by configuring four Type A counters) or two channels (by configuring one Type A counter and one Type B counter).

Channel Configuration Choice	Creates this Number of Channels	Number of Type A Counters Configured	Number of Type B Counters	Number of PWM / Pulse Train Outputs
Four Type A	Four	4	0	0
		3	0	1
		2	0	2
		1	0	3
		0	0	4
One Type A and One Type B	Two	1	1	0
		0	1	1

For Micro PLCs that have only one DC output, only one PWM or Pulse Train output can be configured.

Nano PLCs

A Nano PLC can be set up to have either three channels (by configuring three Type A counters) or two channels (by configuring one Type A counter and one Type B counter).

Channel Configuration Choice	Creates this Number of Channels	Number of Type A Counters Configured	Number of Type B Counters	Number of PWM / Pulse Train Outputs
Three Type A	Three	3	0	0
		2	0	1
		1	0	2
		0	0	3
One Type A and One Type B	Two	1	1	0
		0	1	1

Point Allocation

Configuring High-speed Counter, Pulse Train, or PWM operation enables specific features and assigns them to dedicated points on the PLC. These assignments are listed below. You can mix high-speed counting and regular I/O functions on the same Micro PLC, as long as there are points available.

Assigned Input Points for Micro PLCs and Nano PLCs

Input Reference	Micro PLCs (14, 23, or 28-Points)			Nano PLCs		
	Standard Inputs	**4 Type A Counters**	**1 Type A and 1 Type B**	**Standard Inputs**	**3 Type A Counters**	**1 Type A and 1 Type B**
I001	Input 1	Count 1	Type B counter (Phase 1)	Input 1	Count 1	Type B counter (Phase 1)
I0002	Input 2	Preload/Strobe 1	Not used	Input 2	Preload/Strobe 1	Not used
I0003	Input 3	Count 2	Type B counter (Phase 2)	Input 3	Count 2	Type B counter (Phase 2)
I0004	Input 4	Preload/Strobe 2	Not used	Input 4	Preload/Strobe 2	Preload/Strobe for Type B counter
I0005	Input 5	Count 3	Not used	Input 5	Count 3	Type A counter: Count Input
I0006	Input 6	Preload/Strobe 3	Preload/Strobe for Type B counter	Input 6	Preload/Strobe 3	Type A counter: Preload/Strobe
I0007	Input 7	Count 4	Type A counter: Count 4			
I0008	Input 8	Preload/Strobe 4	Preload/Strobe 4			

I0494	Pulse Train complete on Q1	
I0495	Pulse Train complete on Q2	
I0496	Pulse Train complete on Q3	
I0497	Strobe status HSC1	
I0498	Strobe status HSC2	
I0499	Strobe status HSC3	
I0500	Strobe status HSC4	Reserved
I0501	Preload status HSC1	
I0502	Preload status HSC2	
I0503	Preload status HSC3	
I0504	Preload status HSC4	Reserved
I0505	Output status HSC1	
I0506	Output status HSC2	
I0507	Output status HSC3	
I0508	Output status HSC4	Reserved
I0509	1 (module ready always 1)	
I0510	Not used (always 0)	
I0511	Pulse Train complete on Q4	Reserved
I0512	Counter Error status	

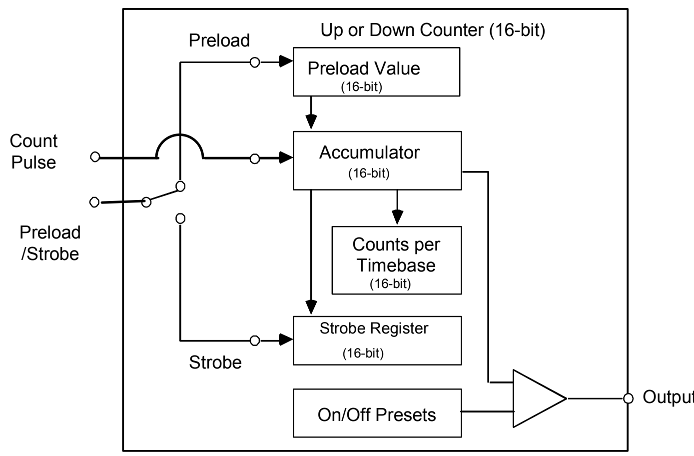
Assigned Output Points for Micro PLCs and Nano PLCs

Output Reference	Micro PLCs (14, 23, or 28-Points)			Nano PLCs		
	Standard Outputs	**4 Type A Counters**	**1 Type A and 1 Type B**	**Standard Outputs**	**3 Type A Counters**	**1 Type A and 1 Type B**
Q0001	Output 1	Counter 1 Output/PWM/PT1		Output 1	Counter 1 Output/PWM/PT1	Type B Counter Output
Q0002	Output 2	Counter 2 Output/PWM/PT2		Output 2	Counter 2 Output/PWM/PT2	Standard Output 2
Q0003	Output 3	Counter 3 Output/PWM/PT3	Standard Output 3	Output 3	Counter 3 Output/PWM/PT3	Type A Counter Output
Q0004	Output 4	Counter 4 Output/PWM/PT4	Type A Counter Output	Output 4	Standard	Standard Output 4
Q0005	Output 5					
Q0006	Output 6					
Q0007-Q9 (23-point units)	Outputs 7-9					

Q0494	Start Q1 Pulse Train	
Q0495	Start Q2 Pulse Train	
Q0496	Start Q3 Pulse Train	
Q0497	Clear Strobe bit for HSC 1	
Q0498	Clear Strobe bit for HSC 2	
Q0499	Clear Strobe bit for HSC 3	
Q0500	Clear Strobe bit for HSC 4	Reserved
Q0501	Reset Preload bit HSC 1	
Q0502	Reset Preload bit HSC 2	
Q0503	Reset Preload bit HSC 3	
Q0504	Reset Preload bit HSC 4	Reserved
Q0505	Enable Output HSC/PTM/PT 1	
Q0506	Enable Output HSC/PTM/PT 2	
Q0507	Enable Output HSC/PTM/PT 3	
Q0508	Enable Output HSC/PTM/PT 4	Reserved
Q0509	Not used but unavailable	
Q0510	Not used but unavailable	
Q0511	Start Q4 Pulse Train	Reserved
Q0512	Clear Error (all counters)	

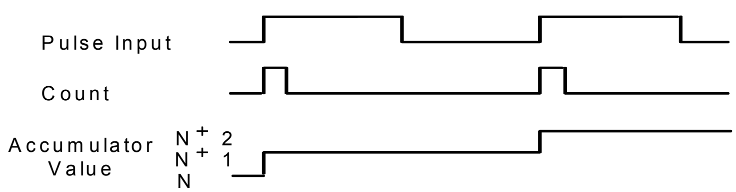
Type A Counter Operation

The Type A counter is one 16-bit counter that can count up or down. Configurable high and low limits set the counter's range. The Type A counter has an Accumulator register, a Counts per Timebase register, a Strobe register, high limit, low limit, and ON/OFF Preset values. These are 16-bit signed numbers. The values selected for the Preload, Accumulator, On Preset, and Off Preset registers must be within the counter limits.



The counter can either count continuously within its limits, or count to either limit then stop (one-shot mode). In continuous counting, the Accumulator wraps when the count limit is reached and continues counting. For example, if the Count Direction is up, when the count exceeds the High Limit by 1, the Accumulator value wraps to the Low Limit. In one-shot mode, the counter stops at Limit N+1 for up counters or N-1 for down counters.

In the example below, the counter has been configured to count on the low to high transition of the Pulse input. The Count signal represents an internal signal that indicates where counting occurs with respect to the pulse input.



High-speed Counters run independently of the application program. When the PLC goes from Run to Stop mode, its High-speed Counters continue to operate. High-speed Counters remain in run mode through a power cycle. If a High-speed Counter is running when power is lost, it will start again as soon as power is restored. Counters will stop on a store of logic or configuration and a write to the user storage device. When power is cycled or the PLC is placed in Run mode, the Accumulator is loaded with the Preload value and the registers start updating.

High-speed Counter Operation Details

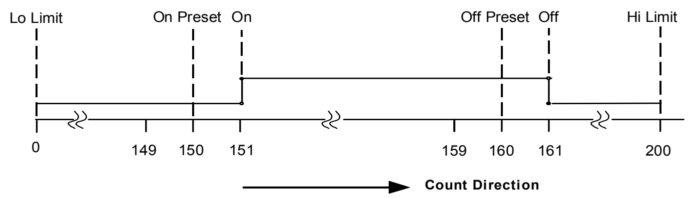
The **Count Pulse** input increments or decrements the counter's accumulator. The count input can be configured to be positive or negative edge-sensitive. The configured **On/Off Preset** values determine when the counter **output** is activated or deactivated.

For example:

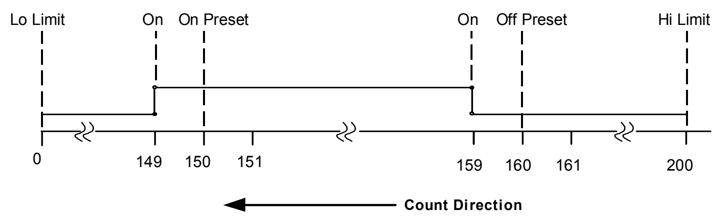
Lo Limit = 0 Hi Limit = 200

On Preset = 150 Off Preset = 160

Count Direction = Up



Count Direction = Down



Depending on the configuration for Preload/Strobe, the **Preload/Strobe Input** can either preload a value into the Accumulator or strobe the accumulator value into a register. Preload/Strobe signals are always positive edge-sensitive.

- If configured as a Preload input, the configured Preload value is transferred to the Accumulator Register when the input transitions from low to high. When a preload occurs, the PLC sets the Preload Status bit. The application program can reset the bit before the next preload.

	Counter 1	Counter 2	Counter 3	Counter 4
Accumulator Registers	AI006	AI008	AI010	AI012
Preload Status Bits	I0501	I0502	I0503	I0504
Reset Preload Bits	Q0501	Q0502	Q0503	Q0504

The Preload input always loads the Accumulator regardless of the state of the Preload Status bit. The value in the Preload register can be configured to any value in the counter's range. This selection is part of the PLC configuration. However, the value can be changed during operation using a COMMREQ function in the program. Also, The program can also use a COMMREQ to load an adjustment value to the Accumulator register. The adjustment value can be between -128 and +127.

- If a counter is configured for Strobe operation, when its Strobe input signal goes active the PLC places the current value in that counter's Accumulator into its Strobe register. The PLC sets the associated Strobe Status bit to indicate that a Strobe value was captured. The Strobe value remains in the Strobe register until the Strobe signal goes active again, at which time it is overwritten by a new value. The Strobe status bit stays on until the program clears it.

	Counter 1	Counter 2	Counter 3	Counter 4
Strobe Registers	AI007	AI009	AI011	AI013
Strobe Status Bits	I0497	I0498	I0499	I0500
Clear Strobe Bits	Q0497	Q0498	Q0499	Q0500

The Strobe input always loads the Strobe register with the Accumulator value regardless of the state of the Strobe bit. Strobe inputs can be used as Pulse Capture Inputs by using the Strobe status bits as a latch.

Timebase is a span of time used to measure the rate of counting. For example, the program could monitor the number of counts that occur in 30 seconds. Timebase is configurable in 1mS increments from 10mS to 65530mS. The **Counts-per-Timebase** register contains the number of counts that occurred during the last-completed timebase interval. The number of counts is a 16-bit signed number. The sign indicates up (+) or down (-) counts. The range is –32768 and +32767 counts. If the configured timebase is too large, the Counts per Timebase register will lose the overflow values.

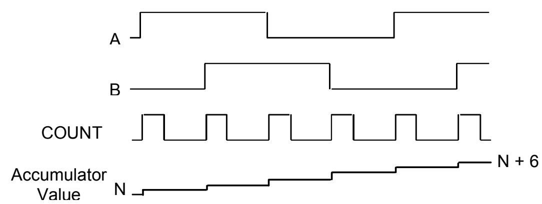
Counts/Timebase Reg.	Counter 1	Counter 2	Counter 3	Counter 4
	AI002	AI003	AI004	AI005

Error Status and Status Code: The program should monitor the Error Status bit %I0512 to check for error conditions. When this bit is 1, the program can look at the Status Code register %AI001 to learn what caused the error. After taking any necessary corrective action, the program logic should clear the error status by clearing the Clear Error output bit (%Q0512). See "Command Word Error Responses" later in this chapter for more information.

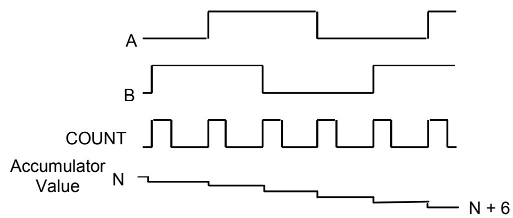
Type B Counter Operation

The Type B counter uses two counter input signals for A-Quad-B counting. The phase relationship between the counter inputs (A & B) determines whether the accumulator is incremented or decremented on a transition of either counter input.

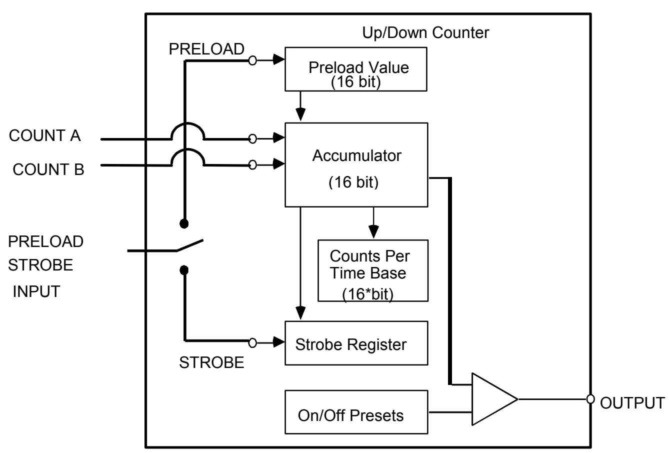
The count direction is up if A leads B.



The count direction is down if A lags B.



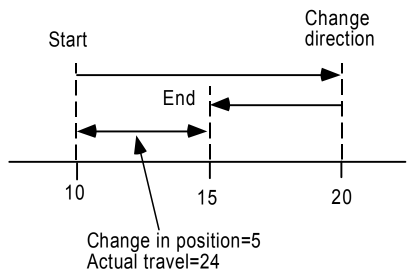
The Type B counter can have one output that is activated based on selected On and Off preset values.



The counter counts continuously within its limits. The Accumulator wraps when the count limit is reached and continues counting. For example, if the Count Direction is up, when the count exceeds the High Limit by 1, the Accumulator value wraps to the Low Limit.

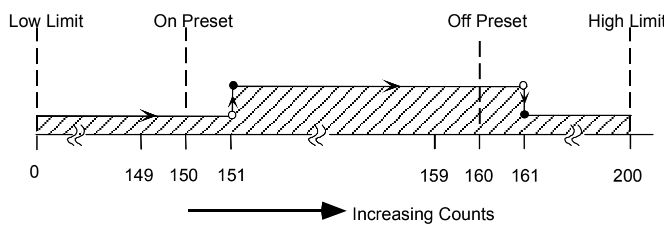
The Type B counter has a Strobe register, a 16-bit Accumulator, and a Counts-per-Timebase register. Except for the Counts per Timebase Register, these operate as described for Type A counters.

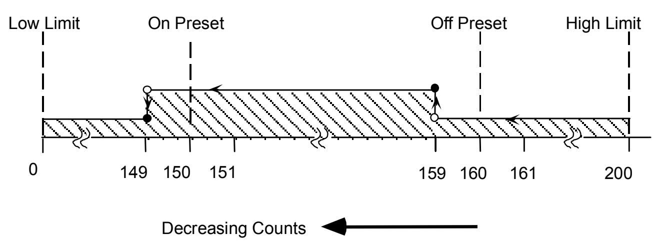
For a B-type counter, the Counts per Timebase value represents the relative shift over the sample time, not an exact number of counts. For example, if the counter starts at 10, counts up to 20, and then counts back to 15, the resulting counts per timebase value is 5.

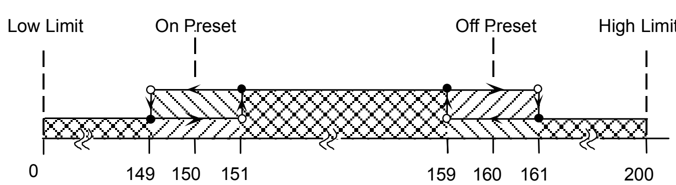


Type B Counter Examples

Low Limit = 0 High Limit = 200
On Preset = 150 Off Preset = 160







Outputs

Four high-speed outputs (three for a Nano PLC) can be individually configured as High-speed Counter outputs, PWM outputs, or Pulse Train outputs.

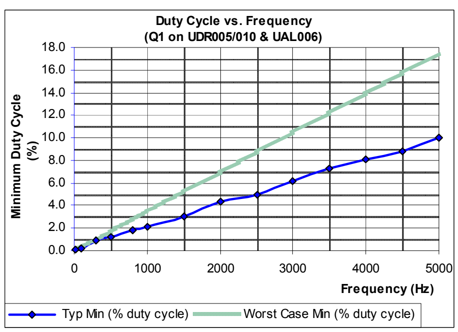
When the Counter Type configured is both Type A and Type B, PWM and Pulse Train outputs 1-3 are not available because AQUADB counting uses channels 1–3, as shown earlier in this chapter.

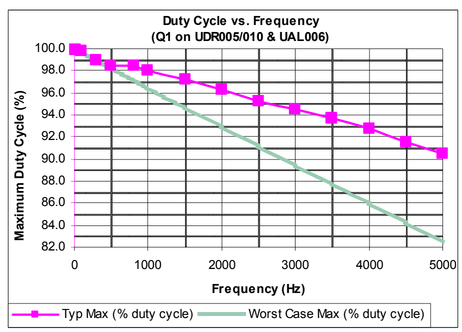
If the configurations are changed for HSC, PWM, and Pulse outputs, the new outputs take effect when the PLC changes from Stop to Run mode and the enable output bit is ON. When the transition to Run mode occurs, the currently-configured output stops running and the new configuration takes over.

Results vary with temperature, but the maximums and minimums shown below apply across the entire operating range for the unit (both temperature and DC output voltage).

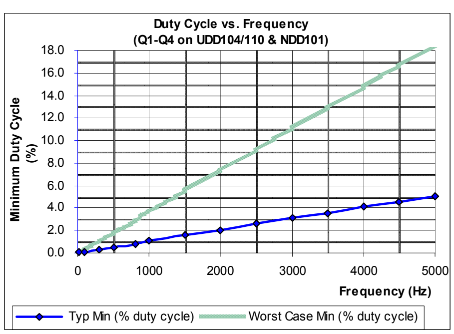
A pulldown resistor, connected between the output (Q1, 2, 3, or 4) and Common, is required for high frequency Pulse and PWM (up to 5kHz) outputs and for duty cycles in the lower ranges (5% and lower). A 1.5 Kohm, 0.5 watt resistor is recommended.

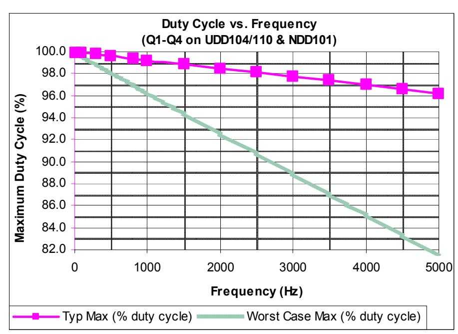
Duty Cycle Limits: with 1.5k ohm pulldown resistor - UDR005/006/010 & UAL004/005/006





Duty Cycle Limits: with 1.5k ohm pulldown resistor - UDD104/110 & NDD101

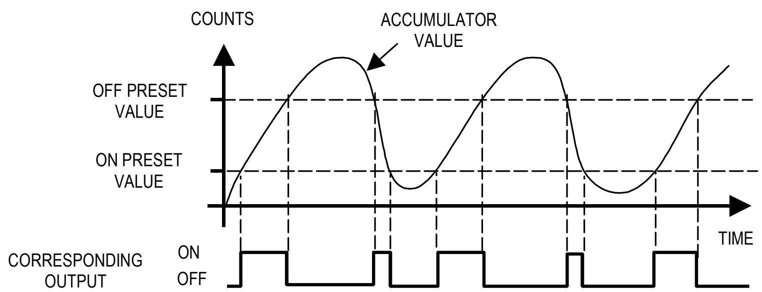




High-Speed Counter Outputs

Each counter output has a Preset on and off point that must lie between the counter's configured high and low limits. Both the Presets and the High/Low limits are initially set up as part of the PLC configuration. The Presets can be changed during operation by using a COMMREQ function as explained later in this chapter.

The output state indicates when the Accumulator value is between the Preset on and off points. For example, using the Type B counter:



If the output is enabled for the High-speed Counter being used, the output turns on as as described in the Type A and Type B counter descriptions.

The minimum span that should be configured between the On and Off Presets depends on the count frequency.

For this Count Frequency:	Minimum Span Between On Preset and Off Preset Should Be:
100KHz	100 counts
90KHz	90 counts
80KHz	80 counts
70KHz	70 counts
60kHZ	60 counts
50KHz	50 counts
40KHz	40 counts
30KHz	30 counts
25KHz	25 counts
20KHz	20 counts
15KHz	15 counts
10KHz	10 counts
5KHz	5 counts
2KHz	2 counts
1KHz	1 count
less than 1KHz	no gap required

Note : Count frequencies above 10kHz are supported only on 64 point Micro PLCs.

PWM Outputs

PWM outputs can be used to control DC and stepper motors. Configuring an output as a PWM output is done in the PLC configuration.

A PWM output is enabled from the application program by setting its Output Enable bit to one. The output is disabled by setting its Output Enable bit to zero. Once a PWM output starts operating, it continues until a new configuration is received, a store occurs (logic and/or configuration), a write to the user storage device occurs, or the Output Enable bit is cleared. A PWM output will also stop if an invalid frequency or duty cycle value are commanded.

When the PLC goes from Run to Stop mode, PWM outputs continue to operate. PWM outputs also continue to operate over a power cycle. Therefore, if PWM is running when power is lost, it will start again as soon as power is restored and the PLC transitions to Run mode and the Output Enable bit is set to one.

The frequency of the PWM output (15hz to 65Khz for 64 point models, and 15Hz to 5Khz for other models) is specified from the application program by writing a value to the associated Frequency reference, as shown below. The PWM duty cycle is selected using the associated Duty Cycle reference. Both frequency and duty cycle can be changed while the output is enabled. The minimum and maximum values depend on the frequency.

Output 1	Output 2	Output 3	Output 4	Description
AQ002	AQ004	AQ006	AQ008	64 Point : PWM Freq(15 to 65000) Nano/14/28 : PWM Freq (15 to 5000)
AQ003	AQ005	AQ007	AQ009	PWM Duty Cycle (0 – 10000)
Q0505	Q0506	Q0507	Q0508	Enable Output 1

Pulse Train Outputs

Pulse Train outputs can be used to control stepper motors. Configuring an output as a Pulse Train output is done in the PLC configuration. The pulse frequency (15hz to 65Khz for 64 point models, and 15Hz to 5Khz for other models) can be controlled from the application program by writing a value to the associated Frequency reference, as listed in the table below. Pulse frequency can be changed while the Pulse Train is operating. One application of this feature would be to produce the effect of ramping up at the beginning of the Pulse Train operation, and ramping down at the end. The number of pulses to be output (0 to 65535) is selected using the associated Number of Pulses reference.

The Pulse Train starts when its Start Pulse Train bit is set to 1 by the application program. Starting the Pulse Train clears its associated Pulse Train Complete bit. When the selected number of pulses has occurred, the associated Pulse Train Complete bit is set to 1 and the Start Pulse Train bit is cleared. Once a Pulse Train is started, it continues until it has completed or until the Output Enable bit is cleared. When the PLC goes from Run to Stop mode, Pulse Train outputs continue to operate. Pulse Train outputs restart after a power cycle if certain conditions are met. Therefore, if a Pulse Train output is running when power is lost, it will restart when power is restored when the PLC transitions with Run mode with both the Enable Output bit and the Start Pulse Train output bits on.

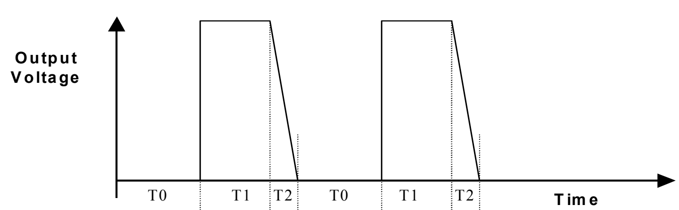
Output 1	Output 2	Output 3	Output 4	Description
AQ123	AQ125	AQ127	AQ121	Frequency Pulse Train (15Hz to 65Khz): 64 Point Frequency Pulse Train (15Hz to 5Khz): Nano/14/28
AQ124	AQ126	AQ128	AQ122	Number of pulses to send to output (0 to 65535)
Q0505	Q0506	Q0507	Q0508	Enable Output
Q0494	Q0495	Q0496	Q00511	Start Pulse Train
I0494	I0495	I0496	I00511	Pulse Train Complete

Note: The sum total of frequency configured for Pulse Train with Ramp should be less than or equal to 65kHz (for 64PT micro only). The minimum frequency that can be configured on each channel is 15Hz.

Load Correction for PWM and Pulse Train Outputs

PWM outputs have a selectable duty cycle and PTO outputs have a nominal duty cycle of 50%, but the PLC's optical isolators skew the duty cycle, depending on temperature and load. To compensate for this, the PLC applies an additional 2 microseconds for 64-point Micro PLCs with DC outputs, 35 microseconds for other Micro PLCs with DC outputs, 10 microseconds for 64-point Micro PLCs with relay outputs, or 85 microseconds for other Micro PLCs with relay outputs to the zero output time of each pulse. The Load Correction can be changed within the range 0 to 200 microseconds by sending the new value in a COMMREQ, as explained later in this chapter.

An example is illustrated below. In the diagram, *T*0 is the OFF Time, which is $\frac{1}{2f} + Correction$, where *f* is the pulse frequency. $T1 = \frac{1}{2f}$, *T*2 = Optical Isolator Delay, and *T*1+*T*2 = ON Time.



Ramp Outputs

When an output function on a Micro-64 CPU function is configured to be Ramp, acceleration and deceleration factors are applied to the Pulse-Train output. Acceleration and deceleration factors can be specified using Data Commands, as explained later in this section. Both acceleration and deceleration can be selected from the range of 10 p/s^2 to 1,000,000 p/s^2. The default for both is 1,000,000. Acceleration and deceleration do not need to be the same. Appropriate values depend on the application and the capability of the stepper motor being driven by the module.

Output 1	***Output 2***	***Output 3***	***Output 4***	***Description***
AQ123	AQ125	AQ127	AQ121	Frequency Pulse Train with Ramp (15Hz to 65Khz): 64 Point
				Frequency Pulse Train with Ramp(15Hz to 5Khz): Nano/14/28
AQ124	AQ126	AQ128	AQ122	Number of pulses to send to output (0 to 65535)
Q0505	Q0506	Q0507	Q0508	Enable Output
Q0494	Q0495	Q0496	Q00511	Start Pulse Train with Ramp
I0494	I0495	I0496	I00511	Pulse Train with Ramp Complete

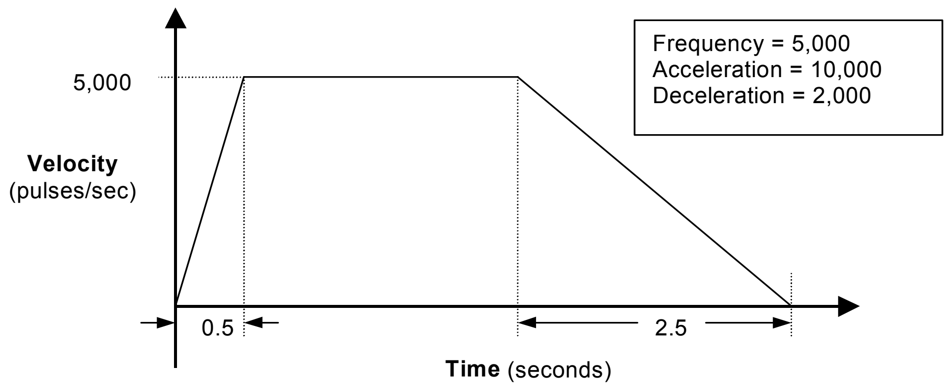
Note 1: The sum total of frequency configured for Pulse Train with Ramp should be less than or equal to 65kHz. The minimum frequency that can be configured on each channel is 15Hz.

Example: If all the channels are to be configured for Pulse Train with Ramp for maximum possible frequency, the frequencies on each channel can be 15kHz, 15kHz, 15kHz, and 20kHz.

Note 2: Acceleration and Deceleration for Pulse Train with Ramp have to be configured through the hardware configuration or through a COMMREQ.

A Ramp function begins when the module detects that the channel's Enable Output bit (discrete output bit 505-508, see "Module Data") is On and an Off-to-On transition has occurred on the channel's Start Pulse Train bit (discrete output bit 494,495,496,511). At that point, the Pulse Train begins and the channel's Pulse Train Complete bit (discrete input bit 494.495,496,511) is set Off. The module outputs the specified number of pulses, in varying pulse widths, to produce a velocity profile similar to the one shown below. After the last pulse is completed, the module sets the channel's Pulse Train Complete bit Off and begins monitoring the channel's Start Pulse Train bit for another Off-to-On transition.

The Ramp feature results in a Pulse-Train profile similar to the example shown below.



Once a Ramp function has started, it continues until all of its pulses have been generated or its Output Enable bit (discrete output bit 505-508) changes from On to Off.

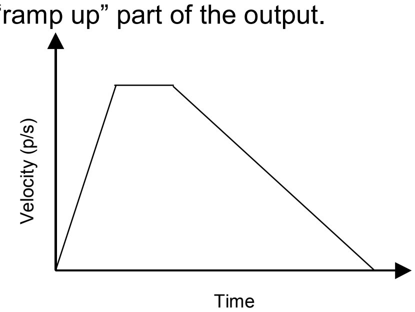
The Ramp up/down motion takes place in steps of 100ms; so the velocity gradient changes every 100ms until the desired frequency is reached (provided there are sufficient number of pulses to ramp up to the desired frequency). For the example above, the ramp up time is 500ms(1/2 second), so the ramp up takes place in 5 steps: 100ms,200ms, 300ms, 400ms, 500ms with a frequency of 1KHz, 2KHz, 3Khz, 4KHz, and 5KHz respectively

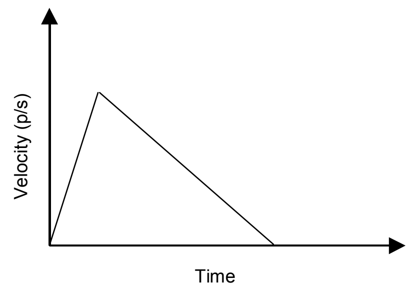
A Pulse Train output can be terminated before the requested number of pulses have been completed by setting its Output Enable bit (discrete output bit 505-508) to Off. If the Enable Output bit transitions from On to Off, the module will either stop the Pulse Train immediately or transition the Ramp output to its deceleration phase—depending on the channel's configuration. If deceleration is configured, the module will output a number of pulses based on: (1) the configured deceleration and (2) the velocity at the time the Enable Output bit goes Off. When the last pulse is completed, the module will set the channel's Pulse Train Complete bit (discrete input bit 494,495,496,511) to On.

The frequency of PTO with Ramp cannot be changed when the ramp output has started. If the frequency is changed in the %AQ references when the ramp output has started, this frequency will be used for the next ramp that is generated. This also applies to the other parameters used for ramping - acceleration, deceleration and the number of counts.

Stop Ramp with Deceleration

The graphics below show how stopping a Ramp early affects the Ramp output if the output is configured for deceleration. The example on the left shows what happens when the Enable Bit is set OFF during the "at velocity" part of the output. The righthand example shows the impact when the Enable Bit is set OFF during the "ramp up" part of the output.





If the Ramp output is already decelerating when the Enable Output bit transitions from On to Off, there is no change to the operation of the Pulse Train output.

Configuration

When the module powers up or receives a new configuration, it automatically sets up all Ramp channels to decelerate when the Output Enable bit goes OFF. If a Ramp output should stop immediately, the channel can be reconfigured with a Data command or a COMMREQ. The data block is the same for both:

	MSB	LSB
Command word	0n	3B
Data word (LSW)	dddd	
Data word (MSW)	Always zero	

- "0n" is the channel number from 1 to 4.
- "3B" is the command (in hexadecimal): Load Stop Mode
- "dddd" is the Stop Mode parameter. It can be "1" for Decelerate and "2" for Stop Immediately. If any other value is specified, error code 13 (hex) is placed in the Module Status Word.

Data Commands for the HSC/PWM/PT Functions

The application program can use the COMMREQ function to provide data or send commands to High-speed Counters, Pulse Train outputs, or PWM outputs that are currently enabled:

- Load Accumulator
- Load High and Low Limits
- Load Accumulator Increment
- Set Counter Direction
- Load Timebase
- Load ON and Off Presets
- Load Preload
- Load Stop Mode or Resume Decelerate Mode (for Micro-64 CPUs only)
- Load Acceleration and Load Deceleration (for Micro-64 CPUs only)
- Load Correction

Program logic should be set up to assure that the command is sent to the module once, not repeatedly. These changes are temporary; they lost when the PLC is powered down and when a new configuration is stored from the programmer.

Command Block

The command data must be placed in the correct order (in a *command block*) in CPU memory before the command is executed. The command block is composed of 14 words as shown below. All values are hexadecimal unless otherwise indicated. The command block can be placed in any word-oriented area of memory that is not reserved.

Location	Data	Description
%R0001	0004	Always 0004
%R0002	don't care	Not used (always zero). The Micro PLC ignores the Wait flag for all COMREQ junctions.
%R0003	don't care	not used
%R0004	don't care	not used
%R0005	don't care	not used
%R0006	don't care	not used
%R0007	don't care	not used
%R0008	don't care	not used
%R0009	0008	Data type (8 = registers)
%R0010	000A	Start location of Command Word –1 (%R0011)
%R0011	nnnn	Command Word
%R0012	nnnn	LS Data Word
%R0013	nnnn	MS Data Word used only for ramping in Micro 64 CPU *not used by other Micro PLCs*

The last three words are treated as independent bytes. They can be entered in hexadecimal or decimal format. The format for the last three words is:

	MSB	LSB
command word	0n	cc
data word (LSW)	dd	dd
data word (MSW)	dd	dd

where: n=counter 1-4
cc=subcommand code
dd=data type

Command Word Contents

Contents of the Command Word are listed below. In the table, for Type A, n = Counter #1–4. For Type B, n = Counter #1 (only counter 1 is B-type)

Command Word (hex)	Command	Description
0n01	Load Accumulator	Loads any value within a counter's limits directly into the Accumulator. If a count is received at the same time, the count is lost. Example: To set Counter 1 to 1234H, load COMREQ command registers with: Command word: 0101 LS data word: 1234
0n02 0n03	Load High Limit Load Low Limit	Sets the High and Low limit to any value in the counter range. Move the Low Limit first when shifting down or the High Limit first when shifting up. Loading limits in the wrong order can cause an error. The command is successful if all parameters are within the new range. Example: To change the upper limit of counter 1 to 10000 (2710H), load registers with: Command word: 0102 LS data word: 2710
0n04	Load Accumulator Increment	Offsets a counter Accumulator by up to +127 or –128 counts. Only the LSB data is used with this command. This can be done at any time, even while the counter is counting at maximum rate. However, if a count is received at the same time the CPU updates the Accumulator value, the count is lost. If the offset causes the counter to exceed its limits, this parameter is rejected. Example: To offset counter 1 by –7 counts, load: Command word: 0104 LS data word: 00F9
0n05	Set Counter Direction	(Type A only) Changes the count direction of a type A counter. Only the LSB of the first data word is used for this command (00 = up, 01 = down). Example: To set the direction of counter 4 to down, load: Command word: 0405 LS data word: 0001
0n06	Load Timebase	Changes the time interval used for the counts/timebase word data. The range is 10 to 1000mS in 10mS intervals. Example: To change the timebase for counter 1 to 600 ms (258H), load: Command word: 0106 LS data word: 0258
0n0B	Load ON Preset	Sets up the output turn on points within the counter range. There is one output associated with each counter. See the previous information about Presets for appropriate settings. Example: To set counter 1 output to turn on at 5000 (1388H) counts, load: Command Code: 010B LS data word: 1388
0n15	Load OFF Preset	Sets up the output turn off points within the counter range. There is one output associated with each counter. See the previous information about Presets for appropriate settings. Example: To set counter 1 output to turn off at 12000 (2EE0H) counts, load: Command Code: 0115 LS data word: 2EE0
0n1F	Load Preload	Changes the count value loaded into the counter Accumulator when the Preload input is activated. Example: To make counter 1 start at 2500 (09C4H) counts at its preload signal, load: Command word: 011F LS data word: 09C4

Command Word (hex)	Command	Description
0n3B	Load Stop Mode (or Resume Decelerate Mode)	(Micro-64 CPU only) Changes a Pulse Train output's deceleration to stop the Ramp immediately when the Output Enable bit goes Off. The Ramp function must be enabled. Example: to set up a Pulse Train output for Stop Ramp (0002) operation on ch.1: Command word: 013B LS data word: 0002 The same command can be used to reset the output to Decelerate mode (the default) by entering the value 0001 in the LS data word. Example: reset the same Pulse Train output to Decelerate (0001) operation: Command word: 013B LS data word: 0001
0n3C	Load Acceleration	(Micro-64 CPU only) Changes a Pulse Train output's acceleration. The Ramp function must be enabled. Both acceleration and deceleration can be selected from the range of 10 p/s^2 to 1,000,000 p/s^2. The default for both is 1,000,000. In the acceleration and deceleration commands, the data value is a 32-bit number. These are the ONLY Data Commands that should have any value other than 0 in the MS data word. Example: to change the acceleration rate of Pulse Train output 1 to 200,000 (30D40H), load: Command word: 013C LS data word: 0D40 MS data word: 0003
0n3D	Load Deceleration	(Micro-64 CPU only) Changes a Pulse Train output's deceleration. The Ramp function must be enabled. Example: to change the deceleration rate of Pulse Train output 1 to 2,000 (700H), load: Command word: 013D LS data word: 700
0n3E	Load Correction	Sets the change (in microseconds) that should be applied to the duty cycle of a Pulse Train output to compensate for the slow turn-off time of the optical isolator circuit (35 microseconds - DC outputs; 85 microseconds relay outputs). The range is 0 to 200 microseconds. Example: to change the duty cycle of Pulse Train output 1 to 100 (64H), load: Command word: 013E LS data word: 64

Command Word Error Responses

If the module receives an invalid command parameter in a Command Word, it returns the following information in the first word of its word input (AI) data:

Note: If your program issues a COMMREQ that changes count direction, the counter will go immediately into the new mode. Remember that the output does not change states at exactly the same points on an Up-counter as it does on a Down-counter.

Error Code	Description	Definition
0–2	not used	N/A
3	Invalid Command	Command number received was invalid for the HSC.
4–5	Unused	N/A
6	Invalid Counter Number	Counter number in the Data Command Word was not a valid counter based on the current configuration.
7–10	Unused	N/A
11 12 13 14	Counter 1 Limit Error Counter 2 Limit Error Counter 3 Limit Error Counter 4 Limit Error	Counter configuration limit was rejected because the new values set would be incompatible (High limit < > Low limit) with current High and Low limit values.

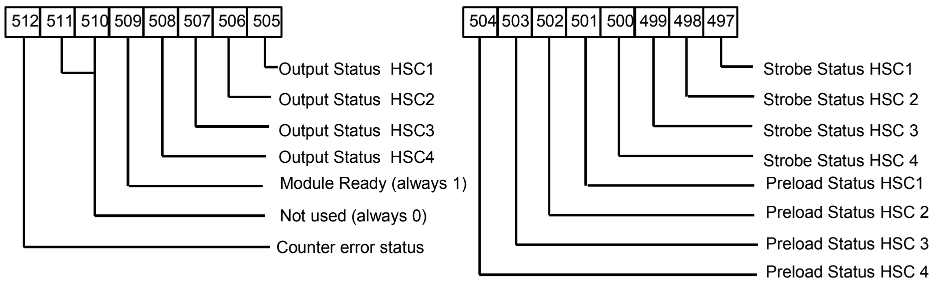
Command Word Error Responses

If the module receives an invalid command parameter in a Command Word, it returns the following information in the first word of its word input (AI) data:

Error Code(hex)	***Commands***	***Description***
0	All (Unless COMREQ)	No Error
0x03	N/A	Unknown command word
0x06	All	Invalid Channel
0b : chan1 0x0c : chan2 0x0d : chan3 0x0e : chan4	Load High/Low Limit Load High/Low Limit Load High/Low Limit Load High/Low Limit Load Accumulator, Load Accumulator Increment Load Preload Load On Preset Load Off Preset	Invalid Low or High limit value New limit places Preload value out of range New limit places Off Preset out of range New limit places Accumulator value out of range Accumulator value is out of range Preload value is out of range On Preset value is out of range Off Preset value is out of range
0x13	Load Stop Mode/Reset Decelerate Mode	Invalid value. Must be 1 (decelerate) or 2 (stop).
0x14	Load Acceleration	Acceleration too low. Must be ≥ 10 for channels 1-3 and >90 for channel 4.
0x15	Load Acceleration	Acceleration too high. Must be ≤ 1,000,000
0x16	Load Deceleration	Deceleration too low. Must be ≥ 10. for channel 1-3 and >90 for channel 4.
0x17	Load Deceleration	Deceleration too high. Must be ≤ 1,000,000

Status Bits

These status bits are part of the %I input data, and can influence outputs sent to the HSC function. The following %I references are reserved for these status bits.



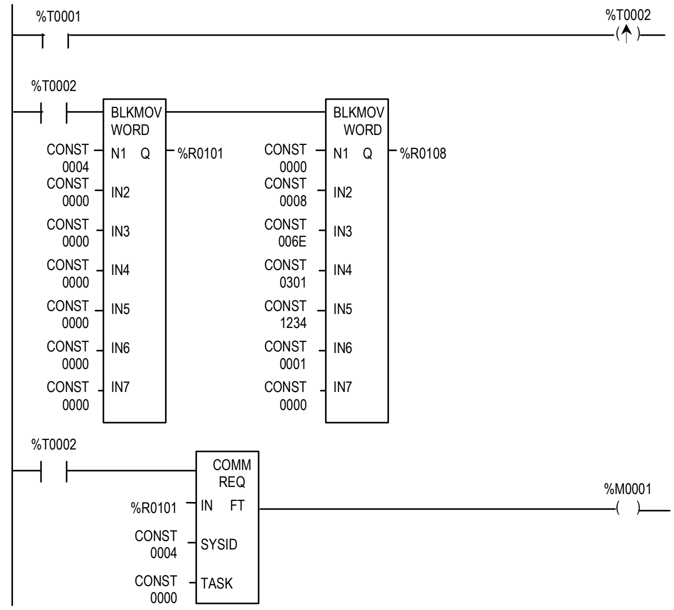
Strobe/Preload Status: Set when a strobe or preload occurs. The application program must clear the bit using the corresponding Reset Strobe/Reset Preload output.

Module Ready: Always a 1.

Error: Set to indicate an error condition. The error code is returned in the HSC Status code (word 1). When the error is acknowledged, it should be cleared using the Clear Error output.

Example

The example uses a COMMREQ to load the value 1234 into the Accumulator for Counter 3.



The first rung in the example includes a one-shot coil (%T0002) that executes the COMMREQ once. This prevents multiple messages from being sent.

The next rung uses a Block Move Word function to load the commands. In this example, %R0101 through %R0114 are used for the COMMREQ Command Block. Any registers can be used.

The COMMREQ function has four inputs and one output.

Parameter	Description
enable	%T0002 to enables the COMMREQ function.
IN	Points to the starting address of the Command Block, which is %R0101.
SYSID	Indicates which rack and slot to send the message to (physical location of HSC module). The SYSID is always 0004 for the Micro PLC.
TASK	This parameter is ignored and should be set to zero.
FT	This output is energized if an error is detected during processing of the COMMREQ.

HSC Application Examples

RPM Indicator

The HSC can be used as a position/motion indicator when connected to a feedback device (such as an encoder) that is coupled to a rotary motion. RPM indication can be obtained directly from the counter's Counts/Timebase register (CTB) or derived from it by a simple calculation.

RPM is calculated by:

$$RPM = \frac{CTB}{PPR \times T}$$

where: CTB = counts/timebase reading from the counter
PPR = pulses/revolution produced by the feedback device
T = timebase expressed in minutes

If the number of pulses per revolution is an integer power of 10, setting the timebase for 6, 60, 600, 6000, or 60,000 produces a direct reading of RPM in the Counts per Timebase register with an assumed decimal placement.

Example 1

If feedback produces 1000 pulses/revolution, CTB reading = 5210, and the timebase is configured for 600ms: then T = 600ms / 60000ms/min = .01 and 1/T = 100

$$RPM = \frac{5210}{1000} \times 100 = 521$$

CTB reading is RPM with .1 RPM resolution.

Example 2

Assume the same conditions as example 1, except the timebase is now set to 60ms, which gives:

T = 60/60000 = .0001 and 1/T = 1000.

Because the rotation is at the same speed as in example 1, the Counts per Timebase reading now equals 521 and

$$RPM = \frac{521}{1000} \times 1000 = 521$$

CTB reading is now RPM with 1 RPM resolution.

Application Example — Input Capture

The High-speed Counter strobe inputs can act as *pulse catch inputs* for inputs 2, 4, 6, and 8 by using the Strobe Status bits as a latch.

To use this feature:

1. Configure the Micro PLC to use the High-speed Counter function with Strobe input.
2. Enable A-type counter(s). (Any or all of the counters can be enabled.)
   - The corresponding Strobe Status bit will be latched if there is a pulse of at least 100 µsec in width.
   - The Reset Strobe bits can be used as clear functions for the latched status bits.

Example:

To capture pulses on input I2, enable Counter 1 and configure strobe for the Pld/strobe parameter.

The Strobe Status bit will be latched if there is a 100 microsecond or longer pulse on I2. To clear this bit, the program should write a 1 followed by a 0 to the corresponding output.

Chapter 14

Fault Handling

This chapter discusses how the Micro PLC handles system faults.

Faults and Fault Handling

A *fault* is a failure or condition that can affect the operation and performance of the system. A fault may impair the ability of the PLC to control a machine or process.

Fault Handling

When a fault is detected, the PLC processes the fault and sets the corresponding system bit(s) (See 'System Bit Reference Table'). The PLC logs the fault into a fault table. There are two different fault tables:

- The I/O Fault Table
- The PLC Fault Table

Contents of the fault tables can be monitored and cleared from the programmer.

Classes of Faults

The Micro PLC detects several classes of faults, including:

- Internal Failures
  - Non-responding circuit boards
  - Memory checksum errors
- External Failures
  - Sequence fault
- Operational Failures
  - Communication failures
  - Configuration failures
  - Password access failures

System Responses to Faults

Some faults can be tolerated, while others require that the PLC shut down. I/O failures may be tolerated by the PLC, but not be acceptable for the application. Operational failures can normally be tolerated.

Fault Actions

The PLC categorizes different groups of faults as:

- Informational
- Diagnostic
- Fatal

The PLC logs all faults in the appropriate fault table. For diagnostic and fatal faults, the PLC sets any associated diagnostic variables. The following table lists the fault action, associated fault table, and diagnostic variables for different types of faults. In addition, if the fault is a fatal fault, the PLC halts the system (STOP/FAULTED mode) to prevent possible damage to the equipment, or personal injury.

Fault Group	Action	Fault Table	Diagnostic Variables			
System Configuration Mismatch	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	cfg_mm(%SA9)
Expansion Unit Configuration Mismatch	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	*cfg_mm(%SA9)*
PLC CPU Hardware Failure	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	hrd_cpu(%SA10)
PLC Software Failure (see below)	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	sft_cpu(%SB13)
PLC Store Failure (see below)	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	stor_er(%SB14)
Program Checksum Failure	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	pb_sum(%SA1)
No User Program on Power-up	Diagnostic	-PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	no_prog(%SB9)	
Corrupted User RAM	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	bad_ram(%SB10)
Unknown PLC Fault	Fatal	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	
Unknown I/O Fault	Fatal	I/O Fault Table	io_flt(%SC11)	any_flt(%SC9)	io_pres(%SC13)	
PLC Fault Table Full	Diagnostic	-	sy_flt(%SC10)			
I/O Fault Table Full	Diagnostic	-	io_full(%S10)			
Application Fault	Diagnostic	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	apl_flt(%SA3)
Password Access Failure	Diagnostic	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	bad_pwd(%SB11)
Constant Sweep Time Exceeded	Diagnostic	PLC Fault Table	sy_flt(%SC10)	any_flt(%SC9)	sy_pres(%SC12)	ov_swp(%SA2)
Loss of Expansion Unit	Diagnostic	I/O Fault Table	io_flt(%SC11)	any_flt(%SC9)	io_pres(%SC13)	los_iom(%SA14)
Addition of Expansion Unit	Diagnostic	I/O Fault Table	io_flt(%SC11)	any_flt(%SC9)	io_pres(%SC13)	add_iom(%SA19)

PLC Software Failure If a PLC Software Failure is logged, the PLC immediately goes into Error Sweep mode. The only way to clear this condition is to cycle power.

PLC Store Failure A ***sequence store*** is the storage of program blocks and other data preceded by the special Start-of-Sequence command and ending with the End-of-Sequence command. If communications with the programmer are interrupted or if any other failure terminates the download, the PLC Store Failure fault is logged. As long as this fault is present in the system, the PLC will not transition to Run mode.

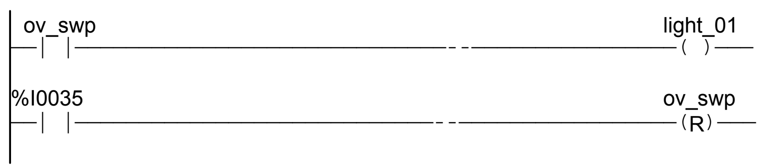
Fault References

The PLC defines a set of special fault references that can be included in the application program to check for fault conditions, and allow appropriate action to be taken should one of these faults occur.

These special fault references remain set until the PLC is cleared or until the application program clears the fault.

Example Program Logic for Fault References

This example ladder logic shows how the fault reference *ov_swp* can be programmed to check for an oversweep condition, then cleared. In this example, an indicator *light_01* is turned on to alert the operator that an oversweep has occurred. After fixing any problem in the application, the operator presses a pushbutton. This causes program input %I0035 contact to pass power flow to the *ov_swp* reference, which clears the associated memory location.



Chapter 15 — *Elements of an Application Program*

This chapter provides basic information about the application program.

- Structure of an application program
- Subroutines
- Program languages
- The Instruction Set

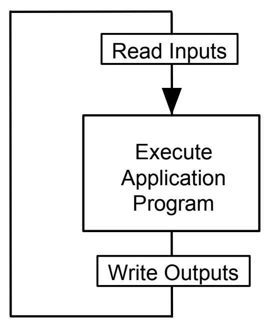
Structure of an Application Program

The application program consists of all the logic needed to control the operation of the Nano or Micro PLC.

Application programs are created using the programming software and transferred to the PLC. Programs are stored in non-volatile memory. A Nano PLC has a maximum program size of 2K words. A Micro PLC has a maximum program size of 9K words.

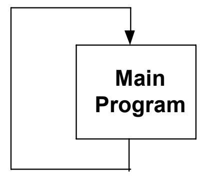
During the CPU Sweep (described in chapter 9), the Micro PLC reads input data and stores the data in its configured input memory locations. The Micro PLC then executes the entire application program once, utilizing this fresh input data. Executing the application program creates new output data that is placed in the configured output memory locations.

After completing the end of the application program, the CPU provides the output data to the output points.



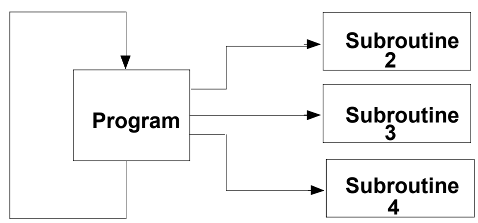
Subroutines

The program can consist of one Main program that executes completely during each CPU sweep.

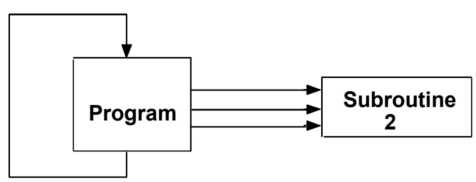


Or a program can be divided into subroutines. The maximum size of a main program block or subroutine block is 16K bytes. A Nano PLC application program can include up to 8 subroutine declarations. A Micro PLC application program can include up to 64 subroutine declarations.

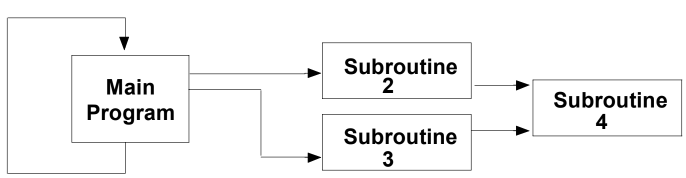
Subroutines can simplify programming and reduce the overall amount of logic. Each subroutine can be called as needed. The main program might serve primarily to sequence the subroutine blocks.



A subroutine block can be called many times as the program executes. Logic that should be repeated can be placed in a subroutine block, reducing total program size.



In addition to being called from the program, subroutine blocks can also be called by other subroutine blocks. A subroutine block can even call itself.



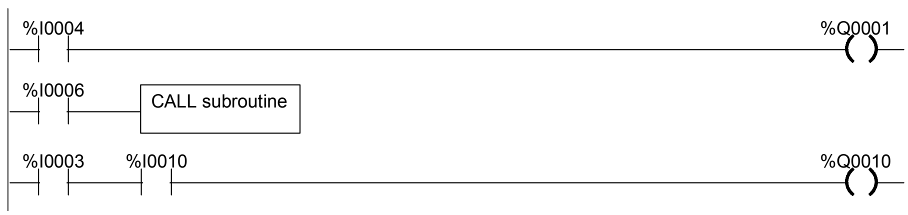
The main program is level 1. The program can include up to eight additional nested call levels.

Declaring a Subroutine

A subroutine must be declared through the block declaration editor of the programming software.

Calling a Subroutine

A subroutine invoked in the program is using a CALL instruction. Up to 64 subroutine block declarations are allowed for Micro CPUs. Up to 8 subroutine block declarations are allowed for NANO CPUs. Regardless of the CPU model, 64 CALL instructions are allowed for each block in the program.



Locking/Unlocking Subroutines

Subroutine blocks can be locked and unlocked from the programming software. There are four levels of locking:

Type of Lock	Description
View	When locked, the subroutine cannot be viewed.
Edit	When locked, the information in the subroutine cannot be changed.
Perm View	The subroutine is permanently locked and cannot be unlocked.
Perm Edit	The subroutine is permanently locked and cannot be unlocked.

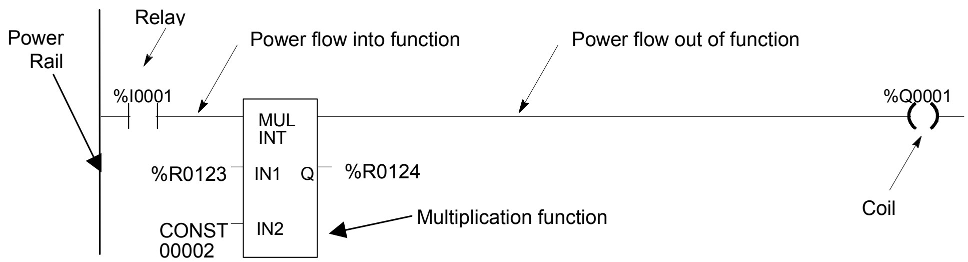
Permanently locked subroutines cannot be unlocked, even if the program is copied, backed up, or restored. A previously view-locked or edit-locked subroutine can be unlocked.

Program Languages

Application programs for VersaMax Nano PLCs and Micro PLCs can be created in Ladder Diagram or Instruction List format.

Ladder Diagram

This traditional PLC programming language, with its rung-like structure, executes from top to bottom. The logic execution is thought of as “power flow”, which proceeds down along the left “rail” of the ladder, and from left to right along each rung in sequence.



The flow of logical power through each rung is controlled by a set of simple program functions that work like mechanical relays and output coils. Whether or not a relay passes logical power flow along the rung depends on the content of a memory location with which the relay has been associated in the program. For instance, a relay might pass power flow if its associated memory location contained the value 1. The same relay would not pass power flow if the memory location contained the value 0.

If a relay or other function in a rung does not pass logical power flow, the rest of that rung is not executed. Power then flows down along the left rail to the next rung.

Within a rung, there are many complex functions that can be used for operations like moving data stored in memory, performing math operations, and controlling communications between the Micro PLC and other devices in the system.

Some program functions, such as the Jump function and Master Control Relay, can be used to control the execution of the program itself.

Together, this large group of Ladder Diagram relays, coils, and functions is called the “Instruction Set” of the Micro PLC.

The Instruction Set

A VersaMax Nano PLC or Micro PLC provides a powerful Instruction Set for building application programs.

As a guide to the programming capabilities of the VersaMax Micro PLC, all of the relays, coils, functions, and other elements of the Instruction Set are listed on the following pages. Complete reference information is included in chapter 8 and in the online help for the programming software.

Contacts

<table>
<tr><td>–| |–</td><td>Normally Open</td><td>Passes power if the associated reference is ON.</td></tr>
<tr><td>–|/|–</td><td>Normally Closed</td><td>Passes power if the associated reference is OFF.</td></tr>
<tr><td><+>——</td><td>Continuation</td><td>Passes power to the right if the preceding continuation coil is set ON.</td></tr>
</table>

Coils

–( )–	**Normally Open**	Sets the associated reference ON if the coil receives power. Otherwise OFF.
–(/)–	**Negated**	Sets the associated discrete reference ON if the coil does not receive power. Otherwise OFF.
–(↑)–	**Positive Transition**	If power flow was OFF to this coil the last time it was executed and is ON this time, then the coil is turned ON. Otherwise, the coil is turned OFF.
–(↓)–	**Negative Transition**	If power flow was ON to this coil the last time it was executed and is OFF this time, then the coil is turned ON. Otherwise, the coil is turned OFF.
–(S)–	**SET**	Sets the associated discrete reference ON if the coil receives power. It remains set until reset by an –(R)– coil.
–(R)–	**RESET**	Sets the associated discrete reference OFF if the coil receives power. It remains reset until set by an –(S)– coil.
–(SM)–	**Retentive SET**	Sets the associated reference ON if the coil receives power. The reference remains set until reset by an –(RM)– coil. Its state is retained through power failure and **STOP-TO-RUN** transition.
–(RM)–	**Retentive RESET**	Resets the associated discrete reference OFF if the coil receives power. The reference remains reset until set by an –(SM)– coil. Its state is retained through power failure and **STOP-TO-RUN** transition.
–(/M)–	**Negated Retentive**	Sets the associated discrete reference ON if the coil does not receive power. The state is retained through power failure and **STOP-TO-RUN** transition. Otherwise OFF.
–(M)–	**Retentive**	Sets the associated discrete reference ON if the coil receives power. The state is retained through power failure and **STOP-TO-RUN** transition. Otherwise OFF.
——<+>	**Continuation**	If power to the coil is ON, the continuation coil sets the next continuation contact ON. If power is OFF, the continuation coil sets the next continuation contact OFF.

Timers and Counters

ondtr	**On-Delay Stopwatch Timer**	Accumulates time while receiving power The current value is reset to zero when the Reset input receives power.
oftd	**Off-Delay Timer**	Accumulates time while NOT receiving power. The current value is reset to zero when there is power flow.
tmr	**On-Delay Timer**	Accumulates time while receiving power The current value is reset to zero when there is no power flow.
upctr	**Up Counter**	Increments by 1 each time the function receives transitional power.
dnctr	**Down Counter**	Counts down from a preset value every time the function receives transitional power.

Math Functions

add	**Addition**	Adds two numbers.
sub	**Subtraction**	Subtracts one number from another.
mul	**Multiplication**	Multiplies two numbers.
div	**Division**	Divides one number by another, yielding a quotient.
mod	**Modulo Division**	Divides one number by another, yielding a remainder.
expt	**Power of X**	Raises X to the power specified by IN and places the result in Q.
sin	**Trigonometric Sine**	Finds the trigonometric sine of a real number.
cos	**Trigonometric Cosine**	Finds the trigonometric cosine of a real number.
tan	**Trigonometric Tangent**	Finds the trigonometric tangent of a real number.
asin	**Inverse Sine**	Finds the inverse sine of a real number.
acos	**Inverse Cosine**	Finds the inverse cosine of a real number.
atan	**Inverse Tangent**	Finds the inverse tangent of a real number.
deg	**Convert to Degrees**	Performs a RAD_TO_DEG conversion on a real radian value.
rad	**Convert to Radians**	Performs a DEG_TO_RAD conversion on a real degree value.
scale	**Scaling**	Scales an input constant or word value.
sqroot	**Square Root**	Finds the square root of an integer or real value.
Log	**Base 10 Logarithm**	Finds the base 10 logarithm of a real value.
ln	**Natural Logarithm**	Finds the natural logarithm base of a real number.
exp	**Power of e**	Raises the natural logarithm base to the power specified by input.

Relational Functions

eq	**Equal**	Tests for equality between two numbers.
ne	**Not Equal**	Tests for non-equality between two numbers.
gt	**Greater Than**	Tests whether one number is greater than another.
ge	**Greater Than or Equal To**	Tests whether one number is greater than or equal to another
lt	**Less Than**	Tests whether one number is less than another.
le	**Less Than or Equal To**	Test whether one number is greater than or equal to another.
range	**Range**	Test the input value against a range of two numbers.

Bit Operation Functions

and	**Logical AND**	Performs Logical AND of two bit strings.
or	**Logical OR**	Performs Logical OR of two bit strings.
xor	**Logical Exclusive OR**	Performs Logical Exclusive OR of two bit strings.
not	**Logical Invert**	Performs a logical inversion of a bit string.
shl	**Shift Left**	Shifts a bit string left.
shr	**Shift Right**	Shifts a bit string right.
rol	**Rotate Left**	Rotates a bit string left.
ror	**Rotate Right**	Rotates a bit string right.
bittst	**Bit Test**	Test a bit within a bit string to determine whether that bit is currently 1 or 0.
bitset	**Bit Set**	Sets one bit within a string to true.
bitclr	**Bit Clear**	Sets one bit within a string to false.
bitpos	**Bit Position**	Locates a bit set to true within a bit string.
mskcmp	**Masked Compare**	Performs a masked compare of two arrays.

Data Move Functions

move	**Move**	Moves one or more bits of data.
blkmov	**Block Move**	Moves a block of up to 7 constants.
blkclr	**Block Clear**	Clears to zero one or more bytes/words of memory.
shfreg	**Shift Register**	Shifts one or more words or bits of data through a block of memory.
bitseq	**Bit Sequencer**	Sequences a 1 through a group of bits in PLC memory.
comreq	**Communication Request**	Sends a communications request.

Table Functions

arrmov	**Array Move**	Copies a specified number of data elements from a source array to a destination array.
srh eq	**Search Equal**	Searches array for values equal to a specified value.
srh ne	**Search Not Equal**	Searches array for values not equal to a specified value.
srh gt	**Search Greater Than**	Searches array for values greater than a specified value.
srh ge	**Search Greater Than or Equal**	Searches array for values greater than or equal to a specified value.
srh lt	**Search Less Than**	Searches array for values less than a specified value.
srh le	**Search Less Than or Equal**	Searches array for values less than or equal to a specified value.

Conversion Functions

→bcd-4	**Convert to BCD-4 (From INT)**	Converts a number to 4-digit BCD format.
→word	**Convert to Word (From REAL)**	Converts a Real value to Word format.
→int	**Convert to INT (From BCD-4 or REAL)**	Converts a number to signed integer format.
→tdint	**Convert to DINT (From BCD-4 or REAL)**	Converts a number to double precision integer format.
→real	**Convert to Real (From INT, DINT, BCD-4 or WORD)**	Converts a value to real value format.
→→int	**Truncate to INT (from REAL)**	Truncates to a 16-bit signed number. The range is –32,768 to +32,767.
→→dint	**Truncate to Double Precision INT (from REAL)**	Truncates to a 32-bit signed number. The range is -2,147,483,648 to +2,147,483,647.

Control Functions

call	**Call**	Causes a program execution to go to a specified subroutine block.
Do io	**Do I/O**	Services a specified range of inputs or outputs immediately (all inputs or outputs on a module will be serviced if any addresses on that module are included in the function – partial I/O module updates are not performed
pidind	**Independent PID Algorithm**	Selects the non-interacting independent PID algorithm.
pidisa	**ISA PID Algorithm**	Selects the ISA PID algorithm.
end	**Temporary End of Logic**	The program executes from the first rung to the last rung or the END instruction, whichever is encountered first. This instruction is useful for debugging purposes.
commnt	**Comment**	A rung explanation.
svcreq	**Service Request**	A special PLC service function.
mcr	**Master Control Relay**	Starts a master control relay range. An MCR causes all rungs between the MCR and its subsequent ENDMCR to be executed with no power flow. Up to 8 MCRs can be nested.
endmcr	**End Master Control Relay**	Ends a master control relay range.
jump	**Jump**	Jumps to a specified location indicated by a LABEL in the logic.
label	**Label**	The target location of a JUMP instruction. Multiple Jump instructions can reference the same label.
drum sequencer	**Drum Sequencer**	Operates like a mechanical drum sequencer, selecting a 16-bit output pattern from an array of stored patterns, and sending it to a set of outputs.

Chapter 16

Program Data and References

This chapter describes the types of data that can be used in an application program, and explains how that data is stored in memory by a VersaMax Nano PLC or VersaMax Micro PLC.

- Data memory references
- Fixed I/O map locations
- Retentiveness of data
- System status references
- Time tick contacts
- How program functions handle numerical data

Data Memory References

Data in PLC programs is referenced by memory addresses that specify both a memory type and a precise address within that memory type. For example:

%I00001 specifies address 1 in Input memory.
%R00256 specifies address 256 in Register memory.

The letter prefix indicates where data is stored in PLC memory.

Memory Allocation

The following table shows the types and sizes of available memory in VersaMax Micro and Nano PLCs. (See appendix B for a further comparison with the Series 90 Micro PLC.)

Reference Type	Reference Range	10-Point Nano PLCs	14-Point Micro PLCs	23 and 28-Point Micro PLCs	64-Point Micro PLCs
User program logic	Not applicable	2K words	9K words	9K words	48K bytes
Discrete inputs	%I0001 - %I0512	512 bits	512 bits	512 bits	512 bits
Discrete outputs	%Q0001 - %Q0512	512 bits	512 bits	512 bits	512 bits
Discrete global references	%G0001 - %G1280	1280 bits	1280 bits	1280 bits	1280 bits
Discrete internal coils	%M0001 - %M1024	1024 bits	1024 bits	1024 bits	1024 bits
Discrete temporary coils	%T0001 - %T0256	256 bits	256 bits	256 bits	256 bits
System status references	%S0001 - %S0032 %SA0001 - %SA0032 %SB0001 - %SB0032 %SC0001 - %SC0032	32 bits 32 bits 32 bits 32 bits	32 bits 32 bits 32 bits 32 bits	32 bits 32 bits 32 bits 32 bits	32 bits 32 bits 32 bits 32 bits
System register references	%R0001 - %R0256 or %R0001 - %R2042	256 words	256 words	2K words	32640 (close to 32k) words
Analog and High Speed Counter inputs	%AI0001 - %AI0128	128 words	128 words	128 words	128 words
Analog outputs	%AQ0001 - %AQ0128	128 words	128 words	128 words	128 words

∗ For viewing only; cannot be referenced in a user logic program.

Word Memory References

Each word memory address (reference) is on a 16-bit word boundary. The PLC uses three types of references for data stored in word memory.

%AI	Normally used for analog inputs.
%AQ	Normally used for analog outputs.
%R	Registers are normally used to store program data in word format.

An example is represented below. The example shows ten addresses. Each has 16 bits that together contain one value. The PLC cannot directly access individual bits in word memory.

%R Addresses	Example Value
0001	12467
0002	12004
0003	231
0004	359
0005	14
0006	882
0007	24
0008	771
0009	735
0010	0000

Bit Memory References

The PLC uses six types of references for data stored in bit memory.

%I	Normally used for discrete inputs, and viewable in the Input Status Table.
%Q	Normally used for physical output references, and viewable in the Output Status Table. A %Q reference may be either retentive or non-retentive, depending on its use in the program.
%M	Normally used to represent internal references. A specific %M reference may be either retentive or non-retentive, depending on its use in the program.
%T	Used for temporary references that can be used many times in a program. Data with %T references is not retained through loss of power or RUN-TO-STOP-TO-RUN transitions. %T references cannot be used with retentive coils.
%S	▪ System status references, which have specific predefinitions. ▪ %S, %SA, %SB, and %SC can be used for any type of logic contact. ▪ %SA, %SB, and %SC can be used for retentive coils. ▪ %S can be used as inputs to functions or function blocks. ▪ %SA, %SB, and %SC can be used as inputs or outputs of functions and function blocks.
%G	Used for Global Data. Data in %G references is retained through power loss. %G references can be used with contacts and retentive coils, but not on non-retentive coils.

Each bit memory address (reference) is on a bit boundary. Data is stored in bit memory as represented below. The example shows 160 individually-addressed bits, with address 1 in the upper left and address 160 in the lower right.

addresses

1	2	3	4	5	6	7	8								
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0
0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0
1	1	1	1	0	0	0	1	1	0	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	1	0	0	1	0	1	0
0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	1	0	0	1	0	1	0
1	1	0	1	0	0	0	1	1	1	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	0	1	1	1	0	1	1
1	0	0	1	0	0	0	1	1	0	1	1	1	0	0	1
0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1

... 160

Transition Bits and Override Bits

%I, %Q, %M, and %G references have associated transition and override bits.

%T, %S, %SA, %SB, and %SC references have associated transition bits only.

The CPU uses transition bits for transitional coils. When override bits are set, the associated references can only be changed from the programmer.

Fixed I/O Map Locations

A Nano/Micro PLC automatically reserves certain memory locations for specific functions. Use of these addresses for other purposes in an application program is not recommended.

Reserved Bit Memory Locations: %I

%I

Address	Function
I0001	Input 1/Count 1/Encoder +
I0002	Input 2/Preload/Strobe/Interrupt 1
I0003	Input 3/Count 2/Encoder –
I0004	Input 4/Preload/Strobe/Interrupt 2
I0005	Input 5/Count 3
I0006	Input 6/Preload/Strobe/Interrupt 3
I0007	Input 7/Count 4
I0008	Input 8/Preload/Strobe/Interrupt 4
I0009-I0016	Inputs for 23 and 28-point Micro PLCs, Default first discrete input for 14pt PLCs (can be reconfigured).
I0017	Default first discrete input from expansion unit (28/23pt PLCs), can be reconfigured.
I0489-I0493	Reserved, must be 0.
I0494	Pulse Train complete on Q1
I0495	Pulse Train complete on Q2
I0496	Pulse Train complete on Q3
I0497—500	Strobe status HSC1—HSC4
I0501—504	Preload status HSC1—HSC4
I00505—508	Output status HSC1—HSC4
I00509	1 (module ready always 1)
I00510	Not used (always 0)
I00511	Pulse Train complete on Q4
I00512	Counter Error status

Reserved Bit Memory Locations: %Q

%Q

Q0001	Output 1 or PWM Output or Pulse Output
Q0002	Output 2 or PWM Output or Pulse Output
Q0003	Output 3 or PWM Output or Pulse Output
Q0004	Output 4 or PWM Output or Pulse Output
Q0005	Output 5
Q0006	Output 6
Q0007-Q0016	Outputs for 23 and 28-point Micro PLCs, Default first discrete output for 14pt PLCs (can be reconfigured).
Q0017	Default first discrete output from expansion unit (28/23pt PLCs), can be reconfigured.
Q0489-Q0493	Reserved
Q0494	Start Q1 Pulse Train
Q0495	Start Q2 Pulse Train
Q0496	Start Q3 Pulse Train
Q0497	Clear Strobe bit for HSC 1
Q0498	Clear Strobe bit for HSC 2
Q0499	Clear Strobe bit for HSC 3
Q0500	Clear Strobe bit for HSC 4
Q0501	Reset Preload bit HSC 1
Q0502	Reset Preload bit HSC 2
Q0503	Reset Preload bit HSC 3
Q0504	Reset Preload bit HSC 4
Q0505	Enable Output HSC 1/PTO/PTM
Q0506	Enable Output HSC 2/PTO/PTM
Q0507	Enable Output HSC 3/PTO/PTM
Q0508	Enable Output HSC 4/PTO/PTM
Q0509	Not used but unavailable
Q00510	Not used but unavailable
Q00511	Start Q4 Pulse Train
Q00512	Clear Error (all counters)

Reserved Word Memory Locations

%AI	AI001	Module Status code	
	AI002	Counts per timebase HSC 1	–32678 to 32767
	AI003	Counts per timebase HSC 2	–32678 to 32767
	AI004	Counts per timebase HSC 3	–32678 to 32767
	AI005	Counts per timebase HSC 4	–32678 to 32767
	AI006	Accumulator HSC 1	–32678 to 32767
	AI007	Strobe Register HSC 1	–32678 to 32767
	AI008	Accumulator HSC 2	–32678 to 32767
	AI009	Strobe Register HSC 2	–32678 to 32767
	AI010	Accumulator HSC 3	–32678 to 32767
	AI011	Strobe Register HSC 3	–32678 to 32767
	AI012	Accumulator HSC 4	–32678 to 32767
	AI013	Strobe Register HSC 4	–32678 to 32767
	AI014	Not used (set to 0)	
	AI015	Not used (set to 0)	
	AI016	Analog potentiometer 1	
	AI017	Analog potentiometer 2	
	AI018	Analog input channel 1	
	AI019	Analog input channel 2	
	AI0020-0023	Inputs 1 - 4 from 1st analog expansion unit, can be reconfigured	
	AI0024-0027	Inputs 1 - 4 from 2nd analog expansion unit, can be reconfigured	
	AI0028-0031	Inputs 1 - 4 from 3rd analog expansion unit, can be reconfigured	
	AI0032-0035	Inputs 1 - 4 from 4th analog expansion unit, can be reconfigured	
%AQ	AQ001	Controls the number of input samples for analog potentiometer input filtering.	
	AQ002	PWM Frequency Q1 (15 to 5000 as 15hz to 5Khz)	
	AQ003	PWM Duty Cycle Q1 (0 to 10,000 as 0 - 100%)	
	AQ004	PWM Frequency Q2 (15 to 5000 as 15hz to 5Khz)	
	AQ005	PWM Duty Cycle Q2 (0 to 10,000 as 0 - 100%)	
	AQ006	PWM Frequency Q3 (15 to 5000 as 15hz to 5Khz)	
	AQ007	PWM Duty Cycle Q3 (0 to 10,000 as 0 - 100%)	
	AQ008	PWM Frequency Q4 (15 to 5000 as 15hz to 5Khz)	
	AQ009	PWM Duty Cycle Q4 (0 to 10,000 as 0 - 100%)	
	AQ011	Discrete input filtering time value	
	AQ012	Analog output channel 1	
	AQ0013, 0014	Outputs 1, 2 for 1st analog expansion unit, can be reconfigured	
	AQ0015, 0016	Outputs 1, 2 for 2nd analog expansion unit, can be reconfigured	
	AQ0017, 0018	Outputs 1, 2 for 3rd analog expansion unit, can be reconfigured	
	AQ0019, 0020	Outputs 1, 2 for 4th analog expansion unit, can be reconfigured	
	AQ121	Frequency of Q4 pulse train (15 to 5000 as 15hz to 5Khz)	
	AQ122	Number of pulses to send to Q4 output (0 to 65535)	
	AQ123	Frequency of Q1 pulse train (15 to 5000 as 15hz to 5Khz)	
	AQ124	Number of pulses to send to Q1 output (0 to 65535)	
	AQ125	Frequency of Q2 pulse train (15 to 5000 as 15hz to 5Khz)	
	AQ126	Number of pulses to send to Q2 output (0 to 65535)	
	AQ127	Frequency of Q3 pulse train (15 to 5000 as 15hz to 5Khz)	
	AQ128	Number of pulses to send to Q3 output (0 to 65535)	

Retentiveness of Data

Data is called “retentive” if it is automatically saved when the PLC is stopped. Retentive data is also saved when the PLC is power cycled on units that have capacitor or battery-backed memory. The following data is retentive:

- Program logic
- Fault tables and diagnostics
- Overrides
- Word data (%R, %AI, %AQ)
- Bit data (%I, %SC, %G, fault bits and reserved bits)
- Word data stored in %Q and %M.
- Data in %Q or %M references that are used as function block outputs or with retentive coils:

-(M)-	retentive coils
-(/M)-	negated retentive coils
-(SM)-	retentive SET coils
-(RM)-	retentive RESET coils

  The last time a %Q or %M reference is used with a coil, the coil type determines whether the data is retentive or non-retentive. For example, if %Q0001 was last programmed as the reference of a retentive coil, the %Q0001 data is retentive. However, if %Q0001 was last programmed on a non-retentive coil, then the %Q0001 data is non-retentive.

- %Q or %M references that have been made retentive by specifically declaring them to be retentive. %Q and %M references default to non-retentive.

The following data is non-retentive:

- %T data
- %S, %SA, and %SB data (but %SC bit data IS retentive).
- %Q and %M references that have not been declared to be retentive.
- %Q and %M references that are used with non-retentive coils:

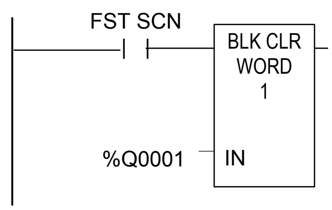
-( )-	coils
-(/)-	negated coils
-(S)-	SET coils
-(R)-	RESET coils

System Status References

The Nano/Micro PLC stores status and other system data in predefined references in %S, %SA, %SB, and %SC memory. Tables on the following pages list all of the System Status References.

Using the System Status References

System status references can be used as needed in application programs. For easier programming, each system status reference has a descriptive nickname. For example, the following function block uses the FST_SCN (first scan) status reference to control power flow to a Block Clear function.



Other system status reference nicknames include T_10MS, T_100MS, T_SEC, and T_MIN (see below), FST_SCN, ALW_ON, and ALW_OFF.

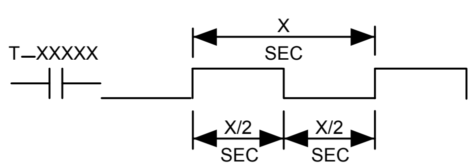
Time-Tick References

Time-tick contacts represent specific locations in %S memory. They can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T_10MS (0.01 second), T_100MS (0.1 second), T_SEC (1.0 second), and T_MIN (1 minute).

The following timing diagram represents the on/off time duration of these contacts.



%S References

References in %S memory are read only.

Reference	Nickname	Definition
%S0001	FST_SCN	Set to 1 when the current sweep is the first sweep.
%S0002	LST_SCN	Reset from 1 to 0 when the current sweep is the last sweep.
%S0003	T_10MS	0.01 second timer contact.
%S0004	T_100MS	0.1 second timer contact.
%S0005	T_SEC	1.0 second timer contact.
%S0006	T_MIN	1.0 minute timer contact.
%S0007	ALW_ON	Always ON.
%S0008	ALW_OFF	Always OFF.
%S0009	SY_FULL	Set when the PLC fault table fills up. Cleared when an entry is removed and when the PLC fault table is cleared.
%S0010	IO_FULL	Set when the I/O fault table fills up. Cleared when an entry is removed from the I/O fault table and when the I/O fault table is cleared.
%S0011	OVR_PRE	Set when an override exists in %I, %Q, %M, or %G memory.
%S0012		reserved
%S0013	PRG_CHK	Set when background program check is active. Cleared when the background program check is inactive.
%S0014	PLC_BAT	Set to indicate a bad battery in the CPU. The contact reference is updated once per sweep. This bit is supported by 28-point Micro PLCs only.
%S0015, 16		reserved
%S0017	SNPXACT	SNP-X host is actively attached to CPU port 1. (Port 2 defaults to disabled, and must be activated with a CRQ).
%S0018	SNPX_RD	SNP-X host has read data from CPU port 1.
%S0019	SNPX_WT	SNP-X host has written data to CPU port 1.
%S0020		Set ON when a relational function using REAL data executes successfully. It is cleared when either input is NaN (Not a Number).
%S0021	FF_OVR	Set to report a Fatal Fault Override.
%S0022	USR_SW	Set to reflect the state of the CPU mode switch. 1 = Run/On 0 = Stop/Off
%S0023-32		reserved

%SA, %SB, and %SC References

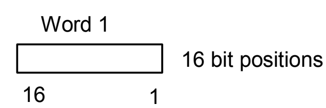
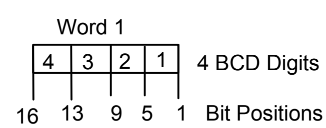
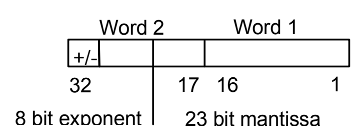
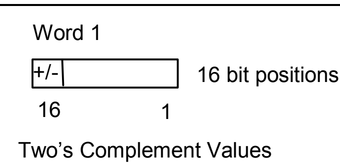
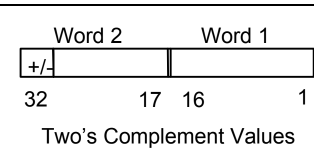
References in %SA, %SB, and %SC memory can be both read and written to.

Reference	Nickname	Definition
%SA0001	PB_SUM	Set when a checksum calculated on the application program does not match the reference checksum. If the fault was due to a temporary failure, the discrete bit can be cleared by again storing the program to the Micro PLC. If the fault was due to a hard RAM failure, the Micro PLC must be replaced.
%SA0002	OV_SWP	Set when a Micro PLC in CONSTANT SWEEP mode detects that the previous sweep took longer than the time specified. Cleared when the PLC detects that the previous sweep did not take longer than specified. Also cleared during transition from STOP to RUN mode.
%SA0003	APL_FLT	Set when an application fault occurs. Cleared when the Micro PLC transitions from STOP to RUN mode.
%SA0004-8		reserved
%SA0009	CFG_MM	Set when a configuration mismatch is detected during power-up or a configuration store. Cleared by powering up the Micro PLC after correcting the condition.
%SA0010	HRD_CPU	Set when the diagnostics detects a problem with the Micro PLC hardware. Requires replacing the Micro PLC. This bit is supported by 28-point Micro PLCs only.
%SA0011	LOW_BAT	Set when a low battery fault occurs. Cleared by replacing the battery then powering up the Micro PLC. This bit is supported by 28-point Micro PLCs only.
%SA0012,13		reserved
%SA0014	LOS_IOM	Set when an expansion module stops communicating with the CPU. Cleared by replacing the module and cycling system power.
%SA0015-18		reserved
%SA0019	ADD_IOM	Set when an expansion module is added. Cleared by cycling PLC power and when the configuration matches the hardware after a store.
%SA0020-31		reserved

Reference	Nickname	Definition
%SB0001-8		reserved
%SB0009	NO_PROG	Set when an attempt is made to put the PLC in Run mode when there is no executable application program stored in the CPU. Cleared by storing an application program to the CPU and putting the PLC in Run mode.
%SB0010	BAD_RAM	Set when the Micro PLC detects corrupted RAM memory at powerup. Cleared when RAM memory is valid at powerup.
%SB0011	BAD_PWD	Set when a password access violation occurs. Cleared when the PLC fault table is cleared.
%SB0012		reserved
%SB0013	SFT_CPU	Set when the Micro PLC detects an unrecoverable error in the software. Cleared by clearing the PLC fault table.
%SB0014	STOR_ER	Set when an error occurs during a programmer store operation. Cleared when a store operation is completed successfully.
%SC0001-8		reserved
%SC0009	ANY_FLT	Set when any fault occurs. Cleared when both fault tables are cleared.
%SC0010	SY_FLT	Set when any fault occurs that causes an entry to be placed in the PLC fault table. Cleared when the PLC fault table is cleared.
%SC0011	IO_FLT	Set when any fault occurs that causes an entry to be placed in the I/O fault table. Cleared when the I/O fault table is cleared.
%SC0012	SY_PRES	Set as long as there is at least one entry in the PLC fault table. Cleared when the PLC fault table has no entries.
%SC0013	IO_PRES	Set as long as there is at least one entry in the I/O fault table. Cleared when the I/O fault table has no entries.
%SC0014	HRD_FLT	Set when a hardware fault occurs. Cleared when both fault tables have no entries. This bit is supported by 28-point Micro PLCs only.
%SC0015	SFT_FLT	Set when a software fault occurs. Cleared when both fault tables have no entries.

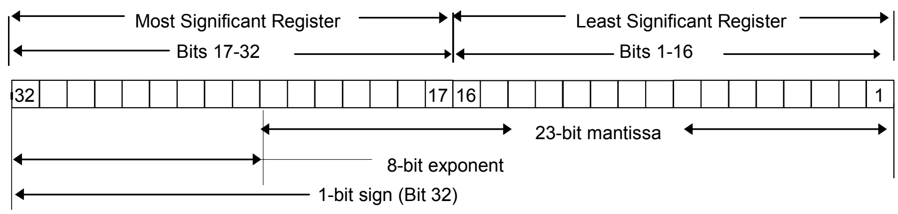
How Program Functions Handle Numerical Data

Regardless of where data is stored in memory—in one of the bit memories or one of the word memories--the application program can handle it as different data types.

Type	Name	Description	Data Format
BIT	Bit	A Bit data type is the smallest unit of memory. It has two states, 1 or 0.	
BYTE	Byte	A Byte data type has an 8-bit value. The valid range is 0 to 255 (0 to FF in hexadecimal).	
WORD		A Word data type uses 16 consecutive bits of data memory that are not separately-addressable to hold a value in the range of 0 to +65,535 (FFFF).	
BCD-4	Four-Digit Binary Coded Decimal	Four-digit BCD numbers use 16-bit data memory locations. Each BCD digit uses four bits and can represent numbers between 0 and 9. This BCD coding of the 16 bits has a value range of 0 to 9999.	
REAL	Floating-Point	Real numbers use two consecutive 16-bit memory locations. The range of numbers that can be stored in this format is ± 1.401298E-45 to ± 3.402823E+38. See the next page for more information.	
INT	Signed Integer	Signed integer data uses 16-bit memory locations. Signed integers are represented in 2's complement notation. Bit 16 is the sign bit, (0 = positive, 1 = negative). Their range is -32,768 to +32,767.	
DINT	Double Precision Signed Integer	Double precision signed integers data uses two consecutive 16-bit memory locations. They are represented in 2's complement notation. Bit 32 is the sign bit, (0 = positive, 1 = negative). Their range is -2,147,483,648 to +2,147,483,647.	

Real Numbers (Floating Point)

The REAL data type, which can be used for some Math functions and Numerical functions, is actually floating point data. Floating-point numbers are stored in single precision IEEE-standard format. This format requires 32 bits, which occupy two (adjacent) 16-bit PLC words.



For example, if the floating-point number occupies registers %R0005 and %R0006, then %R0005 is the least significant register and %R0006 is the most significant register.

The range of numbers that can be stored in this format is from ± 1.401298E–45 to ± 3.402823E+38 and the number zero.

Errors in Real Numbers and Operations

Overflow occurs when a number greater than 3.402823E+38 or less than -3.402823E+38 is generated by a REAL function. The ok output of the function is set OFF; and the result is set to positive infinity (for a number greater than 3.402823E+38) or negative infinity (for a number less than –3.402823E+38). You can determine where this occurs by testing the sense of the ok output.

POS_INF	= 7F800000h	–	IEEE positive infinity representation in hex.
NEG_INF	= FF800000h	–	IEEE negative infinity representation in hex.

If the infinities produced by overflow are used as operands to other REAL functions, they may cause an undefined result. This result is referred to as NaN (Not a Number). For example, the result of adding positive infinity to negative infinity is undefined. When the ADD_REAL function is invoked with positive infinity and negative infinity as its operands, it produces NaN for its result.

Chapter 17 Instruction Set Reference

This section is a reference to the functions in the VersaMax Nano PLC and Micro PLC Instruction Set:

Bit Operation Functions Logical AND, Logical OR Exclusive OR, Logical Invert (NOT) Shift Right/Shift Left Rotate Right/Rotate Left Bit Test Bit Set, Bit Clear Masked Compare Bit Position Bit Sequencer	**Math and Numerical Functions** Add, Subtract, Multiply, Divide Modulo Division Scaling Square Root Trigonometric Functions Logarithmic/Exponential Functions Convert Radians / Degrees
Control Functions Do I/O Call End Comment Jump Master Control Relay Drum Sequencer Service Request (see chapter 16) PID (see chapter 12)	**Relational Functions** Equal Not Equal Greater Than Less Than Greater or Equal Less or Equal Range
Data Move Functions Move Block Move Block Clear Shift Register Communication Request	**Relay Functions** Contacts, Coils Fault and No Fault Contacts Alarm Contacts **Table Functions** Array Move Search
Data Type Conversion Functions Convert to BCD-4 Convert to Signed Integer Convert to Double Precision Signed Integer Convert to Real Convert Real to Word Truncate Real Number	**Timer and Counter Functions** Time-tick Contacts On Delay Stopwatch Timer On Delay Timer Off Delay Timer Up Counter Down Counter

Bit Operation Functions

The Bit Operation functions perform comparison, logical, and move operations on bit strings. The Bit Operation functions are:

- Logical AND
- Logical OR
- Exclusive OR
- Logical Invert (NOT)
- Shift Right/Shift Left
- Rotate Right/Rotate Left
- Bit Test
- Bit Set, Bit Clear
- Masked Compare
- Bit Position
- Bit Sequencer

Data Lengths for the Bit Operation functions

The Logical AND, OR, XOR, and NOT (Invert) functions operate on a single word ofo data. The other Bit Operation functions may operate on up to 256 words.

All Bit Operation functions require Word-type data. However, they operate on data as a continuous string of bits, with bit 1 of the first word being the Least Significant Bit (LSB). The last bit of the last word is the Most Significant Bit (MSB). For example, if you specified three words of data beginning at reference %R0100, it would be operated on as 48 contiguous bits.

%R0100	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	← bit 1 (LSB)
%R0101	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	
%R0102	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	
	↑ (MSB)																

Overlapping input and output reference address ranges in multi-word functions is not recommended, it can produce unexpected results.

Bit Operation Functions
Logical AND, Logical OR

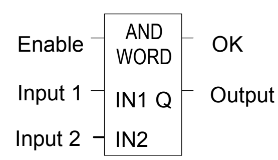
Each scan that power is received, a Logical AND or Logical OR function examines each bit in bit string IN1 and the corresponding bit in bit string IN2, beginning at the least significant bit in each. A string length of 256 words can be selected.

Logical AND

If both bits examined by the Logical AND function are 1, a 1 is placed in the corresponding location in output string Q. If either or both bits are 0, a 0 is placed in string Q in that location. The Logical AND function can be used to build masks or screens, where only certain bits are passed through (bits opposite a 1 in the mask), and all other bits are set to 0. The Logical AND function can also be used to clear an area of word memory by ANDing the bits with another bit string known to contain all 0s. The IN1 and IN2 bit strings specified may overlap.

Logical OR

If either or both bits examined by the Logical OR function is 1, a 1 is placed in the corresponding location in output string Q. If both bits are 0, a 0 is placed in string Q in that location. The Logical OR function can be used to combine strings or to control many outputs with one simple logical structure. The Logical OR function is the equivalent of two relay contacts in parallel multiplied by the number of bits in the string. It can be used to drive indicator lamps directly from input states, or to superimpose blinking conditions on status lights.



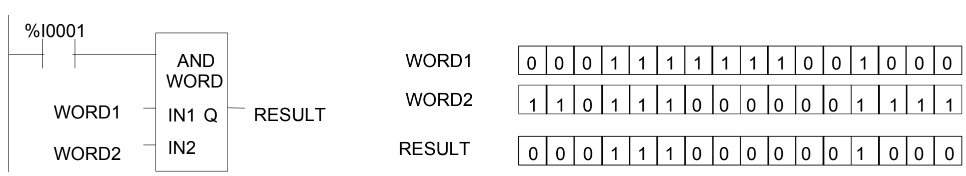
Bit Operation Functions
Logical AND, Logical OR

Parameters of the Logical AND and Logical OR Functions

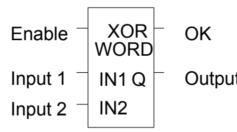
Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word of the first string.
I2	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word of the second string.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Example of the Logical AND Function

In the example, when input %I0001 is set, the 16-bit strings represented by nicknames WORD1 and WORD2 are examined. The results of the Logical AND are placed in output string RESULT.



The Exclusive OR function compares each bit in bit string IN1 with the corresponding bit in string IN2. If the bits are different, a 1 is placed in the corresponding position in the output bit string.



Each scan that power is received, the Exclusive OR function examines each bit in string IN1 and the corresponding bit in string IN2, beginning at the least significant bit in each. For each two bits examined, if only one is 1, then a 1 is placed in the corresponding location in bit string Q. The Exclusive OR function passes power flow to the right whenever power is received.

If string IN2 and output string Q begin at the same reference, a 1 placed in string IN1 will cause the corresponding bit in string IN2 to alternate between 0 and 1, changing state with each scan as long as power is received. Longer cycles can be programmed by pulsing the power flow to the function at twice the desired rate of flashing; the power flow pulse should be one scan long (one-shot type coil or self-resetting timer).

The Exclusive OR function is useful for quickly comparing two bit strings, or to blink a group of bits at the rate of one ON state per two scans.

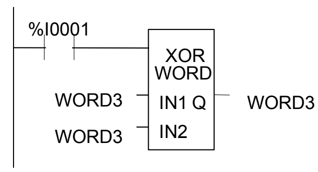
Parameters of the Exclusive OR Function

Input/ Output	***Choices***	***Description***
enable	flow	When the function is enabled, the operation is performed.
IN1	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word to be XORed.
IN2	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the second word to be XORed.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Bit Operation Functions
Exclusive OR

Example

In the example, whenever %I0001 is set, the bit string represented by the nickname WORD3 is cleared (set to all zeros).

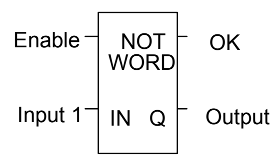


IN1 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
IN2 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
Q (WORD3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit Operation Functions
Logical Invert (NOT)

The Logical Invert (NOT) function sets the state of each bit in the output bit string Q to the opposite of the state of the corresponding bit in bit string IN1.

All bits are altered on each scan that power is received, making output string Q the logical complement of IN1. The function passes power flow to the right whenever power is received. A length of 256 words can be selected.

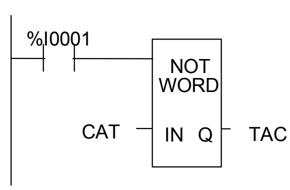


Parameters of the Logical Invert Function

Input/ Output	***Choices***	***Description***
enable	flow	When the function is enabled, the operation is performed.
IN	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the word to be negated.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Example

In the example, whenever input %I0001 is set, the bit string represented by the nickname TAC is set to the inverse of bit string CAT.



Bit Operation Functions
Shift Bits Right, Shift Bits Left

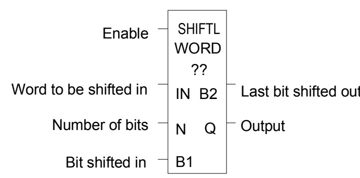
The Shift Left function shifts all the bits in a word or group of words to the left by a specified number of places. When the shift occurs, the specified number of bits is shifted out of the output string to the left. As bits are shifted out of the high end of the string, the same number of bits is shifted in at the low end.

	MSB															LSB	
B2 ←	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	←B1

The Shift Right function is used to shift all the bits in a word or group of words a specified number of places to the right. When the shift occurs, the specified number of bits is shifted out of the output string to the right. As bits are shifted out of the low end of the string, the same number of bits is shifted in at the high end.

	MSB															LSB	
B1 →	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	→B2

A string length of 1 to 256 words can be selected for either function.



If the number of bits to be shifted (N) is greater than the number of bits in the array * 16, the array (Q) is filled with copies of the input bit (B1), and the input bit is copied to the output power flow (B2). If the number of bits to be shifted is zero, then no shifting is performed; the input array is copied into the output array; and input bit (B1) is copied into the power flow.

The bits being shifted into the beginning of the string are specified via input parameter B1. If a length greater than 1 has been specified as the number of bits to be shifted, each of the bits is filled with the same value (0 or 1). This can be:

- The boolean output of another program function.
- All 1s. To do this, use the special reference nickname ALW_ON as a permissive to input B1.
- All 0s. To do this, use the special reference nickname ALW_OFF as a permissive to input B1.

The function passes power flow to the right, unless the number of bits specified to be shifted is zero.

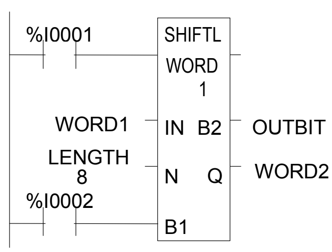
Output Q is the shifted copy of the input string. If you want the input string to be shifted, the output parameter Q must use the same memory location as the input parameter IN. The entire shifted string is written on each scan that power is received. Output B2 is the last bit shifted out. For example, if four bits were shifted, B2 would be the fourth bit shifted out.

Parameters of the Shift Right / Left Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the shift is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word to be shifted.
N	I, Q, M, T, G, R, AI, AQ, constant	N contains the number of places (bits) that the array is to be shifted.
B1	flow	B1 contains the bit value to be shifted into the array.
B2	flow, none	B2 contains the bit value of the last bit shifted out of the array.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the first word of the shifted array.

Example

In the example, whenever input %I0001 is set, the output bit string contained in the memory location represented by the nickname WORD2 is made a copy of of the bits in location WORD1. The output string is left-shifted by 8 bits, as specified by the input LENGTH. The resulting open bits at the beginning of the output string are set to the value of %I0002.



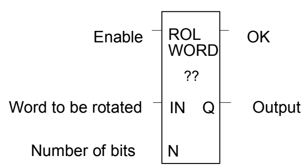
Bit Operation Functions
Rotate Bits Right, Rotate Bits Left

The Rotate Left function rotates all the bits in a string a specified number of places to the left. When rotation occurs, the specified number of bits is rotated out of the input string to the left and back into the string on the right.

The Rotate Right function rotates the bits in the string to the right. When rotation occurs, the specified number of bits is rotated out of the input string to the right and back into the string on the left.

A length of 1 to 256 words can be selected for either function. The number of places to rotate must be more than zero and less than the number of bits in the string.

The Rotate Bits function passes power flow to the right, unless the number of bits specified to be rotated is greater than the total length of the string or is less than zero. The result is placed in output string Q. If you want the input string to be rotated, the output parameter Q must use the same memory location as the input parameter IN. The entire rotated string is written on each scan that power is received.

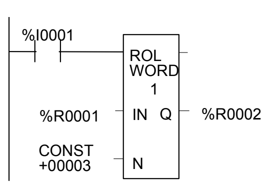


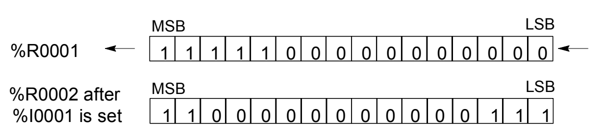
Parameters of the Rotate Bits Right / Left Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the rotation is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word to be rotated.
N	I, Q, M, T, G, R, AI, AQ, constant	N contains the number of places the array is to be rotated.
ok	flow, none	The OK output is energized when the rotation is energized and the rotation length is not greater than the array size.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the first word of the rotated array.

Example

In the example, whenever input %I0001 is set, the input bit string in location %R0001 is rotated 3 bits. The result is placed in %R0002. The input bit string %R0001 is not changed by the function. If the same reference is used for IN and Q, a rotation will occur in place.



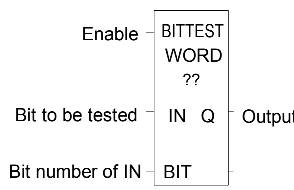


Bit Operation Functions
Bit Test

The Bit Test function tests a bit within a bit string to determine whether that bit is currently 1 or 0. The result of the test is placed in output Q.

Each sweep power is received, the Bit Test function sets its output Q to the same state as the specified bit. If a register rather than a constant is used to specify the bit number, the same function block can test different bits on successive sweeps. If the value of BIT is outside the range ($1 \leq$ BIT $\leq$ (16 * length)), then Q is set OFF.

A string length of 1 to 256 words can be selected.

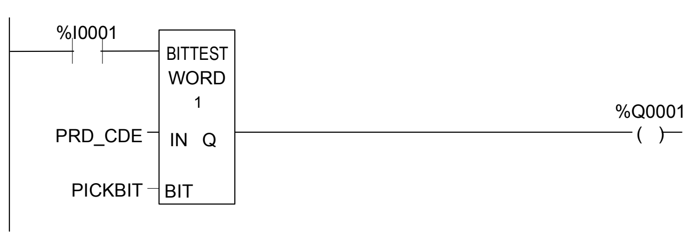


Parameters of the Bit Test Function

Input/ Output	*Choices*	*Description*
enable	flow	When the function is enabled, the bit test is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word of the data to be operated on.
BIT	I, Q, M, T, G, R, AI, AQ, constant	BIT contains the bit number of IN that should be tested. Valid range is ($1 \leq$ BIT $\leq$ (16 * length)).
Q	flow, none	Output Q is energized if the bit tested was a 1.

Example

In the example, whenever input %I0001 is set, the bit at the location contained in reference PICKBIT is tested. The bit is part of string PRD_CDE. If it is 1, output Q passes power flow and the coil %Q0001 is turned on.

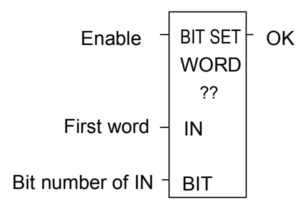


Bit Operation Functions
Bit Set and Bit Clear

The Bit Set function sets a bit in a bit string to 1. The Bit Clear function sets a bit in a string to 0.

Each sweep that power is received, the function sets the specified bit. If a variable (register) rather than a constant is used to specify the bit number, the same function block can set different bits on successive sweeps.

A string length of 1 to 256 words can be selected. The function passes power flow to the right, unless the value for BIT is outside the range (1 ≤ BIT ≤ (16 * length)). Then, OK is set OFF.

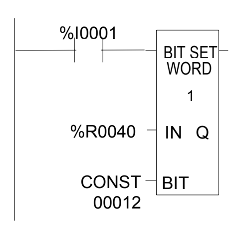


Parameters of the Bit Set and Bit Clear Functions

Input/ Output	*Choices*	*Description*
enable	flow	When the function is enabled, the bit operation is performed.
IN	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	IN contains the first word of the data to be operated on.
BIT	I, Q, M, T, G, R, AI, AQ, constant	BIT contains the bit number of IN that should be set or cleared. Valid range is (1 ≤ BIT ≤ (16 * length)).
ok	flow, none	The OK output is energized whenever the bit input is valid and enable is energized.

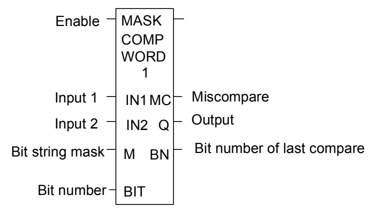
Example

In the example, whenever input %I0001 is set, bit 12 of the string beginning at reference %R0040 is set to 1.



Bit Operation Functions
Masked Compare

The Masked Compare function compares the contents of two separate bit strings. It provides the ability to mask selected bits. Input string 1 might contain the states of outputs such as solenoids or motor starters. Input string 2 might contain their input state feedback, such as limit switches or contacts.



When the function receives power flow, it begins comparing the bits in the first string with the corresponding bits in the second string. Comparison continues until a miscompare is found or until the end of the string is reached.

The BIT input stores the bit number where the next comparison should start (a *0* indicates the first bit in the string). The BN output stores the bit number where the last comparison occurred (where a *1* indicates the first bit in the string). Using the same reference for BIT and BN causes the compare to start at the next bit position after a miscompare; or, if all bits compared successfully upon the next invocation of the function block, the compare starts at the beginning.

To start the next comparison at some other location in the string, you can enter different references for BIT and BN. If the value of BIT is a location that is beyond the end of the string, BIT is reset to 0 before starting the next comparison.

Parameters of the Masked Compare Function

Input/ Output	Choices	Description
enable	flow	Permissive logic to enable the function.
IN1	R, AI, AQ For WORD only: I, Q, M, T, S, G	Reference for the first bit string to be compared.
IN2	R, AI, AQ For WORD only: I, Q, M, T, S, G	Reference for the second bit string to be compared.
M	R, AI, AQ For WORD only: I, Q, M, T, SS, SB, SC, G	Reference for the bit string mask.
BIT	I, Q, M, T, S, G, R, AI, AQ, constant	Reference for the bit number where the next comparison should start.
MC	flow, none	User logic to determine if a miscompare has occurred.
Q	R, AI, AQ For WORD only: I, Q, M, T, SA, SB, SC, G	Output copy of the mask (M) bit string.
BN	I, Q, M, T, S, G, R, AI, AQ	Bit number where the last miscompare occurred.
length	Constant	The number of words in the bit string. Max. is 4095 for WORD and 2047 for DWORD.

Bit Operation Functions
Masked Compare

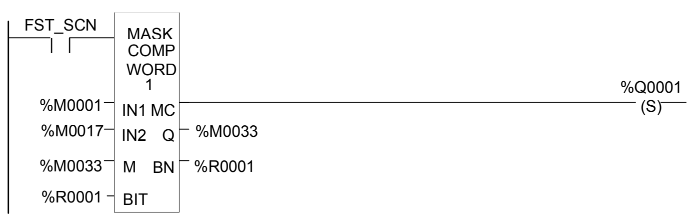
Operation of the Masked Compare

If all corresponding bits in strings IN1 and IN2 match, the function sets the "miscompare" output MC to 0 and BN to the highest bit number in the input strings. The comparison then stops. On the next invocation of a Masked Compare Word, it is reset to 0. When the two bits currently being compared are not the same, the function checks the correspondingly numbered bit in string M (the mask). If the mask bit is a *1*, the comparison continues until it reaches another miscompare or the end of the input strings. If a miscompare is detected and the corresponding mask bit is a 0, the function does the following:

1. Sets the corresponding mask bit in M to 1.
2. Sets the miscompare (MC) output to 1.
3. Updates the output bit string Q to match the new content of mask string M
4. Sets the bit number output (BN) to the number of the miscompared bit.
5. Stops the comparison.

Example

In the example, after first scan the Masked Compare Word function executes. It compares %M0001–16 with %M0017–32. %M0033–48 contain the mask. The value in %R0001 determines the bit position in the two input strings where the comparison starts.



Before the function block is executed, the contents of the above references are:

(IN1) – %M0001 = 6C6Ch =		0 1 1 0 | 1 1 0 0 | 0 1 1 0 | 1 1 0 0
(IN2) – %M0017 = 606Fh	=	0 1 1 0 | 1 1 0 1 | 0 1 1 0 | 1 1 1 1
(M/Q) – %M0033 = 000Fh	=	0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 1 1 1 1
(BIT/BN) – %R0001	=	0
(MC) – %Q0001	=	OFF

The contents of these references after the function block executes are:

(IN1) – %M0001	= (same)	0	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0
(IN2) – %M0017	= (same)	0	1	1	0	1	1	0	1	0	1	1	0	1	1	1	1
(M/Q) – %M0033 (BIT/BN) – %R0001	= 8	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1
(MC) – %Q0001	= ON																

In this example, contact %T1 and coil %M100 force one and only one execution; otherwise the function would repeat with possibly unexpected results.

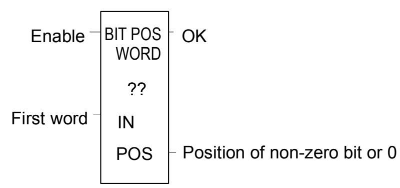
Bit Operation Functions
Bit Position

The Bit Position function locates a bit set to 1 in a bit string.

Each sweep that power is received, the function scans the bit string starting at IN. When the function stops scanning, either a bit equal to 1 has been found or the entire length of the string has been scanned.

POS is set to the position within the bit string of the first non-zero bit; POS is set to zero if no non-zero bit is found.

A string length of 1 to 256 words can be selected. The function passes power flow to the right whenever enable is ON.

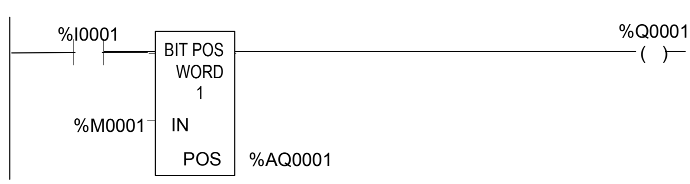


Parameters for the Bit Position Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, a bit search operation is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word of the data to be operated on.
ok	flow, none	The OK output is energized whenever enable is energized.
POS	I, Q, M, T, G, R, AI, AQ	The position of the first non-zero bit found, or zero if a non-zero bit is not found.

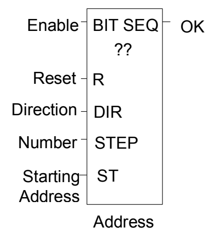
Example

In the example, if %I0001 is set, the bit string starting at %M0001 is searched until a bit equal to 1 is found. Coil %Q0001 is turned on. If a bit equal to 1 is found, its location within the bit string is written to %AQ001. If %I0001 is set, bit %M0001 is 0, and bit %M0002 is 1, then the value written to %AQ001 is 2



Bit Operation Functions
Bit Sequencer

The Bit Sequencer function performs a bit sequence shift through an array of bits.



The operation of the function depends on the previous value of the parameter EN:

R Current Execution	***EN Previous Execution***	***EN Current Execution***	***Bit Sequencer Execution***
OFF	OFF	OFF	Bit sequencer does not execute.
OFF	OFF	ON	Bit sequencer increments/decrements by 1.
OFF	ON	OFF	Bit sequencer does not execute.
OFF	ON	ON	Bit seqencer does not execute.
ON	ON/OFF	ON/OFF	Bit sequencer resets.

The reset input (R) overrides the enable (EN) and always resets the sequencer. When R is active, the current step number is set to the value passed in via the step number parameter. If no step number is passed in, step is set to 1. All of the bits in the sequencer are set to 0, except for the bit pointed to by the current step, which is set to 1.

When Enable is active and Reset is not active, the bit pointed to by the current step number is cleared. The current step number is incremented or decremented, based on the direction parameter. Then, the bit pointed to by the new step number is set to 1.

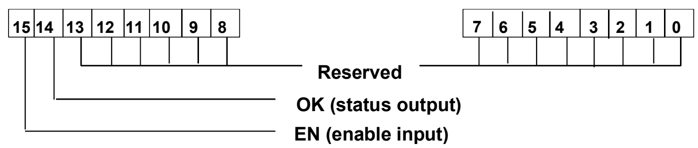
The parameter ST is optional. If it is not used, the Bit Seqencer function operates as described above, except that no bits are set or cleared. The function just cycles the current step number through its legal range.

Memory Required for a Bit Sequencer

Each bit sequencer uses three words (registers) of %R memory to store the information:

word 1	current step number
word 2	length of sequence (in bits)
word 3	control word

Word 3 (the control word) stores the state of the boolean inputs and outputs of its associated function block, in the following format:



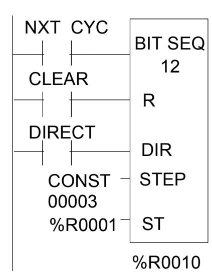
Parameters for the Bit Sequencer Function

Input/ Output	Choices	Description
address	R	Address is the location of the bit sequencer's current step, length, and the last enable and OK status.
enable	flow	When the function is enabled, if it was not enabled on the previous sweep and if R is not energized, the bit sequence shift is performed.
R	flow	When R is energized, the bit sequencer's step number is set to the value in STEP (default = 1), and the bit sequencer is filled with zeros, except for the current step number bit.
DIR	flow	When DIR is energized, the bit sequencer's step number is incremented prior to the shift. Otherwise, it is decremented.
STEP	I, Q, M, T, G, R, AI, AQ, constant, none	When R is energized, the step number is set to this value.
ST	I, Q, M, T, SA, SB, SC, G, R, AI, AQ, none	ST contains the first word of the bit sequencer. Optional.
ok	flow, none	The OK output is energized whenever the function is enabled.

Example

In the example, the Bit Sequencer operates on register memory %R0001. Its static data is stored in registers %R0010–12. When CLEAR is active, the sequencer is reset and the current step is set to step number 3. The first 8 bits of %R0001 are set to zero.

When NXT_CYC is active and CLEAR is not active, the bit for step number 3 is cleared and the bit for step number 2 or 4 (depending on whether DIR is energized) is set.



17

Control Functions

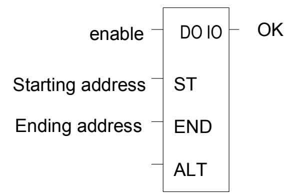
This section describes the control functions, which may be used to limit program execution and to change the way the CPU executes the application program.

- Service specified I/O: DO IO
- Go to a subroutine block: CALL
- Temporary program end: END
- Execute a group of logic rungs without power flow: MCR
- Go to a specified location in the program: JUMP, LABEL
- Place a text explanation in the program logic: COMMENT
- Provide predefined On/Off patterns to a set of 16 discrete outputs in the manner of a mechanical DRUM SEQUENCER.

The more complex Control Functions; Service Request and the PID algorithms, are described in other chapters of this manual.

Control Functions
Do I/O

The Do I/O function updates inputs or outputs for one scan while the program is running. The Do I/O function can also be used to update selected I/O during the program in addition to the normal I/O scan.



Execution of the function continues until all inputs in the selected range have reported or all outputs have been serviced. Program execution then returns to the next function.

The function passes power to the right whenever power is received, unless:

- Not all references of the type specified are present within the selected range.
- The Micro PLC is not able to properly handle the temporary list of I/O created by the function.
- The range specified includes modules associated with a “Loss of I/O" fault.

Using DO I/O with Expansion Units

The Do I/O function always correctly updates the reference addresses of the I/O being scanned, even if some I/O addresses have been skipped in autoconfiguring the PLC. If a 14-point Micro PLC with attached expansion I/O is autoconfigured, I/O addresses I0009 through I0016 and Q0009 through Q0016 are skipped and the I/O addresses of the first expansion unit will start at I0017 and Q0017. The Do I/O function updates these I/O correctly, without reserving the skipped memory areas. The reference memory at the Do I/O ALT parameter contains 16 points of data: 8 points for the module and 8 points for the expansion unit. Note: Using DO_IO with the ALT parameter to expansion modules IC200UDD06, UEC208, UEI016, UEO008, and UER016 is not supported.

Parameters of the Do I/O Function

Input/Output	Choices	Description
enable	flow	When the function is enabled, a limited input or output scan is performed.
ST	I, Q, AI, AQ	The starting address of the I/O to be serviced.
END	I, Q, AI, AQ	The ending address of the I/O to be serviced.
ALT	I, Q, M, T, G, R, AI, AQ, none	For the input scan, ALT specifies the address to store scanned input point/word values. For the output scan, ALT specifies the address to get output point/word values from. If a constant value is specified for ALT, it is ignored.
ok	flow, none	OK is energized when the scan completes normally.

Control Functions
Do I/O

Do I/O for Inputs

If input references are specified, when the function receives power flow, the PLC scans input points from the starting reference (ST) to the END reference. If a reference is specified for ALT, copies of the new input values are placed in memory beginning at that reference, and the real input values are not updated. ALT must be the same size as the reference type scanned. If a discrete reference is used for ST and END, ALT must also be discrete.

If no reference is specified for ALT, the real input values are updated. This allows inputs to be scanned one or more times during the program execution portion of the CPU sweep.

Example Do I/O for Inputs:

In this example, when the function receives power flow, the PLC scans references %I0001-64 and %Q0001 is turned on. Copies of the scanned inputs are placed in internal memory from %M0001-64. Because a reference is specified for ALT, the real inputs are not updated. This allows the current values of inputs to be compared with their values at the beginning of the scan.

Do I/O for Outputs

If output references are specified, when the function receives power flow, the PLC writes the latest output values from the starting reference (ST) to the END reference to the output points. If outputs should be written to the output points from internal memory other than %Q or %AQ, the beginning reference can be specified for ALT.

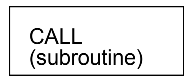
Example Do I/O For Outputs:

In the next example, when the function receives power flow, the PLC writes values from references %R0001-0004 to analog output channels %AQ001-004 and %Q0001 is turned on. Because a reference is entered for ALT, the values at %AQ001-004 are not written to.

If no reference were specified for ALT, the PLC would write values at references %AQ001-004 to analog output channels.

Control Functions
Call

The Call function causes program execution to go to a specified subroutine block.



When the Call function receives power flow, it causes the scan to go immediately to the designated subroutine block and execute it. After the subroutine block execution is complete, control returns to the point in the logic immediately following the Call instruction.

Example

Control Functions
End of Logic

The End of Logic function provides a temporary end of logic. The program executes from the first rung to the last rung or the End of Logic function, whichever is encountered first.

The End of Logic function unconditionally terminates program execution. There can be nothing after the end function in the rung. No logic beyond the End of Logic function is executed, and control is transferred to the beginning of the program for the next sweep.

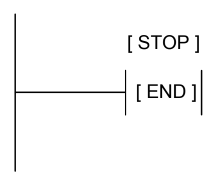
The End of Logic function is useful for debugging purposes because it prevents any logic which follows from being executed.

The programming software provides an [END OF PROGRAM LOGIC] marker to indicate the end of program execution. This marker is used if no End of Logic function is programmed in the logic.

[END]

Example

In the example, an End of Logic function is programmed to terminate the end of the current sweep.



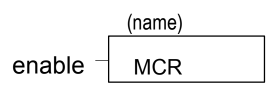
All rungs between an active Master Control Relay (MCRN) and its corresponding End Master Control Relay (ENDMCRN) function are executed without power flow to coils. The ENDMCRN associated with the Master Control Relay is used to resume normal program execution. Unlike Jump functions, Master Control Relays can only move forward; the ENDMCRN must appear after its corresponding Master Control Relay instruction in a program.

Nested MCR

A Nested Master Control Relay function can be nested completely within another MCRN/ENDMCRN pair.

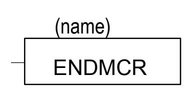
There can be multiple Master Control Relay functions with a single ENDMCRN.

The Master Control Relay function has an enable input and a name. This name is used again with the ENDMCRN. The Master Control Relay has no outputs; there can be nothing after it in a rung.



With a Master Control Relay, function blocks within the scope of the Master Control Relay are executed *without power flow*, and coils *are turned off*.

The ENDMCRN function must be tied to power rail; there can be no logic before it in the rung. The name of the ENDMCRN associates it with the corresponding Master Control Relay(s). The ENDMCRN function has no outputs; there can be nothing after it in a rung.

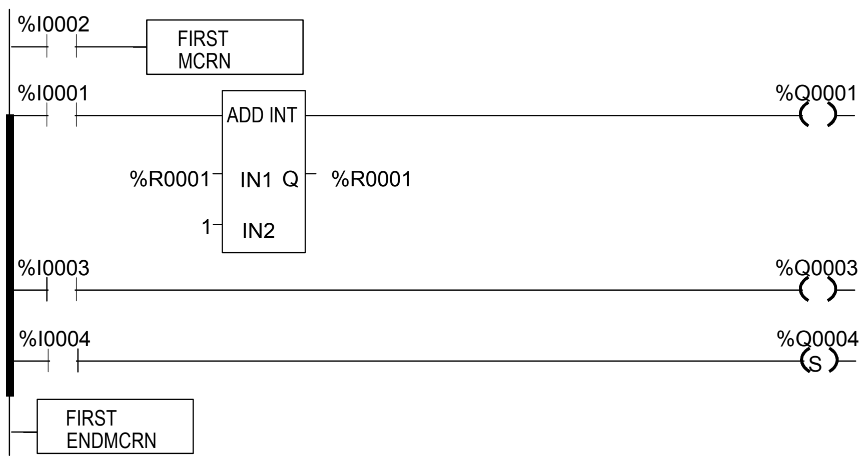


Control Functions
Master Control Relay (MCR) / End MCR

Example Master Control Relay and ENDMCRN Functions

In the example, when %I0002 is ON, the Master Control Relay is enabled. When the Master Control Relay is enabled--even if %I0001 is ON--the Addition function block is executed *without* power flow (i.e., it does not add 1 to %R0001), and %Q0001 is turned OFF.

If %I0003 and %I0004 are ON, %Q0003 is turned OFF and %Q0004 remains ON.



The Nested Jump instruction causes a portion of the program logic to be bypassed. Program execution continues at the Label specified. When the Jump is active, all coils within its scope are left at their previous states. This includes coils associated with timers, counters, latches, and relays.

The Nested Jump instruction has the form ----->>LABEL01, where LABEL01 is the name of the corresponding nested Label instruction.

A nested Jump can be placed anywhere in a program.

There can be multiple nested Jump instructions corresponding to a single nested Label. Nested Jumps can be either forward or backward Jumps.

There can be nothing after the Jump instruction in the rung. Power flow jumps directly from the instruction to the rung with the named label.

Caution

To avoid creating an endless loop with forward and backward Jump instructions, a backward Jump must contain a way to make it conditional.

Label

The Label instruction is the target of a Jump. Use the Label instruction to resume normal program execution. There can be only one Label with a particular name in a program.

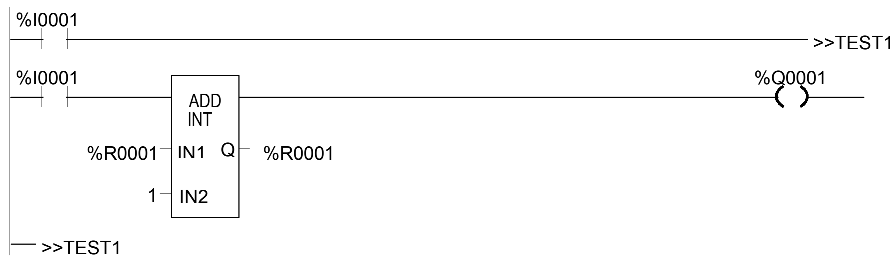
The Label instruction has no inputs and no outputs; there can be nothing either before or after a Label in a rung.

Control Functions
Jump, Label

Example Jump and Label Instructions

In the example, whenever Jump TEST1 is active, power flow is transferred to Label TEST1.

With a Jump, any function blocks between the Jump and the Label *are not* executed, and coils *are not affected*. In the example, when %I0002 is ON, the Jump is taken. Since the logic between the Jump and the Label is skipped, %Q0001 is unaffected (if it was ON, it remains ON; if it was OFF, it remains OFF).



Control Functions
Comment

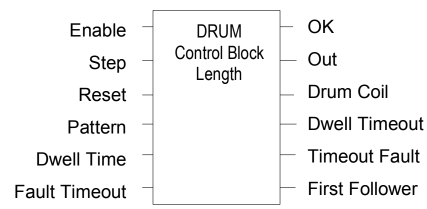
The Comment function is used to enter a comment (rung explanation) in the program. A comment can have up to 2048 characters of text. Longer text can be included in printouts using an annotation text file.

It is represented in the ladder logic like this:

```
(*  COMMENT  *)
```

Control Functions
Drum Sequencer

The Drum Sequencer function is a program instruction that operates like a mechanical drum sequencer. The Drum Sequencer steps through a set of potential output bit patterns and selects one based on inputs to the function block. The selected value is copied to a group of 16 discrete output references.



Power flow to the Enable input causes the Drum Sequencer to copy the content of a selected reference to the Out reference.

Power flow to the Reset input or to the Step input selects the reference to be copied.

The Control Block input is the beginning reference for the Drum Sequencer function's parameter block, which includes information used by the function.

Parameters of the Drum Sequencer Function

Input/ Output	Choices	Description
enable	flow	The Enable input controls execution of the function.
Step	flow	The Step input can be used to go one step forward in the sequence. When the Enable input receives power flow and the Step input makes an Off to On transition, the Drum Sequencer moves one step. When Reset is active, the function ignores the Step input.
Reset	flow	The Reset input can be used to select a specific step in the sequence. When Enable and Reset both receive power flow, the function copies the Preset Step value in the Control Block to the Active Step reference, also in the Control Block. Then the function block copies the value in the Preset Step reference to the Out reference bits. When Reset is active, the function ignores the Step input.
Pattern	R, AI, AQ	The starting address of an array of words, each representing one step of the Drum Sequencer. The value of each word represents the desired combination of outputs for a particular value of Active Step. The number of elements in the array is equal to the length input.
Dwell Time	R, AI, AQ, none	This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the dwell time for the corresponding step of the Drum Sequencer in 0.1 second units. When the dwell time expires for a given step the Dwell Timeout bit is set. If a Dwell Time is specified the drum cannot sequence into its next step until the Dwell Time has expired.
Fault Timeout	R, AI, AQ, none	This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the fault timeout for the corresponding step of the Drum Sequencer in 0.1 second units. When the fault timeout has expired the Fault Timeout bit is set.
Control Block	R	The beginning reference address of the function's parameter block. The length of the Control Block is 5 words. A more complete description of what is contained within this block is listed below.
Length	CONST	Value between 1 and 128 that specifies the number of steps.
ok	flow, none	OK is energized if Enable is On and no error condition is detected. If Enable is Off, this output will always be Off.
OUT	I, Q, M, T, G, R, AI, AQ	A word of memory containing the element of the Pattern Array that corresponds to the current Active Step.
Drum Coil	I, Q, M, T, G, none	This optional bit reference is set whenever the function block is enabled and Active Step is not equal to Preset Step.
Dwell Timeout	I, Q, M, T, G, none	This optional bit reference is set if the dwell time for the current step has expired.
Timeout Fault	I, Q, M, T, G, none	This optional bit reference is set if the drum has been in a particular step longer than the step's specified Fault Timeout.
First Follower	I, Q, M, T, G, none	This optional array of bits has one element for each step of the Drum Sequencer. No more than one bit in the array is On at any time and that bit corresponds to the value of the Active Step

Parameter Block for the Drum Sequencer Function

The parameter block (control block) for the Drum Sequencer function contains information needed to operate the Drum Sequencer.

address	Active Step
address + 1	Preset Step
address + 2	Step Control
address + 3	Timer Control

Active Step The active step value specifies the element in the Pattern array to copy to the Out output memory location. This is used as the array index into the Pattern, Dwell Time, Fault Timeout, and First Follower arrays.

Preset Step A word input that is copied to the Active Step output when the Reset is On.

Step Control A word that is used to detect Off to On transitions on both the Step input and the Enable input. The Step Control word is reserved for use by the function block, and must not be written to.

Timer Control Two words of data that hold values needed to run the timer. These values are reserved for use by the function block and must not be written to.

Notes on Using the Drum Sequencer Function

1. The Dwell Timeout Output bit is cleared the first time the drum is in a new step. This is true:

- Whether the drum is introduced to a new step by changing the Active Step or by using the Step Input.
- Regardless of the Dwell Time Array value associated with the step (even if it is 0).
- During the first sweep the Active Step is initialized.

2. The Active and Preset Step of the Drum Sequencer's control block must be initialized for the Drum Sequencer to work or to pass power flow. Even if the Active Step is in the correct range (between 1 and length of the Pattern array) and the Preset Step is not used, the drum will not function if the Preset Step is not in the proper range.

Data Move Functions

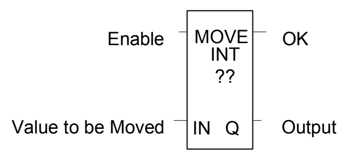
The Data Move functions of the Instruction Set provide basic data move capabilities.

- MOVE Data. This function copies data as individual bits, so the new location does not have to be the same data type.
- Block Move. This function places constants into seven specified memory locations.
- Block Clear. This function fills an area of memory with zeros.
- Shift Register. This function shifts one or more data words or data bits from a reference location in to a specified area of memory. Data already in the area is shifted out.
- Communication Request (COMMREQ). This important function allows the CPU to communicate with intelligent modules in the system, for example, communications modules. The basic format of the COMMREQ function is shown in this chapter. The detailed parameters needed to program specific communications tasks are provided in the documentation for each module.

Data Move Functions
Move Data

The MOVE function copies data as individual bits from one location to another. Because the data is copied in bit format, the new location does not need to be the same data type as the original.

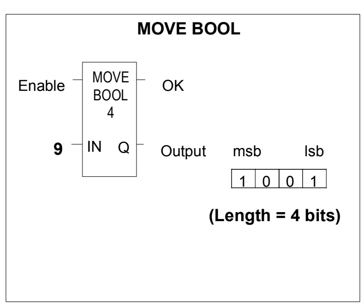
When the Move function receives power flow, it copies data from input parameter IN to output parameter Q as bits. If data is moved from one location in discrete memory to another, (for example, from %I memory to %T memory), the transition information associated with the discrete memory elements is updated to indicate whether or not the Move operation caused any discrete memory elements to change state. Data at the input parameter does not change unless there is an overlap in the source and destination.

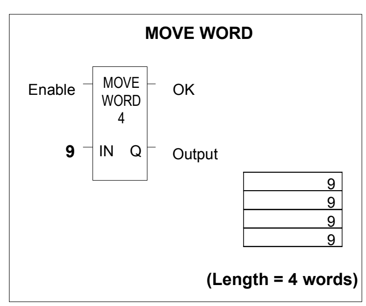


Note that if an array of Bit-type data specified in the Q parameter does not include all the bits in a byte, the transition bits associated with that byte (which are not in the array) are cleared when the Move function receives power flow.

The input IN can be either a reference for the data to be moved or a constant. If a constant is specified, then the constant value is placed in the location specified by the output reference. For example, if a constant value of 4 is specified for IN, then 4 is placed in the memory location specified by Q. If the length is greater than 1 and a constant is specified, then the constant is placed in the memory location specified by Q and the locations following, up to the length specified. Do not allow overlapping of IN and Q parameters.

The result of the Move depends on the data type selected for the function, as shown below. For example, if the constant value 9 is specified for IN and the length is 4, then 9 is placed in the bit memory location specified by Q and the three locations following:





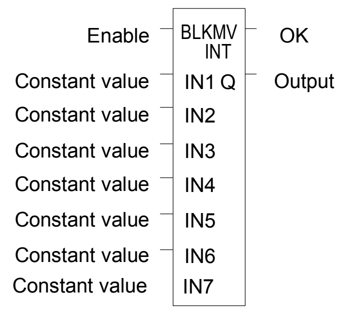
The function passes power to the right whenever power is received.

Parameters for the Move Data Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the move is performed.
Length		The number of bits, words, or double words of data to be copied. This is the length of IN. Length must be from 1 to 256 for all types except BOOL. If IN is a constant and Q is type BOOL, the length must be between 1 and 16. If IN is type BOOL, the length must be between 1 and 256 bits.
IN	I, Q, M, T, G, R, AI, AQ, constant For bit or word data only: S For real data: R, AI, AQ	IN contains the value to be moved. For MOVE BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.
ok	flow, none	The OK output is energized whenever the function is enabled.
Q	I, Q, M, T, G, R, AI, AQ, For bit/ word data: SA, SB, SC For real data: R, AI, AQ	When the move is performed, the value at IN is written to Q. For MOVE BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.

Data Move Functions
Block Move

The Block Move function copies a block of seven constants to a specified location. When the Block Move function receives power flow, it copies the constant values into consecutive locations beginning at the destination specified in output Q. The function passes power to the right whenever power is received.

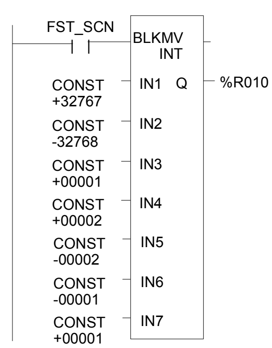


Parameters of the Block Move Function

Input/ Output	*Choices*	*Description*
enable	flow	When the function is enabled, the block move is performed.
IN1 to IN7	constant	IN1 through IN7 contain seven constant values.
ok	flow, none	The OK output is energized whenever the function is enabled.
Q	I, Q, M, T, G, R, AI, AQ For Word data: SA, SB, SC For Real data: R, AI, AQ	Output Q contains the first element of the moved array. IN1 is moved to Q.

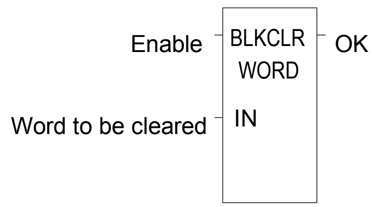
Example

In the example, when the enabling input represented by the nickname FST_SCN is ON, the Block Move function copies the input constants into memory locations %R0010–16.



The Block Clear function fills a specified block of data with zeros. When the function receives power flow, it writes zeros into the memory location beginning at the reference specified by IN. When the data to be cleared is from discrete memory (%I, %Q, %M, %G, or %T), the transition information associated with the references is also cleared.

The function passes power to the right whenever power is received.

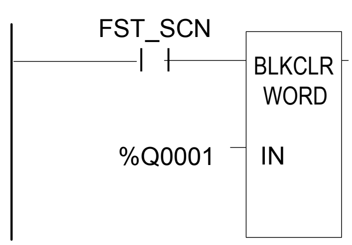


Parameters of the Block Clear Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the array is cleared.
IN	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	IN contains the first word of the array to be cleared. The length of IN must be between 1 and 256 words.
Length		The number of words that will be cleared. This is the length of IN.
ok	flow, none	The OK output is energized whenever the function is enabled.

Example

In the example, at powerup, 32 words of %Q memory (512 points) beginning at %Q0001 are filled with zeros. %Q is defined as WORD of length 32.

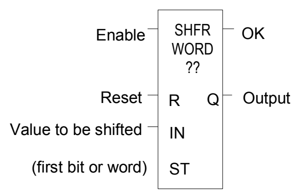


Data Move Functions
Shift Register

The Shift Register function shifts one or more data words or data bits from a reference location into a specified area of memory. For example, one word might be shifted into an area of memory with a specified length of five words. As a result of this shift, another word of data would be shifted out of the end of the memory area.

The reset input (R) takes precedence over the function enable input. When the reset is active, all references beginning at the shift register (ST) up to the length specified for LEN, are filled with zeros.

If the function receives power flow and reset is not active, each bit or word of the shift register is moved to the next highest reference. The last element in the shift register is shifted into Q. The highest reference of the shift register element of IN is shifted into the vacated element starting at ST. The contents of the shift register are accessible throughout the program because they are overlaid on absolute locations in logic addressable memory.



Parameters of the Shift Register Function

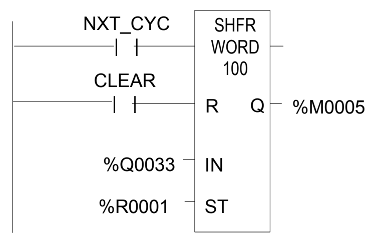
Input/ Output	Choices	Description
enable	flow	When enable is energized and R is not, the shift is performed.
Length	1 to 256 bits or words.	The length of the shift register in bits or words. Length is defined as the length of IN.
R	flow	When R is energized, the shift register located at ST is filled with zeros.
IN	I, Q, M, T, S, G, R, AI, AQ, constant	IN contains the value to be shifted into the first bit or word of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned.
ST	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	ST contains the first bit or word of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned.
ok	flow, none	OK is energized whenever the function is enabled and R is not enabled.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the bit or word shifted out of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned.

CAUTION: the use of overlapping input and output reference address ranges in multi-word functions is not recommended; it may produce unexpected results.

Example 1:

In the example, the shift register operates on register memory locations %R0001 through %R0100. (%R0001 is defined as type Word of length 100). When the reset reference CLEAR is active, the Shift Register words are set to zero.

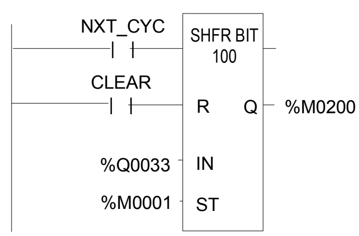
When the NXT_CYC reference is active and CLEAR is not active, the word from output status table location %Q0033 is shifted into the Shift Register at %R0001. The word shifted out of the Shift Register from %R0100 is stored in output %M0005.



Example 2:

In this example, the Shift Register operates on memory locations %M0001 through %M0100. (%M0001 is defined as type Boolean of length 100). When the reset reference CLEAR is active, the Shift Register function fills %M0001 through %M0100 with zeros.

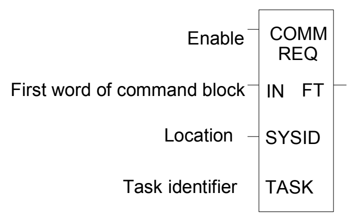
When NXT_CYC is active and CLEAR is not, the Shift Register function shifts the data in %M0001 to %M0100 down by one bit. The bit in %Q0033 is shifted into %M0001 while the bit shifted out of %M0100 is written to %M0200.



Data Move Functions
Communication Request

The Communication Request (COMMREQ) function is use for specialized communications. Many types of COMMREQs have been defined. The information below describes only the basic format of the function.

When the function receives power flow, a command block of data is sent to the specified module. After sending the COMMREQ, the program can either suspend execution and wait for a reply for a maximum waiting period specified in the command, or resume immediately.



Parameters of the COMMREQ Function

Input/ Output	*Choices*	*Description*
enable	flow	When the function is energized, the communications request is performed.
IN	R, AI, AQ	IN contains the first word of the command block.
SYSID	I, Q, M, T, G, R, AI, AQ, constant	SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device.
TASK	R, AI, AQ, constant	TASK contains the task ID of the process on the target device.
FT	flow, none	FT is energized if an error is detected processing the COMM REQ: 1. The specified target address is not present (SYSID). 2. The specified task is not valid for the device (TASK). 3. The data length is 0. 4. The device's status pointer address (in the command block) does not exist.

Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMM REQ. The Command Block has the following structure:

address	Length (in words)
address + 1	Wait/No Wait Flag
address + 2	Status Pointer Memory
address + 3	Status Pointer Offset
address + 4	Idle Timeout Value
address + 5	Maximum Communication Time
address + 6 to address + 133	Data Block

Example

In the example, when enabling input %M0020 is ON, a Command Block starting at %R0016 is sent to communications task 1 in the device located at rack 1, slot 2 of the PLC. If an error occurs processing the COMMREQ, %Q0100 is set.

Data Type Conversion Functions

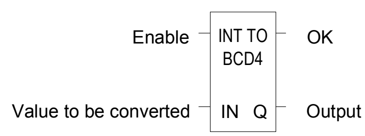
The Data Type Conversion functions are used to change a data item from one number type to another. Many programming instructions, such as math functions, must be used with data of one type.

- Convert data to BDC-4
- Convert data to signed integer
- Convert data to double-precision integer
- Convert data to Real
- Convert data to Word
- Round a Real number toward zero (TRUN)

The Convert to BCD-4 function outputs the four-digit BCD equivalent of signed integer data. The original data is not changed by this function. The output data can be used directly as input for another program function.

Data can be converted to BCD format to drive BCD-encoded LED displays or presets to external devices such as high-speed counters.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to 9999.



Parameters of the Convert to BCD-4 Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	I, Q, M, T, G, R, AI, AQ, constant	IN contains a reference for the integer value to be converted to BCD-4.
OK	flow, none	The OK output is energized when the function is performed without error.
Q	I, Q, M, T, G, R, AI, AQ	Output Q contains the BCD-4 form of the original value in IN.

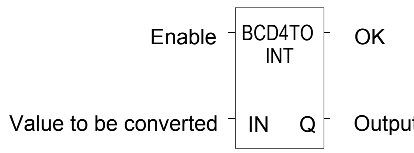
Example

In the example, whenever input %I0002 is set and no errors exist, the integer at input location %I0017 through %I0032 is converted to four BCD digits, and the result is stored in memory locations %Q0033 through %Q0048. Coil %Q1432 is used to check for successful conversion.

Data Type Conversion Functions
Convert to Signed Integer

The Convert to Signed Integer function outputs the integer equivalent of BCD-4 or Real data. The original data is not changed by this function. The output data can be used as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the data is out of range.

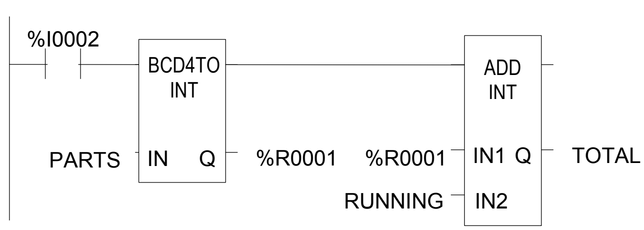


Parameters of the Convert to Signed Integer Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	For BCD-4: I, Q, M, T, G, R, AI, AQ, constant For REAL: R, AI, AQ	IN contains a reference for the BCD-4, REAL, or Constant value to be converted to integer.
ok	flow, none	The OK output is energized whenever enable is energized, unless the data is out of range or NaN (Not a Number).
Q	For BCD-4: I, Q, M, T, G, R, AI, AQ For REAL: R, AI, AQ	Output Q contains the integer form of the original value in IN.

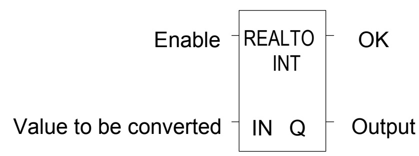
Example

In the example, whenever input %I0002 is set, the BCD-4 value in PARTS is converted to a signed integer and passed to the Addition function, where it is added to the signed integer value represented by the reference RUNNING. The sum is output by the Addition function to the reference TOTAL.



The Convert to Double Precision Signed Integer function outputs the double precision signed integer equivalent of real data. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the real value is out of range.



Note that loss of precision can occur when converting from Real-type data to Double-Precision Integer, because Real data has 24 significant bits.

Parameters of the Convert to Double Precision Signed Integer Function

Input/ Output	***Choices***	***Description***
rapidan	flow	When the function is enabled, the conversion is performed.
IN	I, Q, M, T, G, R, AI, AQ, constant	Constant or reference for the value to be converted
ok	flow, none	OK is energized whenever enable is energized, unless the real value is out of range.
Q	R, AI, AQ	Reference that contains the double precision signed integer form of the original value.

Example

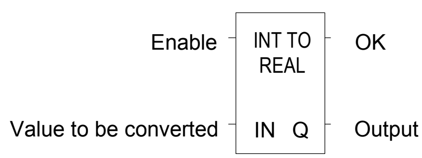
In the example, whenever input %I0002 is set, the integer value at input location %I0017 is converted to a double precision signed integer and the result is placed in location %R0001. The output %Q1001 is set whenever the function executes successfully.

Data Type Conversion Functions
Convert to Real Data

The Convert to Real function outputs the real value equivalent of the input data. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range.

Note that loss of precision can occur when converting from Double-Precision Integer to Real data, because since the number of significant bits is reduced to 24.

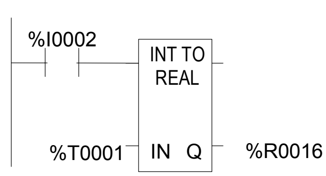


Parameters of the Convert to Real Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant For INT only: I, Q, M, T, G	IN contains a reference for the integer value to be converted to Real.
ok	flow, none	OK is energized when the function is performed without error.
Q	R, AI, AQ	The Real form of the original value in IN.

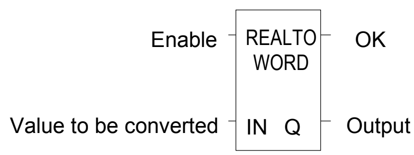
Example

In the example, the integer value of input IN is 678. The result value placed in %T0016 is 678.000.



The Convert to Word function outputs the Word equivalent of Real data. The original data is not changed by this function.

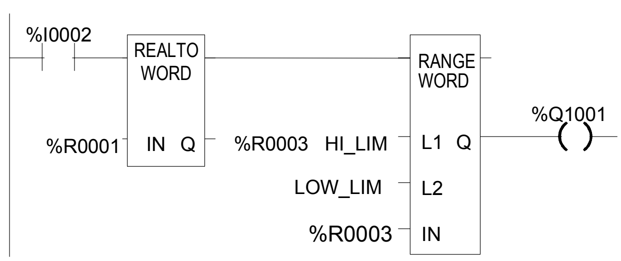
When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to FFFFh.



Parameters of the Convert to Word Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant	IN contains a reference for the value to be converted to Word type.
ok	flow, none	OK is energized when the function is performed without error.
Q	I, Q, M, T, G, R, AI, AQ	Contains the unsigned integer form of the original value in IN.

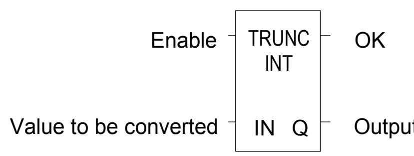
Example



Data Type Conversion Functions
Truncate Real Number

The Truncate function copies a Real number and rounds the copied number down to an integer or double precision integer. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range or unless IN is not a number.

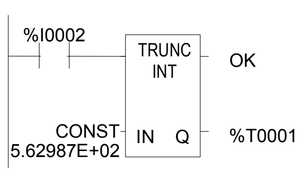


Parameters of the Truncate Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant	IN contains a reference for the real value to be truncated.
ok	flow, none	The OK output is energized when the function is performed without error, unless the value is out of range or IN is NaN.
Q	R, AI, AQ For integer only: I, Q, M, T, G	Q contains the truncated INT or DINT value of the original value in IN.

Example

In the example, the displayed constant is truncated and the integer result 562 is placed in %T0001.



Math and Numerical Functions

This section describes the Math and Numerical functions of the Instruction Set:

- Standard Math Functions: Addition, Subtraction, Multiplication, Division
- Modulo Division
- Scaling Function
- Square Root
- Trigonometric functions
- Logarithmic/Expontial functions
- Convert to Degrees
- Convert to Radians

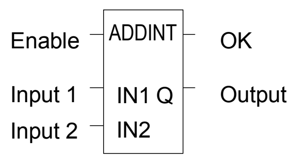
Converting Data for the Math and Numerical Functions

The program may need to include logic to convert data to a different type before using a Math or Numerical function. The description of each function includes information about appropriate data types. The section *Data Type Conversion Functions* explains how to convert data to a different type.

Math and Numerical Functions
Add, Subtract, Multiply, Divide

The standard math functions are Addition, Subtraction, Multiplication, and Division. The Division function rounds down; it does not round to the closest integer. (For example, 24 DIV 5 = 4.)

When a math function receives power flow, the appropriate operation is performed on input parameters IN1 and IN2. Parameters IN1, IN2, and the output Q must be the same data type.



The standard math functions pass power if there is no math overflow. If an overflow occurs, the result is the largest value with the proper sign and no power flow.

Parameters of the Standard Math Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN1	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	IN1 contains a constant or reference for the first value used in the operation. (IN1 is on the left side of the mathematical equation, as in IN1 + IN2). Range for constants in double-precision signed integer operations is minimum/maximum DINT.
IN2	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	IN2 contains a constant or reference for the second value used in the operation. (IN2 is on the right side of the mathematical equation, as in IN1 + IN2). Range for constants in double-precision signed integer operations is minimum/maximum DINT.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.
Q	All data types: R, AI, AQ INT only: I, Q, M, T, G	Output Q contains the result of the operation.

Data Types for Standard Math Functions

Standard math functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

The input and output parameter data types must be the same (16 bits or 32 bits).

Avoiding Overflows

Be careful to avoid overflows when using Multiplication and Division functions.

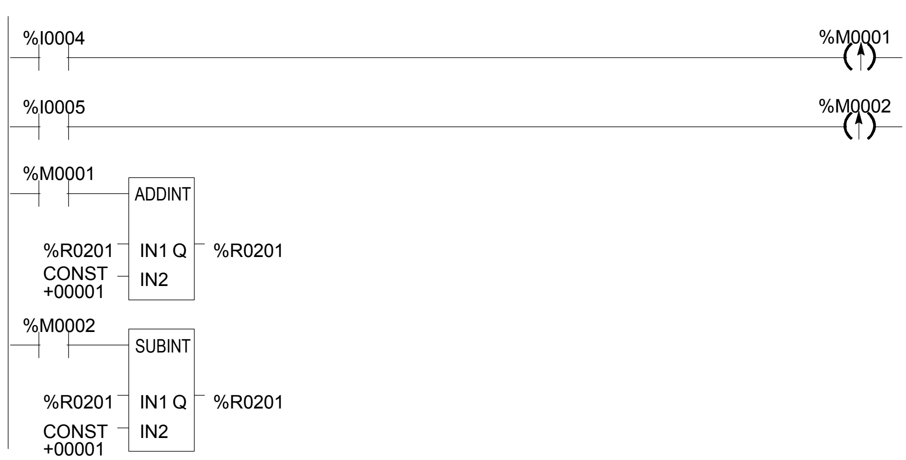
If you have to convert Integer to Double-Precision Integer values, remember that the CPU uses standard 2's complement with the sign extended to the highest bit of the second word. You must check the sign of the low 16-bit word and extend it into the second 16 bit word. If the most significant bit in a 16-bit INT word is 0 (positive), move a 0 to the second word. If the most significant bit in a 16-bit word is –1 (negative), move a –1 or hex 0FFFFh to the second word.

Converting from Double-Precision Integer to Integer data is easier, because the low 16-bit word (first register) is the integer portion of a Double-Precision Integer 32-bit word. The upper 16 bits or second word should be either a 0 (positive) or –1 (negative) value or the Double-Precision Integer number will be too big to convert to 16 bits.

Example

This example uses the Addition and Subtraction functions to keep track of the number of parts in a temporary storage area. Each time a part enters the storage area, power flows through relay %I0004 to a positive transition coil with reference %M0001. Relay %M0001 then enables the Addition function, adding the (constant) value 1 to the current total value in %R0201.

Each time a part leaves the storage area, power flows through relay %I0005 to a positive transition coil with reference %M0002. Relay %M0002 then enables the Subtraction function, subtracting the (constant) value 1 from the current total value in %R0201.



Math and Numerical Functions
Modulo Division

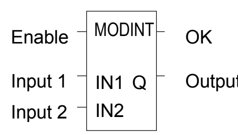
The Modulo Division function divides one value by another of the same data type, to obtain the remainder. The sign of the result is always the same as the sign of input parameter IN1. The Modulo function operates on these types of data:

INT	Signed integer
DINT	Double precision signed integer

When the function receives power flow, it divides input IN1 by input IN2. These parameters must be the same data type. Output Q is calculated using the formula:

Q = IN1-((IN1 DIV I2) * I2)

The division produces an integer number. Q is the same data type as inputs IN1 and IN2. OK is always ON when the function receives power flow, unless there is an attempt to divide by zero. In that case, it is set OFF.

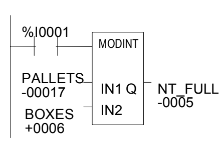


Parameters of the Modulo Division Function

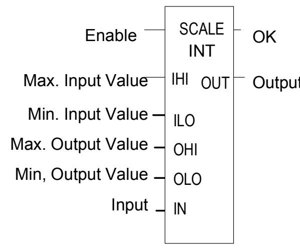
Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN1	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	IN1 contains a constant or reference for the value to be divided by IN2. Range for constants in double precision signed integer operations is minimum/maximum DINT.
IN2	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	IN2 contains a constant or reference for the value to be divided into IN1. Range for constants in double precision signed integer operations is minimum/maximum DINT.
ok	flow, none	The OK output is energized when the function is performed without overflow.
Q	All data types: R, AI, AQ INT data type only: I, Q, M, T, G	Output Q contains the result of dividing IN1 by IN2 to obtain a remainder.

Example

In the example, the remainder of the integer division of BOXES into PALLETS is placed into NT_FULL whenever %I0001 is ON.



The Scaling function scales an input parameter and places the result in an output location. For integer-type data, all parameters must be integer-based (signed). For word-type data, all parameters must be word-based (unsigned).

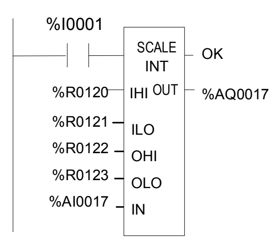


Parameters of the Scaling Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IHI ILO	R ,AI, AQ, constant	IHI and ILO contain a constant or reference for the upper and lower limits of the unscaled data. These limits, together with the values for OHI and OLO, are used to calculate the scaling factor that will be applied to the input value IN.
OHI OLO	R ,AI, AQ, constant	OHI and OLO contain a constant or reference for the upper and lower limits of the scaled data.
IN	R, AI, AQ, constant	IN contains a constant or reference for the actual value to be scaled.
ok	flow, none	The OK output is energized when the function is performed without overflow.
OUT	R, AI, AQ	Output OUTcontains the scaled equivalent of the input value.

Example

In the example, the registers %R0120 through %R0123 are used to store the high and low scaling values. The input value to be scaled is analog input %AI0017. The scaled output data is used to control analog output %AQ0017. The scaling is performed whenever %I0001 is ON.



Math and Numerical Functions
Square Root

The Square Root function finds the square root of a value. When the function receives power flow, the value of output Q is set to the integer portion of the square root of the input IN. The output Q must be the same data type as IN.

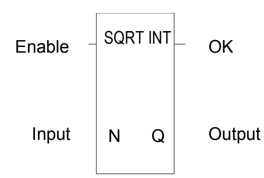
The Square Root function operates on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

OK is set ON if the function is performed without overflow, unless one of these invalid REAL operations occurs:

- IN < 0
- IN is NaN (Not a Number)

Otherwise, OK is set OFF.

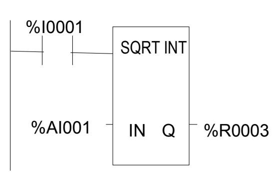


Parameters of the Square Root Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	A constant or reference for the value whose square root is to be calculated. If IN is less than zero, the function will not pass power flow. Range for constants is minimum/maximum DINT for double-precision signed integer operations.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.
Q	All data types: R, AI, AQ INT data type only: I, Q, M, T, G	Output Q contains the square root of IN.

Example

In the example, the square root of the integer number located at %AI001 is placed into the result located at %R0003 whenever %I0001 is ON.

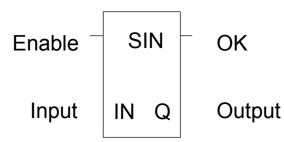


Math and Numerical Functions
Trigonometric Functions

There are six Trigonometric functions: Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent.

Sine, Cosine, and Tangent

When a Sine, Cosine, or Tangent function receives power flow, it operates on IN, whose units are radians, and stores the result in output Q. Both IN and Q are floating-point values.



The Sine, Cosine, and Tangent functions accept a broad range of input values, where

$$-2^{63} < IN < +2^{63},\ (2^{63} = 9.22 \times 10^{18})$$

Inverse Sine, Cosine, and Tangent

When an Inverse Sine, Cosine, or Tangent function receives power flow, it operates on IN and stores the result in output Q, whose units are radians. Both IN and Q are floating-point values.

The Inverse Sine and Cosine functions accept a narrow range of input values, where

$$-1 \leq IN \leq 1.$$

Given a valid value for the IN parameter, the Inverse Sine Real function produces a result Q such that:

$$\text{ASIN (IN)} \quad = \quad \frac{\pi}{2} \leq Q \leq \frac{\pi}{2}$$

The Inverse Cosine Real function produces a result Q such that:

$$\text{ACOS (IN)} \quad = \quad 0 \leq Q \leq \pi$$

The Inverse Tangent function accepts the broadest range of input values, where

$$-\infty \leq IN \leq +\infty.$$

Given a valid value for the IN parameter, the Inverse Tangent Real function produces a result Q such that:

$$\text{ATAN (IN)} \quad = \quad \frac{\pi}{2} \leq Q \leq \frac{\pi}{2}$$

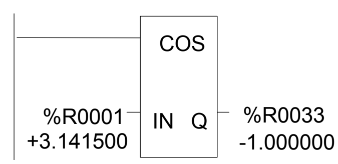
Math and Numerical Functions
Trigonometric Functions

Parameters of the Trigonometric Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	R, AI, AQ, constant	IN contains the constant or reference real value to be operated on.
ok	flow, none	OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN.
Q	R, AI, AQ	Output Q contains the trigonometric value of IN.

Example

In the example, the Cosine of the value in %R0001 is placed in %R0033.

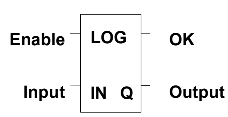


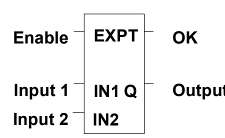
Math and Numerical Functions
Logarithmic / Exponential Functions

When a Logarithmic or Exponential function receives power flow, it performs the appropriate logarithmic/exponential operation on the Real value in input IN and places the result in output Q.

- For the Base 10 Logarithm (LOG) function, the base 10 logarithm of IN is placed in Q.
- For the Natural Logarithm (LN) function, the natural logarithm of IN is placed in Q.
- For the Power of E (EXP) function, ***e*** is raised to the power specified by IN and the result is placed in Q.
- For the Power of X (EXPT) function, the value of input IN1 is raised to the power specified by the value IN2 and the result is placed in output Q. (The EXPT function has three input parameters and two output parameters.)

The OK output receives power flow unless the input is NaN (Not a Number) or is negative.



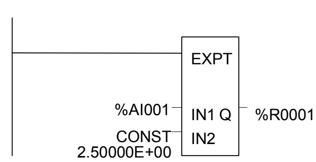


Parameters of the Logarithmic/Exponential Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN or IN1, IN2	R, AI, AQ, constant	For EXP, LOG, and LN, IN contains the real value to be operated on. The EXPT function has two inputs, IN1 and IN2. For EXPT, IN1 is the base value and IN2 is the exponent.
ok	flow, none	OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN or is negative.
Q	R, AI, AQ	Output Q contains the logarithmic/exponential value of IN.

Example of the EXPT Function

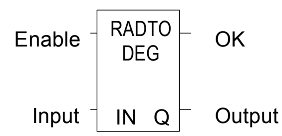
In the example, the value of %AI001 is raised to the power of 2.5 and the result is placed in %R0001.



Math and Numerical Functions
Radian Conversion Functions

When Degree/Radian Conversion function receives power flow, the appropriate conversion (radians to degrees or degrees to radians) is performed on the Real value in input IN and the result is placed in output Q.

The OK output will receive power flow unless IN is NaN (Not a Number).

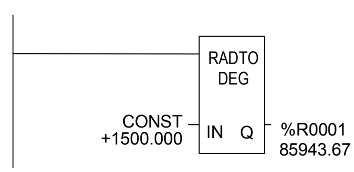


Parameters of the Radian Conversion Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	R, AI, AQ, constant	IN contains the real value to be operated on.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless IN is NaN.
Q	R, AI, AQ	Output Q contains the converted value of IN.

Example

In the example, +1500 is converted to DEG and is placed in %R0001.

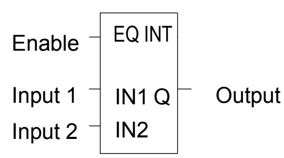


Relational Functions

The Relational functions can be used to compare two numbers and to determine whether a number lies within a specified range.

▪ Equal	Test two numbers for equality
▪ Not Equal	Test two numbers for non-equality
▪ Greater Than	Test whether one number is greater than another
▪ Greater Than or Equal	Test whether one number is greater than or equal to another
▪ Less Than	Test whether one number is less than another
▪ Less Than or Equal	Test whether one number is less than or equal to another
▪ Range	Tests whether one number lies between two other numbers

When the function receives power flow, it compares input IN1 to input IN2. These parameters must be the same data type.



If inputs IN1 and IN2 match the specified relational condition, output Q receives power flow and is set ON (1); otherwise, it is set OFF (0).

Data Types for Relational Functions

Relational functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

The %S0020 bit is set ON when a relational function using Real data executes successfully. It is cleared when either input is NaN (Not a Number).

Relational Functions
Equal, Not Equal, Less Than, Less/Equal, Greater Than, Greater/Equal

Parameters for the Relational Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN1	R, AI, AQ, constant For INT data only: I, Q, M, T, G	IN1 contains a constant or reference for the first value to be compared. IN1 must be a valid number. Constants must be integers for double precision signed integer operations. IN1 is on the left side of the relational equation, as in IN1 < IN2.
IN2	R, AI, AQ, constant For INT data only: I, Q, M, T, G	IN2 contains a constant or reference for the second value to be compared. IN2 must be a valid number. Constants must be integers for double precision signed integer operations. IN2 is on the right side of the relational equation, as in IN1 < IN2.
Q	flow, none	Output Q is energized when IN1 and IN2 match the specified relation.

Example

In the example, two double precision signed integers are tested for equality. When the relay %I0001 passes power flow to the LE (Less or Equal) function, the value presently in the reference nicknamed PWR_MDE is compared to the value presently in the reference BIN_FUL. If the value in PWR_MDE is less than or equal to the value in BIN_FUL, coil %Q0002 is turned on.

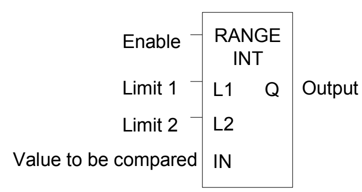
The Range function determines if a value is within the range of two numbers.

Data Types for the Range Function

The Range function operates on these types of data:

INT	Signed integer (default).
DINT	Double precision signed integer.
WORD	Word data type.

When the Range function is enabled, it compares the value of input IN against the range specified by limits L1 and L2. Either L1 or L2 can be the high or low limit. When the value is within the range specified by L1 and L2, inclusive, output parameter Q is set ON (1). Otherwise, Q is set OFF (0).



Parameters for the Range Function

Input/ Output	***Choices***	***Description***
enable	flow	When the function is enabled, the operation is performed.
L1	R, AI, AQ, constant INT and WORD only: I, Q, M, T, G	L1 contains the start point of the range. Constants must be integer values for double precision signed integer operations.
L2	R, AI, AQ, constant INT and WORD only: I, Q, M, T, G	L2 contains the end point of the range. Constants must be integer values for double precision signed integer operations.
IN	R, AI, AQ INT and WORD only: I, Q, M, T, G	IN contains the value to be compared against the range specified by L1 and L2.
Q	flow, none	Output Q is energized when the value in IN is within the range specified by L1 and L2, inclusive.

Relational Functions
Range

Example

In this example, when the Range function receives power flow from relay %I0001, the function determines whether the value in %AI001 is within the range 0 to 100.

%R0001 contains the value 100. %R2 contains the value 0.

Output coil %Q0001 is On only if the value presently in %AI0001 is within the range 0 to 100.

IN Value %AI001	Q State %Q0001
< 0	OFF
0 — 100	ON
> 100	OFF

Relay Functions

- Normally Open Contact –| |–
- Normally Closed Contact –|/|–
- Normally Open Coil –( )–
- Retentive SET Coil –(SM)–
- Retentive RESET Coil –(RM)–
- Negated Retentive Coil –(/M)–
- Negated Coil –(/)–
- Retentive Coil –(M)–
- SET Coil –(S)–
- RESET Coil –(R)–
- Positive Transition Coil –(↑)–
- Negative Transition Coil –(↓)–
- Vertical Link vert |
- Horizontal Link horz –
- Continuation Coil ——<+>
- Continuation Contact <+>——

Each relay contact and coil has one input and one output. Together, they provide logic flow through the contact or coil.

Input→ —| |— ← *Output*

Relay Functions
Normally-open, Normally-closed, Continuation Contacts

A contact is used to monitor the state of a reference. Whether the contact passes power flow depends on the state or status of the reference being monitored and on the contact type. A reference is ON if its state is 1; it is OFF if its state is 0.

Type of Contact	*Display*	*Contact Passes Power to Right:*
Normally Open	-| |-	When reference is ON.
Normally Closed	-|/|-	When reference is OFF.
Continuation Contact	<+>---	If the preceding continuation coil is set ON.

Normally Open Contact -| |-

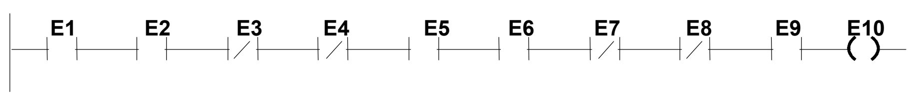
A normally open contact acts as a switch that passes power flow if the associated reference is ON (1).

Normally Closed Contact -|/|-

A normally closed contact acts as a switch that passes power flow if the associated reference is OFF (0).

Example

The example shows a rung with 10 elements having nicknames from E1 to E10. Coil E10 is ON when reference E1, E2, E5, E6, and E9 are ON and references E3, E4, E7, and E8 are OFF.



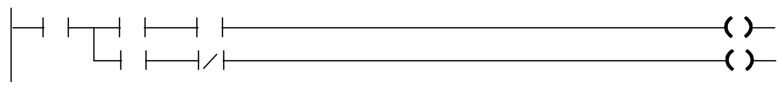
Continuation Coils and Contacts

Continuation coils and continuation contacts are used to continue relay ladder rung logic beyond the last column. The state of the last executed continuation coil is the flow state used on the next executed continuation contact. If the flow of logic does not execute a continuation coil before it executes a continuation contact, the state of the contact is no flow. There can be only one continuation coil and contact per rung; the continuation contact must be in column 1, and the continuation coil must be in the last column.

Relay Functions
Coils

Coils are used to control discrete references. Conditional logic must be used to control the flow of power to a coil. Coils cause action directly; they do not pass power flow to the right. If additional logic in the program should be executed as a result of the coil condition, an internal reference for the coil, or a continuation coil/contact combination may be used.

Coils are always located at the rightmost position of a line of logic:



References and Coil Checking

When the level of coil checking is set to “single”, you can use a specific %M or %Q reference with only one Coil, but you can use it with one Set Coil and one Reset Coil simultaneously. When the level of coil checking is “warn multiple” or “multiple”, each reference can be used with multiple Coils, Set Coils, and Reset Coils. With multiple usage, a reference could be turned On by either a Set Coil or a normal Coil and could be turned Off by a Reset Coil or by a normal Coil.

Power Flow and Retentiveness

The following table summarizes how power flow to different types of coils affects their reference. The states of retentive coils are saved when power is cycled or when the PLC goes from Stop to Run mode. The states of non-retentive coils are set to zero when power is cycled or the PLC goes from Stop to Run mode.

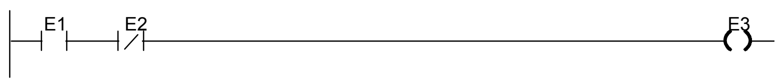
Type of Coil	Symbol	Power to Coil	Result
Normally Open	-( )-	ON OFF	Sets reference ON, non-retentive. Sets reference OFF, non-retentive.
Negated	-(/)-	ON OFF	Sets reference OFF, non-retentive. Sets reference ON, non-retentive.
Retentive	-(M)-	ON OFF	Sets reference ON, retentive. Sets reference OFF, retentive.
Negated Retentive	-(/M)-	ON OFF	Sets reference OFF, retentive. Sets reference ON, retentive.
Positive Transition	-(P)-	OFF□ON	If power flow into the coil was OFF the previous sweep and is ON this sweep, sets the coil ON.
Negative Transition	-(N)-	ON□OFF	If power flow into the coil was ON the previous sweep and is OFF this sweep, sets the coil ON.
SET	-(S)-	ON OFF	Sets reference ON until reset OFF by (R), non-retentive. Does not change the coil state, non-retentive.
RESET	-(R)-	ON OFF	Sets reference OFF until set ON by (S), non-retentive. Does not change the coil state, non-retentive.
Retentive SET	-(SM)-	ON OFF	Sets reference ON until reset OFF by (RM), retentive. Does not change the coil state.
Retentive RESET	-(RM)-	ON OFF	Sets reference OFF until set ON by (SM)-, retentive. Does not change the coil state.
Continuation Coil	----<+>	ON OFF	Sets next continuation contact ON. Sets next continuation contact OFF.

Relay Functions
Coils

A coil sets a discrete reference ON while it receives power flow. It is non-retentive; therefore, it cannot be used with system status references (%SA, %SB, %SC, or %G).

Example

In the example, coil E3 is ON when reference E1 is ON and reference E2 is OFF.

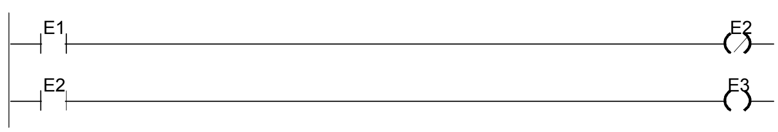


Negated Coil

A negated coil sets a discrete reference ON when it does not receive power flow. It is not retentive, so it cannot be used with system status references (%SA, %SB, %SC, or %G).

Example

In the example, coil E3 is ON when reference E1 is OFF.



Retentive Coil

Like a normally open coil, the retentive coil sets a discrete reference ON while it receives power flow. The state of the retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

Negated Retentive Coil

The negated retentive coil sets a discrete reference ON when it does not receive power flow. The state of the negated retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

Positive Transition Coil

If the reference associated with a positive transition coil was OFF , when the coil receives power flow it is set to ON until the next time the coil is executed. (If the rung containing the coil is skipped on subsequent sweeps, it will remain ON.) This coil can be used as a one-shot.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

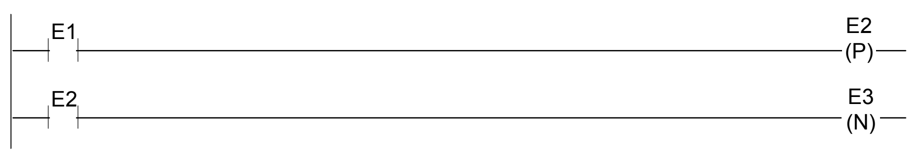
Negative Transition Coil

If the reference associated with this coil is OFF, when the coil stops receiving power flow the reference is set to ON until the next time the coil is executed.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

Example

In the example, when reference E1 goes from OFF to ON, coils E2 and E3 receive power flow, turning E2 ON for one logic sweep. When E2 goes from ON to OFF, power flow is removed from E2 and E3, turning coil E3 ON for one sweep.



Relay Functions
Coils

SET Coil

SET and RESET are non-retentive coils that can be used to keep ("latch") the state of a reference either ON or OFF. When a SET coil receives power flow, its reference stays ON (whether or not the coil itself receives power flow) until the reference is reset by another coil.

SET coils write an undefined result to the transition bit for the given reference.

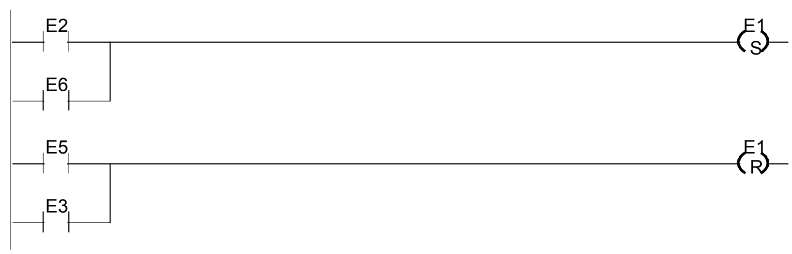
RESET Coil

The RESET coil sets a discrete reference OFF if the coil receives power flow. The reference remains OFF until the reference is set by another coil. The last-solved SET coil or RESET coil of a pair takes precedence.

RESET coils write an undefined result to the transition bit for the given reference.

Example

In the example, the coil represented by E1 is turned ON whenever reference E2 or E6 is ON. The coil represented by E1 is turned OFF whenever reference E5 or E3 is ON.



Retentive SET Coil

Retentive SET and RESET coils are similar to SET and RESET coils, but they are retained across power failure or when the PLC transitions from to Run mode. A retentive SET coil sets a discrete reference ON if the coil receives power flow. The reference remains ON until reset by a retentive RESET coil.

Retentive SET coils write an undefined result to the transition bit for the given reference.

Retentive RESET Coil

This coil sets a discrete reference OFF if it receives power flow. The reference remains OFF until set by a retentive SET coil. The state of this coil is retained across power failure or when the PLC transitions from Stop to Run mode.

Retentive RESET coils write an undefined result to the transition bit for the given reference.

Table Functions

The Table functions are used to:

- Copy array data: ARRAY MOVE
- Search for values in an array

The maximum length allowed for these functions is 32,767 for any type.

Data Types for the Table Functions

Table functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
BIT *	Bit data type
BYTE	Byte data type
WORD	Word data type

* Applies to Array Move only.

Table Functions
Array Move

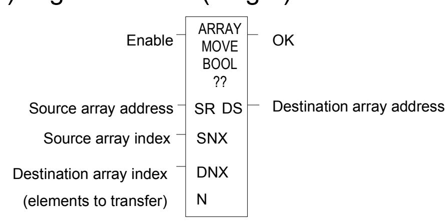
The Array Move function copies a specified number of elements from a source array to a destination array. When the function receives power flow, it copies the number of elements specified from the input array, starting at the indexed location. The function then writes the copied elements to the output array starting with the indexed location.

For bit data, when word-oriented memory is selected for the parameters of the source array and/or destination array starting address, the least significant bit of the specified word is the first bit of the array.

The indices in an Array Move instruction are 1-based. In using an Array Move, no element outside either the source or destination arrays (as specified by their starting address and length) may be referenced.

The OK output receives power flow unless one of the following occurs:

- Enable is OFF.
- (N + SNX – 1) is greater than (length).
- (N + DNX – 1) is greater than (length).

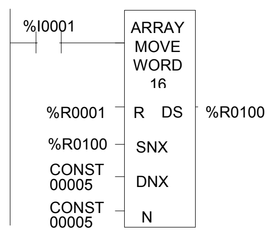


Parameters for the Array Move Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
SR	For all: R, AI, AQ For INT, BIT, BYTE, WORD: I, Q, M, T, G, For BIT, BYTE, WORD: SA, SB, SC	SR contains the starting address of the source array. For ARRAY_MOVE_ BIT, any reference may be used; it does not need to be byte aligned.
SNX	I, Q, M, T, G, R, AI, AQ, constant	SNX contains the index of the source array.
DNX	I, Q, M, T, G, R, AI, AQ, constant	DNX contains the index of the destination array.
N	I, Q, M, T, G, R, AI, AQ, constant	N provides a count indicator.
ok	flow, none	OK is energized whenever enable is energized.
DS	For all: SA, SB, SC, R, AI, AQ For INT, BIT, BYTE, WORD: I, Q, M, T, G	The starting address of the destination array. For ARRAY_MOVE_ BIT, any reference may be used; it does not need to be byte aligned.
length		The number of elements starting at SR and DS that make up each array. It is defined as the length of SR+DS.

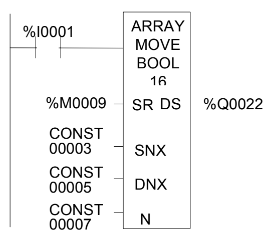
Example 1:

In this example, if %R100=3 then %R0003 - %R0007 of the array %R0001 - %R0016 is read and is written into %R0104 - %R0108 of the array %R0100 - %R0115. (%R001 and %R0100 are declared as type WORD of length 16.)



Example 2:

Using bit memory for SR and DS, %M0011 - %M0017 of the array %M0009 - %M0024 is read and then written to %Q0026 - %Q0032 of the array %Q0022 - %Q0037. (%M009 and %Q0022 are declared as type BOOL of length 16).



Example 3:

Using word memory, for SR and DS, the third least significant bit of %R0001 through the second least significant bit of %R0002 of the array containing all 16 bits of %R0001 and four bits of %R0002 is read and then written into the fifth least significant bit of %R0100 through the fourth least significant bit of %R0101 of the array containing all 16 bits of %R0100 and four bits of %R0101. 0001 and %R0100 are declared as type BOOL of length 20).

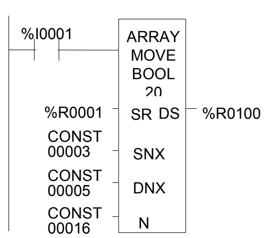
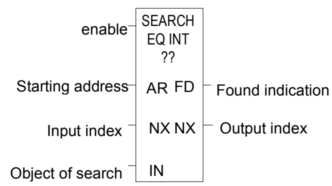


Table Functions
Search for Array Values

Use the Search functions listed below to search for values in an array.

▪ Search Equal	▪ Equal to a specified value.
▪ Search Not Equal	▪ Not equal to a specified value.
▪ Search Greater Than	▪ Greater than a specified value.
▪ Search Greater Than or Equal	▪ Greater than or equal to a specified value.
▪ Search Less Than	▪ Less than a specified value.
▪ Search Less Than or Equal	▪ Less than or equal to a specified value.

When the Search function receives power, it searches the specified array. Searching begins at the starting address (AR) plus the index value (NX).



The search continues until the array element of the search object (IN) is found or until the end of the array is reached. If an array element is found, the Found Indication (FD) is set ON and the Output Index (output NX) is set to the relative position of this element within the array. If no array element is found before the end of the array is reached, the Found Indication (FD) is set OFF and the Output Index (output NX) is set to zero.

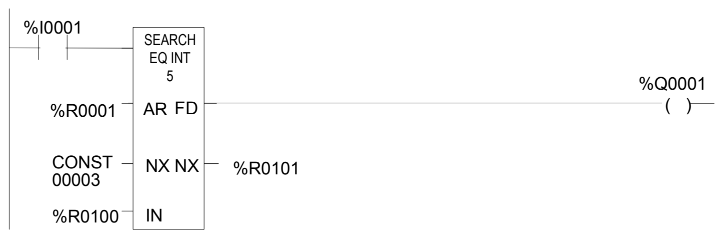
The valid values for input NX are 0 to (length –1). NX should be set to zero to begin searching at the first element. This value increments by one at the time of execution. The values of output NX are 1 to (length). If the value of input NX is out-of-range, (< 0 or ≥ length), its value is set to the default value of zero.

Parameters of the Search Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the search is performed.
AR	For all: R, AI, AQ For INT, BYTE, WORD: I, Q, M, T, G, For BYTE, WORD: S	Contains the starting address of the array.
Input NX	I, Q, M, T, G, R, AI, AQ, constant	Contains the zero-based index into the array at which to begin the search.
IN	For all: R, AI, AQ, constant For INT, BYTE, WORD: I, Q, M, T, G, For BYTE, WORD: S	IN contains the object of the search.
Output NX	I, Q, M, T, G, R, AI, AQ	Holds the one-based position within the array of the search target.
FD	flow, none	FD indicates that an array element has been found and the function was successful.
length	1 to 32,767 bytes or words.	The number of elements starting at AR that make up the array to be searched.

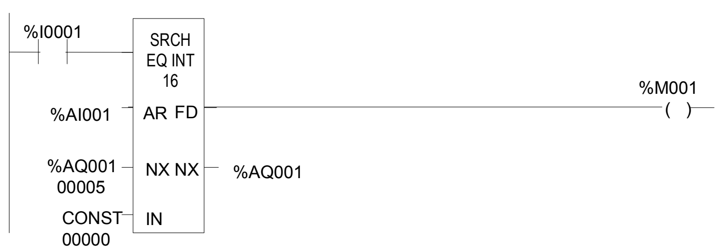
Example 1:

The array AR is defined as memory addresses %R0001 - %R0005. When EN is ON, the portion of the array between %R0004 and %R0005 is searched for an element whose value is equal to IN. If %R0001 = 7, %R0002 = 9, %R0003 = 6, %R0004 = 7, %R0005 = 7, and %R0100 = 7, then the search will begin at %R0004 and conclude at %R0004 when FD is set ON and a 4 is written to %R0101.



Example 2:

Array AR is defined as memory addresses %AI001 - %AI016. The values of the array elements are 100, 20, 0, 5, 90, 200, 0, 79, 102, 80, 24, 34, 987, 8, 0, and 500. Initially, %AQ001 is 5. When EN is ON, each sweep will search the array looking for a match to the IN value of 0. The first sweep will start searching at %AI006 and find a match at %AI007, so FD is ON and %AQ001 is 7. The second sweep will start searching at %AI008 and find a match at %AI015, so FD remains ON and %AQ001 is 15. The next sweep will start at %AI016. Since the end of the array is reached without a match, FD is set OFF and %AQ001 is set to zero. The next sweep will start searching at the beginning of the array.



Timer and Counter Functions

This section describes the timing and counting functions of the Instruction Set. The data associated with these functions is retentive through power cycles.

- On-Delay Stopwatch Timer
- Off-Delay Timer
- On-Delay Timer
- Up Counter
- Down Counter

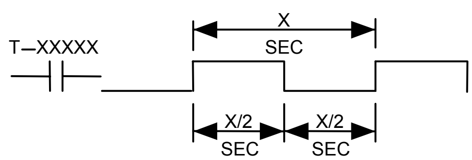
Time-Tick Contacts

In addition to the Timer functions of the Instruction Set, the VersaMax PLC has four time-tick contacts. These contacts can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T_10MS (0.01 second), T_100MS (0.1 second), T_SEC (1.0 second), and T_MIN (1 minute).

The following timing diagram represents the on/off time duration of these contacts.



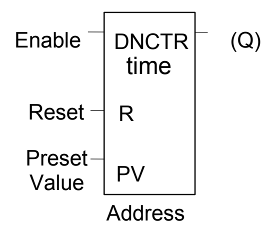
These time-tick contacts represent specific locations in %S memory.

Function Block Data Required for Timers and Counters

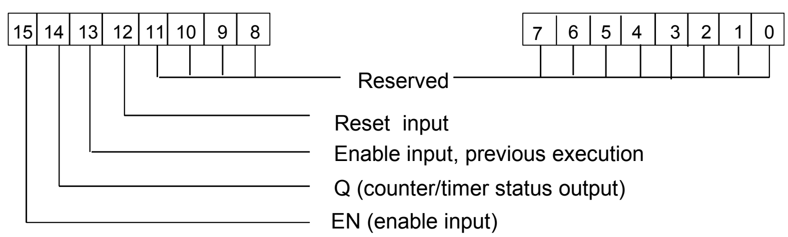
Each timer or counter uses three words (registers) of %R memory to store the following information:

current value (CV)	word 1
preset value (PV)	word 2
control word	word 3

When you enter a timer or counter, you must enter a beginning address for these three words (registers). Do not use consecutive registers for the 3 word timer/counter blocks. Timers and counters will not work if you place the current value of a block on top of the preset for the previous block.



The control word stores the state of the boolean inputs and outputs of its associated function block in the following format:



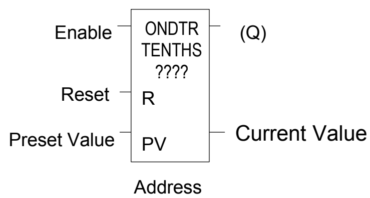
Bits 0 through 11 are used for timer accuracy; not for counters.

If the Preset Value (PV) is not a constant, PV is normally set to a different location than the second word. Some applications use the second word address for the PV, such as using %R0102 when the bottom data block starts at %R0101. It is then possible to change the Preset Value while the timer or counter is running. The first (CV) and third (Control) words can be read but should not be written, or the function will not work.

Timer and Counter Functions
On Delay Stopwatch Timer

A retentive On-Delay Stopwatch Timer (ONDTR) increments while it receives power flow and holds its value when power flow stops. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths (0.001) of a second. The range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.

When this function first receives power flow, it starts accumulating time (current value). When this timer is encountered in the ladder logic, its Current Value is updated.



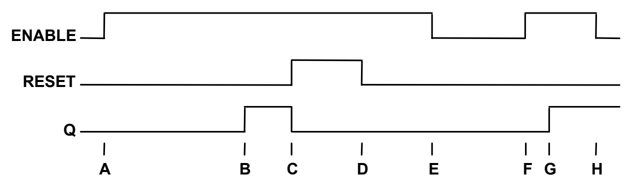
When the Current Value equals or exceeds the Preset Value PV, output Q is energized. As long as the timer continues to receive power flow, it continues accumulating until the maximum value is reached. Once the maximum value is reached, it is retained and output Q remains energized regardless of the state of the enable input.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the current values of the timers will be the same.

Parameters of the On Delay Stopwatch Timer Function

Input/ Output	*Choices*	*Description*
address	R	The function uses three consecutive words (registers) of %R memory to store the following: ▪ Current value (CV) =word 1. ▪ Preset value (PV) = word 2. ▪ Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic timer operation.
enable	flow	When enable receives power flow, the timer's Current Value increments.
R	flow	When R receives power flow, it resets the Current Value to zero.
PV	I ,Q, M, T, G, R, AI, AQ, constant, none	The Preset Value, which is used when the timer is enabled or reset.
Q	flow, none	Output Q is energized when the current value of the timer is greater than or equal to the Preset Value.
time	tenths, hundredths, or thousandths of seconds	Time increment for the low bit of the PV preset and CV current value.

Operation of the On Delay Timer Function



A.	ENABLE goes high; timer starts accumulating
B.	Current value reaches preset value PV; Q goes high
C.	RESET goes high; Q goes low, accumulated time is reset (CV=0)
D.	RESET goes low; timer then starts accumulating again
E.	ENABLE goes low; timer stops accumulating. Whatever time has been accumulated remains. Step F: When ever enable input is high again timer starts accumulating from the earlier accumulated value.
F.	ENABLE goes high again; timer starts accumulating time from the earlier accumulated value.
G.	Current value becomes equal to preset value PV; Q goes high. Timer continues to accumulate time until ENABLE goes low, RESET goes high or current value becomes equal to the maximum time
H.	ENABLE goes low; timer stops accumulating time.

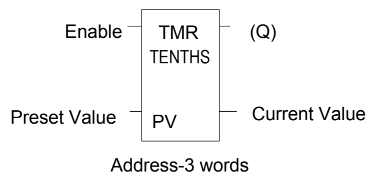
When power flow to the timer stops, the current value stops incrementing and is retained. Output Q, if energized, will remain energized. When the function receives power flow again, the current value again increments, beginning at the retained value. When reset R receives power flow, the current value is set back to zero and output Q is de-energized unless PV equals zero.

Example

In the example, a retentive on-delay timer is used to create a signal (%Q0011) that turns on 8.0 seconds after %Q0010 turns on, and turns off when %Q0010 turns off.

Timer and Counter Functions
On Delay Timer

The On-Delay Timer (TMR) increments while it receives power flow and resets to zero when power flow stops. Time may be counted in tenths of a second (the default selection), hundredths of a second, or thousandths of a second. The range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.



When the On Delay Timer function receives power flow, the timer starts accumulating time (Current Value). The Current Value is updated when it is encountered in the logic to reflect the total elapsed time the timer has been enabled since it was last reset.

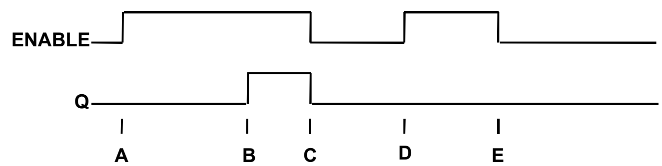
If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the Current Values of the timers will be the same.

This update occurs as long as the enabling logic remains ON. When the current value equals or exceeds the Preset Value PV, the function begins passing power flow to the right. The timer continues accumulating time until the maximum value is reached. When the enabling parameter transitions from ON to OFF, the timer stops accumulating time and the Current Value is reset to zero.

Parameters for the On Delay Timer Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic operation of the timer.
enable	flow	When enable receives power flow, the timer's current value is incremented. When the TMR is not enabled, the current value is reset to zero and Q is turned off.
PV	I Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the timer's preset value when the timer is enabled or reset.
Q	flow, none	Output Q is energized when TMR is enabled and the current value is greater than or equal to the preset value.
time	tenths (0.1), hundredths (0.01), or thousandths (0.001) of seconds	Time increment for the low bit of the PV preset and CV current value.

Operation of the On-Delay Timer Function



A. ENABLE goes high; timer begins accumulating time.

B. Current value reaches preset value PV; Q goes high, and timer continues accumulating time.

C. ENABLE goes low; Q goes low; timer stops accumulating time and current time is cleared.

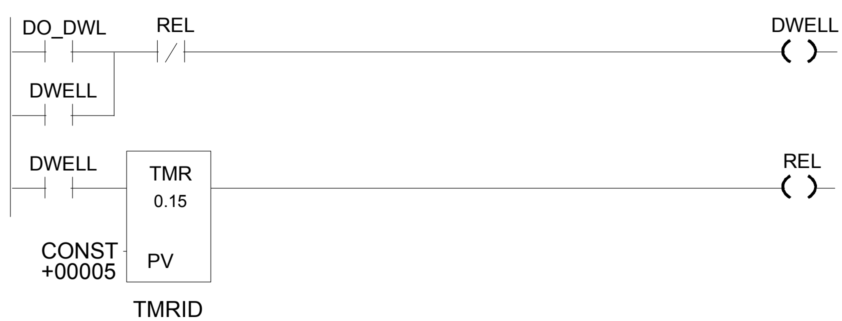
D. ENABLE goes high; timer starts accumulating time.

E. ENABLE goes low before current value reaches preset value PV; Q remains low; timer stops accumulating time and is cleared to zero (CV=0).

Example

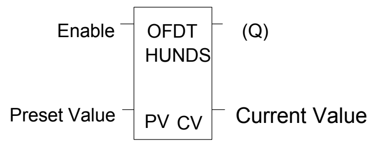
In the example, a delay timer (with address) TMRID is used to control the length of time that coil is on. This coil has been assigned the Nickname DWELL . When the normally open (momentary) contact with the Nickname DO_DWL is on, coil DWELL is energized.

The contact of coil DWELL keeps coil DWELL energized (when contact DO_DWL is released), and also starts the timer TMRID. When TMRID reaches its preset value of one-half second, coil REL energizes, interrupting the latched-on condition of coil DWELL. The contact DWELL interrupts power flow to TMRID, resetting its current value and de-energizing coil REL. The circuit is then ready for another momentary activation of contact DO_DWL.



Timer and Counter Functions
Off Delay Timer

The Off-Delay Timer increments while power flow is off, and resets to zero when power flow is on. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths of a second (0.001). The range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.



Address-3 words

When the Off-Delay Timer first receives power flow, it passes power to the right, and the Current Value (CV) is set to zero. The function uses word 1 as its CV storage location. The output remains on as long as the function receives power flow. If the function stops receiving power flow from the left, it continues to pass power to the right, and the timer starts accumulating time in the Current Value.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the Current Values of the timers will be the same.

The Off-Delay Timer does not pass power flow if the Preset Value is zero or negative.

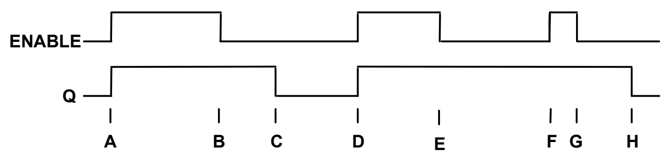
Each time the function is invoked with the enabling logic set to OFF, the Current Value is updated to reflect the elapsed time since the timer was turned off. When the Current Value (CV) is equal to the Preset Value (PV), the function stops passing power flow to the right. When that occurs, the timer stops accumulating. When the function receives power flow again, the current value resets to zero.

When the Off-Delay Timer is used in a program block that is *not* called every sweep, the timer accumulates time between calls to the program block unless it is reset. This means that it functions like a timer operating in a program with a much slower sweep than the timer in the main program block. For program blocks that are inactive for a long time, the timer should be programmed to allow for this catch-up feature. For example, if a timer in a program block is reset and the program block is not called (is inactive) for four minutes, when the program block is called, four minutes of time will already have accumulated. This time is applied to the timer when enabled, unless the timer is first reset.

Example

In the example, an Off-Delay Timer is used to turn off an output (%Q00001) whenever an input (%I00001) turns on. The output is turned on again 0.3 seconds after the input goes off.

Operation of the Off-Delay Timer Function



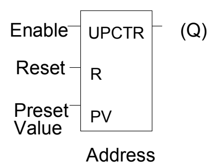
A. ENABLE and Q both go high; timer is reset (CV = 0).
B. ENABLE goes low; timer starts accumulating time.
C. CV reaches PV; Q goes low, and timer stops accumulating time.
D. ENABLE goes high; timer is reset (CV = 0).
E. ENABLE goes low; timer starts accumulating time.
F. ENABLE goes high; timer is reset (CV = 0).
G. ENABLE goes low; timer begins accumulating time.
H. CV reaches PV; Q goes low, and timer stops accumulating time.

Parameters of the Off-Delay Timer Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic operation of the timer.
enable	flow	When enable receives power flow, the timer's current value is reset to 0.
PV	I Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the timer's preset value when the timer is enabled or reset. For a register (%R) OV reference, the PV parameter is specified as the second word of the address parameter. For example, an address parameter of %R0001 would use %R0002 as the PV parameter.
Q	flow, none	Output Q is energized when the current value is less than the preset value. The Q state is retentive on power failure; no automatic initialization occurs at power-up.
time	tenths, hundredths, or thousandths of seconds	Time increment for the low bit of the PV preset and CV current value.

Timer and Counter Functions
Up Counter

The Up Counter function counts up to a designated value. The range is 0 to +32,767 counts. When the Up Counter reset is ON, the Current Value of the counter resets to 0. Each time the enable input transitions from OFF to ON, the Current Value increments by 1. The current value can be incremented past the Preset Value PV. The output is ON whenever the Current Value is greater than or equal to the Preset Value. The state of the CTU is retentive on power failure; no automatic initialization occurs at power-up.



Parameters of the Up Counter Function

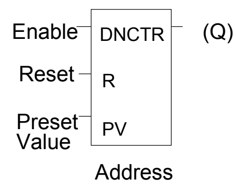
Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with another up counter, down counter, or any other instruction or improper operation will result. **Careful:** Overlapping references cause erratic operation of the counter.
enable	flow	On a positive transition of enable, the current count is incremented by one.
R	flow	When R receives power flow, it resets the current value back to zero.
PV	I, Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the counter's preset value when the counter is enabled or reset.
Q	flow, none	Output Q is energized when the Current Value is greater than or equal to the Preset Value.

Example of the Up Counter Function

In the example, every time input %I0012 transitions from OFF to ON, up counter PRT_CNT counts up by 1; internal coil %M0001 is energized when 100 parts have been counted. When %M0001 is ON, the accumulated count is reset to zero.

The Down Counter function counts down from a preset value. The minimum Preset Value is zero; the maximum present value is +32,767 counts. The minimum Current Value is –32,768. When reset, the Current Value of the counter is set to the Preset Value PV. When the enable input transitions from OFF to ON, the Current Value is decremented by one. The output is ON whenever the Current Value is less than or equal to zero.

The Current Value of the Down Counter is retentive on power failure; no automatic initialization occurs at power-up.



Parameters of the Down Counter Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with another down counter, up counter, or any other instruction or improper operation will result. **Careful:** Overlapping references will result in erratic counter operation.
enable	flow	On a positive transition of enable, the Current Value is decremented by one.
R	flow	When R receives power flow, it resets the Current Value to the Preset Value.
PV	I, Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the counter's Preset Value when the counter is enabled or reset.
Q	flow, none	Output Q is energized when the Current Value is less than or equal to zero.

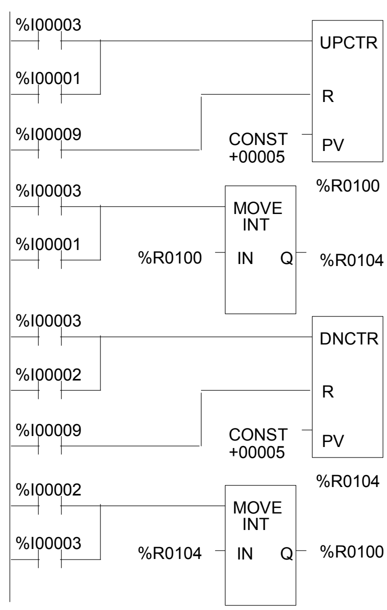
Timer and Counter Functions
Down Counter

Example 1

In the example, the down counter identified as COUNTP counts 500 new parts before energizing output %Q0005.

Example 2

The following example shows how the PLC can keep track of the number of parts in a temporary storage area. It uses an up/down counter pair with a shared register for the accumulated or current value. When parts enter the storage area, the up counter increases the current value of the parts in storage by 1. When a part leaves the storage area, the down counter decrements by 1, decreasing the inventory storage value by 1. The two counters use different register addresses. When a register counts, its current value must be moved to the current value register of the other counter.



See the pages on Math functions for an example of using the Addition and Subtraction functions to provide storage tracking.

Chapter 18

The Service Request Function

This chapter explains the Service Request (SVCREQ) function, which requests a special PLC service. It describes SVCREQ parameters for the VersaMax Nano PLC and Micro PLC.

- SVCREQ Function Numbers
- Format of the SVCREQ Function
- SVCREQ 1: Change/Read Constant Sweep Timer
- SVCREQ 2: Read Window Times
- SVCREQ 3: Change Programmer Communications Window Mode
- SVCREQ 4: Change System Communications Window Mode
- SVCREQ 6: Change/Read Number of Words to Checksum
- SVCREQ 7: Read or Change the Time-of-Day Clock
- SVCREQ 8: Reset Watchdog Timer
- SVCREQ 9: Read Sweep Time from Beginning of Sweep
- SVCREQ 10: Read Folder Name
- SVCREQ 11: Read PLC ID
- SVCREQ 13: Shut Down (Stop) PLC
- SVCREQ 14: Clear Fault
- SVCREQ 15: Read Last-Logged Fault Table Entry
- SVCREQ 16: Read Elapsed Time Clock
- SVCREQ 18: Read I/O Override Status
- SVCREQ 23: Read Master Checksum
- SVCREQ 26/30: Interrogate I/O
- SVCREQ 34: Enter Analog Calibration Mode
- SVCREQ 35: Execute Analog Calibration
- SVCREQ 52: Read from Flash
- SVCREQ 53: Write to Flash

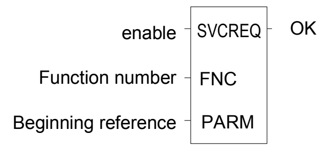
SVCREQ Function Numbers

Each Service Request has its own function number, as listed in the following table.

Function #	Description
1	Change/Read Constant Sweep Timer
2	Read Window Times
3	Change Programmer Communications Window Mode and Time
4	Change System Communications Window Mode and Time
5	reserved
6	Change/Read Number of Words to Checksum
7	Change/Read Time-of-Day Clock
8	Reset Watchdog Timer
9	Read Sweep Time from Beginning of Sweep
10	Read Folder Name
11	Read PLC ID
12	reserved
13	Shut Down the PLC
14	Clear Fault Tables
15	Read Last-Logged Fault Table Entry
16	Read Elapsed Time Clock
17	reserved
18	Read I/O Override Status
19-22	reserved
23	Read Master Checksum
26/30	Interrogate I/O
27, 28	reserved
29	Read Elapsed Power Down Time
31-33	reserved
34	Enter Analog Calibration mode
35	Execute Analog Calibration
36-51	reserved
52	Read from Flash
53	Write to Flash
53-255	reserved

Format of the SVCREQ Function

The SVCREQ function has three inputs and one output.



When the SVCREQ receives power flow, the PLC is requested to perform the function number (FNC) indicated. Parameters for the function are located beginning at the reference given for PARM. This is the beginning of the “parameter block" for the function. The number of 16-bit references required depends on the SVCREQ function being used.

Parameter blocks may be used as both inputs for the function and the location where data may be output after the function executes. Therefore, data returned by the function is accessed at the same location specified for PARM.

The SVCREQ function passes power flow unless an incorrect function number, incorrect parameters, or out-of-range references are specified. Specific SVCREQ functions have additional causes for failure.

Parameters of the SVCREQ Function

Input/ Output	*Choices*	*Description*
enable	flow	When enable is energized, the service request is performed.
FNC	I, Q M, T, G, R, AI, AQ, constant	Contains the constant or reference for the requested service.
PARM	I, Q M, T, G, R, AI, AQ	Contains the beginning reference for the parameter block for the requested service.
ok	flow, none	OK is energized when the function is performed without error.

Example of the SVCREQ Function

In the example, when the enabling input %I0001 is ON, SVCREQ function number 7 is called, with the parameter block located starting at %R0001. Output coil %Q0001 is set ON if the operation succeeds.

SVCREQ 1: Change/Read Constant Sweep Timer

Use SVCREQ 1 to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

Input Parameter Block for SCVREQ 1

For this function, the parameter block has a length of two words.

Disable Constant Sweep Mode

To disable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

address	0
address + 1	ignored

Enable Constant Sweep Mode

To enable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

address	1
address + 1	0 or timer value

Note: If the timer should use a new value, enter it in the second word. If the timer value should not be changed, enter 0 in the second word. If the timer value does not already exist, entering 0 causes the function to set the OK output to OFF.

Change the Constant Sweep Time

To change the timer value **without** changing the selection for sweep mode state, enter SVCREQ function #1 with this parameter block:

address	2
address + 1	new timer value

Read the Constant Sweep State and Time

To read the current timer state and value without changing either, enter SVCREQ function #1 with this parameter block:

address	3
address + 1	ignored

Successful execution will occur, unless:

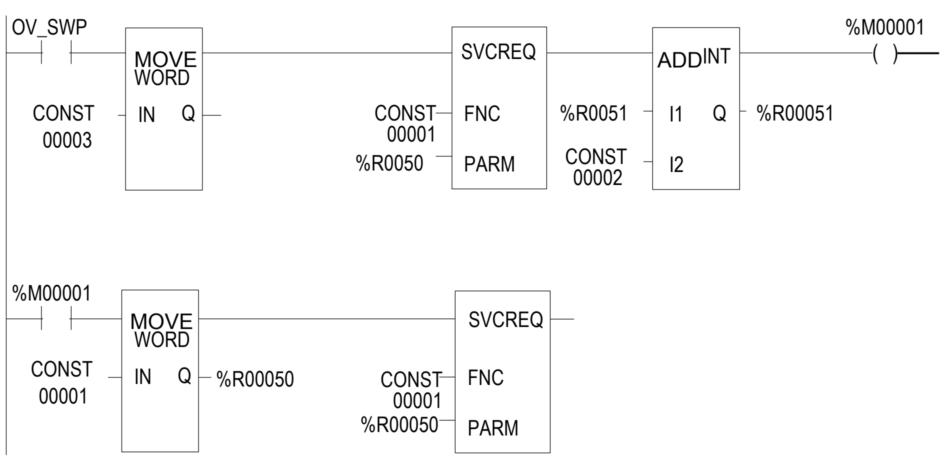
1. A number other than 0, 1, 2, or 3 is entered as the requested operation:
2. The sweep time value is greater than 500ms (0.5 seconds).
3. Constant sweep time is enabled with no timer value programmed or with an old value of 0 for the timer.

After the function executes, the function returns the timer state and value in the same parameter block references:

	0 = disabled
address	1 = enabled
address + 1	current timer value

Example of SVCREQ 1

In this example, if contact OV_SWP is set, the Constant SweepTimer is read, the timer is increased by two milliseconds, and the new timer value is provided to the CPU. The parameter block is in local memory at location %R0050. Because the MOVE and ADD functions require three horizontal contact positions, the example logic uses discrete internal coil %M00001 as a temporary location to hold the successful result of the first rung line. On any sweep in which OV_SWP is not set, %M00001 is turned off.



SVCREQ 2: Read Window Times

SVCREQ 2 can be used to read the times of the programmer communications window and the system communications window. These windows can operate in Limited or Run to Completion Mode.

Mode Name	Value	Description
Limited Mode	0	The execution time of the window is limited to 6ms. The window terminates when it has no more tasks to complete or after 6ms elapses.
Run to Completion Mode	2	Regardless of the time assigned to a window, it runs until all tasks within that window are completed (up to 400ms).

A window is disabled when the time value is zero.

Output Parameter Block for SVCREQ 2

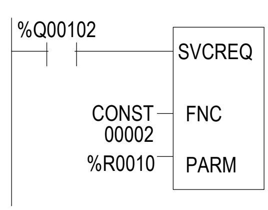
The parameter block has a length of three words:

	High Byte	Low Byte	
address	Mode	Value in ms	Programmer Window
address + 1	Mode	Value in ms	System Communications Window
address + 2	must be zero	must be zero	reserved

All parameters are output parameters. It is not necessary to enter values in the parameter block to program this function.

Example of SVCREQ 2

In the following example, when enabling output %Q00102 is set, the Micro PLC CPU places the current time values of the windows in the parameter block starting at location %R0010.



SVCREQ 3: Change Programmer Communications Window Mode

Use SVCREQ 3 to change the programmer communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 3 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

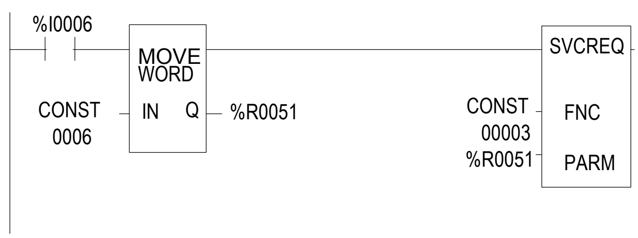
Changing the Programmer Communications Window Mode

To change the programmer window, enter SVCREQ 3 with this parameter block:

	High Byte	Low Byte
address	Mode	6

Example of SVCREQ 3

In the following example, when enabling input %I006 goes ON, the programmer communications window is enabled and assigned a value of 6ms. The parameter block is in reference memory location %R0051.



SVCREQ 4: Change System Communications Window Mode

Use SVCREQ 4 to change the system communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 4 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

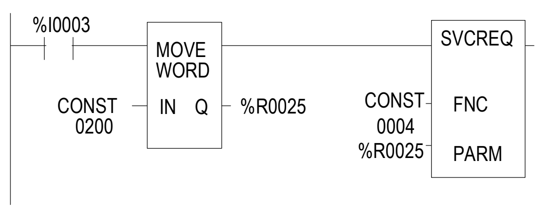
Changing the System Communications Window Mode

To change the programmer window, enter SVCREQ 4 with this parameter block:

	High Byte	Low Byte
address	Mode	6

Example of SVCREQ 4

In the following example, when enabling input %I0003 is ON the system communications window is changed to Run-to-Completion mode. The parameter block is at location %R0025.



SVCREQ 6: Change/Read Number of Words to Checksum

Use SVCREQ 6 to read or change the number of words in the program to be checksummed. The function is successful unless some number other than 0 or 1 is entered as the requested operation.

Parameter Block Formats for SVCREQ 6

The parameter block has a length of 2 words. To read the word count, the first word of the parameter block must contain a zero:

address	0 (read word count)
address + 1	ignored

The function returns the current word count in the second word of the parameter block.

address	0
address + 1	current word count

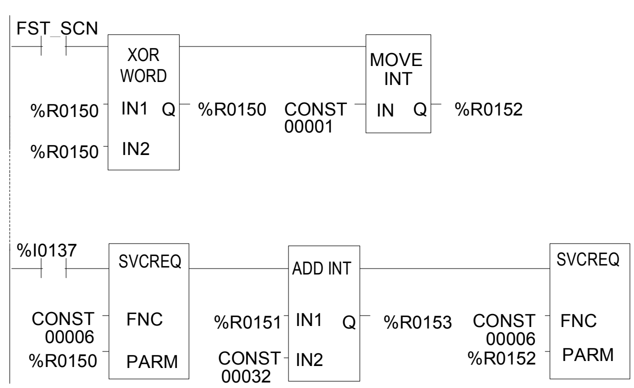
To change the word count, the first word of the parameter block must contain a one:

address	1 (change word count)
address + 1	new word count (0 to 32)

The PLC will change the number of words to be checksummed to the new value.

Example of SVCREQ 6

In the example, when enabling contact FST_SCN is set, the parameter blocks for the checksum function are built. Later in the program, if input %I0137 turns on, the SVCREQ reads the number of words being checksummed. The parameter block for the Read function is located at %R0150-151. The ADD function adds 32 to the current word count in %R0151 and places the result in %R0153. The parameter block for the Change function is located at %R00152-153. The second SVCREQ then changes to the new word count specified in %R0153.



SVCREQ 7: Read or Change the Time-of-Day Clock

Use SVCREQ 7 to read or change the time of day clock in the PLC. The data can be either BCD or ASCII. Either 2-digit-year or 4-digit-year format is available. The function is successful unless some number other than 0 (read) or 1 (change) is entered for the requested operation, or an invalid data format is specified, or data is provided in an unexpected format.

Parameter Block Format for SVCREQ 7

For the date/time functions, the length of the parameter block depends on the data format. The data block is either BCD or ASCII. BCD format requires 6 words; packed ASCII requires 12 words (13 words for 4-digit year). For both data types:

- Hours are stored in 24-hour format.
- Day of the week is a numeric value from 1 (Sunday) to 7 (Saturday).

	2-Digit Year Format	**4-Digit Year Format**
address	0 = read time and date 1 = set time and date	0 = read time and date 1 = set time and date
address + 1	1 = BCD format 3 = packed ASCII format	81h = BCD format 83h = packed ASCII format
address + 2 to end	data	data

Words 3 to the end of the parameter block contain output data returned by a read function, or new data being supplied by a change function. In both cases, format of these data words is the same. When reading the date and time, words (address + 2) to the end of the parameter block are ignored on input.

SVCREQ 7 Parameter Block Content: BCD Format

In BCD format, each time and date item occupies one byte, so the parameter block has six words.

2-Digit Year

The last byte of the sixth word is not used. When setting the date and time, this byte is ignored; when reading date and time, the function returns 00.

Parameter Block Format: High Byte: / Low Byte

Example: Read Date and Time in BCD format (Sun., July 3, 1998, at 2:45:30 p.m.)

High Byte	Low Byte			
1 = change or 0 = read		address	0 (read)	
1 (BCD format)		address + 1	1 (BCD format)	
month	year	address + 2	07 (July)	98 (year)
hours	day of month	address + 3	14 (hours)	03 (day)
seconds	minutes	address + 4	30 (seconds)	45 (minutes)
(null)	day of week	address + 5	00	06 (Friday)

4-Digit Year

The parameter block has six words. All bytes are used.

Parameter Block Format: High Byte: / Low Byte

Example: Read Date and Time in BCD format (Sun., July 3, 1998, at 2:45:30 p.m.)

High Byte	Low Byte			
1 = change or 0 = read		address	00	00 (read)
81h (BCD format, 4-digit)		address + 1	00	81h (BCD, 4-digit)
year	year	address + 2	19 (year)	98 (year)
day of month	month	address + 3	03 (day)	07 (July)
minutes	hours	address + 4	45 (minutes)	14 (hours)
day of week	seconds	address + 5	06 (Friday)	30 (seconds)

SVCREQ 7 Parameter Block Content: Packed ASCII Format

In Packed ASCII format, each digit of the time and date items is an ASCII formatted byte. Spaces and colons are embedded into the data to format it for printing or display. ASCII format requires 12 words in the parameter block (13 words for 4-digit year).

2-Digit Year

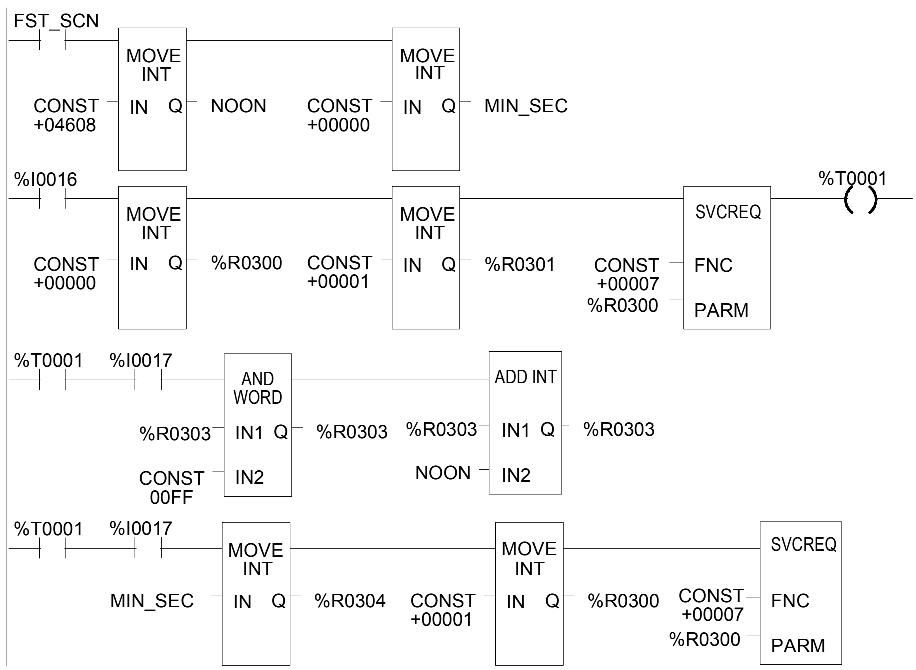
Parameter Block Format: High Byte	Low Byte		Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)	
1 = change or 0 = read		address	0 (read)	
3 (ASCII format)		address + 1	3 (ASCII format)	
year	year	address + 2	38 (8)	39 (9)
month	(space)	address + 3	31 (1)	20 (space)
(space)	month	address + 4	20 (space)	30 (0)
day of month	day of month	address + 5	35 (5)	30 (leading 0)
hours	(space)	address + 6	31 (1)	20 (space)
:	hours	address + 7	3A (:)	31 (1)
minutes	minutes	address + 8	33 (3)	31 (1)
seconds	:	address + 9	30 (0)	3A (:)
(space)	seconds	address + 10	20 (space)	30 (0)
day of week	day of week	address + 11	32 (2: Mon.)	30 (leading 0)

4-Digit Year

Parameter Block Format: High Byte	Low Byte		Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)	
1 = change or 0 = read		address	0 (read)	
83h (ASCII 4 digit)		address + 1	83h (ASCII 4 digit)	
year (hundreds)	year (thousands)	address + 2	39 (9)	31 (1)
year (ones)	year (tens)	address + 3	38 (8)	39 (9)
month (tens)	(space)	address + 4	31 (1)	20 (space)
(space)	month (ones)	address + 5	20 (space)	30 (0)
day of month (ones)	day of month (tens)	address + 6	35 (5)	30 (leading 0)
hours (tens)	(space)	address + 7	31 (1)	20 (space)
: (colon)	hours (ones)	address + 8	3A (:)	31 (1)
minutes (ones)	minutes (tens)	address + 9	33 (3)	31 (1)
seconds (tens)	: (colon)	address + 10	30 (0)	3A (:)
(space)	seconds (ones)	address + 11	20 (space)	30 (0)
day of week (ones)	day of week (tens)	address + 12	32 (2: Mon.)	30 (leading 0)

Example of SVCREQ 7

In the example, when called for by previous logic, a parameter block for the time-of-day clock is built. It requests the current date and time, then sets the clock to 12 noon using BCD format. The parameter block is located at location %R0300. Array NOON has been set up elsewhere in the program to contain the values 12, 0, and 0. (Array NOON must also contain the data at %R0300.) BCD format requires six contiguous memory locations for the parameter block.



SVCREQ 8: Reset Watchdog Timer

Use SVCREQ 8 to reset the watchdog timer during the sweep. Ordinarily, when the watchdog timer expires the PLC shuts down without warning. SVCREQ 8 allows the timer to keep going during a time-consuming task (for example, while waiting for a response from a communications line).

Caution

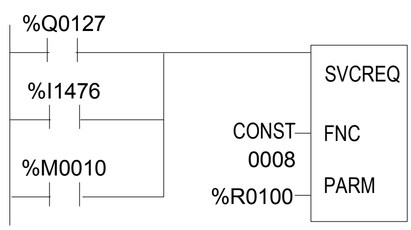
Be sure that resetting the watchdog timer does not adversely affect the controlled process.

Parameter Block Format for SVCREQ 8

This function has no associated parameter block.

Example of SVCREQ 8

In this example, power flow through enabling output %Q0027 or input %I1476 or internal coil %M00010 causes the watchdog timer to be reset.



SVCREQ 9: Read Sweep Time from Beginning of Sweep

Use SVCREQ 9 to read the time in milliseconds since the start of the sweep. The data format is unsigned 16-bit integer.

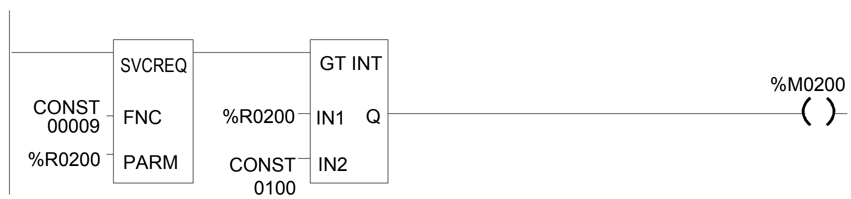
Output Parameter Block Format for SVCREQ 9

The parameter block is an output parameter block only; it has a length of one word.

address	time since start of sweep

Example of SVCREQ 9

In the following example, the elapsed time from the start of the sweep is always read into location %R0200. If it is greater than 100ms, internal coil %M0200 is turned on.



SVCREQ 10: Read Folder Name

Use SVCREQ 10 to read the name of the currently-executing folder.

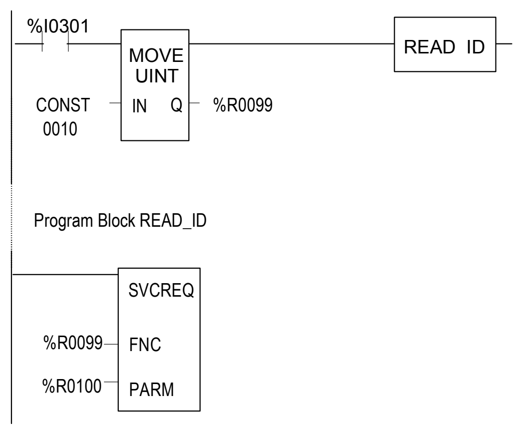
Output Parameter Block Format for SVCREQ 10

The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the program name has fewer than seven characters, null characters are added to the end.

	Low Byte	High Byte
address	character 1	character 2
address + 1	character 3	character 4
address + 2	character 5	character 6
address + 3	character 7	00

Example of SVCREQ 10

In this example, when enabling input %I0301 goes OFF, register location %R0099 is loaded with the value 10, which is the function code for the Read Folder Name function. The Program Block READ_ID is then called to retrieve the folder name. The parameter block is located at address %R0100.



SVCREQ 11: Read PLC ID

Use SVCREQ 11 to read the name of the PLC executing the program.

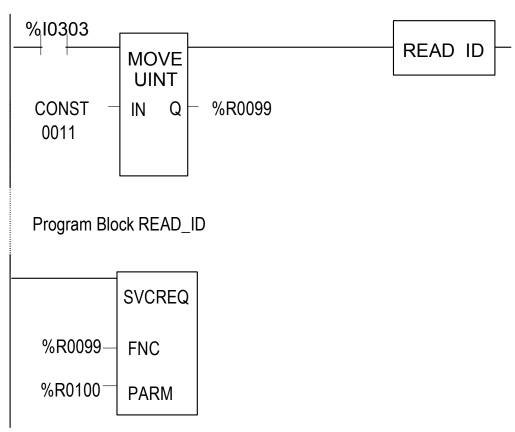
Output Parameter Block Format for SVCREQ 11

The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the PLC ID has fewer than seven characters, null characters are added to the end.

	Low Byte	High Byte
address	character 1	character 2
address + 1	character 3	character 4
address + 2	character 5	character 6
address + 3	character 7	00

Example of SVCREQ 11

In this example, when enabling input %I0302 goes OFF, register location %R0099 is loaded with the value 11, which is the function code for the Read PLC ID function. The program block READ_ID is then called to retrieve the ID. The parameter block is located at address %R0100.



SVCREQ 13: Shut Down (Stop) PLC

Use SVCREQ 13 to stop the Micro PLC *at the end of the next sweep*. All outputs go to the OFF state at the start of the next PLC sweep. An informational "Shut Down PLC" fault is placed in the PLC Fault Table. The I/O scan continues as configured.

Parameter Block for SVCREQ 13

This function has no parameter block.

Example of SVCREQ 13

In the example, when %T0001 is set SVCREQ 13 executes. The PARM input is not used.

This example uses a JUMP to the end of the program to force a shutdown if the Shutdown PLC function executes successfully. This JUMP and LABEL are needed because the transition to Stop mode does not occur until the end of the sweep in which the function executes.

SVCREQ 14: Clear Fault

Use SVCREQ 14 to clear either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation.

Input Parameter Block for SVCREQ 14

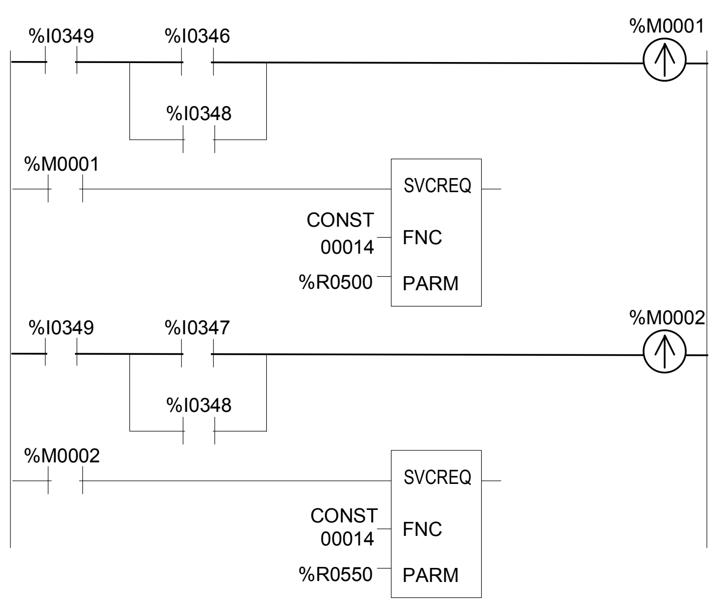
For this function, the parameter block has a length of 1 word. It is an input parameter block only. There is no output parameter block.

0 = clear PLC fault table.
1 = clear I/O fault table.

Example of SVCREQ 14

In the example, when input %I0346 is on and input %I0349 is on, the PLC fault table is cleared. When input %I0347 is on and input %I0349 is on, the I/O fault table is cleared. When input %I0348 is on and input %I0349 is on, both are cleared. A positive transition coil should be used to trigger SVCREQ14.

The parameter block for the PLC fault table is located at %R0500; for the I/O fault table the parameter block is located at %R0550. Both parameter blocks are set up elsewhere in the program.



SVCREQ 15: Read Last-Logged Fault Table Entry

Use SVCREQ 15 to read the last entry logged in either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation or the fault table is empty.

Input Parameter Block for SVCREQ 15

For this function, the parameter block has a length of 22 words. The input parameter block has this format:

	2-Digit Year Format	4-Digit Year Format
address	0 = Read PLC fault table. 1 = Read I/O fault table.	8 = Read PLC fault table. 9 = Read I/O fault table.

The format of the output parameter block depends on whether the function reads data from the PLC fault table or the I/O fault table.

PLC Fault Table Output Format: High Byte	PLC Fault Table Output Format: Low Byte		I/O Fault Table Output Format: High Byte	I/O Fault Table Output Format: Low Byte
0			1	
spare	long/short	address + 1	memory type	long/short
spare	spare	address + 2		offset
slot	rack	address + 3	slot	rack
	task	address + 4	block	bus
fault action	fault group	address + 5		point
	error code	address + 6	fault action	fault group
	fault specific data	address + 7	fault type	fault category
		address + 8 to address + 18	fault specific data	fault description
minutes	seconds	address + 19	minutes	seconds
day of month	hour	address + 20	day of month	hour

2-Digit Year Format

High Byte	Low Byte		High Byte	Low Byte
year	month	address + 21	year	month

or

4-Digit Year Format

High Byte	Low Byte		High Byte	Low Byte
spare	month	address + 21	spare	month
year		address + 22	year	

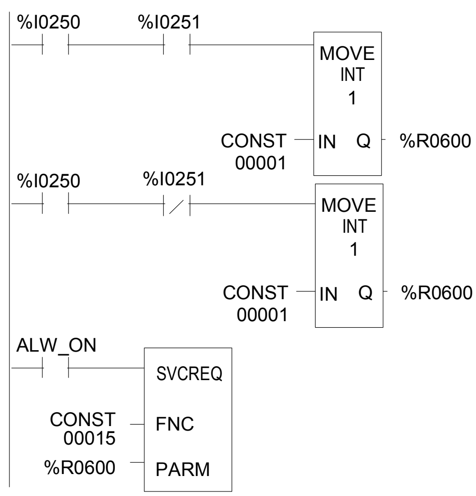
Long/Short Value

The first byte of word address +1 contains a number that indicates the length of the fault-specific data in the fault entry. These possible values are:

PLC fault table	00 = 8 bytes (short) 01 = 24 bytes (long)
I/O fault table	02 = 5 bytes (short) 03 = 21 bytes (long)

Example of SVCREQ 15

When inputs %I0250 and %I0251 are both on, the first Move function places a zero (read PLC fault table) into the parameter block for SVCREQ 15. When input %I0250 is on and input %I0251 is off, the Move instruction instead places a one (read I/O fault table) in the SVCREQ parameter block. The parameter block is located at location %R0600.



SVCREQ 16: Read Elapsed Time Clock

Use SVCREQ 16 to read the system's elapsed time clock. The elapsed time clock measures the time in seconds since the Micro PLC was powered on.

Output Parameter Block for SVCREQ 16

This function has an output parameter block only. Its length is 3 words.

address	seconds from power on (low order)
address + 1	seconds from power on (high order)
address + 2	100 microsecond ticks

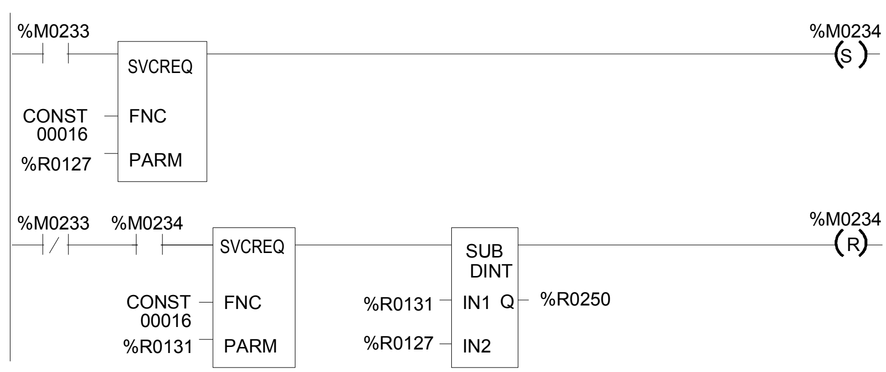
The first two words are the elapsed time in seconds. The last word is the number of 100 microsecond ticks in the current second.

Example of SVCREQ 16

In the example, when internal coil %M0233 is on, the SVCREQ with a parameter block located at %R0127 reads the system's elapsed time clock and sets internal coil %M0234. When coil %M0233 is off, the SVCREQ with a parameter block at %R0131 reads the elapsed time clock again.

The subtraction function finds the difference between the first and second readings, which have been stored in the SVCREQ parameter blocks. The subtraction ignores the hundred microsecond ticks.

The difference between the two readings is placed in memory location %R0250.



SVCREQ 18: Read I/O Override Status

Use SVCREQ 18 to check for any overrides in the Micro PLC 's %I and %Q memories.

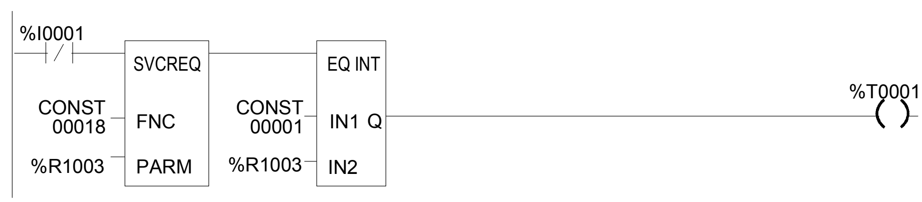
Output Parameter Block for SVCREQ 18

This function has an output parameter block only. Its length is 1 word.

address	0 = No overrides are set. 1 = Overrides are set.

Example of SVCREQ 18

The following SVCREQ reads the status of I/O overrides memory into location %R1003. The equality function checks %R1003 to see if it is equal to (the constant) 1. If it is, the equality function turns on output %T0001.



SVCREQ 23: Read Master Checksum

Use SVCREQ 23 to read the master checksums of the application program and the configuration. The SVCREQ output is always ON if the function is enabled.

Output Parameter Block for SVCREQ 23

For this function, the output parameter block has a length of 12 words with this format:

The first two items in the output parameter block indicate when the program and configuration checksums are valid. (Program checksums may not be valid during a Run Mode Store.)

address	Master Program Checksum Valid (0 = not valid, 1 = valid)
address + 1	Master Configuration Checksum Valid (0 = not valid, 1 = valid)
address + 2	Number of Program Blocks (including _MAIN)
address + 3	Size of User Program in Bytes (DWORD data type)
address + 5	Program Additive Checksum
address + 6	Program CRC Checksum (DWORD data type)
address + 8	Size of Configuration Data in Bytes
address + 9	Configuration Additive Checksum
address + 10	Configuration CRC Checksum (DWORD data type)

Example of SVCREQ 23

In the example, when input %I0251 is ON, the master checksum information is placed into the parameter block at %R0050 and the output coil (%Q0001) is turned on.

SVCREQ 26/30: Interrogate I/O

Use SVCREQs 26 and 30 to check whether the installed modules match the software configuration. If not, these SVCREQs place appropriate addition, loss, and mismatch faults in the PLC and/or I/O fault tables. SVCREQs 26 and 30 both perform the same function.

The more configuration faults there are, the longer it takes these SVCREQs longer to execute.

These SVCREQs have no parameter block. They always output power flow.

Example of SVCREQ 26

In the example, when input %I0251 is ON, the SVCREQ checks the installed modules and compares them to the software configuration. Output %Q0001 is turned on after the SVCREQ is complete.

SVCREQ 29: Read Elapsed Power Down Time

Use SVCREQ 29 to read the amount of time elapsed between the last power-down and the most recent powerup. If the watchdog timer expired before power-down, the PLC is not able to calculate the power down elapsed time, so the time is set to 0.

The SVCREQ output is always ON.

Output Parameter Block for SVCREQ 29

This function has an output parameter block only. The parameter block has a length of 3 words.

address	Power-Down Elapsed Seconds (low order)
address + 1	Power-Down Elapsed Seconds (high order)
address + 2	zero

The first two words are the power-down elapsed time in seconds. The last word is always 0.

Example of SVCREQ 29

In the example, when input %I0251 is ON, the Elapsed Power-Down Time is placed into the parameter block that starts at %R0050. The output coil (%Q0001) is turned on.

SVCREQ 34: Enter Analog Calibration Mode

The final step of calibrating an analog channel (see the complete process description in chapter 11) consists of storing the calibration values in flash memory. This step requires the use of two SVCREQ functions, SVCREQ 34 and 35.

SVCREQ 34 places the Micro PLC in calibration mode. When SVCREQ 34 is executed, the PLC uses default gain and offset so that you can start the calibration process. No parameter block is needed with SVCREQ 34.

Note: This calibration procedure applies to analog channels on 23pt Micro PLCs only. Software calibration of Analog Expansions and Nano PLCs is not available.

Example of SVCREQ 34

In the following example, when enabling input %I0251 goes ON, the analog calibration defaults are restored and output coil %Q0001 is turned on.

SVCREQ 35: Store Analog Calibration

SVCREQ 35 stores the previously-computed analog calibration in the Micro PLC. The calibration can be stored in either volatile or non-volatile memory.

SVCREQ 35 uses an input parameter block containing the new calibration data and control data. Contents of the parameter block are shown on the next page. When the SVCREQ is successfully completed, the new calibration values take effect.

After the SVCREQ function executes, the PLC returns the function status and the number of tries available to the 2 words of the output parameter block.

Example of SVCREQ 35

In the example, when contact %I0003 is on, the SVCREQ with a parameter block located at %R0127 stores the analog calibration to the memory type specified in the parameter block, and sets coil %Q00234.

Input Parameter Block for SVCREQ 35

The input parameter block for SVCREQ 35 contains the following 32 input words. See the explanations on the next page.

Address	Password ("CA" 4143H)
address + 1	Password ("LB" 424CH)
address + 2	Destination Control: 0 for RAM, 1 for flash
address + 3	Select Control AI Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory
address + 4	Input Channel 1 %AI0018 High Value, Voltage
address + 5	Input Channel 1 %AI0018 Low Value, Voltage
address + 6	Input Channel 1 Meter High Value, Voltage (mV)
address + 7	Input Channel 1 Meter Low Value, Voltage (mV)
address + 8	Select Control AI Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory
address + 9	Input Channel 1 %AI0018 High Value, Current
address + 10	Input Channel 1 %AI0018 Low Value, Current
address + 11	Input Channel 1 Meter High Value, Current (mA)
address + 12	Input Channel 1 Meter Low Value, Current (mA)
address + 13	Select Control AI Ch 2 Vol: 0: last, 1: new, 2: default, 3: factory
address + 14	Input Channel 2 %AI0019 High Value, Voltage
address + 15	Input Channel 2 %AI0019 Low Value, Voltage
address + 16	Input Channel 2 Meter High Value, Voltage (mV)
address + 17	Input Channel 2 Meter Low Value, Voltage (mV)
address + 18	Select Control AI Ch 2 Cur: 0: last, 1: new, 2: default, 3: factory
address + 19	Input Channel 2 %AI0019 High Value, Current
address + 20	Input Channel 2 %AI0019 Low Value, Current
address + 21	Input Channel 2 Meter High Value, Current (mA)
address + 22	Input Channel 2 Meter Low Value, Current (mA)
address + 23	Select Control AQ Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory
address + 24	Output Channel 1 %AQ0012 High Value, Voltage
address + 25	Output Channel 1 %AQ0012 Low Value, Voltage
address + 26	Output Channel 1 Meter High Value, Voltage (mV)
address + 27	Output Channel 1 Meter Low Value, Voltage (mV)
address + 28	Select Control AQ Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory
address + 29	Output Channel 1 %AQ0012 High Value, Current
address + 30	Output Channel 1 %AQ0012 Low Value, Current
address + 31	Output Channel 1 Meter High Value, Current (mA)
address + 32	Output Channel 1 Meter Low Value, Current (mA)
address + 33	Status
address + 34	Number of tries available

Output Parameter Block for SVCREQ 35

The output parameter block for SVCREQ 35 contains the following 2 output words:

address	Status
address + 1	Number of tries available

Parameter Definitions

Password (address and address +1) must be CALB. If an invalid password is provided, the service request returns error 3 in the status word.

Destination Control (at address +2), determines whether to write the constants in flash or in RAM. You can select the RAM option (0) and calibrate as many times as necessary without burning the calibration constants into the flash memory. When you are satisfied with the calibration, you can select the flash option (1) and finalize the calibration. When the flash option is selected, the calibration data is copied into RAM as well as burned into flash memory. It is important to issue a SVCREQ with the flash option selected in the Destination Control parameter field once the desired calibration state is reached. Otherwise, the new calibration values will be lost when the unit is powered off.

Select Control (address +3) Allows you to calibrate a particular channel in a specific mode. Four choices are allowed for each channel:

0: Last user calibration. The last calibration in flash is used for the channel and for the mode. (If no user calibration exists, the last factory calibration is used.)

1: New. The PLC calculates new gain and offset using the values supplied in the next four words. New calibration value will replace the value in the RAM or flash as determined by the **Destination Control** field.

2: Default. If this option is specified, the default calibration value is used.

3: Factory. If this option is specified, the last factory calibration value is used.

Status (address +33) A status word is returned by the service request:

1=Complete	4=Not in calibration mode
2=Out of tries	5=Calibration values checksum bad
3=Invalid password	6=Invalid calibration data

Number of Tries Available (address +34) Indicates the number of tries remaining.

SVCREQ 52: Read from Flash

This Service Request is available with Release 3.0 and later Micro PLCs..

Service Request 52 reads Reference Variables that were previously written into flash memory using Service Request 53, and stores the variables in CPU reference memory. Each execution of Service Request 52 can read:

- 1 to 10 words of %R, %AI, or %AQ reference data.
- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data.

SVCREQ 52 uses an input parameter block containing the reference memory to be read. After SVCREQ 52 executes, the PLC returns the function status to the two words of the output parameter block.

Example of SVCREQ 52

In this example, when enabling input %M0003 goes on, the Service Request reads the flash memory location specified in the Parameter Block located at %R00040 and places the data into the intended destination. It then sets coil %M0004.

Input Parameter Block for SVCREQ 52

The input parameter block for SVCREQ 52 contains the following 5 input words.

Address	Memory type (number) of the flash memory location of the first byte or word of data to be read. Numbers are:		
	Memory	*Decimal*	*Hex*
	%I (byte)	16	10
	%Q (byte)	18	12
	%T (byte)	20	14
	%M (byte)	22	16
	%G (byte)	56	38
	%R (word)	8	08
	%AI (word)	10	0A
	%AQ (word)	12	0C
address + 1	Offset of the requested data within the memory type in flash memory		
address + 2	Length of data to be read, 1 – 10 bytes or words.		
address + 3	Memory type of the PLC reference memory type where the requested data should be placed. See the numbers above.		
address + 4	Offset to place the requested data within the requested memory type in PLC reference memory.		
address + 5	Memory type of the PLC reference memory type for the completion status. See the numbers above. For example, %R1 = memory type 8.		
address + 6	Offset in PLC Memory to write completion status (zero based). For example, %R1 = offset 0.		

Status Data for SVCREQ 52

SVCREQ 52 returns one of the following status indications:

Word 0			
Hex	***Dec***	***Status***	***Definition***
0x0001	1	Full Success	All requested data was successfully read
0x0101	257	Partial Success	Less than requested data length was read. Can occur if all data requested was not present in flash.
0x0102	258	Insufficient Dest Mem	Can occur if the PLC reference memory location specified is not sufficient to store all the data read from flash
0x0202	514	Invalid Length	Length is beyond minimum 1 and maximum 10
0x0302	770	Source/Dest Mem Wrong	Wrong source or destination reference memory specified in the SVCREQ.
Word 1			
Number of bytes read			

SVCREQ 53: Write to Flash

This Service Request is available with Release 3.0 and later Micro PLCs.

Service Request 53 stores requested PLC reference data in flash memory. Each execution of Service Request 53 can write:

- 1 to 10 words of %R, %AI, or %AQ reference data.
- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data.

SVCREQ 53 uses an input parameter block containing the reference memory requested to be written. After SVCREQ 53 executes, the PLC returns the function status and the amount of user flash memory still available to the output parameter block.

Example of SVCREQ 53

In the example, when enabling input %M0003 goes on, the Service Request reads the PLC memory location specified in the Parameter Block located at %R00040 and writes the data to flash. It then sets coil %M0004.

Input Parameter Block for SVCREQ 53

The input parameter block for SVCREQ 53 contains the following 5 input words.

Address	Memory type (number) of the PLC memory location of the first byte or word of data to be written. Numbers are:		
	Memory	*Decimal*	*Hex*
	%I (byte)	16	10
	%Q (byte)	18	12
	%T (byte)	20	14
	%M (byte)	22	16
	%G (byte)	56	38
	%R (word)	8	08
	%AI (word)	10	0A
	%AQ (word)	12	0C
address + 1	Offset of the requested data within the memory type in PLC memory		
address + 2	Length of data to be read, 1 – 10 bytes or words.		
address + 3	Memory type of the PLC reference memory type for the completion status. See the numbers above. For example, %R1 = memory type 8.		
address + 4	Offset in PLC Memory to write completion status (zero based). For example, %R1 = offset 0.		

Status Data for SVCREQ 53

SVCREQ 53 returns one of the following status indications:

Word 1			
Hex	**Dec**	**Status**	**Definition**
0x0001	1	Full Success	All requested data was successfully written
0x0101	257	Partial Success	Less than requested data length was written. Can occur if some requested data is already in flash.
0x0102	258	Insufficient Destination Memory	Flash memory area full, connect with the programmer and write all data to flash in order to erase and store latest values.
0x0202	514	Invalid Length	Length is beyond minimum 1 and maximum 10
0x0302	770	Source/Dest Mem Wrong	Wrong source or destination reference memory specified in the SVCREQ.
Word 2			
Number of bytes written			
Word 3			
Number of bytes remaining in flash			

Chapter 19 Serial I/O / SNP / RTU Protocols

This chapter describes the VersaMax Micro PLC's Serial I/O feature, which can be used to control the read/write activities of one of the Micro PLC ports directly from the application program.

This chapter also contains instructions for using COMMREQs to configure the CPU serial ports for SNP, RTU, or Serial I/O protocol.

- Format of the COMMREQ Function
- Configuring Serial Ports Using the COMMREQ Function
  - RTU Slave/SNP Slave Operation with a Programmer Attached
  - COMMREQ Command Block for Configuring SNP Protocol
  - COMMREQ Data Block for Configuring RTU Protocol
  - COMMREQ Data Block for Configuring Serial I/O
- Serial I/O COMMREQ Commands
  - Initialize Port
  - Set Up Input Buffer
  - Flush Input Buffer
  - Read Port Status
  - Write Port Control
  - Cancel Operation
  - Autodial
  - Write Bytes
  - Read Bytes
  - Read String

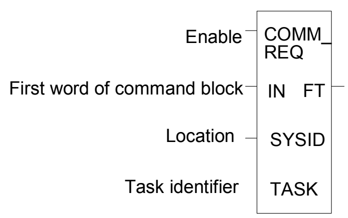
Details of RTU and SNP protocol are described in the *Serial Communications User's Manual* (GFK-0582).

Format of the Communication Request Function

Serial I/O is implemented through the use of Communication Request (COMMREQ) functions. The operations of the protocol, such as transmitting a character through the serial port or waiting for an input character, are implemented through the COMMREQ function block.

The COMMREQ requires that all its command data be placed in the correct order (in a *command block*) in PLC memory before it is executed. The COMMREQ should then be executed by a contact of a one-shot coil to prevent sending the data multiple times. A series of Block Move (BLKMV) commands should be used to move the words to create a command block in the Register tables.

The COMMREQ function has three inputs and one output. When the function receives power flow, a command block of data is sent to the specified module.



Parameters of the COMMREQ Function

Input/ Output	Choices	Description
enable	flow	When the function is energized, the communications request is performed.
IN	R, AI, AQ	IN contains the first word of the command block.
SYSID	I, Q, M, T, G, R, AI, AQ, constant	SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device. For the CPU, SYSID must specify rack/slot 0.
TASK	R AI, AQ, constant	TASK specifies the port for which the operation is intended: task 19 for port 1 task 20 for port 2
FT	flow, none	FT is energized if an error is detected processing the COMMREQ: • The specified target address is not present (SYSID). • The specified task is not valid for the device (TASK). • The data length is 0. • The device's status pointer address (in the command block) does not exist. (applies only to HSC COMMREQs)

Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMMREQ. The Command Block has the following structure:

address	Length (in words)
address + 1	Wait/No Wait Flag
address + 2	Status Pointer Memory
address + 3	Status Pointer Offset
address + 4	Idle Timeout Value
address + 5	Maximum Communication Time
address + 6 to address + 133	Data Block

Example of the COMMREQ Function

In the example, when %M0021 is ON, a Command Block located starting at %R0032 is sent to port 2 (communications task 20) of the CPU (rack 0, slot 0). If an error occurs processing the COMMREQ, %Q0110 is set.

Configuring Serial Ports Using the COMMREQ Function

The following tables list the command block values required for setting up a Serial Port for SNP, RTU, and Serial I/O. All values are in hexadecimal unless otherwise indicated. The BLKMV commands that are used to create the command block are described in the example.

Timing

If a port configuration COMMREQ is sent to a serial port that currently has an SNP/SNPX master (for example, the programmer) connected to it, the serial port configuration specified by the COMMREQ does not take effect until the Micro PLC detects a loss of the SNP/SNPX master. This occurs the configured T3' time after the master disconnects. The COMMREQ status word for the port configuration COMMREQ is updated as soon as the CPU verifies that the specified configuration is valid. That means a COMMREQ Successful value may be returned by the Port Configuration COMMREQ before the specified configuration is actually installed.

Sending Another COMMREQ to the Same Port

The application program must wait at least 2 seconds after a new serial port protocol is installed before sending any COMMREQs specific to that protocol to the port. This applies to a new protocol installed by Storing a new hardware configuration or by a port configuration COMMREQ. If the port is configured for Serial I/O, this waiting period must also follow any Stop to Run mode transition of the Micro PLC.

Invalid Port Configurations

Commreqs to configure protocols for the port(s) of the Micro PLC are limited to the supported protocols for the given port as indicated in Chapter 8 (Port 1 and Port 2 Configuration sections). Any commreqs that request invalid port configurations will be rejected.

RTU Slave/SNP Slave Operation with Programmer Attached

A programmer (an SNP/SNPX master device) can be attached to port 1 or port 2 while RTU Slave mode is active on the port. For multi-drop connections, the Micro PLC must have been configured to use an appropriate PLC ID. Note that for a multi-drop SNP connection with the port currently configured for RTU, the SNP ID associated with the Micro PLC settings must match the multi-drop ID.

The programmer must use the same serial communications parameters (baud rate, parity, stop bits, etc…) as the currently-active RTU Slave protocol for it to be recognized.

When the Micro PLC recognizes the programmer, the Micro PLC removes the RTU Slave protocol from the port and installs SNP Slave as the currently-active protocol. The SNP ID, modem turnaround time, and default idle time for this new SNP Slave session are obtained from the configured Micro PLC settings, not the port 1 or port 2 configurations. Connection should be established within 12 seconds. When the programmer connection has been enabled, normal programmer communications can take place. (Failure of the programmer to establish communications within 12-seconds is treated as a Loss of Programmer Communications).

The programmer may send a new protocol via configuration or a Serial Port Setup COMMREQ. (COMMREQs not supported by SNP Slave protocol are rejected). If a new protocol is received, it will not take effect until the programmer is disconnected.

After the programmer is removed, there is a slight delay (equal to the configured SNP T3' timeout) before the Micro PLC recognizes its absence. During this time, no messages are processed on the port. The Micro PLC detects removal of the programmer as an SNP Slave protocol timeout. Therefore, it is important to be careful when disabling timeouts used by the SNP Slave protocol.

When the Micro PLC recognizes the disconnect, it reinstalls RTU Slave protocol, unless a new protocol has been received. In that case, the Micro PLC installs the new protocol instead.

Note: If an RTU slave receives a message with length greater than 265 bytes it responds with an error code 0x03 indicating "Invalid Data Field"

Example

1. Port 1 is running RTU Slave protocol at 9600 baud.
2. A programmer is attached to port 1. The programmer is using 9600 baud.
3. The Micro PLC installs SNP Slave on port 1 and the programmer communicates normally.
4. The programmer stores a new configuration to port 1. The new configuration sets the port for SNP Slave at 4800 baud (it will not take effect until the port loses communications with the programmer).
5. When the Micro PLC loses communications with the programmer, the new configuration takes effect.

COMMREQ Command Block for Configuring SNP Protocol

	Values	Meaning
Address	10H	Data Block Length
Address + 1	0 = No Wait	WAIT/NOWAIT Flag
Address + 2	0008 = %R, register memory	Status Word Pointer Memory Type
Address + 3	Zero-based number that gives the address of the COMMREQ status word (for example, a value of 99 gives an address of 100 for the status word)	Status Word Pointer Offset
Address + 4	0 (Only used in Wait/No Wait mode)	Idle Timeout Value
Address + 5	0 (Only used in Wait/No Wait mode)	Maximum Communication Time
Address + 6	FFF0H	Command Word (serial port setup)
Address + 7	0001	Protocol: 1=SNP
Address + 8	0000=Slave, 0001=Master	Port Mode
Address + 9	7=38400, 6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	1 = None	Flow Control
Address + 12	0 = None, 1 = 10ms, 2 = 100ms, 3 = 500ms	Turnaround Delay
Address + 13	0 = Long, 1 = Medium, 2 = Short, 3 = None	Timeout
Address + 14	1 = 8 bits	Bits Per Character
Address + 15	0 = 1 Stop Bit, 1 = 2 Stop bits	Stop Bits
Address + 16	not used	Interface
Address + 17	not used	Duplex Mode
Address + 18	user-provided*	Device identifier bytes 1 and 2
Address + 19	user-provided*	Device identifier bytes 3 and 4
Address + 20	user-provided*	Device identifier bytes 5 and 6
Address + 21	user-provided*	Device identifier bytes 7 and 8

* The device identifier for SNP Slave ports is packed into words with the least significant character in the least significant byte of the word. For example, if the first two characters are “A” and “B,” the Address + 18 will contain the hex value 4241.

COMMREQ Data Block for Configuring RTU Protocol

	Values	Meaning
First 6 words		Reserved for COMMREQ use.
Address + 6	FFF0H	Command
Address + 7	3	Protocol: 0003=RTU
Address + 8	0	Port Mode: 0000=Slave
Address + 9	7=38400, 6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	0 = Hardware, 1 = None	Flow Control
Address + 12	0-255 (units of 10ms. For example, 10-100ms)	Turnaround delay. For release 2.02 and later CPUs only. 0 for all other CPUs.
Address + 13	not used	Timeout
Address + 14	not used	Bits per Character
Address + 15	not used	Stop Bits
Address + 16	not used	Interface
Address + 17	0 = 2-wire, 1 = 4-wire	Duplex Mode
Address + 18	Station Address (1-247)	Device Identifier
Address + 19—21	not used	Device Identifier
Address+22*	0 –255 (units of 10ms)	Receive to Transmit Delay
Address + 23*	0-255 (units of 10mS)	RTS Drop Delay

Receive to Transmit Delay and RTS Drop Delay

Release 2.02 and later Micro PLC CPUs support Receive to Transmit Delay and RTS Drop Delay functionality for RTU and Serial IO through the Serial Port Setup COMMREQ.

When configuring the protocol, these two optional parameters can be added to the port setup COMMREQ. The data block length (Address + 0) for a COMMREQ that includes the Receive to Transmit Delay and RTS Drop Delay parameters should be 12H, not 10H. Either length (10H or 12H) is valid for this COMMREQ.

Receive to transmit delay - This is the time interval that defines the end of each received response message. It is measured from the end of the last received character. RTS is off and the transmitter is silent during this interval. If a new query is ready for transmission, RTS is asserted no earlier than the end of this interval.

Zero specifies the default, defined as 3.5 character times at the specified data rate, assuming 11 bits per character.

Data Rate	Default (10 ms Units)	Data Rate	Default (10 ms Units)
1200	322	19200	21
2400	161	38400	10
4800	80	57600	7
9600	40	115200	3

If the required delay is greater than the default value at the current data rate, increase the specified value to required delay in 10-millisecond units. If the required delay is less than the default at the current data rate, no additional delay is necessary.

RTS Drop Delay -This is the time from the end of the last transmitted character to the time when RTS is turned off (dropped). The RTS Drop Delay is also specified in 10 millisecond units. The receiver is disabled during transmission and remains disabled during the RTS drop delay time.

Data Rate	Default (10 ms Units)	Data Rate	Default (10 ms Units)
1200	92	19200	6
2400	46	38400	3
4800	23	57600	2
9600	12	115200	1

COMMREQ Data Block for Configuring Serial I/O Protocol

	Values	Meaning
First 6 words		Reserved for COMMREQ use.
Address + 6	FFF0H	Command
Address + 7	0005	Protocol: 0005=Serial IO
Address + 8	0 = Slave	Port Mode
Address + 9	7 = 38400, 6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	0 = Hardware, 1 = None	Flow Control
Address + 12	0-255 (units of 10ms). For example, 10 = 100ms).	Turnaround Delay. For release 2.02 and later CPUs only. 0 for all other CPUs.
Address + 13	0 = Long	Timeout
Address + 14	0=7 bits, 1=8 bits	Bits per Character
Address + 15	0 = 1 stop bit, 1 = 2 stop bits	Stop Bits
Address + 16	not used	Interface
Address + 17	0 = 2-wire, 1 = 4-wire	Duplex Mode
Address + 18—21	not used	Device Identifier
Address + 22*	0-255 (units of 10ms)	Receive to transmit delay / RTS Drop Delay

Release 2.02 and later Micro PLC CPUs support Receive to Transmit Delay and RTS Drop Delay functionality for RTU and Serial IO through the Serial Port Setup COMMREQ. Both of these optional parameters are described on the preceding page.

When configuring the protocol, these two optional parameters can be added to the port setup COMMREQ. The data block length (Address + 0) for a COMMREQ that includes the Receive to Transmit Delay and RTS Drop Delay parameters should be 12H, not 10H. Either length (10H or 12H) is valid for this COMMREQ.

Calling Serial I/O COMMREQs from the PLC Sweep

Implementing a serial protocol using Serial I/O COMMREQs may be restricted by the Micro PLC sweep time. For example, if the protocol requires that a reply to a certain message from the remote device be initiated within 5mS of receiving the message, this method may not be successful if the sweep time is 5mS or longer, since timely response is not guaranteed.

When using Serial I/O protocol with a VersaMax Nano or 14 point Micro PLC, the user switch must be configured. A Nano PLC requires an external switch connection. When a Nano PLC or 14-Point Micro PLC is in Run mode, Serial I/O protocol is active; after a Run-to-Stop transition, the Nano PLC or 14-Point Micro PLC automatically reverts to SNP. An SNP master device (VersaPro, for instance) is not able to communicate with a Nano PLC or 14-Point Micro PLC that is configured for Serial I/O when it is in Run mode.

Since the Serial I/O is completely driven by the application program, in STOP mode a port configured as Serial I/O automatically reverts to SNP slave, to facilitate programmer communication. Therefore, while in Stop mode, Serial I/O protocol is not active; it is only active when the PLC is in Run mode.

Compatibility

The COMMREQ function blocks supported by Serial I/O are not supported by other currently-existing protocols (such as SNP slave, SNP master, and RTU slave). Errors are returned if they are attempted for a port configured for one of those protocols.

Status Word for Serial I/O COMMREQs

A value of 1 is returned in the COMMREQ status word upon successful completion of the COMMREQ. Any other value returned is an error code where the low byte is a major error code and the high byte is a minor error code.

Major Error Code	Minor Error Code	Description
1 (01h)		Successful Completion (the expected completion value in the COMMREQ status word).
12 (0Ch)		Local error —Error processing local command. Minor error code identifies the specific error.
	1 (01h)	Wait-type command is not permitted. Use No-Wait command.
	2 (02h)	COMMREQ command is not supported.
	5 (05h)	Error writing COMMREQ status word to PLC memory.
	6 (06h)	Invalid PLC memory type specified.
	7 (07h)	Invalid PLC memory offset specified.
	8 (08h)	Unable to access PLC memory.
	12 (0Ch)	COMMREQ data block length too small.
	14 (0Eh)	COMMREQ data is invalid.
13 (0Dh)		Remote error — Error processing a remote command. Minor error code identifies the error.
	2 (02h)	Number of bytes to read exceeds input buffer size, or more than 250 bytes requested to be written.
	3 (03h)	COMMREQ data block length is too small. String data is missing or incomplete.
	4 (04h)	Receive timeout awaiting serial reception of data
	8 (08h)	Unable to access PLC memory.
	12 (0Ch)	COMMREQ data block length too small.
	48 (30h)	Serial output timeout. The port was unable to transmit the string. (Could be missing CTS signal when the serial port is configured to use hardware flow control.)
	50 (32h)	COMMREQ timeout. The COMMREQ did not complete within 20-second time limit.
14 (0Eh)		Autodial Error — An error occurred while attempting to send a command string to an attached external modem. The minor error code identifies the specific error.
	2 (02h)	The modem command string length exceeds end of reference memory type.
	3 (03h)	COMMREQ Data Block Length too small. Output command string data missing or incomplete.
	4 (04h)	Serial output timeout. The port was unable to transmit the modem autodial output.
	5 (05h)	Response was not received from modem. Check modem and cable.
	6 (06h)	Modem responded with BUSY. Modem is unable to complete the requested connection. The remote modem is already in use; retry the connection request later.
	7 (07h)	Modem responded with NO CARRIER. Modem is unable to complete the requested connection. Check the local and remote modems and the telephone line.
	8 (08h)	Modem responded with NO DIALTONE. Modem is unable to complete the requested connection. Check the modem connections and the telephone line.
	9 (09h)	Modem responded with ERROR. Modem is unable to complete the requested command. Check the modem command string and modem.
	10 (0Ah)	Modem responded with RING; the modem is being called by another modem. Modem is unable to complete the requested command. Retry the command later.
	11 (0Bh)	Unknown response from modem. Modem unable to complete the command. Check modem command string and modem. Response should be CONNECT or OK.
	50 (32h)	COMMREQ timeout. The COMMREQ did not complete within 20 seconds.

Serial I/O COMMREQ Commands

The following COMMREQs are used to implement Serial I/O:

- Local COMMREQs - do not receive or transmit data through the serial port.
  - Initialize Port (4300)
  - Set Up Input Buffer (4301)
  - Flush Input Buffer (4302)
  - Read Port Status (4303)
  - Write Port Control (4304)
  - Cancel Operation (4399)
- Remote COMMREQs - receive and/or transmit data through the serial port.
  - Autodial (4400)
  - Write bytes (4401)
  - Read bytes (4402)
  - Read String (4403)

Overlapping COMMREQs

Some of the Serial I/O COMMREQs must complete execution before another COMMREQ can be processed. Others can be left pending while others are executed.

COMMREQS that Must Complete Execution

- Autodial (4400)
- Initialize Port (4300)
- Set Up Input Buffer (4301)
- Flush Input buffer (4302)
- Read port status (4303)
- Write port control (4304)
- Cancel Operation (4399)
- Serial Port Setup (FFF0)

COMMREQs that Can be Pending While Others Execute

The table below shows whether Write Bytes, Read Bytes and Read String COMMREQs can be pending when other COMMREQs are executed.

	New COMMREQ										
Currently-pending COMMREQs	Autodial (4400)	Write Bytes (4401)	Initialize Port (4300)	Set Up Input Buffer (4301)	Flush Input Buffer (4302)	Read Port Status (4303)	Write Port Control (4304	Read Bytes (4402)	Read String (4403)	Cancel Operation (4399)	Serial Port Setup (FFF0)
Write Bytes (4401)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Read Bytes (4402)	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No
Read String (4403)	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No

Initialize Port Function (4300)

This function causes a reset command to be sent to the specified port. It also cancels any COMMREQ currently in progress and flushes the internal input buffer. RTS is set to inactive.

Example Command Block for the Initialize Port Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0001	0001	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4300	10CC	Initialize port command

Operating Notes

Note: COMMREQs that are cancelled due to this command executing do not have their respective COMMREQ status words updated.

Caution: If this COMMREQ is sent when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

Set Up Input Buffer Function (4301)

This function can be used to change the size of the internal memory buffer where input data will be placed as it is received. By default, the buffer is set to a maximum of 2K *bytes*. As data is received from the serial port it is placed in the input buffer. If the buffer becomes full, any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Retrieving Data from the Buffer

Data can be retrieved from the buffer using the Read String or Read Bytes function. It is not directly accessible from the application program.

If data is not retrieved from the buffer in a timely fashion, some characters may be lost.

Example Command Block for the Set Up Input Buffer Function

	Value (decimal)	*Value (hexadecimal)*	*Meaning*
address	0002	0002	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4301	10CD	Setup input buffer command
address +7	0064	0040	Buffer length (in words)

Operating Notes

It is not possible to set the buffer length to zero. If zero is entered as the buffer length, the buffer size will be set to the 2K bytes default.

If a length greater than 2K bytes is specified, an error is generated.

Flush Input Buffer Function (4302)

This operation empties the input buffer of any characters received through the serial port but not yet retrieved using a read command. All such characters are lost.

Example Command Block for the Flush Input Buffer Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0001	0001	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4302	10CE	Flush input buffer command

Read Port Status Function (4303)

This function returns the current status of the port. The following events can be detected:

1. A read request was initiated previously and the required number of characters has now been received or the specified time-out has elapsed.
2. A write request was initiated previously and transmission of the specified number of characters is complete or a time-out has elapsed.

The status returned by the function indicates the event or events that have completed. More than one condition can occur simultaneously, if both a read and a write were initiated previously.

Example Command Block for the Read Port Status Function

	Value (decimal)	*Value (hexadecimal)*	*Meaning*
address	0003	0003	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4303	10CF	Read port status command
address +7	0070	0046	Port status memory type (%I)
address +8	0001	0001	Port status memory offset (%I0001)

Port Status

The port status consists of a status word and the number of characters in the input buffer that have not been retrieved by the application (characters which have been received and are available).

word 1	Port status word (see below)
word 2	Characters available in the input buffer

The Port Status Word can be:

Bit	*Name*	*Definition*	*Meaning*	
15	RI	Read In progress	Set	Read Bytes or Read String invoked
			Cleared	Previous Read bytes or String has timed out, been canceled, or finished
14	RS	Read Success	Set	Read Bytes or Read String has successfully completed
			Cleared	New Read Bytes or Read String invoked
13	RT	Read Time-out	Set	Receive timeout occurred during Read Bytes or Read String
			Cleared	New Read Bytes or Read String invoked
12	WI	Write In progress	Set	New Write Bytes invoked
			Cleared	Previously-invoked Write Bytes has timed out, been canceled, or finished
11	WS	Write Success	Set	Previously-invoked Write Bytes has successfully completed
			Cleared	New Write Bytes invoked
10	WT	Write Time-out	Set	Transmit timeout during Write Bytes
			Cleared	New Write Bytes invoked
9	CA	Character Available	Set	Unread characters are in the buffer
			Cleared	No unread characters in the buffer
8	OF	OverFlow error	Set	Overflow error occurred on the serial port or internal buffer
			Cleared	Read Port Status invoked
7	FE	Framing Error	Set	Framing error occurred on the serial port
			Cleared	Read Port Status invoked
6	PE	Parity Error	Set	Parity error occurred on the serial port
			Cleared	Read Port Status invoked
5	CT	CTS is active	Set	CTS line on the serial port is active or the serial port does not have a CTS line
			Cleared	CTS line on the serial port is not active
4 - 0	U	not used, should be 0		

Write Port Control Function (4304)

This function forces RTS for the specified port:

Example Command Block for the Write Port Control Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0002	0002	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4304	10D0	Write port control command
address +7	xxxx	xxxx	Port control word

Port Control Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RTS	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

The Port Control Word can be:

15 **RTS** Commanded state of the **RTS** output
1 = Activates RTS
0 = Deactivates RTS

0-14 **U** **U**nused (should be zero)

Operating Note

For Micro PLC port 2 (RS-485), the RTS signal is also controlled by the transmit driver. Therefore, control of RTS is dependent on the current state of the transmit driver. If the transmit driver is not enabled, asserting RTS with the Write Port Control COMMREQ will not cause RTS to be asserted on the serial line. The state of the transmit driver is controlled by the protocol and is dependent on the current Duplex Mode of the port. For 2-wire and 4-wire Duplex Mode, the transmit driver is only enabled during transmitting. Therefore, RTS on the serial line will only be seen active on port 2 (configured for 2-wire or 4-wire Duplex Mode) when data is being transmitted. For point-to-point Duplex Mode, the transmit driver is always enabled. Therefore, in point-to-point Duplex Mode, RTS on the serial line will always reflect what is chosen with the Write Port Control COMMREQ.

Cancel Commreq Function (4399)

This function cancels the current operations in progress. It can be used to cancel both read operations and write operations. If a read operation is in progress and there are unprocessed characters in the input buffer, those characters are left in the input buffer and available for future reads. The serial port is not reset.

Example Command Block for the Cancel Operation Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0002	0002	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4399	112F	Cancel operation command
address +7	0001	0001	Transaction type to cancel 1 All operations 2 Read operations 3 Write operations

Operating Notes

This function does not update the status of words of the cancelled COMMREQs.

Caution: If this COMMREQ is sent in either Cancel All or Cancel Write mode when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

Autodial Function (4400)

This feature allows the VersaMax Micro PLC to automatically dial a modem and send a specified byte string.

To implement this feature, the port must be configured for Serial I/O.

For example, pager enunciation can be implemented by three commands, requiring three COMMREQ command blocks:

- **Autodial**: 04400 (1130h) Dials the modem.
- **Write Bytes**: 04401 (1131h) Specifies an ASCII string, from 1 to 250 bytes in length, to send from the serial port.
- **Autodial**: 04400 (1130h) It is the responsibility of the Micro PLC application program to hang up the phone connection. This is accomplished by reissuing the autodial command and sending the hang up command string.

Autodial Command Block

The Autodial command automatically transmits an Escape sequence that follows the Hayes convention. If you are using a modem that does not support the Hayes convention, you may be able to use the Write Bytes command to dial the modem.

Examples of commonly used command strings for Hayes-compatible modems are listed below:

Command String	***Length***	***Function***
ATDP15035559999<CR>	16 (10h)	Pulse dial the number 1-503-555-9999
ATDT15035559999<CR>	16 (10h)	Tone dial the number 1-503-555-9999
ATDT9,15035559999<CR>	18 (12h)	Tone dial using outside line with pause
ATH0<CR>	5 (05h)	Hang up the phone
ATZ <CR>	4 (04h)	Restore modem configuration to internally saved values

Example Autodial Command Block

This example COMMREQ command block dials the number 234-5678 using a Hayes-compatible modem.

Word	Definition	Values
1	0009h	CUSTOM data block length (includes command string)
2	0000h	NOWAIT mode
3	0008h	Status word memory type (%R)
4	0000h	Status word address minus 1 (Register 1)
5	0000h	not used
6	0000h	not used
7	04400 (1130h)	Autodial command number
8	00030 (001Eh)	Modem response timeout (30 seconds)
9	0012 (000Ch)	Number of bytes in command string
10	5441h	A (41h), T (54h)
11	5444h	D (44h), T (54h)
12	3332h	Phone number: 2 (32h), 3 (33h)
13	3534h	4 (34h), 5 (35h)
14	3736h	6 (36h), 7 (37h)
15	0D38h	8 (38h) <CR> (0Dh)

Write Bytes Function (4401)

This operation can be used to transmit one or more characters to the remote device through the specified serial port. The character(s) to be transmitted must be in a word reference memory. They should not be changed until the operation is complete.

Up to 250 characters can be transmitted with a single invocation of this operation. The status of the operation is not complete until all of the characters have been transmitted or until a timeout occurs (for example, if hardware flow control is being used and the remote device never enables the transmission).

Example Command Block for the Write Bytes Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0006	0006	Data block length (includes characters to send)
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4401	1131	Write bytes command
address +7	0030	001E	Transmit time-out (30 seconds). See note below.
address +8	0005	0005	Number of bytes to write
address +9	25960	6568	‘h’ (68h), ‘e’ (65h)
address +10	27756	6C6C	‘l’ (6Ch), ‘l’ (6Ch)
address +11	0111	006F	‘o’ (6Fh)

Although printable ASCII characters are used in this example, there is no restriction on the values of the characters that can be transmitted.

Operating Notes

Note: Specifying zero as the Transmit time-out sets the time-out value to the amount of time actually needed to transmit the data, plus 4 seconds.

Caution: If an Initialize Port (4300) COMMEQ is sent or a Cancel Operation (4399) COMMREQ is sent in either Cancel All or Cancel Write mode while this COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission has halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

Read Bytes Function (4402)

This function causes one or more characters to be read from the specified port. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer is returned.

If insufficient characters are available to satisfy the request and a non-zero value is specified for the number of characters to read, the status of the operation is not complete until either sufficient characters have been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation. The status word is not updated until the read operation is complete (either due to timeout or when all the data has been received).

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested amount of data, or until it is cancelled.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains, and can be retrieved with a subsequent read request.

Example Command Block for the Read Bytes Function

	Value (decimal)	*Value (hexadecimal)*	*Meaning*
address	0005	0005	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4402	1132	Read bytes command
address +7	0030	001E	Read time-out (30 seconds)
address +8	0005	0005	Number of bytes to read
address +9	0008	0008	Input data memory type (%R).
address +10	0001	0001	Input data memory address (%R0001)

Return Data Format for the Read Bytes Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters.

Address	Number of characters actually read
Address + 1	Number of characters still available in the input buffer, if any
Address + 2	first two characters (first character is in the low byte)
Address + 3	third and fourth characters (third character is in the low byte)
Address + n	subsequent characters

Operating Note

If the input data memory type parameter is specified to be a word memory type and an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Read String Function (4403)

This function causes characters to be read from the specified port until a specified terminating character is received. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer are returned.

If the terminating character is not in the input buffer, the status of the operation is not complete until either the terminating character has been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation.

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested string, terminated by the specified end character.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains, and can be retrieved with a subsequent read request.

Example Command Block for the Read String Function

	Value (decimal)	Value (hexadecimal)	Meaning
address	0005	0005	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4403	1133	Read string command
address +7	0030	001E	Read time-out (30 seconds)
address +8	0013	000D	Terminating character (carriage return): must be between 0 and 255 (0xFF), inclusive
address +9	0008	0008	Input data memory type (%R)
address +10	0001	0001	Input data memory address (%R0001)

Return Data Format for the Read String Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters:

Address	Number of characters actually read
Address + 1	Number of characters still available in the input buffer, if any
Address + 2	first two characters (first character is in the low byte)
Address + 3	third and fourth characters (third character is in the low byte)
Address + n	subsequent characters

Operating Note

If the input data memory type parameter is specified to be a word memory type and an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Example

The following Block Move will set up values to perform a serial I/O port configuration. In this example, port 2 is being configured. The entries of the first Block Move set up the following:

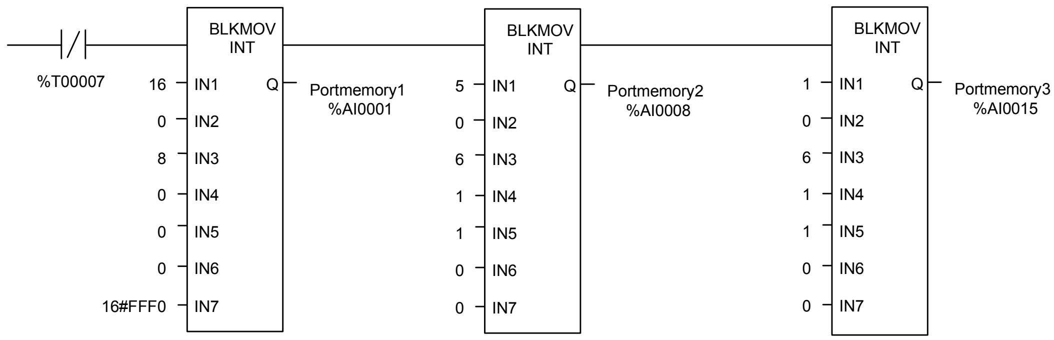
IN1	Length of the data block, which is always16 for a configuration COMMREQ
IN2	Wait/No Wait flag: 0 for No Wait
IN3	Status Word pointer: 8 signifies %R
IN4	Status word pointer offset; this number is zero based, so 0 points to %R1
IN5	Idle timeout value; not used with No Wait mode
IN6	Maximum communication time; not used with No Wait mode
IN7	Command Word; FFF0 hex is the command for serial port setup

In the second Block Move:

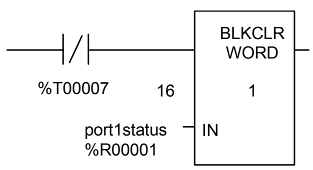
IN1	Protocol selector; 5 selects Serial I/O
IN2	Port mode; 0 selects slave mode
IN3	Data rate; 6 selects 19200
IN4	Parity; 1 selects odd
IN5	Flow control; 1 selects none
IN6	Turnaround delay; 0 selects none
IN7	Timeout; 0 selects none

In the third Block Move:

IN1	Bits per character; 1 chooses 8 bits per character
IN2	Stop bits; 0 selects 1 stop bit
IN3	Interface; not used so set to 0
IN4	Duplex mode; 1 selects 4-wire
IN5 – IN7	Not used

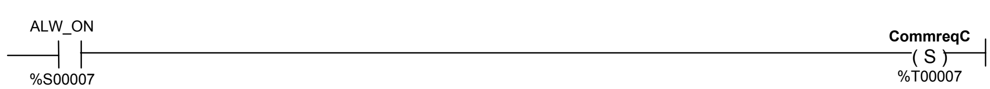


%R1 is used as the status word for the COMMREQ. The following rung clears the word before the COMMREQ is issued:



The following logic issues a COMMREQ for port 2. The SYSID is set to rack 0 slot 1. The TASK ID of 20 defines port 2. The IN parameter points to %AI1 which is where all the configuration data was placed with the Block Move statements. If an error occurs, the bit CommreqP1bad (%T6) will be set.

The following rung sets the bit Commreq Complete (%T7) which keeps the COMMREQ from being issued more than once and keeps the status from being overwritten.



Chapter 20

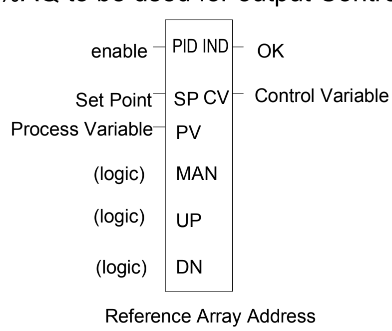
The PID Function

This chapter describes the PID (Proportional plus Integral plus Derivative) function, which is used for closed-loop process control. The PID function compares feedback from a process variable with a desired process Set Point and updates a Control Variable based on the error.

- Format of the PID Function
- Operation of the PID Function
- Parameter Block for the PID Function
- PID Algorithm Selection
- Determining the Process Characteristics
- Setting Parameters Including Tuning Loop Gains
- Sample PID Call

Format of the PID Function

The PID function uses PID loop gains and other parameters stored in an array of 40 16 bit words to solve the PID algorithm at the desired time interval. All parameters are 16 bit integer words. This allows %AI memory to be used for input Process Variables and %AQ to be used for output Control Variables.



The PID function does not pass power flow if there is an error in the configurable parameters. It can be monitored using a temporary coil while modifying data.

Parameters of the PID Function

Input/ Output	Choices	Description
enable	flow	When enabled through a contact, the PID algorithm is performed.
SP	I, Q, M, T, G, R, AI, AQ, constant	The control loop or process Set Point. Set using Process Variable counts, the PID function adjusts the output Control Variable so that the Process Variable matches the Set Point (zero error).
PV	I, Q, M, T, G, R, AI, AQ	Process Variable input from the process being controlled, often a %AI input.
MAN	flow	When energized to 1 (through a contact), the PID block is in manual mode. If the PID block is on manual off, the PID block is in automatic mode.
UP	flow	If energized along with MAN, it adjusts the Control Variable up by 1 CV per solution.*
DN	flow	If energized along with MAN, it adjusts the Control Variable down by 1 CV per solution.*
Address	R	Location of the PID control block information (user and internal parameters). Uses 40 %R words that cannot be shared.
ok	flow, none	OK is energized when the function is performed without error. It is Off if errors exist.
CV	I, Q, M, T, G, R, AI, AQ	The Control Variable output to the process, often a %AQ output.

* Incremented (UP parameter) or decremented (DN parameter) by one (1) per access of the PID function.

As scaled 16 integer numbers, many parameters must be defined in either Process Variable (PV) counts or units or Control Variable (CV) counts or units. For example, the Set Point (SP) input must be scaled over the same range as the Process Variable as the PID block calculates the error by subtracting these two inputs. The Process Variable and Control Variable Counts may be –32000 or 0 to 32000 matching analog scaling or from 0 to 10000 to display variables as 0.00% to 100.00%. The Process Variable and Control Variable Counts do not have to have the same scaling, in which case there will be scale factors included in the PID gains.

Operation of the PID Function

Automatic Operation

The PID function can be called every sweep by providing power flow to Enable and no power flow to Manual input contacts. The block compares the current PLC elapsed time clock with the last PID solution time stored in the internal RefArray. If the difference is greater than the sample period defined in the third word (%Ref+2) of the RefArray, the PID algorithm is solved using the time difference. Both the last solution time and Control Variable output are updated. In Automatic mode, the output Control Variable is placed in the Manual Command parameter %Ref+13.

Manual Operation

The PID block is placed in Manual mode by providing power flow to both the Enable and Manual input contacts. The output Control Variable is set from the Manual Command parameter %Ref+13. If either the UP or DN inputs have power flow, the Manual Command word is incremented or decremented by one CV count every PID solution. For faster manual changes of the output Control Variable, it is also possible to add or subtract any CV count value directly to/from the Manual Command word

The PID block uses the CV Upper and CV Lower Clamp parameters to limit the CV output. If a positive Minimum Slew Time is defined, it is used to limit the rate of change of the CV output. If either the CV amplitude or rate limit is exceeded, the value stored in the integrator is adjusted so that CV is at the limit. This anti-reset windup feature means that even if the error tried to drive CV above (or below) the clamps for a long period of time, the CV output will move off the clamp as soon as the error term changes sign.

This operation, with the Manual Command tracking CV in Automatic mode and setting CV in Manual mode, provides a bumpless transfer between Automatic and Manual modes. The CV Upper and Lower Clamps and the Minimum Slew Time still apply to the CV output in Manual mode and the internal value stored in the integrator is updated. This means that if you were to step the Manual Command in Manual mode, the CV output will not change any faster that the Minimum Slew Time (Inverse) rate limit and will not go above or below the CV Upper or CV Lower Clamp limits.

Time Interval for the PID Function

The PID will not execute more often than once every 10 milliseconds. If it is set up to execute every sweep and the sweep is under 10 milliseconds, the PID function will not run until enough sweeps have occurred to accumulate an elapsed time of 10 milliseconds. For example, if the sweep time is 9 milliseconds, the PID function executes every other sweep, so the overall elapsed time between executions is 18 milliseconds. A specific PID function should not be called more than once per sweep.

The longest possible interval between executions is 10.9 minutes. The PID function compensates for the actual time elapsed since the last execution within 100 microseconds.

The PID algorithm is solved only if the current Micro PLC elapsed time clock is at or later than the last PID solution time plus the sample period. If the sample period is set to 0, the function executes each time it is enabled; however, it is restricted to a minimum of 10 milliseconds as noted above.

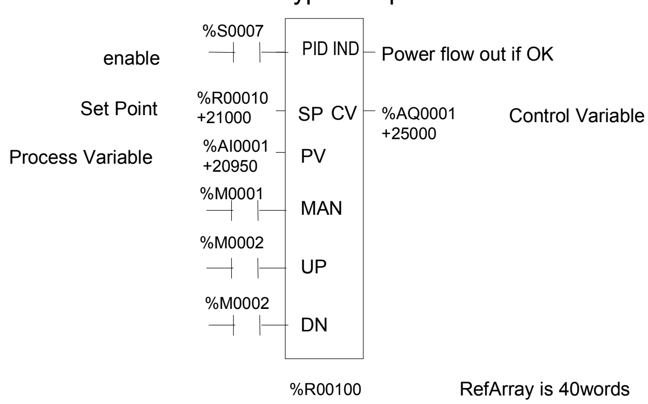
Scaling Input and Outputs

All parameters of the PID function are 16 bit integer words for compatibility with 16 bit analog process variables. Some parameters must be defined in either process variable counts or units or control variable counts or units.

The set point input must be scaled over the same range as process variable, because the PID function calculates error by subtracting these two inputs. The process variable and control variable counts do not have to use the same scaling. Either may be -32000 or 0 to 32000 to match analog scaling, or from 0 to 10000 to display variables as 0.00% to 100.00%. If the process and control variables do not use the same scaling, scale factors are included in the PID gains.

Example of the PID Function

The example shown below includes typical inputs.



Parameter Block for the PID Function

The parameter block for the PID function occupies 40 words of %R memory. Many of the 40 words are used by the Micro PLC and not configurable. Every PID function call must use a different 40-word memory area even if all 13 configurable parameters are the same.

The first 13 words of the parameter block must be specified before executing the PID function. Zeros can be used for most default values. Once suitable PID values have been chosen, they can be defined as constants in a BLKMOV so they can be changed by the program as needed.

Internal Parameters in RefArray

The PID function reads 13 parameters and uses the rest of the 40-word RefArray for internal PID storage. Normally you would not change these values. If you call the PID block in Auto mode after a long delay, you may want to use SVC_REQ 16 to load the current PLC elapsed time clock into %Ref+23 to update the last PID solution time to avoid a step change on the integrator. If you have set the Override low bit of the Control Word (%Ref+14) to 1, the next four bits of the Control Word must be set to control the PID block input contacts, and the Internal SP and PV must be set as you have taken control of the PID block away from the ladder logic.

	Parameter	***Low Bit Units***	***Range***	***Description***
Address	Loop Number	Integer	0 to 255.	Optional number of the PID block. It provides a common identification in the PLC with the loop number defined by an operator interface device.
Address +1	Algorithm	-	Set by the PLC	1 = ISA algorithm 2 = independent algorithm
Address+2	Sample Period	10ms	0 (every sweep) to 65535 (10.9 Min) At least 10ms.	The shortest time, in 10mS increments, between solutions of the PID algorithm. For example, use a 10 for a 100mS sample period.
Address+3 Address+4	Dead Band + and Dead Band -	PV Counts	0 to 32000 (+ never negative) (- never positive)	INT values defining the upper (+) and lower (-) Dead Band limits in PV Counts. If no Dead Band is required, these values must be 0. If the PID Error (SP - PV) or (PV - SP) is above the (-) value and below the (+) value, the PID calculations are solved with an Error of 0. If non-zero, the (+) value must greater than 0 and the (-) value less than 0 or the PID block will not function. Leave these at 0 until the PID loop gains are set up or tuned. A Dead Band might be added to avoid small CV output changes due to variations in error.
Address+5	Proportional Gain -Kp (Controller gain, Kc, in the ISA version)	0.01 CV%/PV%	0 to 327.67%	Change in the control variable in CV Counts for a 100 PV Count change in the Error term. A Kp entered as 450 is displayed as 4.50 and results in a Kp*Error/100 or 450*Error/100 contribution to the PID Output. Kp is generally the first gain set when adjusting a PID loop.

	Parameter	Low Bit Units	Range	Description
Address+6	Derivative Gain-Kd	0.01 seconds	0 to 327.67 sec	Change in the control variable in CV Counts if the Error or PV changes 1 PV Count every 10ms. Entered as a time with the low bit indicating 10ms. For example, a Kd entered as 120 is displayed as 1.20 Sec and results in a Kd * delta Error/delta time or 120*4/3 contribution to the PID Output if Error was changing by 4 PV Counts every 30ms. Kd can be used to speed up a slow loop response, but is very sensitive to PV input noise.
Address+7	Integral Rate-Ki	Repeat/1000 Sec	0 to 32.767 repeat/sec	Change in the control variable in CV Counts if the Error were a constant 1 PV Count. Displayed as 0.000 Repeats/Sec with an implied decimal point of 3. For example, a Ki entered as 1400 is displayed as 1.400 Repeats/Sec and results in a Ki * Error *dt or 1400 * 20 * 50/1000 contribution to PID Output for an Error of 20 PV Counts and a 50ms PLC sweep time (Sample Period of 0). Ki is usually the second gain set after Kp.
Address+8	CV Bias/Output Offset	CV Counts	-32000 to 32000 (add to integrator output)	Number of CV Counts added to the PID Output before the rate and amplitude clamps. It can be used to set non-zero CV values if only Kp Proportional gains are used, or for feed forward control of this PID loop output from another control loop.
Address+9 Address+10	CV Upper and Lower Clamps	CV Counts	-32000 to 32000 (>%Ref+10)	Number of CV Counts that define the highest and lowest value for CV. These values are required. The Upper Clamp must have a more positive value than the Lower Clamp, or the PID block will not work. These are usually used to define limits based on physical limits for a CV output. They are also used to scale the Bar Graph display for CV. The block has anti-reset windup to modify the integrator value when a CV clamp is reached.
Address+11	Minimum Slew Time	Second/Full Travel	0 (none) to 32000 sec to move 32000 CV	Minimum number of seconds for the CV output to move from 0 to full travel of 100% or 32000 CV Counts. It is an inverse rate limit on how fast the CV output can be changed. If positive, CV cannot change more than 32000 CV Counts times Delta Time (seconds) divided by Minimum Slew Time. For example, if the Sample Period is 2.5 seconds and the Minimum Slew Time is 500 seconds, CV cannot change more than 32000*2.5/500 or 160 CV Counts per PID solution. The integrator value is adjusted if the CV rate limit is exceeded. If Minimum Slew Time is 0, there is no CV rate limit. Set Minimum Slew Time to 0 while tuning or adjusting PID loop gains.

	Parameter	Low Bit Units	Range	Description
Address+12	Config Word	Low 6 bits used		The low 6 bits of this word are used to modify six default PID settings. The 10 high-order bits should be set to 0. Bit 0: Error Polarity. Setting this bit to 1 modifies the standard PID Error Term from the normal (SP – PV) to (PV – SP), reversing the sign of the feedback term. This is for Reverse Acting controls where the CV must go down when the PV goes up. Bit 1: Output Polarity: Setting this bit to 1 inverts the Output Polarity so that CV is the negative of the output rather than the normal positive value. Bit 2: Setting this bit to 1 removes the setpoint from the Derivative calculation. Bit 3: Deadband Action: When this bit is 0, no deadband action is chosen. If the error is within the deadband limits, the error is to be zero. Otherwise the error is not affected by the deadband limit. If this bit is 1, the deadband action is chosen. If the error is within the deadband limits, the error is forced to be zero. If, however, the error is outside the deadband limits, the error is reduced by the deadband limit (error = error – deadband limit). Bit 4: Anti-reset windup action. When this bit is 0, the anti-reset windup action uses a reset back calculation. When the output is clamped, this replaces the accumulated Y remainder value with whatever value is necessary to produce the clamped output exactly. When the bit is 1, this replaces accumulated Y term with the value of the Y term at the start of the calculation. In this way, the pre-clamp Y value is held as long as the output is clamped. Bit 5: Enable derivative filtering. When this bit is set to 0, no filtering is applied to the derivative term. When bit 5 is set to 1, a first order filter is applied. This limits the effects of higher frequency process disturbances on the derivative term.
				Bit 0 – Bit 5: Remember that the bits are set in powers of 2. To set bit 0, add 1 to the Config Word parameter value. To set bit 1, add 2. To set bit 2, add 4. To set bit 3, add 8. To set bit 4, add 16. To set bit 5, add 32. For example, set Config Word to 0 for default PID configuration. Add 1 to change the Error Term from SP - PV to PV - SP, add 2 to change the Output Polarity from CV = PID Output to CV = – PID Output, or add 4 to change Derivative Action from Error rate of change to PV rate of change, etc.
Address+13	Manual Command	CV Counts	Tracks CV in Auto or Sets CV in Manual	Set to the current CV output while the PID block is in Automatic mode. When the block is switched to Manual mode, this value is used to set the CV output and the internal value of the integrator within the Upper and Lower Clamp and Slew Time limits.
Address+14	Control Word	Maintained by the PLC, unless Bit 1 is set.	PLC maintained unless set otherwise: low bit sets Override if 1.	If the Override low bit is set to 1, this word and other internal SP, PV and CV parameters must be used for remote operation of this PID block (see below). This allows remote operator interface devices, such as a computer, to take control away from the PLC program. Caution: if you do not want this to happen, make sure the Control Word is set to 0. If the low bit is 0, the next 4 bits can be read to track the status of the PID input contacts as long as the PID Enable contact has power. A discrete data structure with the first five bit positions in the following format:

Bit	***Word Value***	***Function***	***Status or External Action if Override bit set to 1***

	Parameter	Low Bit Units	Range	Description			
				0	1	Override	If 0, monitor block contacts below. If 1, set them externally.
				1	2	Manual /Auto	If 1, block is in Manual mode; other numbers it is in Automatic mode.
				2	4	Enable	Should normally be 1; otherwise block is never called.
				3	8	UP /Raise	If 1 and Manual (Bit 1) is 1, CV is being incremented every solution.
				4	16	DN /Lower	If 1 and Manual (Bit 1) is 1, CV is being incremented every solution.
Address+15	Internal SP	Set and maintained by the PLC	Non-configurable	Tracks SP in; must be set externally if Override = 1.			
Address+16	Internal CV	“	“	Tracks CV out.			
Address+17	Internal PV	“	“	Tracks PV in; must be set externally if Override bit = 1.			
Address+18	Output	“	“	Signed word value representing the output of the function block before the optional inversion. If no output inversion is configured and the output polarity bit in the control word is set to 0, this value equals the CV output. If inversion is selected and the output polarity bit is set to 1, this value equals the negative of the CV output.			
Address+19	Diff Term Storage						
Address+20 Address+21	Int Term Storage			Used internally for storage of intermediate values. Do not write to these locations			
Address+22	Slew Term Storage						
Address+23 to Address+25	Clock			Internal elapsed time storage (time last PID executed). Do not write to these locations			
Address+26	Y Remainder Storage			Holds remainder for integrator division scaling for 0 steady state error.			
Address+27 Address+28	SP, PV Lower and Upper Range	PV Counts	-32000 to 32000	Optional INT values in PV Counts that define high and low display values.(Ref +27 must be lower than Ref+28)			
Address+29 to Address+39	Reserved	N/A	Non-configurable	29-34 are reserved for internal use; 35-39 are reserved for external use. Do not use these references.			

PID Algorithm Selection (PIDISA or PIDIND) and Gains

The PID block can be programmed selecting either the Independent (PID_IND) term or standard ISA (PID_ISA) versions of the PID algorithm. The only difference in the algorithms is how the Integral and Derivative gains are defined.

Error Term

The Independent (PID_IND) term and standard ISA (PID_ISA) versions of the PID algorithm both calculate the Error Term as:

Error Term (in Normal Mode) = Set Point (SP) – Process Variable (PV)

Error Term in Reverse-Action Mode

The Error Term calculation can be changed to Reverse Action mode:

Error Term (in Reverse Action Mode) = Process Variable (PV) – Set Point (SP)

by setting the Error Term (low bit 0 in the Config Word %Ref+12) to 1.

Effect of the Process Variable on the Control Variable

In Normal mode, the Control Variable (CV) responds to changes in the Process Variable (PV) by moving in the same direction. In Reverse-Action mode, when the Process Variable goes up, the Control Variable goes down.

Derivative Term

The Derivative term is the time rate of change of the Error term in the interval since the last PID solution.

Derivative = ΔError / Delta time (dt) =
(Error – previous Error) / Delta time (dt)

where

Delta time (dt) = Current PLC elapsed time - PLC elapsed time at previous PID solution.

In Normal Mode (without Reverse-Action mode), the Derivative Term is equal to the change in the Error term.

(Error – previous Error) = (SP – PV) – (previous SP – previous PV)
= (previous PV – PV) – (previous SP – SP)

However, when the Error Polarity bit (bit 0) in the Config Word is set, the sign of the change in the Error term is reversed.

(Error – previous Error) = (PV – SP) – (previous PV – previous SP)
= (PV – previous PV) – (SP – previous SP)

The change in the Error term depends on changes in both the Set Point and the Process Variable. If the Set Point is constant, the difference between SP and the previous SP is zero and has no effect on the output. However, Set Point changes can cause large changes in the Derivative term and in the output.

Removing Set Point Changes from the Derivative Calculation

Loop stability can be improved by eliminating the effect of Set Point changes on the Derivative term. Set the third bit (bit 2) of the Config Word to 1 to calculate the derivative based only on the change in PV.

For bit 2 set in normal mode (bit 0 = 0),

(Error – previous Error) = (previous PV – PV),

and with bit 2 set in Reverse-Action mode (bit 0 = 1),

(Error – previous Error) = (PV – previous PV).

Delta Time

The dt (or Delta Time) is determined by subtracting the last PID solution clock time for this block from the current PLC elapsed time clock.

dt = Current PLC Elapsed Time clock - PLC Elapsed Time Clock at Last PID solution
Derivative = (Error - previous Error)/dt or (PV - previous PV)/dt if 3rd bit of Config Word set to 1

The Independent term PID (PID_IND) algorithm calculates the output as:

PID Output = Kp * Error + Ki * Error * dt + Kd * Derivative + CV Bias

The standard ISA (PID_ISA) algorithm has a different form:

PID Output = Kc * (Error + Error * dt/Ti + Td * Derivative) + CV Bias

where Kc is the controller gain, and Ti is the Integral time and Td is the Derivative time. The advantage of ISA is that adjusting the Kc changes the contribution for the integral and derivative terms as well as the proportional one, which may make loop tuning easier. If you have PID gains in terms or Ti and Td, use

Kp = Kc Ki = Kc/Ti and Kd = Kc/Td

to convert them to use as PID User Parameter inputs.

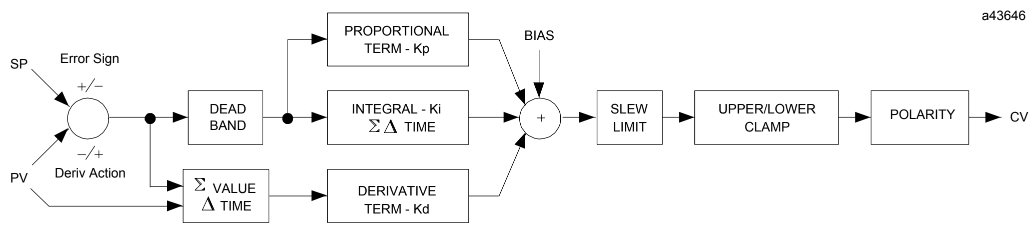
The CV Bias term above is an additive term separate from the PID components. It may be required if you are using only Proportional Kp gain and you want the CV to be a non-zero value when the PV equals the SP and the Error is 0. In this case, set the CV Bias to the desired CV when the PV is at the SP. CV Bias can also be used for feed forward control where another PID loop or control algorithm is used to adjust the CV output of this PID loop.

If an Integral Ki gain is used, the CV Bias would normally be 0 as the integrator acts as an automatic bias. Just start up in Manual mode and use the Manual

Command word (%Ref+13) to set the integrator to the desired CV, then switch to Automatic mode. This also works if Ki is 0, except the integrator will not be adjusted based on the Error after going into Automatic mode.

Independent Term Algorithm (PIDIND)

The following diagram shows how the PID algorithms work:



The ISA Algorithm (PIDISA) is similar except the Kp gain is factored out of Ki and Kd so that the integral gain is Kp * Ki and derivative gain is Kp * Kd. The Error sign, DerivAction and Polarity are set by bits in the Config Word user parameter.

CV Amplitude and Rate Limits

The block does not send the calculated PID Output directly to CV. Both PID algorithms can impose amplitude and rate of change limits on the output Control Variable. The maximum rate of change is determined by dividing the maximum 100% CV value (32000) by the Minimum Slew Time, if specified as greater than 0. For example, if the Minimum Slew Time is 100 seconds, the rate limit will be 320 CV counts per second. If the dt solution time was 50 milliseconds, the new CV output can not change more than 320*50/1000 or 16 CV counts from the previous CV output.

The CV output is then compared to the CV Upper and CV Lower Clamp values. If either limit is exceeded, the CV output is set to the clamped value. If either rate or amplitude limits are exceeded modifying CV, the internal integrator value is adjusted to match the limited value to avoid reset windup.

Finally, the block checks the Output Polarity (2nd bit of the Config Word %Ref+12) and changes the sign of the output if the bit is 1.

CV = Clamped PID Output   or
 - Clamped PID Output if Output Polarity bit set

If the block is in Automatic mode, the final CV is placed in the Manual Command %Ref+13. If the block is in Manual mode, the PID equation is skipped as CV is set by the Manual Command, but all the rate and amplitude limits are still checked. That means that the Manual Command can not change the output above the CV Upper Clamp or below the CV Lower Clamps and the output can not change faster than the Minimum Slew Time allowed.

Sample Period and PID Block Scheduling

The PID block is a digital implementation of an analog control function, so the dt sample time in the PID Output equation is not the infinitesimally small sample time available with analog controls. The majority of processes being controlled can be approximated as a gain with a first or second order lag, possibly with a pure time delay. The PID block sets a CV output to the process and uses the process feedback PV to determine an Error to adjust the next CV output. A key process parameter is the total time constant, which is how fast does the PV respond when the CV is changed. As discussed in the Setting Loop Gains section below, the total time constant, Tp+Tc, for a first order system is the time required for PV to reach 63% of its final value when CV is stepped. The PID block will not be able to control a process unless its Sample Period is well under half the total time constant. Larger Sample Periods will make it unstable.

The Sample Period should be no bigger than the total time constant divided by 10 (or down to 5 worst case). For example, if PV seems to reach about 2/3 of its final value in 2 seconds, the Sample Period should be less than 0.2 seconds, or 0.4 seconds worst case. On the other hand, the Sample Period should not be too small, such as less than the total time constant divided by 1000, or the Ki * Error * dt term for the PID integrator will round down to 0. For example, a very slow process that takes 10 hours or 36000 seconds to reach the 63% level should have a Sample Period of 40 seconds or longer.

Unless the process is very fast, it is not usually necessary to use a Sample Period of 0 to solve the PID algorithm every PID sweep. If many PID loops are used with a Sample Period greater than the sweep time, there may be wide variations in PLC sweep time if many loops end up solving the algorithm at the same time. The simple solution is to sequence a one or more 1 bits through an array of bits set to 0 that is being used to enable power flow to individual PID blocks.

Determining the Process Characteristics

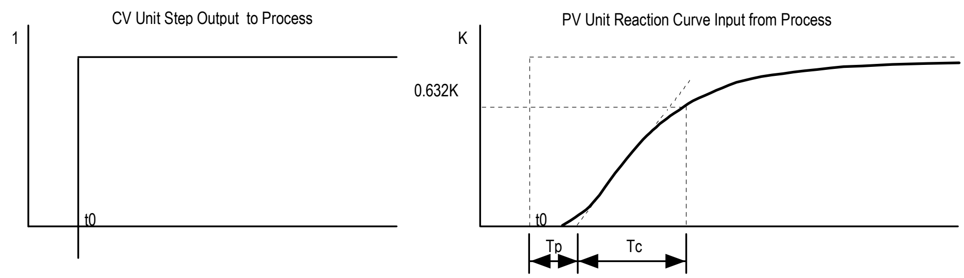
The PID loop gains, Kp, Ki and Kd, are determined by the characteristics of the process being controlled. Two key questions when setting up a PID loop are:

1. How big is the change in PV when we change CV by a fixed amount, or what is the open loop gain?
2. How fast does the system respond, or how quickly does PV change after the CV output is stepped?

Many processes can be approximated by a process gain, first or second order lag and a pure time delay. In the frequency domain, the transfer function for a first order lag system with a pure time delay is:

PV(s)/CV(s) = G(s) = K * e **(-Tp s)/(1 + Tc s)

Plotting a step response at time t0 in the time domain provides an open loop unit reaction curve:



The following process model parameters can be determined from the PV unit reaction curve:

K	Process open loop gain = final change in PV/change in CV at time t0 (Note no subscript on K)
Tp	Process or pipeline time delay or dead time after t0 before the process output PV starts moving
Tc	First order Process time constant, time required after Tp for PV to reach 63.2% of the final PV

Usually the quickest way to measure these parameters is by putting the PID block in Manual mode and making a small step in CV output, by changing the Manual Command %Ref+13, and plotting the PV response over time. For slow processes, this can be done manually, but for faster processes a chart recorder or computer graphic data logging package will help. The CV step size should be large enough to cause an observable change in PV, but not so large that it disrupts the process being measured. A good size may be from 2 to 10% of the difference between the CV Upper and CV Lower Clamp values.

Setting Parameters Including Tuning Loop Gains

As all PID parameters are totally dependent on the process being controlled, there are no predetermined values that will work; however, it is usually simple to find acceptable loop gain.

1. Set all the User Parameters to 0, then set the CV Upper and CV Lower Clamps to the highest and lowest CV expected. Set the Sample Period to the estimated process time constant(above)/10 to 100.
2. Put block in Manual mode and set Manual Command (%Ref+13) at different values to check if CV can be moved to Upper and Lower Clamp. Record PV value at some CV point and load it into SP.
3. Set a small gain, such as 100 * Maximum CV/Maximum PV, into Kp and turn off Manual mode. Step SP by 2 to 10% of the Maximum PV range and observe PV response. Increase Kp if PV step response is too slow or reduce Kp if PV overshoots and oscillates without reaching a steady value.
4. Once a Kp is found, start increasing Ki to get overshooting that dampens out to a steady value in 2 to 3 cycles. This may required reducing Kp. Also try different step sizes and CV operating points.
5. After suitable Kp and Ki gains are found, try adding Kd to get quicker responses to input changes providing it doesn't cause oscillations. Kd is often not needed and will not work with noisy PV.
6. Check gains over different SP operating points and add Dead Band and Minimum Slew Time if needed. Some Reverse Acting processes may need setting Config Word Error Sign or Polarity bits.

Setting Loop Gains Using the Ziegler and Nichols Tuning Approach

Once the three process model parameters, K, Tp and Tc, are determined, they can be used to estimate initial PID loop gains. The following approach provides good response to system disturbances with gains producing an amplitude ratio of 1/4. The amplitude ratio is the ratio of the second peak over the first peak in the closed loop response.

1. Calculate the Reaction rate:
   R = K/Tc
2. For Proportional control only, calculate Kp as:
   Kp = 1/(R * Tp) = Tc/(K * Tp)

   For Proportional and Integral control, use:
   Kp = 0.9/(R * Tp) = 0.9 * Tc/(K * Tp) Ki = 0.3 * Kp/Tp

   For Proportional, Integral and Derivative control, use:
   Kp = G/(R * Tp) where G is from 1.2 to 2.0
   Ki = 0.5 * Kp/Tp
   Kd = 0.5 * Kp * Tp
3. Check that the Sample Period is in the range
   (Tp + Tc)/10 to (Tp + Tc)/1000

The Ideal Tuning Method

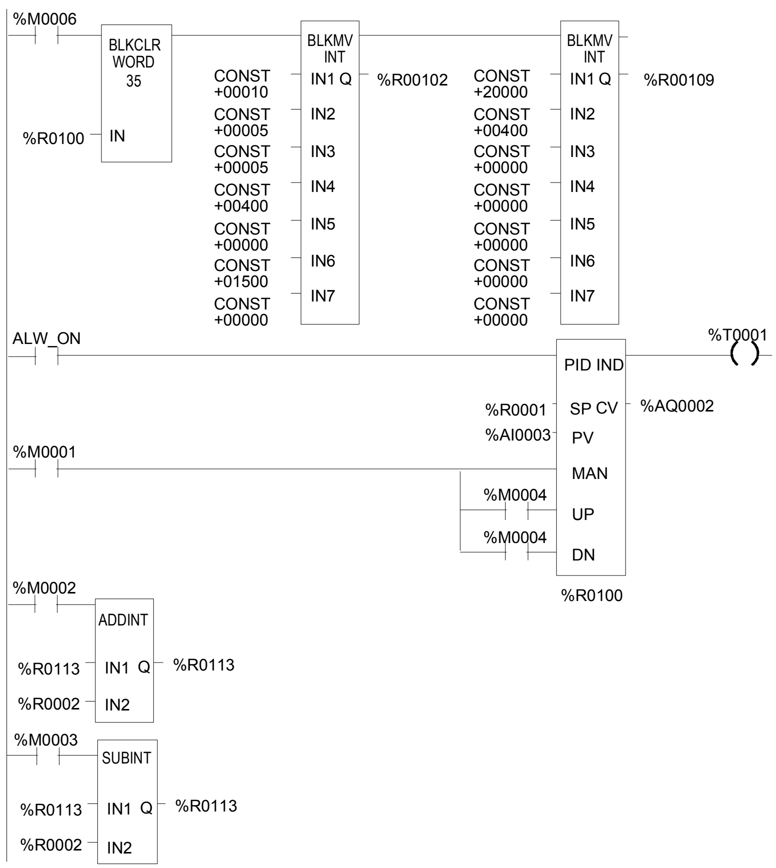
The "Ideal Tuning" procedure provides the best response to SP changes, delayed only by the Tp process delay or dead time.

Kp = 2 * Tc/(3 * K * Tp)
Ki = Tc
Kd = Ki/4 if Derivative term is used

Once initial gains are determined, convert them to integers. Calculate the Process gain K as a change in input PV Counts divided by the output step change in CV Counts and not in process PV or CV engineering units. Specify all times in seconds. Once Kp, Ki and Kd are determined, Kp and Kd can be multiplied by 100 and entered as integer while Ki can be multiplied by 1000 and entered into the User Parameter %RefArray.

Sample PID Call

The following PID example has a sample period of 100Ms, a Kp gain of .4.00 and a Ki gain of 1.500. The set point is stored in %R0001, the control variable output in %AQ0002, and the process variable is returned in %AI0003. CV Upper and CV Lower Clamps must be set, in this case to 20000 and 4000, and an optional small Dead Band of +5 and -5 has been included. The 40-word RefArray starts in %R0100. Normally User Parameters are set in the RefArray, but %M0006 can be set to reinitialize the 14 words starting at %R0102 (%Ref+2) from constants stored in logic (a useful technique).



The block can be switched to Manual mode with %M1 so that the Manual Command, %R113, can be adjusted. Bits %M4 or %M5 can be used to increase or decrease %R113 and the PID CV and integrator by 1 every 100 MSec solution. For faster manual operation, bits %M2 and %M3 can be used to add or subtract the value in %R2 to/from %R113 every PLC sweep. The %T1 output is on when the PID is OK.

Chapter 21 Reading and Writing Data in Flash Memory

For Release 3.0 and later VersaMax Micro PLCs, two Service Request commands can be used to read or write flash memory during run time:

- SVCREQ 52: Reads from Flash Memory into Reference Memory
- SVCREQ 53: Writes from Reference Memory into Flash Memory

Chapter 18 gives details of using use these Service Request commands in the application program.

This chapter describes the Logic-driven Write to Flash feature, and gives application program examples.

Logic-Driven Write to Flash

For a VersaMax Micro PLC, one of the configuration choices is whether the CPU will read the initial values from flash or RAM at powerup. If RAM is the choice, the CPU will read the reference tables data from its RAM memory at powerup.

If “Read from flash” is the configured choice, the CPU will read previously-stored reference tables from flash memory at powerup. In addition, Release 3.0 and later VersaMax Micro PLCs (which includes all 64-Point Micro PLCs) will also read from flash all data that has been stored to flash using Service Request 53. This feature is called “Logic-drive write to flash”.

The logic-driven flash data area is cleared using the programmer. When storing an application to the PLC, if “Write All To Flash” is configured, all data that has been written to flash using Service Request 53 is automatically deleted. The data area can also be cleared by using the flash-eeprom tab and selecting Write All Data to Flash. This option is not available during Run mode due to the time required to erase flash.

Data Quantities

For 64-point Micro PLCs, the flash memory used for the Logic-driven write to flash feature has a total size of 8192 bytes. Of this, 8 bytes are reserved and cannot be used. So the maximum available capacity is 8184 bytes. For 14, 23, and 28-point Micro PLCs, the Logic-driven user flash memory is 64kB(65536 bytes) and the maximum available capacity is 65528 after 8 bytes are reserved.

Each execution of Service Request 52 or 53 can transfer:

- 1 to 10 words of %R, %AI, or %AQ reference data plus 6 bytes of command data. That means a 1-word write to flash requires 8 bytes of flash memory, while a 10-word write to flash requires 26 bytes of flash memory ((10 words X 2 bytes per word) + 6 bytes of command data).
- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data plus 6 bytes of command data. A 1-byte write to flash requires 7 bytes of flash memory, while a 10-byte write to flash occupies 16 bytes of flash memory.

Therefore, because each request requires 6 bytes of command data, the most efficient use of flash is by transferring data in 10-word increments.

If Flash Memory Becomes Full

If Service Request 53 attempts to write more data to flash memory than the maximum available, a fault is logged in the PLC Fault Table.

Fault Group	APPLICATION_FLT	22
Fault Action	DIAGNOSTIC	2
Error Code	USERFLASH_FULL	204
Error Message	*Logic Driven Userflash Full*	

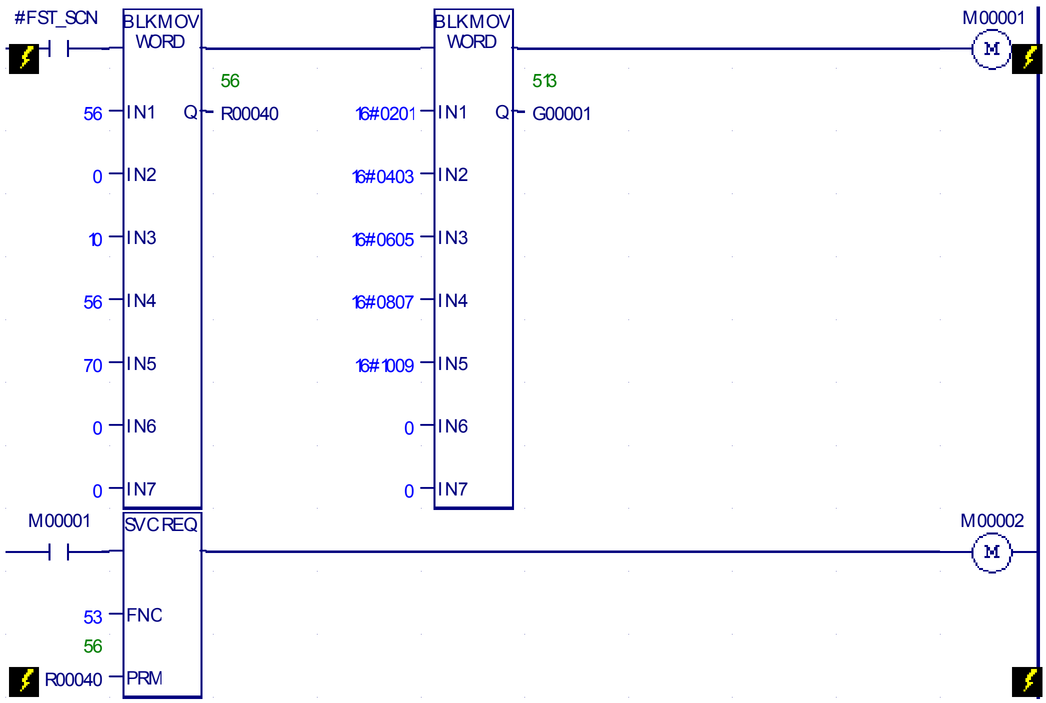
If a *Logic Driven Userflash Full* fault is logged in the PLC Fault Table, the PLC must be power-cycled.

After power-cycling the PLC, if another *Logic Driven Userflash Full* fault is logged, the contents of flash memory must be completely erased by downloading new logic with 'Write All To Flash' selected during download to PLC. After power-cycling the PLC, data can again be stored in flash until the *Logic Driven Userflash Full* " fault is logged again.

The same configuration and application program must be stored on RAM and PLC flash to use this feature. It should not be done with configuration stored with 'Read from flash' set and ladder program on RAM. If the program on RAM calls Service Request 53 to store reference memory on flash, then the PLC is power-cycled, if the configuration says to read data from flash, the data will be read but the application program may not be the same one that called Service Request 53.

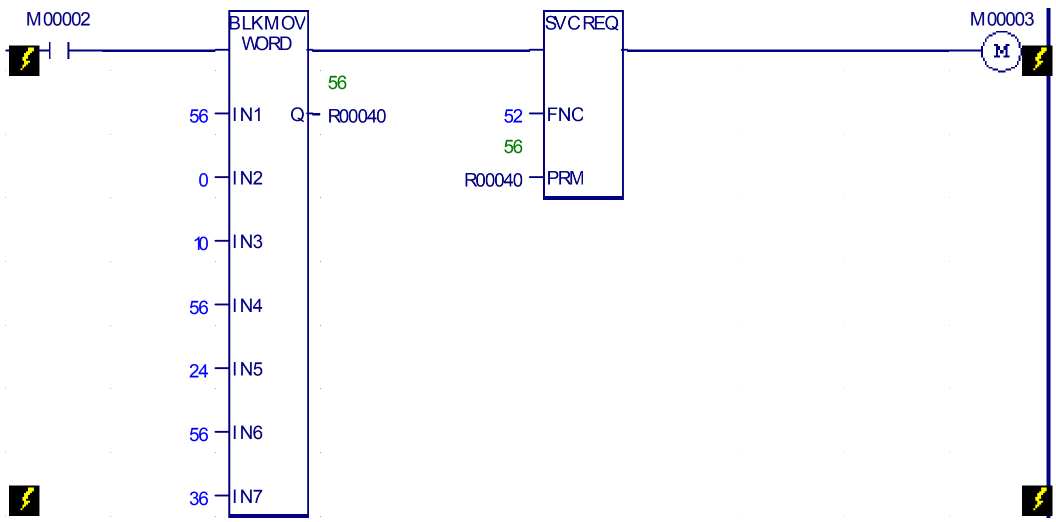
Example 1, Writing Data to Flash Memory

This example writes 10 continuous bytes from PLC references %G0001 through %G0080 into flash memory. In this example, the segment selector (56) is for byte access and so are the offsets and lengths.



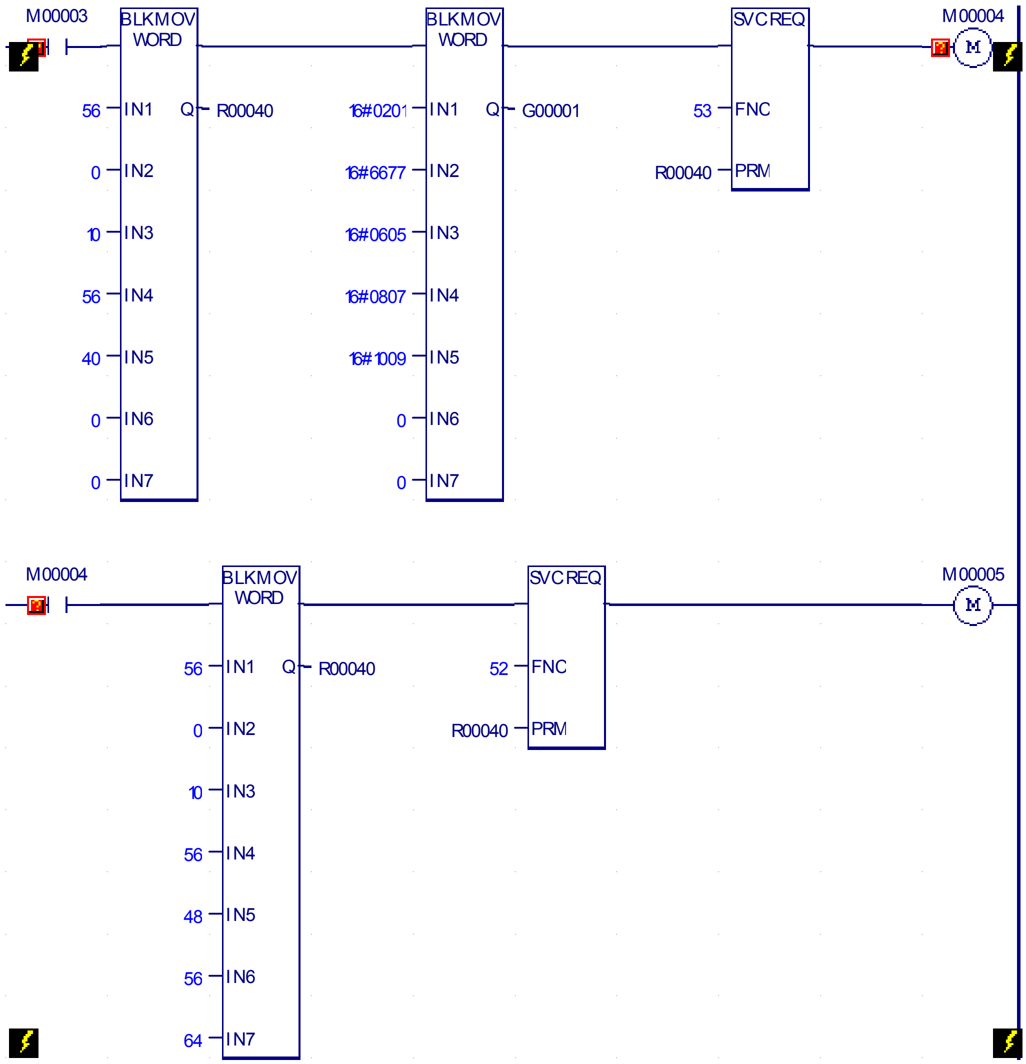
Example 2, Reading Data from Flash Memory

This example reads the same 10 continuous bytes from %G0001 through %G0080 from flash into %G reference memory into the PLC.



Example 3, Writing Over Data in Reference Memories

By changing values, the same logic can be used to write over some data in the same reference memories.



Results of Example 3

In this example, the status words returned for Service Request begin at PLC reference %G00321.

<--			%G00001					Address
00001000	00000111	00000110	00000101	01100110	01110111	00000010	00000001	%G00001
00001010	00000000	00000000	00000000	00000000	00000000	00010000	00001001	%G00065
00000000	00000000	00000000	00000000	00000000	00011111	11101000	00000000	%G00129
00001000	00000111	00000110	00000101	00000100	00000011	00000010	00000001	%G00193
00000000	00001010	00000000	00000001	00000000	00001010	00010000	00001001	%G00257
00000000	00000000	00011111	11011010	00000000	00001000	00000001	00000001	%G00321
00001000	00000111	00000110	00000101	01100110	01110111	00000010	00000001	%G00385
00000000	00000000	00000000	00000000	00000000	00000000	00010000	00001001	%G00449
00000000	00000001	00000000	00000000	00000000	00001010	00000000	00000001	%G00513
00000000	00000000	00000000	00000000	00011111	11101000	00000000	00001010	%G00577
00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	%G00641
00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	%G00705

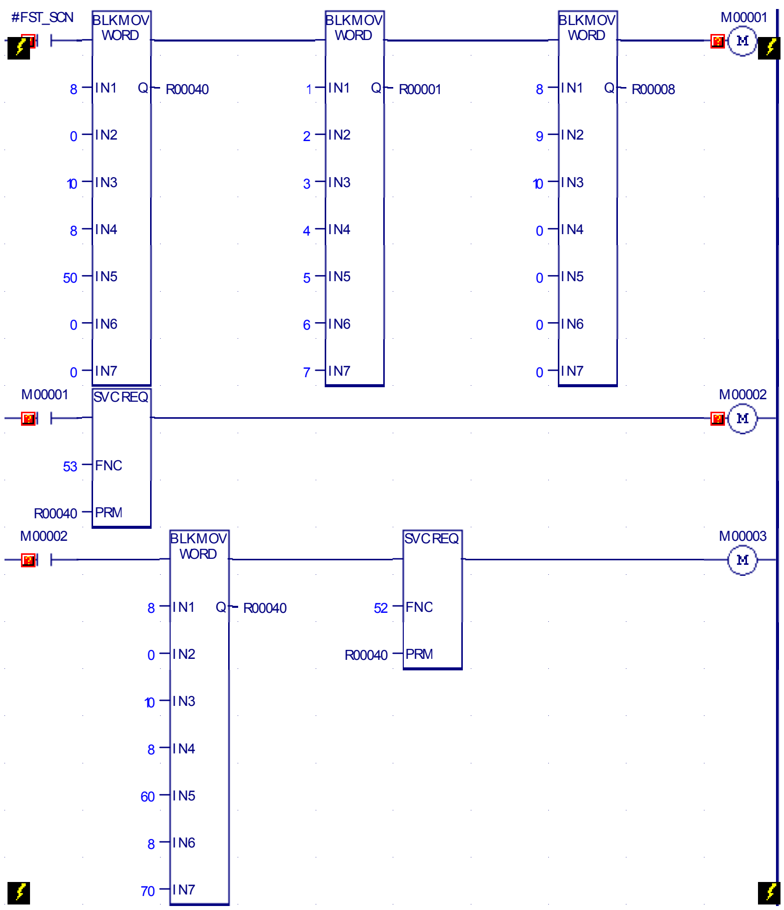
Example 4, Multiple Writes and Reads

This 4-part example shows how to perform multiple reads and writes on a 64-point CPU.

Example 4, Part 1

The first part of this example:

1. Writes %R0001 through %R0010 from PLC reference memory to flash. Return Write status data to PLC references starting at %R0051.
2. Reads back %R0001 through %R0010 from flash into CPU references %R0061 through %R0070. It returns status data into PLC references starting at %R0071.



Results of Example 4, Part 1

Looking at the references used by this part of Example 4:

- %R0051 shows the Write status as 1. That means all data was successfully written.
- %R0052 shows that 10 words of data have been written to flash.
- %R0053 shows the remaining available flash memory as 8158 bytes. Note: The available memory will be 65518 for 14, 23, or 28-point Micro PLCs.

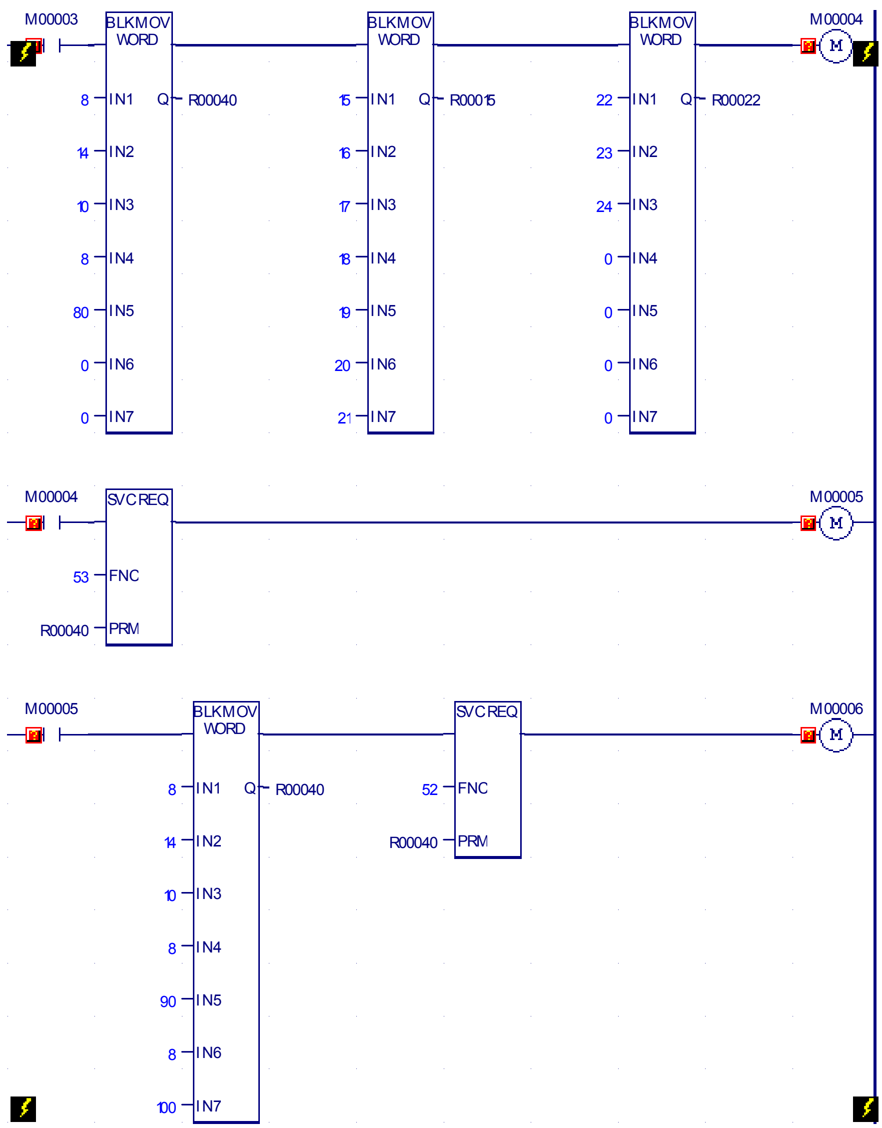
The Read status references are not shown here.

+10	+9	8	7	6	5	4	3	2	1	%R00001
+0	+0	+0	1717	1616	1515	14	13	12	11	%R00011
+0	+0	+0	+0	+0	+0	+24	23	22	+0	%R00021
+8	+0	+0	+0	+0	0	0	0	0	0	%R00031
+0	+0	+0	+0	+170	+8	+160	8	10	20	%R00041
+0	+0	+0	0	0	0	0	8158	10	1	%R00051

Example 4, Part 2

The next part of Example 4:

1. Writes the contents of PLC references %R0015 through %R0024 into flash. It returns Write status data to PLC references starting at %R0081.
2. Reads flash references %R0015 through %R0024 into PLC references %R0091 through %R0100 and returns Read status information to PLC references starting at %R0101.



Results of Example 4, Part 2

For Example 4, Part 2, the Write status references start at %R0081:

- %R0081 shows status as 1 signifying full success (all data written)
- %R0082 shows that 10 words of data have been stored
- %R0083 shows that the available flash memory is 8132

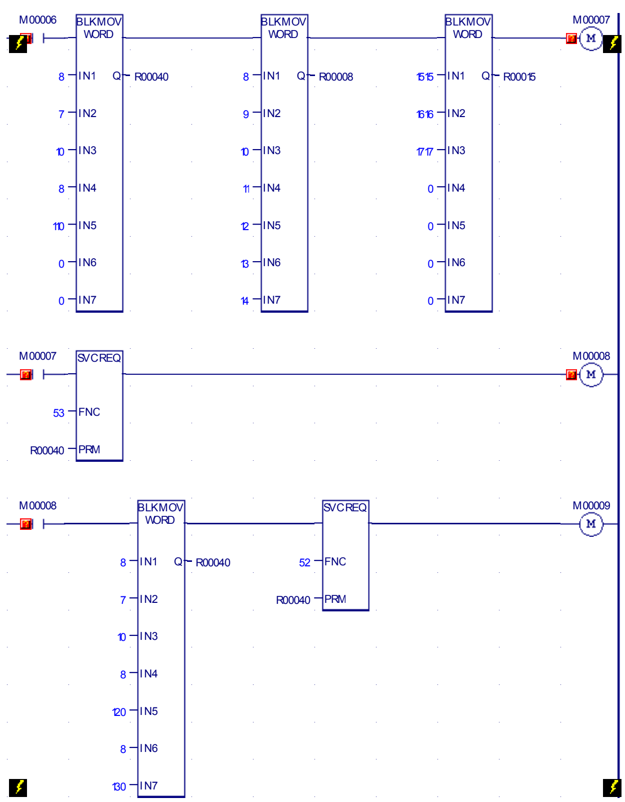
The Read status references, which start at %R101, are not shown here. However, the Write status references from part 1 of this example, starting at %R0051, are shown.

+10	+9	8	7	6	5	4	3	2	1	%R00001
+0	+0	+0	1717	1616	1515	14	13	12	11	%R00011
+0	+0	+0	+0	+0	+0	+24	23	22	+0	%R00021
+8	+0	+0	+0	+0	0	0	0	0	0	%R00031
+0	+0	+0	+0	+170	+8	+160	8	10	20	%R00041
+0	+0	+0	0	0	0	0	8158	10	1	%R00051
+10	+9	+8	+7	6	5	4	3	2	1	%R00061
+0	+0	+0	+0	+0	+0	+0	0	10	1	%R00071
+0	+0	+0	+0	0	+0	+0	8132	10	1	%R00081

Example 4, Part 3

This part of Example 4:

1. Writes PLC references %R0008 through %R0017 to flash and returns Write status data to PLC references starting at %R0111. This single Service Request:
   - Overwrites the values in %R0008 through %R0010 that were written in Example 4 Part 1.
   - Writes new data into %R0011 through %R0014.
   - Overwrites the values in %R0015 through %R0017 that were written in Example 4 Part 2.
2. Reads %R0008 through %R017 from flash into PLC references %R0121 through %R0130 and returns Read status data to PLC references starting at %R0131.



Results of Example 4, Part 3

For Example 4, Part 3, the Write status references start at %R0111:

- The value in status reference %R0111 is 257 (0x0101). That indicates partial success, because not all 10 bytes of data were written to flash. Error 257 may occur if some requested data is already stored in user flash, as was done in this example.
- %R0112 shows that only 7 words of data were stored, not the 10 words requested.
- %R0113 shows that the remaining available flash memory is 8112 bytes.

The Read status references start at %R0131:

- %R0131 shows that the Read Service Request completed successfully.
- %R0132 shows that 10 words of data were read.

+10	+9	8	7	6	5	4	3	2	1	%R00001
+0	+0	+0	1717	1616	1515	14	13	12	11	%R00011
+0	+0	+0	+0	+0	+0	+24	23	22	+0	%R00021
+8	+0	+0	+0	+0	0	0	0	0	0	%R00031
+0	+0	+0	+0	+170	+8	+160	8	10	20	%R00041
+0	+0	+0	0	0	0	0	8158	10	1	%R00051
+10	+9	+8	+7	6	5	4	3	2	1	%R00061
+0	+0	+0	+0	+0	+0	+0	0	10	1	%R00071
+0	+0	+0	+0	0	+0	+0	8132	10	1	%R00081
+24	+23	+22	+21	+20	+19	+18	+17	+16	+15	%R00091
+0	+0	+0	+0	+0	+0	+0	+0	+10	+1	%R00101
+0	+0	+0	+0	+0	+0	+0	8112	7	257	%R00111
+1717	+1616	+1515	+14	+13	+12	+11	+10	+9	+8	%R00121
+0	+0	+0	+0	+0	+0	+0	+0	+10	+1	%R00131

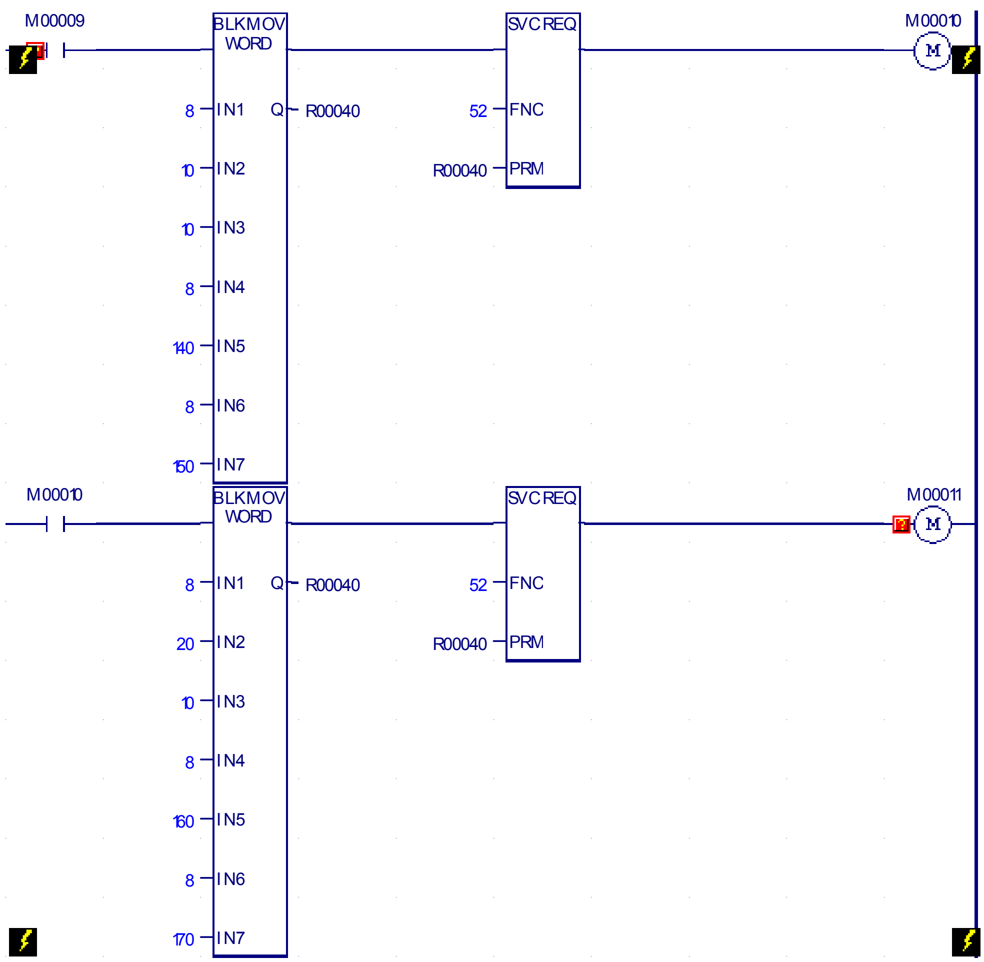
%R00094

Example 4, Part 4

This part of the example program logic:

1. Reads flash references %R0011 through %R0020 into PLC references %R0141 through %R0150 and returns Read status information to PLC memory starting at %R0151.

2. Reads flash references %R0021 through %R0030 into PLC references %R0161 through %R0170 and returns Read status information to PLC memory starting at %R0171.



Results of Example 4, Part 4

For Example 4, Section 4, the Read status references start at %R0151 and %R0171:

- The value in Read status reference %R0151 is 1. The Read operation was successful.
- %R0152 shows that all 10 words of data were read into PLC memory.
- The value in Read status reference %R0171 is 257 (0x0101). That indicates partial success, because not all 10 bytes of data were written to flash. That can occur if not enough memory is available in the selected PLC reference area for the data that has been read from flash.
- %R0172 shows that only 4 words of data were read.

	<--	Unsigned Decimal		0000000100000001			%R00111			Address
+10	+9	8	7	6	5	4	3	2	1	%R00001
+0	+0	+0	1717	1616	1515	14	13	12	11	%R00011
+0	+0	+0	+0	+0	+0	+24	23	22	+0	%R00021
+8	+0	+0	+0	+0	0	0	0	0	0	%R00031
+0	+0	+0	+0	+170	+8	+160	8	10	20	%R00041
+0	+0	+0	0	0	0	0	8158	10	1	%R00051
+10	+9	+8	+7	6	5	4	3	2	1	%R00061
+0	+0	+0	+0	+0	+0	+0	0	10	1	%R00071
+0	+0	+0	+0	0	+0	+0	8132	10	1	%R00081
+24	+23	+22	+21	+20	+19	+18	+17	+16	+15	%R00091
+0	+0	+0	+0	+0	+0	+0	+0	+10	+1	%R00101
+0	+0	+0	+0	+0	+0	+0 (%R00094)	8112	7	257	%R00111
+1717	+1616	+1515	+14	+13	+12	+11	+10	+9	+8	%R00121
+0	+0	+0	+0	+0	+0	+0	+0	+10	+1	%R00131
+20	+19	+18	+1717	+1616	+1515	+14	+13	+12	+11	%R00141
+0	+0	+0	+0	+0	+0	+0	+0	+10	+1	%R00151
+0	+0	+0	+0	+0	+0	+24	+23	+22	+21	%R00161
+0	+0	+0	+0	+0	+0	+0	+0	4	257	%R00171
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	%R00181

_MAIN | %R - Register

Appendix A

Instruction Timing

This appendix contains tables listing the memory size in bytes and the execution times in microseconds for each function supported by a VersaMax Nano PLC or Micro PLC.

- Notes on Timing Information
- Typical Execution Times for Boolean Contacts
- Typical Execution Times for Release 3.0 CPUs
- Typical Execution Times for Release 2.0 CPUs
- Typical Execution Times for Release 1.1 CPUs
- Typical Execution Times for Release 1.0 CPUs

Notes on the Timing Information

Execution Times with Function Block Enabled or Disabled

Two execution times are shown for each type of function block, labeled "enabled" and "disabled".

For each instance of the function block in the logic program:

- the value in the "enabled" column represents a range of typical contribution times when the function block receives power flow during that sweep.
- the value in the "disabled" column represents the typical contribution time when the function block is not receiving power flow during that sweep and/or there is power flow to reset of the function block.
- All timing values represent typical execution time. Actual execution time may vary with input and error conditions.

Additional Notes

1. Timers and counters are updated each time they are encountered in the logic; timers by the amount of time consumed by the last sweep and counters by one count.
2. For bit operation functions, L = the number of bits. For bit position, N = the bit that is set. For data move functions, N = the number of bits or words. B= the number of bits shifted more than 1 (that is, not counting the first bit). W = the number of words.
3. Memory size refers to the number of bytes required by the function in a ladder diagram application program.
4. For table functions, increment is in units of length specified.
5. Enabled time for single length units of type %R, %AI, and %AQ.
6. The DO I/O function block timing represents execution on 8 points (%I0001 to %I0008).

Typical Execution Times for Boolean Contacts

Boolean contact execution times for Boolean logic are as follows:

	Release 3.0	**release 2.0 and 1.10**	**release 1.07**	**release 1.05**	**release 1.0**
10-point Nano PLCs	1.4 ms/K	1.3 ms/K	N/A	N/A	1.2 ms/K
14-point Micro PLCs	1.5 ms/K	1.1 ms/K	N/A	N/A	1.0 ms/K
23-point Micro PLCs	1.5 ms/K	1.1 ms/K	N/A	N/A	1.0 ms/K
28-point Micro PLCs	1.5 ms/K	1.1 ms/K	N/A	1.0 ms/K	1.0 ms/K
28-point Micro PLC with ESCP (IC200UDD120	1.3 ms/K	1.0 ms/K	1.0 ms/K	N/A	N/A
64-point Micro PLC	1.7 ms/K	N/A	N/A	N/A	N/A

Sweep Times for Micro-64 CPUs

No expansion units connected = 2.9ms to 3.1ms

With 1 expansion unit = 3.5ms to 3.8ms

With 2 expansion unit = 3.8ms to 4ms

With 3 expansion unit = 4.3ms to 4.5ms

With 4 expansion unit = 4.4ms to 5ms

Typical Execution Times for Release 3.0 CPUs

The following table details function block timing for Release 3.0, Micro-64 PLCs.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

			Execution Time(Range in µsec.) per PLC Type							
			64-Point		14/23/28 pt		28pt ESCP		Nano	
Group	**Function**	**Size bytes**	**Enabled**	**Dis-abled**	**En-abled**	**Dis-abled**	**En-abled**	**Dis-abled**	**En-abled**	**Dis-abled**
Timers	Off Delay Timer	15	68-76	49-56	64-71	35-41	55-60	31-36	61-67	33-38
	On Delay Timer	15	70-78	55-62	79-85	43-49	63-69	37-42	71-76	40-45
	Elapsed Timer	15	69-74	36-42	66-71	53-58	49-53	39-43	60-64	49-53
Counters	Up Counter	13	44-51	40-47	57-63	54-61	41-46	39-45	53-59	50-55
	Down Counter	13	64-71	62-69	48-55	47-53	41-47	39-45	42-48	40-46
Math	Addition (INT)	13	33-38	4-10	30-35	4-9	27-31	4-8	28-33	4-8
	Addition (DINT)	19	45-51	4-10	41-47	4-9	35-39	4-8	38-43	4-8
	Addition (REAL)	17	134-139	4-10	109-114	4-9	87-91	4-8	114-119	4-8
	Subtraction (INT)	13	24-29	3-8	26-31	4-9	21-25	3-7	24-29	4-8
	Subtraction (DINT)	19	29-34	3-8	31-36	4-9	24-28	3-7	29-33	4-8
	Subtraction (REAL)	17	104-109	3-8	125-130	4-9	88-91	3-7	113-117	4-8
	Multiplication (INT)	13	37-42	4-10	34-39	4-9	30-34	4-8	31-36	4-8
	Multiplication (DINT)	13	28-33	4-10	25-30	4-9	23-27	4-8	23-27	4-8
	Multiplication (REAL)	17	134-139	4-10	126-131	4-9	101-104	4-8	106-110	4-8
	Division (INT)	13	54-59	4-10	43-48	4-9	37-41	4-8	44-49	4-8
	Division (DINT)	19	42-47	5-10	27-32	4-9	25-28	4-8	37-42	4-8
	Division (REAL)	17	220-225	5-10	206-211	4-9	165-169	4-8	184-188	4-8
	Modulo Division (INT)	13	45-50	5-10	43-49	4-9	38-42	4-8	45-50	4-8
	Modulo Division (DINT)	19	54-60	5-10	41-46	4-9	36-39	4-8	49-53	4-8
	Square Root (INT)	10	29-34	3-8	32-37	4-9	24-28	3-7	29-34	4-8
	Square Root (DINT)	13	34-39	3-8	36-42	4-9	30-34	3-7	34-39	4-8
	Square Root (REAL)	11	453-459	3-8	498-504	4-9	336-340	3-7	449-454	4-8

Typical Execution Times for Release 3.0 CPUs, continued

			Execution Time(Range in µsec.) per PLC Type							
			64-Point		14/23/28 pt		28pt ESCP		Nano	
Group	Function	Size bytes	Enabled	Dis-abled	Enabled	Dis-abled	Enabled	Dis-abled	Enabled	Dis-abled
Trigonometric	SIN (REAL)	11	1142-1148	3-8	1246-1251	4-9	869-873	3-7	1131-1135	4-8
	COS (REAL)	11	1328-1333	4-10	1212-1217	4-9	964-967	4-8	1088-1092	4-8
	TAN (REAL)	11	1633-1639	3-8	1634-1639	4-9	1290-1293	3-7	1634-1639	4-8
	ASIN (REAL)	11	1633-1639	5-10	1634-1639	4-9	1383-1387	4-8	1581-1586	4-8
	ACOS (REAL)	11	1633-1639	4-10	1634-1639	4-9	1354-1358	4-8	1537-1542	4-8
	ATAN (REAL)	11	850-856	4-10	782-788	4-9	616-620	4-8	704-709	4-8
Logarithmic	LOG (REAL)	11	889-894	5-10	826-831	4-9	650-654	4-8	744-749	4-8
	LN (REAL)	11	820-825	4-10	757-762	4-9	597-600	4-8	690-694	4-8
Exponential	Power of e	11	618-623	4-10	562-568	4-9	442-446	4-8	512-517	4-8
	Power of X	11	339-344	4-10	327-332	4-9	254-258	4-8	294-299	4-8
Radian Conv	Convert RAD to DEG	11	347-353	5-10	319-324	4-9	252-256	34-38	295-300	4-8
	Convert DEG to RAD	17	78-84	4-10	78-83	4-9	63-67	4-8	75-79	4-8
Relational	Equal (INT)	10	25-30	4-10	22-28	4-9	20-24	4-8	21-26	4-8
	Equal (DINT	16	19-25	4-10	18-23	4-9	17-20	4-8	16-21	4-8
	Equal (REAL)	14	36-41	4-10	31-36	4-9	27-31	4-8	34-39	4-8
	Not Equal (INT)	10	17-22	4-10	15-21	4-9	15-18	4-8	14-19	4-8
	Not Equal (DINT)	16	33-38	5-10	29-35	4-9	26-29	4-8	28-32	4-8
	Not Equal (REAL)	14	45-51	4-10	35-40	4-9	30-34	4-8	35-39	4-8
	Greater Than (INT)	10	28-33	4-10	26-31	4-9	22-26	4-8	24-29	4-8
	Greater Than (DINT)	16	22-27	4-10	19-25	4-9	18-21	4-8	18-23	4-8
	Greater Than (REAL)	14	48-53	4-10	34-39	4-9	30-33	4-8	32-37	4-8
	Greater Than/Equal (INT)	10	17-22	4-10	16-21	4-9	14-18	4-8	15-19	4-8
	Greater Than/Equal (DINT)	16	19-24	5-10	17-23	4-9	16-20	4-8	16-20	4-8
	Greater Than/Equal (REAL)	14	37-42	4-10	34-39	4-9	29-33	4-8	21-26	4-8
	Less Than (INT)	10	17-22	4-10	15-21	4-9	14-18	4-8	14-19	4-8
	Less Than (DINT)	16	19-24	4-10	17-22	4-9	16-20	4-8	16-20	4-8
	Less Than (REAL)	14	37-42	4-10	23-29	4-9	22-25	4-8	22-26	4-8
	Less Than/Equal (INT)	10	17-22	4-10	15-21	4-9	15-19	4-8	15-19	4-8
	Less Than/Equal (DINT)	16	19-24	4-10	17-22	4-9	16-20	4-8	16-20	4-8
	Less Than/Equal (REAL)	14	37-42	5-10	24-29	4-9	22-25	4-8	22-26	4-8
	Range (INT)	13	21-26	4-10	19-25	4-9	18-22	4-8	18-22	4-8
	Range (DINT)	22	23-29	4-10	21-27	4-9	20-24	4-8	20-24	4-8
	Range (WORD)	13	21-26	5-10	19-24	4-9	18-21	4-8	18-23	4-8

Typical Execution Times for Release 3.0 CPUs, continued

			Execution Time(Range in µsec.) per PLC Type							
			64-Point		14/23/28 pt		28pt ESCP		Nano	
Group	Function	Size bytes	Enabled	Dis-abled	En-abled	Dis-abled	En-abled	Dis-abled	En-abled	Dis-abled
Bit Operation	Logical AND	13	33-38	4-10	31-36	4-9	27-31	4-8	28-32	4-8
	Logical OR	13	34-39	4-10	30-35	4-9	27-31	4-8	28-32	4-8
	Logical Exclusive OR	13	28-33	3-8	30-35	4-9	23-27	3-7	28-33	4-8
	Logical Invert, NOT	10	29-35	4-10	27-32	4-9	24-27	4-8	25-29	4-8
	Shift Bit Left	16	158-164	4-10	118-123	5-10	127-131	4-8	161-166	5-9
	Shift Bit Right	16	102-108	4-10	113-118	5-10	80-84	4-8	103-107	5-9
	Rotate Bit Left	16	98-103	5-10	84-89	4-9	67-71	4-8	76-81	4-8
	Rotate Bit Right	16	88-93	5-10	88-93	4-9	71-75	4-8	80-84	4-8
	Bit Position	13	48-53	4-10	43-48	4-9	38-41	4-8	40-44	4-8
	Bit Clear	13	51-56	4-10	46-52	4-9	34-38	3-7	43-47	4-8
	Bit Test	13	32-37	4-10	29-35	4-9	26-29	4-8	27-32	4-8
	Bit Set	13	43-48	4-10	39-44	4-9	34-38	4-8	37-41	4-8
	Mask Compare (WORD)	25	122-127	4-9	108-113	4-9	89-93	3-7	99-104	3-8
	Mask Compare (DWORD)	25	97-102	4-10	94-99	3-9	77-81	3-7	80-84	4-8
Data Move	Move (INT)	10	22-27	5-10	20-25	4-9	18-22	4-8	18-23	4-8
	Move (BOOL)	13	53-58	4-10	49-54	4-9	42-46	4-8	45-50	4-8
	Move (WORD)	10	22-27	4-10	20-25	4-9	18-22	4-8	18-23	4-8
	Move (REAL)	13	31-37	5-10	28-33	4-9	26-29	4-8	26-31	4-8
	Block Move (INT)	28	28-34	5-10	26-31	4-9	24-27	4-8	24-28	4-8
	Block Move (WORD)	28	28-34	4-10	25-31	4-9	24-27	4-8	24-28	4-8
	Block Move (REAL)	13	51-57	4-10	47-52	4-9	43-47	4-8	51-55	10-14
	Block Clear (WORD)	11	47-52	4-10	43-48	4-9	38-42	4-8	40-45	4-8
	Shift Register (BIT)	16	89-94	4-10	95-100	5-10	69-72	4-8	87-92	5-9
	Shift Register (WORD)	16	63-69	4-10	73-78	5-10	54-58	4-8	67-71	5-9
	Bit Sequencer	16	82-91	78-87	71-79	67-75	59-65	56-62	73-81	70-77
	COMM_REQ	13	82-87	16-21	75-80	12-17	62-66	11-15	65-70	16-21

Typical Execution Times for Release 3.0 CPUs, continued

Group	Function	Size bytes	Execution Time(Range in µsec.) per PLC Type: 64-Point En-abled	64-Point Dis-abled	14/23/28 pt En-abled	14/23/28 pt Dis-abled	28pt ESCP En-abled	28pt ESCP Dis-abled	Nano En-abled	Nano Dis-abled
Table	Array Move (INT)	22	74-79	4-10	67-72	4-9	58-61	4-8	62-66	4-8
	Array Move(DINT)	22	65-71	4-10	60-65	4-9	52-56	4-8	54-58	4-8
	Array Move (BOOL)	22	105-110	4-10	90-95	4-9	75-79	4-8	83-87	4-8
	Array Move (BYTE)	22	68-74	4-10	63-68	4-9	54-58	4-8	58-62	4-8
	Array Move (WORD)	22	73-79	5-10	66-72	4-9	58-61	4-8	62-66	4-8
	Search Equal (INT)	19	60-66	5-10	58-63	4-9	49-53	4-8	53-58	4-8
	Search Equal (DINT)	22	61-67	5-10	53-58	4-9	45-49	4-8	48-52	4-8
	Search Equal (BYTE)	19	43-48	5-10	49-54	4-9	42-46	4-8	45-50	4-8
	Search Equal (WORD)	19	62-67	5-10	58-63	4-9	49-53	4-8	54-58	4-8
	Search Not Equal (INT)	19	45-50	3-8	59-64	4-9	44-48	3-7	54-59	4-8
	Search Not Equal (DINT)	22	52-58	3-8	52-57	4-9	41-44	3-7	48-53	4-8
	Search Not Equal (BYTE)	19	29-35	3-8	41-46	4-9	31-35	3-7	38-43	4-8
	Search Not Equal (WORD)	19	45-51	3-8	59-64	4-9	44-48	3-7	54-59	4-8
	Search Greater/Equal (INT)	19	49-54	5-10	53-58	4-9	40-44	3-7	49-54	4-8
	Search Greater/Equal (DINT)	22	51-56	5-10	54-59	4-9	40-44	3-7	51-55	4-8
	Search Greater/Equal (BYTE)	19	48-53	5-10	38-43	4-9	30-34	3-7	34-39	4-8
	Search Greater/Equal (WORD)	19	58-63	5-10	50-55	4-9	38-42	3-7	46-50	4-8
	Search Greater Than (INT)	19	51-57	3-8	55-60	4-9	42-46	3-7	51-56	4-8
	Search Greater Than (DINT)	22	54-59	3-8	49-54	4-9	38-41	3-7	46-51	4-8
	Search Greater Than (BYTE)	19	45-50	3-8	47-52	4-9	36-40	3-7	44-48	4-8
	Search Greater Than (WORD)	19	45-50	3-8	49-54	4-9	38-42	3-7	46-51	4-8
	Search Less Than (INT)	19	42-47	3-8	57-62	4-9	42-46	3-7	53-57	4-8
	Search Less Than (DINT)	22	51-57	3-8	66-72	4-9	49-53	3-7	61-66	4-8
	Search Less Than (BYTE)	19	43-49	3-8	38-43	4-9	30-33	3-7	36-40	4-8
	Search Less Than (WORD)	19	57-63	3-8	55-60	4-9	41-45	3-7	50-54	4-8
	Search Less/Equal (INT)	19	53-58	3-8	55-60	4-9	41-45	3-7	52-56	4-8
	Search Less/Equal (DINT)	22	55-60	3-8	58-63	4-9	43-46	3-7	54-58	4-8
	Search Less/Equal (BYTE)	19	42-47	3-8	32-37	4-9	25-29	3-7	30-34	4-8
	Search Less/Equal (WORD)	19	44-49	3-8	42-47	4-9	32-36	3-7	39-43	4-8

Typical Execution Times for Release 3.0 CPUs, continued

Group	Function	Size bytes	Execution Time(Range in µsec.) per PLC Type							
			64-Point		14/23/28 pt		28pt ESCP		Nano	
			En-abled	Dis-abled	En-abled	Dis-abled	En-abled	Dis-abled	En-abled	Dis-abled
Conversion	Convert INT to REAL	10	33-39	4-10	34-39	4-9	29-32	4-8	28-33	4-8
	Convert REAL to INT	13	723-729	4-10	683-688	4-9	543-547	4-8	629-634	4-8
	Convert DINT to REAL	13	29-34	4-10	35-41	4-9	30-34	4-8	25-29	4-8
	Convert REAL to DINT	13	741-747	5-10	671-676	4-9	532-535	4-8	610-615	4-8
	Convert WORD to REAL	10	38-43	4-10	31-36	4-9	23-27	3-7	26-30	4-8
	Convert REAL to WORD	13	728-733	4-10	666-671	4-9	529-533	4-8	612-616	4-8
	Convert BDC to INT	10	51-56	4-10	29-34	4-9	25-29	4-8	26-31	4-8
	Convert INT to BCD	10	107-112	4-10	86-91	4-9	74-78	4-8	78-82	4-8
	Convert BCD to REAL	10	51-56	4-10	37-42	4-9	31-35	4-8	47-52	4-8
	Truncate to INT	13	149-155	3-8	168-173	4-9	117-121	3-7	148-152	4-8
	Truncate to DINT	13	142-147	3-8	161-166	4-9	113-117	3-7	141-145	4-8
Control	Call a Subroutine	7	31-36	2-7	28-33	2-7	26-30	2-6	25-29	2-6
	Do I/O	13	248-253	5-10	207-212	4-9	166-170	4-8	167-171	4-8
	Service Request #6	10	51-56	3-8	59-64	4-9	43-47	3-7	53-57	4-8
	Service Request #7 Read	10	296-301	3-9	308-313	4-9	221-225	3-7	0-0	0-0
	Service Request #7 Write	10	1372-1378	1-5	281-286	1-6	194-198	1-4	0-0	0-0
	Service Request #9	10	82-88	3-8	102-107	4-9	72-76	3-7	90-95	4-8
	Service Request #14	10	245-251	3-8	258-263	4-9	208-212	4-8	104-109	4-8
	Service Request #15	10	146-151	3-8	156-161	4-9	126-130	4-8	132-136	4-8
	Service Request #16	10	71-77	3-8	91-96	4-9	74-77	4-8	71-75	4-8
	Service Request #18	10	65-70	3-8	67-72	4-9	59-63	4-8	55-59	4-8
	Service Request #23	10	212-217	3-8	236-242	4-9	173-177	3-7	207-212	4-8
	Service Request #26, #30	10	323-328	3-8	342-347	4-9	279-283	4-8	293-298	4-8
	Service Request #29	10	39-44	3-8	56-61	4-9	47-51	4-8	40-44	4-8
	Service Request #34	10	na	na	57-62	4-9	n/a	n/a	n/a	n/a
	Service Request #35	10	na	na	494-499	4-9	n/a	n/a	n/a	n/a
	Service Request #52	10	364-369	3-8	333-338	4-9	281-285	4-8	n/a	n/a
	Service Request #53	10	3-4	2-4	3-5	1-5	3-4	2-4	3-4	1-4
	Nested MCR/ENDMCR	4	213-222	46-55	196-204	42-50	155-162	37-43	191-198	50-57
	PID-ISA Algorithm	16	213-221	46-54	196-204	42-50	155-161	37-43	191-198	50-58
	PID-IND Algorithm	16	82-87	16-21	75-80	12-17	62-66	11-15	65-70	16-21

Typical Execution Times for Release 2.0 CPUs

The following table details function block timing for Release 2.0, Micro PLCs and Nano PLCs. PLCs are grouped by similar types: Nano PLCs, 14/23/28 Point Micro PLCs, and 28-Point Micro PLCS with ESCP.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

			Execution Time (Range in µsec.)					
			Function Enabled			Function Disabled		
Group	**Function**	**Size (bytes)**	**14/23/28 pt**	**28pt ESCP**	**Nano**	**14/23/28 pt**	**28pt ESCP**	**Nano**
Timers	Off Delay Timer	15	64-112	54-75	63-93	46-76	39-53	44-67
	On Delay Timer	15	63-120	66 - 79	61-100	45-83	40-58	42-71
	Elapsed Timer	15	58-114	59-75	56-96	34-75	40-52	32-66
Counters	Up Counter	13	67-69	–50-53	89-136	63-64	48-48	47-74
	Down Counter	13	47-82	57-63	43-79	39-77	50-60	37-75
Math	Addition (INT)	13	30-63	27-45	28-55	6-10	5-8	6-10
	Addition (DINT)	19	41-57	35-43	38-54	6-10	5-8	6-10
	Addition (REAL)	17	89-121	–77-91	87-118	6-10	5-8	6-10
	Subtraction (INT)	13	26-62	24-45	26-55	6-10	5-8	6-10
	Subtraction (DINT)	19	36-57	27-44	30-53	6-10	5-8	6-10
	Subtraction (REAL)	17	96-112	–83-90	100-117	6-10	5-8	6-9
	Multiplication (INT)	13	34-66	30-47	31-57	6-10	5-8	6-10
	Multiplication (DINT)	13	25-56	23-44	24-53	6-10	5-8	6-10
	Multiplication (REAL)	17	106-149	97-114	109-141	6-10	5-8	6-10
	Division (INT)	13	42-77	34-55	39-67	6-10	5-8	6-10
	Division (DINT)	19	27-65	28-50	26-61	6-10	5-8	6-10
	Division (REAL)	17	187-241	152-186	179-229	6-10	5-8	6-10
	Modulo Division (INT)	13	46-86	38-61	40-75	6-10	5-8	6-10
	Modulo Division (DINT)	19	41-72	38-55	38-68	6-10	5-8	6-10
	Square Root (INT)	10	43-82	38-64	41-79	6-9	5-8	6-10
	Square Root (DINT)	13	51-83	34-77	34-96	6-10	5-8	5-10
	Square Root (REAL)	11	437-534	351 - 406	420-506	6-10	5-8	6-10

Typical Execution Times for Release 2.0 CPUs, continued

			Execution Time (Range in μsec.)					
			Function Enabled			Function Disabled		
Group	**Function**	**Size (bytes)**	**14/23/28 pt**	**28pt ESCP**	**Nano**	**14/23/28 pt**	**28pt ESCP**	**Nano**
Trigonometric	SIN (REAL)	11	1103-1523	919-1156	1064-1446	6-10	5-8	6-10
	COS (REAL)	11	1091-1519	908-1192	1048-1444	6-10	5-8	5-9
	TAN (REAL)	11	1691-2256	1370-1708	1622-2144	8-12	5-9	7-10
	ASIN (REAL)	11	1528-1638	1274-1479	1507-1639	6-10	5-8	6-10
	ACOS (REAL)	11	1528-1639	1220-1442	1507-1638	6-10	5-8	6-9
	ATAN (REAL)	11	695-867	564-671	678-822	6-10	5-8	6-10
Logarithmic	LOG (REAL)	11	734-926	599-710	709-878	6-10	5-8	6-10
	LN (REAL)	11	672-866	555-659	646-821	6-10	5-8	6-10
Exponential	Power of e	11	516-623	411-472	497-591	6-10	5-8	6-10
	Power of X	11	292-379	226-287	276-359	6-10	5-8	6-10
Radian Conv	Convert RAD to DEG	11	288-326	238-252	274-308	6-10	5-8	6-10
	Convert DEG to RAD	17	70-100	59-77	66-95	6-10	5-8	6-10
Relational	Equal (INT)	10	25-36	21-28	24-34	8-12	7-9	7-11
	Equal (DINT	16	21-44	19-34	20-42	8-12	7-9	7-10
	Equal (REAL)	14	33-57	29-44	31-54	8-12	7-9	7-11
	Not Equal (INT)	10	18-36	17-28	18-34	8-12	7-9	7-11
	Not Equal (DINT)	16	32-42	27-32	30-39	8-12	7-9	7-11
	Not Equal (REAL)	14	37-57	32-44	34-54	8-12	7-9	7-11
	Greater Than (INT)	10	28-36	24-28	27-34	8-12	7-9	7-11
	Greater Than (DINT)	16	22-42	20-32	21-40	8-12	7-9	7-11
	Greater Than (REAL)	14	37-58	31-44	34-54	8-12	7-9	7-11
	Greater Than/Equal (INT)	10	19-36	17-28	17-34	8-12	7-9	7-11
	Greater Than/Equal (DINT)	16	20-42	19-32	19-39	8-12	7-9	7-11
	Greater Than/Equal (REAL)	14	29-57	32-44	34-54	8-12	7-9	7-11
	Less Than (INT)	10	19-36	16-28	18-34	8-12	7-9	7-11
	Less Than (DINT)	16	20-42	18-32	19-39	8-12	7-9	7-11
	Less Than (REAL)	14	36-58	23-44	24-54	8-12	7-9	7-11
	Less Than/Equal (INT)	10	18-36	17-28	17-34	8-12	7-9	7-11
	Less Than/Equal (DINT)	16	20-42	18-32	19-39	8-12	7-9	7-11
	Less Than/Equal (REAL)	14	26-58	23-44	24-54	8-12	7-9	7-11
	Range (INT)	13	22-44	20-34	20-42	8-12	7-9	7-11
	Range (DINT)	22	24-51	20-39	22-48	8-12	7-9	7-11
	Range (WORD)	13	22-43	20-33	20-41	8-12	7-9	7-11

Typical Execution Times for Release 2.0 CPUs, continued

			Execution Time (Range in µsec.)					
			Function Enabled			Function Disabled		
Group	**Function**	**Size (bytes)**	**14/23/ 28 pt**	**28pt ESCP**	**Nano**	**14/23/ 28 pt**	**28pt ESCP**	**Nano**
Bit Operation	Logical AND	13	30-55	27-42	29-52	6-10	5-8	6-10
	Logical OR	13	30-55	27-42	28-52	6-10	5-8	6-10
	Logical Exclusive OR	13	31-55	27-42	28-52	6-10	5-8	6-10
	Logical Invert, NOT	10	27-45	24-35	25-43	6-10	5-8	6-10
	Shift Bit Left	16	109-130	90-101	102-123	7-11	6-8	7-11
	Shift Bit Right	16	108-120	88-93	102-113	7-11	6-8	7-11
	Rotate Bit Left	16	77-108	64-83	72-102	6-10	5-8	6-10
	Rotate Bit Right	16	82-109	64-71	78-103	6-10	5-8	6-10
	Bit Position	13	43-72	36-55	40-68	6-10	5-9	6-10
	Bit Clear	13	45-67	38-51	43-63	6-10	5-8	6-10
	Bit Test	13	32-54	28-42	29-51	8-12	7-8	7-11
	Bit Set	13	38-66	34-50	36-62	6-10	5-8	6-10
	Mask Compare (WORD)	25	90-145	83-113	82-137	8-12	7-9	7-11
	Mask Compare (DWORD)	25	92-145	77-112	88-137	8-12	7-9	7-11
Data Move	Move (INT)	10	20-42	19-32	19-40	6-10	5-8	6-10
	Move (BOOL)	13	47-75	37-47	45-71	6-10	5-8	6-10
	Move (WORD)	10	20-42	18-32	19-40	6-10	5-8	6-10
	Move (REAL)	13	28-56	26-44	26-53	6-10	5-8	6-10
	Block Move (INT)	28	26-58	24-44	24-54	6-10	5-8	6-10
	Block Move (WORD)	28	26-58	24-44	24-54	6-10	5-8	6-10
	Block Move (REAL)	13	47-108	44-82	46-103	7-10	6-8	7-10
	Block Clear (WORD)	11	43-90	38-70	40-85	6-10	5-8	6-9
	Shift Register (BIT)	16	92-125	73-98	87-119	7-11	6-9	7-10
	Shift Register (WORD)	16	67-111	51-88	65-106	7-11	6-9	7-11
	Bit Sequencer	16	111-142	97-140	109-134	86-104	68-107	78-98
	COMM_REQ	13	616-762	489-541	405-456	6-10	5-8	6-10

Typical Execution Times for Release 2.0 CPUs, continued

Group	Function	Size (bytes)	Execution Time (Range in µsec.) Function Enabled 14/23/28 pt	Function Enabled 28pt ESCP	Function Enabled Nano	Function Disabled 14/23/28 pt	Function Disabled 28pt ESCP	Function Disabled Nano
Table	Array Move (INT)	22	61-106	53-83	57-100	6-10	5-8	6-10
	Array Move(DINT)	22	54-95	48-72	51-90	6-10	5-8	6-10
	Array Move (BOOL)	22	77-130	67-101	72-123	6-10	5-8	6-10
	Array Move (BYTE)	22	58-104	51-79	53-98	6-10	5-8	6-10
	Array Move (WORD)	22	62-106	53-83	57-100	6-10	5-8	6-10
	Search Equal (INT)	19	51-85	42-66	47-81	8-12	7-10	7-11
	Search Equal (DINT)	22	41-81	46-63	38-77	8-12	7-10	7-11
	Search Equal (BYTE)	19	50-80	35-62	46-76	8-12	7-9	7-11
	Search Equal (WORD)	19	51-85	42-66	48-81	8-12	7-9	7-11
	Search Not Equal (INT)	19	64-93	42-72	59-88	8-12	7-9	7-11
	Search Not Equal (DINT)	22	67-101	65-80	65-97	8-12	7-9	7-11
	Search Not Equal (BYTE)	19	50-80	33-55	42-66	8-12	7-9	7-11
	Search Not Equal (WORD)	19	44-77	38-60	49-73	8-12	6-9	7-11
	Search Greater/Equal (INT)	19	55-83	49-66	52-80	8-11	7-9	7-11
	Search Greater/Equal (DINT)	22	50-81	49-63	47-77	8-12	7-9	7-11
	Search Greater/Equal (BYTE)	19	44-80	40-62	43-76	8-12	7-9	7-11
	Search Greater/Equal (WORD)	19	48-86	40-66	46-81	8-12	7-9	7-11
	Search Greater Than (INT)	19	56-89	46-72	53-86	8-12	7-9	7-11
	Search Greater Than (DINT)	22	57-87	44-69	53-83	8-12	7-9	7-11
	Search Greater Than (BYTE)	19	46-93	48-67	44-82	8-12	7-9	7-11
	Search Greater Than (WORD)	19	55-91	52-72	52-88	8-12	7-9	7-11
	Search Less Than (INT)	19	54-78	38-61	50-74	8-12	7-9	7-11
	Search Less Than (DINT)	22	66-103	47-80	62-98	8-12	7-9	7-12
	Search Less Than (BYTE)	19	40-71	38-55	36-67	8-12	7-9	7-11
	Search Less Than (WORD)	19	43-79	48-61	40-74	8-12	7-9	7-11
	Search Less/Equal (INT)	19	43-78	46-61	40-73	8-12	7-9	7-11
	Search Less/Equal (DINT)	22	41-81	48-63	38-77	8-12	7-9	7-11
	Search Less/Equal (BYTE)	19	48-71	36-55	45-67	8-12	7-9	7-11
	Search Less/Equal (WORD)	19	55-78	45-61	60-74	8-12	7-9	7-11

Typical Execution Times for Release 2.0 CPUs, continued

			Execution Time (Range in µsec.)					
			Function Enabled			Function Disabled		
Group	**Function**	**Size (bytes)**	**14/23/28 pt**	**28pt ESCP**	**Nano**	**14/23/28 pt**	**28pt ESCP**	**Nano**
Conversion	Convert INT to REAL	10	37-56	29-42	30-52	6-10	5-8	6-10
	Convert REAL to INT	13	616-705	507-547	585-668	6-10	5-8	6-10
	Convert DINT to REAL	13	37-58	28-44	32-54	6-10	5-8	6-9
	Convert REAL to DINT	13	605-695	507-539	567-659	6-10	5-8	6-9
	Convert WORD to REAL	10	34-55	28-42	28-52	6-10	5-8	6-10
	Convert REAL to WORD	13	607-663	501-513	576-628	6-10	5-8	6-10
	Convert BDC to INT	10	28-53	25-40	27-50	6-10	5-8	6-10
	Convert INT to BCD	10	80-170	76-130	76-161	6-10	5-8	6-10
	Convert BCD to REAL	10	41-68	33-52	33-64	6-10	5-8	6-10
	Truncate to INT	13	152-190	134-146	145-179	6-10	5-8	6-10
	Truncate to DINT	13	150-181	113-140	137-171	6-10	5-9	6-10
Control	Call a Subroutine	7	28-56	27-44	26-52	4-6	3-4	4-5
	Do I/O	13	183-206	149-205	168-186	6-10	5-10	6-10
	Service Request #6	10	57-71	41-55	53-67	6-12	5-8	6-10
	Service Request #7 Read	10	289-427 *	236-315	N/A	6-10 *	5-8	N/A
	Service Request #7 Write	10	519-520 *	393-406	N/A	6-10 *	5-8	N/A
	Service Request #9	10	76-112	65-86	105-123	5-10	5-7	5-9
	Service Request #14	10	250-363	199-274	103-149	7-10	5-8	6-10
	Service Request #15	10	66-92	65-72	64-87	6-10	5-8	6-10
	Service Request #16	10	78-103	64-79	71-97	6-10	5-8	6-10
	Service Request #18	10	56-141	52-107	52-133	6-10	5-8	6-10
	Service Request #23	10	206-433	186-325	163-210	6-10	5-8	6-10
	Service Request #26, #30	10	269-362	201-283	249-343	6-10	5-8	6-10
	Service Request #29	10	48-69	41-53	45-65	6-10	5-8	6-10
	Nested MCR/ENDMCR	4	4	3	4	3	3	3
	PID-ISA Algorithm	16	166-194	135-149	155-185	50-79	43-61	47-74
	PID-IND Algorithm	16	164-194	135-150	155-184	50-80	43-61	47-74

* Not applicable for 14-Point CPUs.

Typical Execution Times for Release 1.1 CPUs

Depending upon the application, release 1.1 CPUs show the following estimated reductions in program execution times when compared with release 1.0 CPUs:

Nano PLCs: 20% - 28%
14 Pt Micro PLCs: 28%
28 Pt Micro PLCs: 28%

The following table details function block timing for a Release 1.1, 28-Point Micro PLC CPU with ESCP, model IC200UDD120. For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

Group	***Function***	***Size***	***Rel. 1.07 / 1.1 28-Point CPU with ESCP***	
			Function Enabled	***Function Disabled***
		(bytes)	***Time, Range***	***Time, Typical***
Timers	Off Delay Timer	15	60 - 70	56
	On Delay Timer	15	66 - 77	56
	Elapsed Timer	15	62 - 72	50
Counters	Up Counter	13	40 - 60	58
	Down Counter	13	60	54
Math	Addition (INT)	13	30 - 40	7
	Addition (DINT)	19	40	9
	Addition (REAL)	17	89 - 100	8
	Subtraction (INT)	13	30 - 40	6
	Subtraction (DINT)	19	30 -40	7
	Subtraction (REAL)	17	91 - 100	9
	Multiplication (INT)	13	29 - 42	7
	Multiplication (DINT)	13	24 - 40	8
	Multiplication (REAL)	17	80 - 108	8
	Division (INT)	13	40 - 50	6
	Division (DINT)	19	31 - 49	10
	Division (REAL)	17	150 - 182	9
	Modulo Division (INT)	13	48 - 60	7
	Modulo Division (DINT)	19	44 - 51	10
	Square Root (INT)	10	39 - 60	7
	Square Root (DINT)	13	34 - 74	10
	Square Root (REAL)	11	351 - 404	8

Typical Execution Times for Release 1.1 CPUs, continued

Group	Function	Size (bytes)	Rel. 1.07 / 1.1 28-Point CPU with ESCP	
			Function Enabled	Function Disabled
			Time, Range	Time, Typical
Trigonometric	SIN (REAL)	11	898 - 1149	9
	COS (REAL)	11	867 - 1155	9
	TAN (REAL)	11	1138 - 1710	1
	ASIN (REAL)	11	1242 - 1474	10
	ACOS (REAL)	11	1220 - 1435	10
	ATAN (REAL)	11	552 - 655	10
Logarithmic	LOG (REAL)	11	587 - 697	8
	LN (REAL)	11	545 - 655	8
Exponential	Power of e	11	407 - 466	10
	Power of X	17	226 - 283	10
Radian Conversion	Convert RAD to DEG	11	228 - 246	10
	Convert DEG to RAD	17	65 - 72	9
Relational	Equal (INT)	10	20 - 30	10
	Equal (DINT)	16	20 - 30	10
	Equal (REAL)	14	30 - 40	10
	Not Equal (INT)	10	20 - 24	10
	Not Equal (DINT)	16	20 - 30	10
	Not Equal (REAL)	14	30 - 40	10
	Greater Than (INT)	10	20 - 22	10
	Greater Than (DINT)	16	20 - 30	10
	Greater Than (REAL)	14	40	10
	Greater Than/Equal (INT)	10	23 - 30	10
	Greater Than/Equal (DINT)	16	20 - 30	10
	Greater Than/Equal (REAL)	14	39 - 40	10
	Less Than (INT)	10	20 - 22	10
	Less Than (DINT)	16	30	10
	Less Than (REAL)	14	36 - 40	10
	Less Than/Equal (INT)	10	21 - 23	10
	Less Than/Equal (DINT)	16	30 - 40	10
	Less Than/Equal (REAL)	14	40 - 55	10
	Range (INT)	13	21 - 30	10
	Range (DINT)	22	26 - 38	10
	Range (WORD)	13	25 - 30	10

Typical Execution Times for Release 1.1 CPUs, continued

Group	Function	Size (bytes)	Rel. 1.07 / 1.1 28-Point CPU with ESCP	
			Function Enabled	Function Disabled
			Time, Range	Time, Typical
Bit Operation	Logical AND	13	36 - 40	4
	Logical OR	13	30 - 40	5
	Logical Exclusive OR	13	30 - 40	5
	Logical Invert, NOT	10	30	4
	Shift Bit Left	16	85 - 96	9
	Shift Bit Right	16	90	10
	Rotate Bit Left	16	61 - 80	4
	Rotate Bit Right	16	70 - 80	5
	Bit Position	13	50	4
	Bit Clear	13	34 - 50	6
	Bit Test	13	30 - 40	10
	Bit Set	13	36 - 47	4
	Mask Compare (WORD)	25	80 - 109	10
	Mask Compare (DWORD)	25	70 - 106	10
Data Move	Move (INT)	10	27 - 30	4
	Move (BOOL)	13	40 - 55	4
	Move (WORD)	10	27 - 30	4
	Move (REAL)	13	40	4
	Block Move (INT)	28	30 - 40	4
	Block Move (WORD)	28	30 - 40	4
	Block Move (REAL)	13	37 - 83	8
	Block Clear (WORD)	11	37 - 65	4
	Shift Register (BIT)	16	77 - 93	9
	Shift Register (WORD)	16	55 - 83	10
	Bit Sequencer	16	92 - 108	83
	COMM_REQ	13	470 - 485	135

Typical Execution Times for Release 1.1 CPUs, continued

Group	Function	Size (bytes)	Rel. 1.07 / 1.1 28-Point CPU with ESCP: Function Enabled Time, Range	Function Disabled Time, Typical
Table	Array Move			
	INT	22	51 - 79	4
	DINT	22	50 - 70	4
	BOOL	22	70 - 96	5
	BYTE	22	46 - 75	5
	WORD	22	51 - 79	4
	Search Equal			
	INT	19	46 - 60	10
	DINT	22	50 - 60	10
	BYTE	19	40 - 60	10
	WORD	19	46 - 60	10
	Search Not Equal			
	INT	19	46 - 68	10
	DINT	22	69 - 75	10
	BYTE	19	39 - 50	10
	WORD	16	47 - 68	10
	Search Greater Than/Equal			
	INT	19	51 - 60	10
	DINT	22	50 - 60	10
	BYTE	19	42 - 60	10
	WORD	19	46 - 60	10
	Search Greater Than			
	INT	19	50 - 70	10
	DINT	22	48 - 65	10
	BYTE	19	50 - 61	10
	WORD	19	55 - 69	10
	Search Less Than			
	INT	19	40 - 57	10
	DINT	22	50 - 75	10
	BYTE	19	40 - 50	10
	WORD	19	50 - 58	10
	Search Less Than/Equal			
	INT	19	50 - 58	10
	DINT	22	50 - 60	10
	BYTE	19	40 - 50	10
	WORD	19	50 - 58	10

Typical Execution Times for Release 1.1 CPUs, continued

Group	*Function*	*Size (bytes)*	*Rel. 1.07 / 1.1 28-Point CPU with ESCP*	
			Function Enabled	*Function Disabled*
			Time, Range	*Time, Typical*
Conversion	Convert INT to REAL	10	28 - 40	4
	Convert REAL to INT	13	495 - 537	4
	Convert DINT to REAL	13	30 - 40	4
	Convert REAL to DINT	13	496 - 534	5
	Convert WORD to REAL	10	30 - 40	3
	Convert REAL to WORD	13	490 - 506	4
	Convert BDC to INT	10	30 - 38	4
	Convert INT to BCD	10	80 - 124	4
	Convert BCD to REAL	10	36 - 50	4
	Truncate to INT	13	132 - 142	4
	Truncate to DINT	13	113 - 134	4
Control	Call a Subroutine	7	30 - 40	0
	Do I/O	13	142 - 144	4
	Service Request			
	#6	10	46 - 50	8
	#7 (read)	10	153 - 165	6
	#7 (set)	10	384 - 387	5
	#9	10	65 - 86	7
	#14	10	97 - 125	5
	#15	10	66 - 69	4
	#16	10	70 - 75	5
	#18	10	56 - 103	5
	#23	10	183 - 322	4
	#26,#30	10	196 - 243	4
	#29	10	40 - 50	5
	Nested MCR/ENDMCR (combined)	4	40 - 50	5
	PID-ISA Algorithm	16	131 - 149	62
	PID-IND Algorithm	16	131 - 150	62

Typical Execution Times for Release 1.0 CPUs

Group	Function	Size (bytes)	Execution Time(μ sec.)			
			Function Enabled		Function Disabled	
			Nano PLC (10 points)	Micro PLC (14, 23, 28 pt)	Nano PLC (10 points)	Micro PLC (14, 23, 28 pt)
Coils/Relays	Coils/Relays	3	1.2ms/K	1.0ms/K		
Timers	Off Delay Timer	15	95	100	64	70
	On Delay Timer	15	100	106	70	73
	Elapsed Timer	15	90	99	60	70
Counters	Up Counter	13	76	80	70	80
	Down Counter	13	77	82	71	80
Math	Addition (INT)	13	50	60	10	10
	Addition (DINT)	19	50	59	10	10
	Addition (REAL)	17	119	127	10	10
	Subtraction (INT)	13	50	60	10	10
	Subtraction (DINT)	19	50	52	10	10
	Subtraction (REAL)	17	119	128	10	10
	Multiplication (INT)	13	53	60	10	10
	Multiplication (DINT)	13	50	60	10	10
	Multiplication (REAL)	17	133	137	10	10
	Division (INT)	13	65	70	10	10
	Division (DINT)	19	60	60	10	10
	Division (REAL)	17	213	223	10	10
	Modulo Division (INT)	13	70	80	10	10
	Modulo Division (DINT)	19	65	70	10	10
	Square Root (INT)	10	80	81	10	10
	Square Root (DINT)	13	89	94	10	10
	Square Root (REAL)	11	472	491	10	10
Trigonometric	SIN (REAL)	11	1337	1399	10	10
	COS (REAL)	11	1342	1396	10	10
	TAN (REAL)	11	1993	2077	10	20
	ASIN (REAL)	11	1712	1783	10	10
	ACOS (REAL)	11	1663	1740	10	10
	ATAN (REAL)	11	761	795	10	10
Logarithmic	LOG (REAL)	11	814	848	10	10
	LN (REAL)	11	760	790	10	10
Exponential	Power of e	11	542	569	10	10
	Power of X	17	332	351	10	10

Typical Execution Times for Release 1.0 CPUs continued

Group	Function	Size (bytes)	Execution Time(μ sec.)			
			Function Enabled		Function Disabled	
			Nano PLC (10 points)	Micro PLC (14, 23, 28 points)	Nano PLC (10 points)	Micro PLC (14, 23, 28 points)
Radian Conversion	Convert RAD to DEG	11	289	300	10	10
	Convert DEG to RAD	17	89	97	10	10
Relational	Equal (INT)	10	30	40	10	10
	Equal (DINT)	16	40	40	10	10
	Equal (REAL)	14	50	52	10	10
	Not Equal (INT)	10	30	31	10	10
	Not Equal (DINT)	16	40	40	10	10
	Not Equal (REAL)	14	50	51	10	10
	Greater Than (INT)	10	30	32	10	10
	Greater Than (DINT)	16	40	40	10	10
	Greater Than (REAL)	14	50	52	10	10
	Greater Than/Equal (INT)	10	30	31	10	10
	Greater Than/Equal (DINT)	16	40	40	10	10
	Greater Than/Equal (REAL)	14	50	55	10	10
	Less Than (INT)	10	30	32	10	10
	Less Than (DINT)	16	40	40	10	10
	Less Than (REAL)	14	50	59	10	10
	Less Than/Equal (INT)	10	30	31	10	10
	Less Than/Equal (DINT)	16	40	40	10	10
	Less Than/Equal (REAL)	14	50	55	10	10
	Range (INT)	13	40	40	10	10
	Range (DINT)	22	45	50	10	10
	Range (WORD)	13	40	40	10	10

Typical Execution Times for Release 1.0 CPUs continued

Group	Function	Size (bytes)	Execution Time(μ sec.)			
			Function Enabled		Function Disabled	
			Nano PLC (10 points)	Micro PLC (14, 23, 28 points)	Nano PLC (10 points)	Micro PLC (14, 23, 28 points)
Bit Operation	Logical AND	13	50	51	10	10
	Logical OR	13	50	51	10	10
	Logical Exclusive OR	13	50	51	10	10
	Logical Invert, NOT	10	40	43	10	10
	Shift Bit Left	16	110	118	10	10
	Shift Bit Right	16	99	109	10	10
	Rotate Bit Left	16	90	99	10	10
	Rotate Bit Right	16	89	98	10	10
	Bit Position	13	61	70	10	10
	Bit Clear	13	60	70	10	10
	Bit Test	13	50	52	10	10
	Bit Set	13	60	70	10	10
	Mask Compare (WORD)	25	129	138	10	10
	Mask Compare (DWORD)	25	128	138	10	10
Data Move	Move (INT)	10	40	40	10	10
	Move (BOOL)	13	79	80	10	10
	Move (WORD)	10	40	40	10	10
	Move (REAL)	13	50	58	10	10
	Block Move (INT)	28	50	52	10	10
	Block Move (WORD)	28	50	52	10	10
	Block Move (REAL)	13	99	108	10	10
	Block Clear (WORD)	11	89	99	10	10
	Shift Register (BIT)	16	118	127	10	10
	Shift Register (WORD)	16	101	109	10	10
	Bit Sequencer	16	121	127	89	10
	COMM_REQ	13	600	590	144	155

Typical Execution Times for Release 1.0 CPUs continued

Group	Function	Size (bytes)	Execution Time(µ sec.)			
			Function Enabled		Function Disabled	
			Nano PLC (10 points)	Micro PLC (14, 23, 28 points)	Nano PLC (10 points)	Micro PLC (14, 23, 28 points)
Table	Array Move					
	INT	22	98	101	10	10
	DINT	22	89	97	10	10
	BOOL	22	127	133	10	10
	BYTE	22	98	100	10	10
	WORD	22	98	101	10	10
	Search Equal					
	INT	19	79	80	10	10
	DINT	22	70	80	10	10
	BYTE	19	70	80	10	10
	WORD	19	79	80	10	10
	Search Not Equal					
	INT	19	86	90	10	10
	DINT	22	98	100	10	10
	BYTE	19	60	70	10	10
	WORD	16	87	90	10	10
	Search Greater Than/Equal					
	INT	19	80	81	10	10
	DINT	22	70	80	10	10
	BYTE	19	70	80	10	10
	WORD	19	79	80	10	10
	Search Greater Than					
	INT	19	79	90	10	10
	DINT	22	79	89	10	10
	BYTE	19	79	83	10	10
	WORD	19	80	89	10	10
	Search Less Than					
	INT	19	70	78	10	10
	DINT	22	90	99	10	10
	BYTE	19	60	70	10	10
	WORD	19	70	80	10	10
	Search Less Than/Equal					
	INT	19	70	78	10	10
	DINT	22	70	80	10	10
	BYTE	19	60	70	10	10
	WORD	19	70	80	10	10

Typical Execution Times for Release 1.0 CPUs continued

Group	Function	Size (bytes)	Execution Time(μ sec.)			
			Function Enabled		Function Disabled	
			Nano PLC (10 points)	Micro PLC (14, 23, 28 points)	Nano PLC (10 points)	Micro PLC (14, 23, 28 points)
Conversion	Convert INT to REAL	10	50	51	10	10
	Convert REAL to INT	13	50	647	10	10
	Convert DINT to REAL	13	50	59	10	10
	Convert REAL to DINT	13	611	641	10	10
	Convert WORD to REAL	10	50	51	10	10
	Convert REAL to WORD	13	583	606	10	10
	Convert BDC to INT	10	50	50	10	10
	Convert INT to BCD	10	156	166	10	10
	Convert BCD to REAL	10	60	70	10	10
	Truncate to INT	13	169	179	10	10
	Truncate to DINT	13	161	173	10	10
Control	Call a Subroutine	7	46	51	10	10
	Do I/O	13	173	185	10	10
	Service Request					
	#6	10	70	71	10	10
	#7 (read)	10	163	173	10	10
	#7 (set)	10	143	150	10	10
	#9	10	107	112	10	9
	#14	10	157	167	10	10
	#15	10	84	90	10	10
	#16	10	98	100	10	10
	#18	10	134	139	10	10
	#23	10	222	476	10	10
	#26,#30	10	298	310	10	10
	#29	10	69	70	10	10
	Nested MCR/ENDMCR (combined)	4	3	4	10	10
	PID-ISA Algorithm	16	188	194	12.8	3.2
	PID-IND Algorithm	16	186	195	70	73

Appendix B Feature Comparison

Information in this appendix is arranged to provide a convenient means of comparing the capabilities of the VersaMax Micro PLC and the Series 90 Micro PLC.

Operating Differences: Lists ways in which the VersaMax Nano and Micro PLCs operate differently than earlier PLCs.

Program Functions Supported: This section compares the program functions supported by VersaMax Nano PLCs and Micro PLCs with functions supported by Series 90 Micro PLCs.

Program References: Compares the program references used by VersaMax and Series 90 Micro PLCs.

Operating Differences

1. Subroutines are available on the VersaMax Nano and Micros. The maximum of subroutines is 64 for Micro PLCs and 8 for Nano PLCs.
2. The VersaMax Nano and Micros have several functions that the Series 90 Micro did not support.
   - PID
   - Nested JUMP, LABEL, and MCR. Use of JUMP, LABEL, and MCR functions in Series 90 programs must be changed to nested.
   - Scaling
   - Floating point data types
   - Override capability
3. Word-for-word changes are not allowed by VersaMax Nano & Micro PLCs. The Series 90 Micro allowed word-for-word changes in STOP mode.
4. The VersaMax 14-point Micro PLCs support expansion units; the Series 90 14-point Micro PLCs did not.
5. When a serial port is configured for RTU slave it will revert to SNP when a programmer is attached.
6. VersaMax Nano/Micros support Serial I/O protocol.
7. VersaMax 23, 28, and 64 point units feature a time of day clock.
8. The VersaMax Nano and Micros support Break-free SNP communications for greater compatibility with modems.
9. All VersaMax Nano/Micros support autoconfiguration capability.
10. High-speed Counter/PWM/Pulse Train differences:
    - VersaMax Nano/Micro PLCs do not support negative edge triggering for High-speed Counter Preload/Strobe inputs. This is different from the Series 90 Micro PLC.
    - VersaMax Nano/Micro PLCs have 4 PTO channels where the Series 90 Micro PLC had 3 PTO channels..
    - VersaMax Nano/Micro PLCs output for PTO are on Q1, Q2, Q3, and Q5. While the Series 90 Micro PLCs output PTO on Q1, Q3, Q5. **Wiring changes will be required when a VersaMax Nano/Micro is used to replace a Series 90 PLC.**
    - The PTO #4 Complete bit is I511 and Start is Q511.

- For VersaMax Micro PLCs and Nano PLCs, the High-speed Counter PWM and PTO features use different %AQ settings than in the Series 90 Micro PLC. **A Series 90 Micro PLC folder containing these features will not function properly if converted directly to a VersaMax Micro PLC folder.** The logic which calculates the %AQ frequencies and/or duty cycles must be changed before being used on a VersaMax Micro or Nano PLC. Series 90 Micro programs which used the PWM and PTO features needed to calculate values to put into the %AQ registers, based on the desired frequency and duty cycle. For the VersaMax Nano and Micro PLCs, this calculation is not necessary; the frequency and duty cycle must be input directly into the %AQ registers.
- Frequency limits for the Versamax HSC/Pulse outputs have been improved

	HSC Frequency Limits	PTO/PWM Frequency Limits
Series 90 Micro	19hz - 5Khz	19hz - 2khz
VersaMax		
Nano	15hz - 10Khz	15hz - 5khz
Micro 14 –point / 28- point	15hz - 10Khz	15hz - 5khz
Micro 64-point	15hz - 100Khz	15hz - 65khz

- For VersaMax Nano and Micro PLCs, the frequency of Pulse Train outputs can be changed while the Pulse Train is operating. This is different from the Series 90 Micro PLC, which continues at the previous frequency until the start of the next Pulse Train.
- New COMMREQ for load correction value for pulse train outputs. Sets the change (in microseconds) that should be applied to the duty cycle of a Pulse Train output to compensate for the slow turn-off time of the optical isolator circuit (see below). The range is 0 to 200 microseconds.

  35 microseconds - DC outputs for Nano/ 14-point/ 28point;
  02 microseconds - DC outputs for Micro 64-point;
  85 microseconds relay outputs for Nano/ 14-point/ 28-point ;
  10 microseconds relay outputs for micro 64-point .

- HSC/PWM/PTO stops during Store or Clear
- PTO/PWM use enable bits (Q0505 to Q0508). A Series 90 PLC did not use bits to enable the PTO/PWM. These bits must be enabled for the PTO/PWM feature to work in the VersaMax Nano/Micros.

VersaMax Nano/Micro PWM/Pulse Outputs

Operating parameters for PWM and Pulse Train outputs are specified from the application program by writing a value to the associated %AQ reference. For VersaMax Nano/Micro PLCs, you need only to write the desired value to the %AQ reference. Series 90 Micro PLCs require a mathematical conversion to determine the values to be written to the %AQ references for PWM frequency, PWM duty cycle, and Pulse Train frequency. Therefore, these values will be incorrect if you convert a Series 90 Micro application to a VersaMax Nano/Micro application. You will need to change your application program so that it writes the correct values to the %AQ references.

%AQ References for PWM

The frequency of the PWM output (15hz to 5Khz for Nano/14-Point/28-Point ; 15hz – 65Khz for 64-Point) is specified from the application program by writing a value to the associated Frequency register. The PWM duty cycle (0 to 100%) is selected using the associated Duty Cycle register. The number of PWM/PTO channels available varies according to the Nano/Micro model.

Output 1	Output 2	Output 3	Output 4	Description
AQ002	AQ004	AQ006	AQ008	PWM Frequency (15 to 5000) : Nano PWM Frequency (15 to 5000) : 14pt PWM Frequency (15 to 5000) : 28pt PWM Frequency (15 to 65000) : 64pt
AQ003	AQ005	AQ007	AQ009	PWM Duty Cycle (0 – 10000)
Q0505	Q0506	Q0507	Q0508	Enable Output

If you don't know the PWM frequency and duty cycle specified by the Series 90 Micro application, you can calculate them from the %AQ reference values. See the formulas that follow.

%AQ References for Pulse Train

The pulse frequency (15hz to 5Khz for Nano/14-Point/28-Point ; 15hz – 65Khz for 64-Point) can be controlled from the application program by writing a value to the associated Frequency register, as shown below. The number of pulses to be output (0 to 65535) is selected using the associated Number of Pulses register. The number of PWM/PTO channels available varies according to the Nano/Micro model.

Output 1	Output 2	Output 3	Output 4	Description
AQ123	AQ125	AQ127	AQ121	PWM Frequency (15 to 5000) : Nano PWM Frequency (15 to 5000) : 14pt PWM Frequency (15 to 5000) : 28pt PWM Frequency (15 to 65000) : 64pt
AQ124	AQ126	AQ128	AQ122	Number of pulses to send to output (0 to 65535)
Q0505	Q0506	Q0507	Q0508	Enable Output
Q0494	Q0495	Q0496	Q00511	Start Pulse Train
I0494	I0495	I0496	I00511	Pulse Train Complete

If you don't know the pulse frequency specified by the Series 90 Micro application, you can calculate them from the %AQ reference values .

Note: Number of Pulses does not require conversion.

Enabling Outputs

The output for a channel must be enabled before its PWM or Pulse Train function can be used. A PWM or Pulse Train output is enabled from the application program by setting its Output Enable bit to one. The output is disabled by setting its Output Enable bit to zero.

Output 1	Output 2	Output 3	Output 4	Description
Q0505	Q0506	Q0507	Q0508	Enable Output

Load Correction

PWM duty cycles are configurable and Pulse-train outputs have a nominal duty cycle of 50%, but the PLC's optical isolators skew the duty cycle to something greater than 50%, depending on temperature and loading due to the output. To compensate for this, the PLC applies load correction to correct the pulse width (duty cycle) of each pulse. The default Load Correction is 40 microseconds, which approximates the correction needed for an *output tied directly to an input* at 50% duty cycle. The Load Correction can be changed within the range 0 to 200 microseconds by sending the new value in a COMMREQ.

Formulas for Converting Series 90 Micro Frequencies and Duty Cycles

For additional information about these parameters, refer to the *Series 90 Micro User's Manual*, GFK-1065.

Functions Supported

Function	***VersaMax Nano PLC, Micro PLC***	***Series 90 Micro PLC***
Contacts		
Normally Open Contact	all	all
Normally Closed Contact	all	all
Continuation Contact <+>–	all	all
Coils		
Normally Open Coil	all	all
Negated Retentive Coil	all	all
Negated Coil	all	all
Retentive Coil	all	all
SET Coil	all	all
Retentive SET Coil	all	all
RESET Coil	all	all
Retentive RESET Coil	all	all
Positive Transition Coil	all	all
Negative Transition Coil	all	all
Continuation Coil –<+>	all	all
Links		
Horizontal link	all	all
Vertical link	all	all
Timers and Counters		
Elapsed Timer	all	all
On-Delay Timer	all	all
Off-Delay Timer	all	all
Up Counter	all	all
Down Counter	all	all

Function	*VersaMax Nano PLC, Micro PLC*	*Series 90 Micro PLC*
Math		
Addition	all	all
Addition, double precision	all	all
Addition, Floating Point	all	Not supported
Subtraction	all	all
Subtraction, double precision	all	all
Subtraction, Floating point	all	Not supported
Multiplication	all	all
Mult., double precision	all	all
Multiplication, floating point	all	Not supported
Division	all	all
Division, double precision	all	all
Division, Floating Point	all	Not supported
Modulo Division	all	all
Modulo Div., double precision	all	all
Scaling	all	not supported
Square Root	all	all
Power of x	all	not supported
Power of e	all	not supported
Trigonometric sine	all	not supported
Trigonometric cosine	all	not supported
Trigonometric tangent	all	not supported
Inverse sine	all	not supported
Inverse cosine	all	not supported
Inverse tangent	all	not supported
Convert to Degrees	all	not supported
Convert to Radians	all	not supported
Logarithm, base 10	all	not supported
Logarithm, natural	all	not supported
Square Root, double prec.	all	all

Function	*VersaMax Nano PLC, Micro PLC*	*Series 90 Micro PLC*
Relational		
Equal	all	all
Not Equal	all	all
Less Than or Equal To	all	all
Greater Than or Equal To	all	all
Less Than	all	all
Greater Than	all	all
Equal, double precision	all	all
Not Equal, double precision	all	all
Less Than or Equal To, double precision	all	all
Greater Than or Equal To, double precision	all	all
Less Than, double precision	all	all
Greater Than, double precision	all	all
Range, signed integer	all	all
Range, double precision signed integer	all	all
Range, word	all	all
Range, double word	all	all
Bit Operation		
Bit Set	all	all
Logical AND	all	all
Bit Clear	all	all
Logical OR	all	all
Bit Test	all	all
Logical Exclusive OR	all	all
Bit Position	all	all
Logical Invert	all	all
Shift Left	all	all
Shift Right	all	all
Rotate Left	all	all
Rotate Right	all	all
Masked Compare, word	all	all
Masked Compare, double word	all	all

Function	*VersaMax Nano PLC, Micro PLC*	*Series 90 Micro PLC*
Data Move		
Multiple Integer Move	all	all
Constant Block Move, Integer	all	all
Multiple Bit Move	all	all
Multiple Word Move	all	all
Constant Block Move	all	all
Block Clear	all	all
Shift Register Word	all	all
Shift Register Bit	all	all
Bit Sequencer	all	all
Communication Request	all	all
Table Functions		
Search equal to	all	all
Search not equal to	all	all
Search less than	all	all
Search less than or equal to	all	all
Search greater than	all	all
Search greater than or equal to	all	all
Array move	all	all
Conversion		
Integer to BCD	all	all
BCD to integer	all	all
Control		
Comment	all	all
End	all	all
no operation	all	all
Nested Jump	all	not supported
Non-Nested Jump	not supported	All
nested master control relay	all	not supported
Target number for jump	all	all
nested endmcr	all	not supported
Master Control Relay (non-nested)	not supported	all
End Master Control Relay (non-nested)	not supported	all
Do I/O update	all	Rel. 3.00
pid-isa algorithm	all	all
pid-ind algorithm	all	all
Service Request	all	all
Drum Sequencer	all	all

Program References

The table below compares reference sizes for VersaMax and Series 90 Micro PLCs with similar numbers of I/O points.

Reference Type	***Reference Range***	***VersaMax 10-Point Nano PLCs***	***VersaMax 14-Point Micro PLCs***	***VersaMax 23 and 28-Point Micro PLCs***	***Series 90 14-Point Micro PLCs***	***Series 90 23 and 28-Point Micro PLCs***
User program logic	Not applicable	2K words	9K words	9K words	3K words	6K words
Register references	%R0001 - %R0256 or %R2048	256 words		2K words	256 words	2K words
Discrete inputs	%I0001 - %I0512	512 bits				
Discrete outputs	%Q0001 - %Q0512	512bits				
Discrete global references	%G0001 - %G1280	1280 bits				
Discrete internal coils	%M0001 - %M1024	1024 bits				
Discrete temporary coils	%T0001 - %T0256	256 bits				
System status references	%S0001 - %S0032	32 bits				
	%SA0001 - %SA0032	32 bits				
	%SB0001 - %SB0032	32 bits				
	%SC0001 - %SC0032	32 bits				
Analog and High Speed Counter inputs	%AI0001 - %AI0128	128 words				
Analog outputs	%AQ0001 - %AQ0128	128 words				

Appendix C Battery Backup Options

Backup battery options are available for 23-point, 28-point, and 64-point VersaMax Micro PLCs. A backup battery protects the RAM memory contents of the PLC when the PLC power is removed or turned off. The battery also backs up the CPU's real-time clock.

CPU Battery Consumption

The battery consumption of the Micro PLC depends on whether the power is on or off and on the serial number of the Micro PLC. Consumption with the power off is greater at higher temperatures.

Controller Status	***Battery Consumption per Hour***
Power ON	PLCs with serial number prior to 07000069274: 30 micro Amps
	PLCs with serial number after 07000069274: 3 micro Amps
Power OFF	PLCs with serial number prior to 07000069274: 83 micro Amps @ 70C 36 micro Amps @ 20C
	PLCs with serial number after 07000069274: 56 micro Amps @ 70C 9 micro Amps @ 20C
	64-Pt Micro PLCs: 31 micro Amps @ 55C 3 microAmps @ 25C

Backup Batteries for VersaMax Micro PLCs

Two types of backup battery are available, IC200ACC403 and IC200ACC414.

Part Number	***Battery Type***	***Battery Capacity***	***Memory Backup at 70C (power OFF continuous)***	***Memory Backup at 20C (power OFF continuous)***
IC200ACC403	Coin Type	3.0 vdc @ 210mAh	3.5 months* 5.2 months**	8.1 months* 32.4 months**
IC200ACC414	Cylinder Type	3.6 vdc @ 790mAh	13.2 months* 19.6 months**	30.4 months* 121.9 months**

** Units with serial number prior to 07000069274 (manufactured before November 2002)*
*** Units with serial number after 07000069274 (manufactured after November 2002)*

The High Capacity battery (IC200ACC414) is provided with a special battery holder that is compatible with all 23-point, 28-point, and 64-point VersaMax Micro PLCs.

Calculating the Life of a Battery

This example compares typical battery longevity for the two types of Micro PLC backup battery, for VersaMax Micro PLCs with a serial number after 07000069274.

In this example, a machine sits at the OEM facility for 30 days with the battery attached to the Micro PLC CPU, prior to shipment to the end user. No power is applied.

- CPU battery consumption during 30 days with no power: 40,320 micro amps:

  24 hours x 56 micro amps per hour = 1,344 x 30 days = 40,320 micro amps (worst case of 70C storage temperature)

After the machine is shipped and installed, the end user maintains power on the machine 24 hours a day but shuts down the machine during the weekends.

- Power ON: 24 hours x 3 micro amps = 72 micro amps/day
- Power ON: 5 days x 72 micro amps = 360 micro amps/5 days
- Power OFF: 48 hours x 32.5 micro amps (45C cabinet temperature) = 1560 micro amps/weekend
- Total weekly usage: 1,920 micro amps

For Standard Backup Battery IC200ACC403

Standard Backup Battery has 210,000 micro Amps available. In this example, subtracting the CPU battery consumption during the 30 days at the OEM facility (40,320, see above), would leave 169,680 micro Amps still available. Therefore, the battery would last approximately 1.7 years (88 weeks) at the end-user location before needing replacement:

169,680 divided by 1,920 total weekly usage (see above) = 88 weeks

For High Capacity Battery IC200ACC414

High-capacity Backup Battery has 790,000 micro Amps available. In the example, subtracting the CPU battery consumption at the OEM facility (40,320) would leave 749,680 micro Amps still available. Therefore, the battery would last approximately 7.5 years (390 weeks) at the end user location before needing replacement:

749,680 divided by 1,920 weekly usage (see above)= 390 weeks

Appendix D

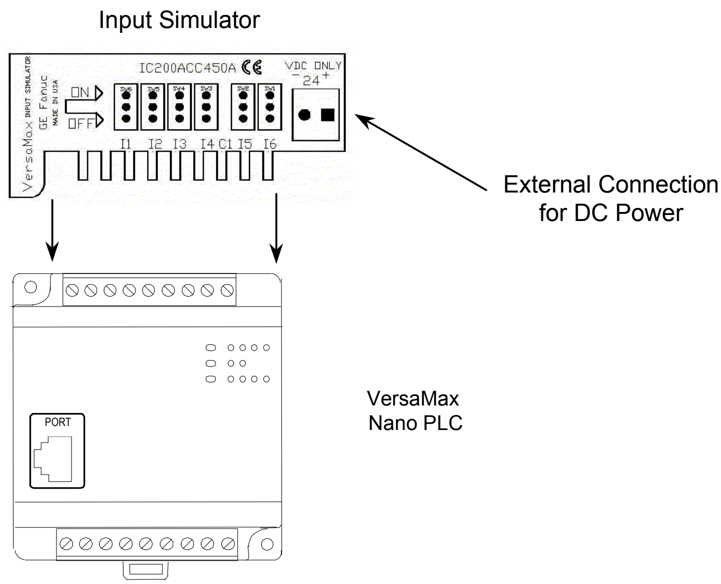
Input Simulators

This section describes input simulators that can be used to easily turn on or off any DC input point on a VersaMax Nano PLC or VersaMax Micro PLC.

- IC200ACC450 Input Simulator for DC-powered VersaMax Nano PLCs
- IC200ACC451 Input Simulator for DC-powered VersaMax Micro PLCs and Expansion Units

IC200ACC450
Input Simulator for DC-powered VersaMax Nano PLCs

The six-position DC input simulator connects directly to the input terminals on a VersaMax Nano PLC. An external connection for the 12VDC or 24VDC is required.



Compatibility

Input Simulator IC200ACC450 is compatible with any DC input VersaMax Nano PLC. ***The input simulator is not to be used with AC Inputs.***

Installation Instructions

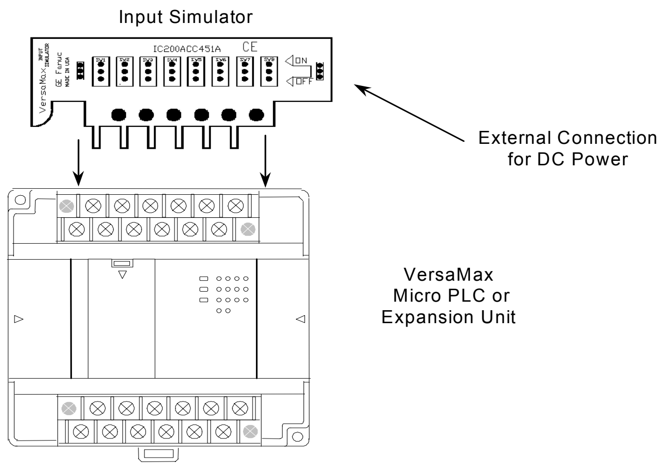
Warning

To avoid a risk of electric shock, turn off power to the VersaMax Nano PLC and disconnect the main power before attaching the Input Simulator.

1. Loosen all screws on the input terminal block.
2. Insert the Input Simulator as shown above.
3. Tighten all screws on the input terminal block.
4. Turn power on and turn switches on the simulator ON and OFF. The corresponding LEDs on the VersaMax Nano PLC should light up, showing proper installation. If the LEDs do not light, power down and recheck the screws to make sure they are tight.

IC200ACC451
Input Simulator for DC-powered VersaMax Micro PLCs and Expansion Units

The eight position DC input simulator connects directly to the input terminals of a VersaMax Micro PLC or Expansion Unit. The connection takes advantage of the 24VDC provided by the Micro PLC or Expansion Unit; no external wiring is required.



Compatibility

Input Simulator IC200ACC451 is compatible with any VersaMax DC input:

- 14-point, 23-point, or 28-point Micro PLC
- 14-point or 28-point Expansion Unit

The input simulator is not to be used with AC Inputs.

Installation Instructions

Warning

To avoid a risk of electric shock, turn off power to the VersaMax Micro PLC or Expansion Unit, and disconnect the main power before attaching the Input Simulator.

1. Loosen all screws on the input terminal block.
2. Insert the Input Simulator as shown above.
3. Tighten all screws on the input terminal block.
4. Turn power on and turn switches on the simulator ON and OFF. The corresponding LEDs on the Micro PLC or Expansion Unit should light up, showing proper installation. If the LEDs do not light, power down and recheck the screws to make sure they are tight.

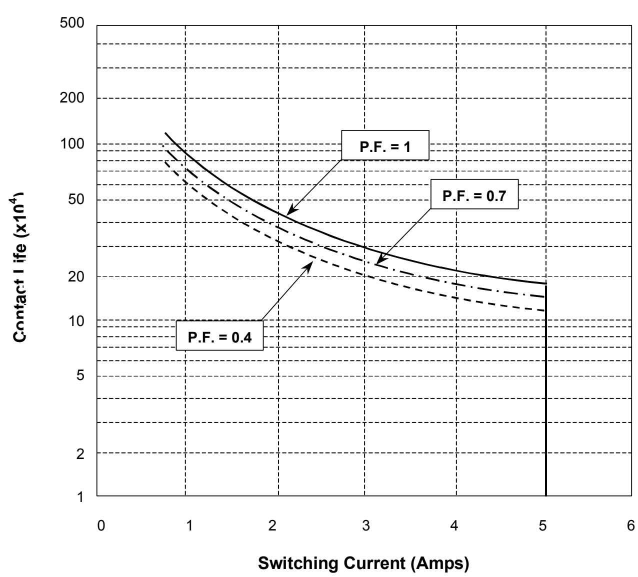
Appendix E — Relay Contact Ratings

This section shows relay contact ratings for modules with output relays.

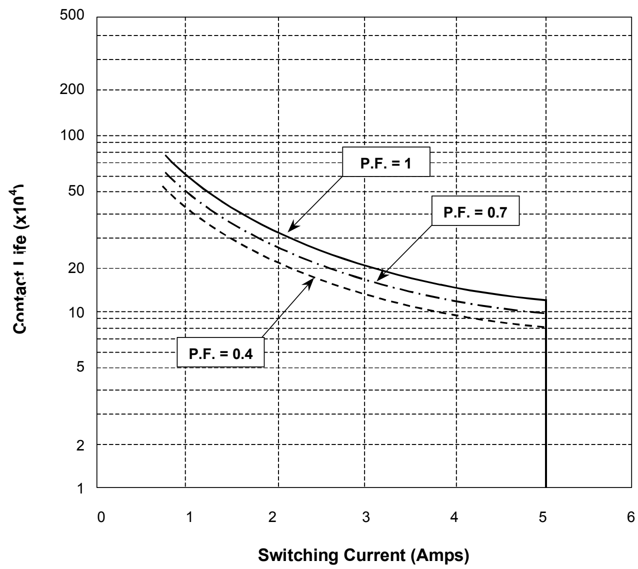
Load Condition		Current (Amps)
125VAC	P.F. = 1 P.F. = 0.7 P.F. = 0.4	0.6 0.4 0.2
250VAC	P.F. = 1 P.F. = 0.7 P.F. = 0.4	0.9 0.6 0.3
30VDC	L/R = 1ms L/R = 7mS L/R = 15mS	0.6 0.3 0.15

P.F = power factor for AC inductive loads
L/R = time constant for DC inductive loads

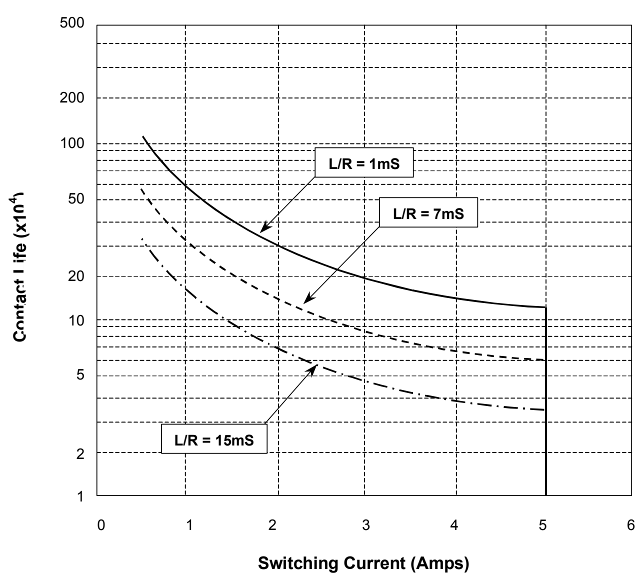
125VAC



250VAC



30VDC



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