NUM 1020/1040

INSTALLATION AND COMMISSIONING MANUAL

0101938938/2-E1

11-97 **en-938938/2-E1**

Despite the care taken in the preparation of this document, NUM cannot guarantee the accuracy of the information it contains and cannot be held responsible for any errors therein, nor for any damage which might result from the use or application of the document.

The physical, technical and functional characteristics of the hardware and software products and the services described in this document are subject to modification and cannot under any circumstances be regarded as contractual.

The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

Table of Contents

This executive summary includes only the level 1 and 2 titles. A complete table of contents is given at the beginning of each chapter.

Part One: INSTALLATION

Part Two: COMMISSIONING

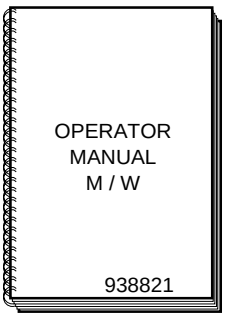
Record of Revisions

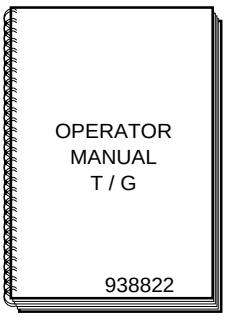
Date	Index	Description
06 - 95	0	Document creation
07 - 95	1	Miscellaneous corrections
09 - 96	2	Additions and miscellaneous corrections
11 - 97	2 - E1	Additional information on operating conditions Modified system cooling design data Modified cable shielding connection to connector plug covers Miscellaneous corrections

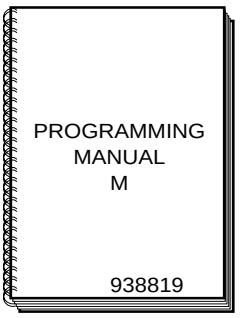
NUM 1020 / 1040 Documentation Structure

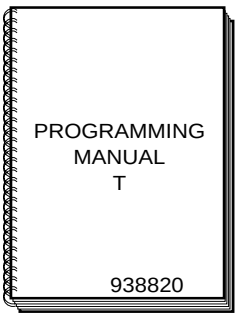
User Documents

These documents are designed for use of the CNC.



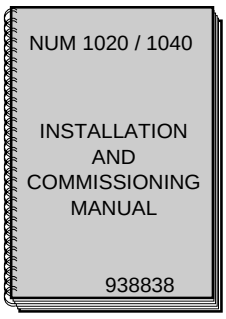


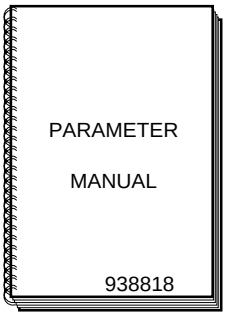


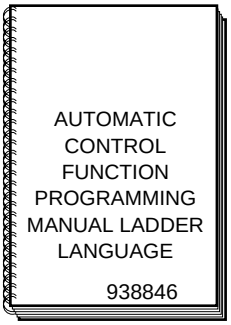


Integrator Documents

These documents are designed for setting up the CNC on a machine.







List of NUM 1060 and NUM 1060-7 Utilities

A series of utilities are available for the NUM 1060 and NUM 1060-7 CNCs for integration and use of the systems.

These utilities may be included in the basic version or available as options.

Depending on the function performed by each utility, its use is described in the integration manual or operator manual, as appropriate.

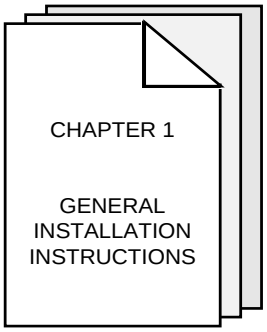
The table below lists the utilities and gives the references of the document describing them:

Utility	Name	Manual	Chapter
UT2	axis calibration	installation and commissioning manuals (938938)	10
UT3	resident macros	operator manuals (938821 or 938822)	8
UT5	parameter integration	parameter manual (938818)	12
UT7	programme debugging	automatic control function programming manual - Ladder Language (938846)	16
UT12	option locking	operator manuals (938821 or 938822)	8
UT20	interaxis calibration	Installation and Commissioning Manual (938938)	11
UT22	integration of axis parameters	SETTOOL Manual (938924)	8

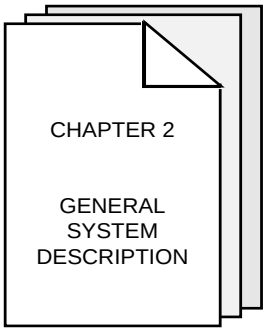
Installation and Commissioning Manual

This manual includes two parts:
- installation: physical integration of the numerical control with the machine and its environment,
- commissioning: adaptation of the CNC to the machine configuration.

Part One: Installation

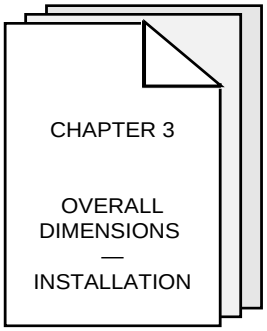


General requirements concerning the CNC environment:
- Applicable standards,
- Power consumption,
- Heat dissipation,
- Electrical specifications,
- Equipment colours.

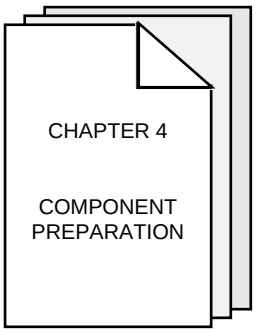


Detailed explanation of the various possible configurations.

Overview of the system architecture.



Data used for installation of the components:
- detailed configuration,
- overall dimensions,
- mounting dimensions.



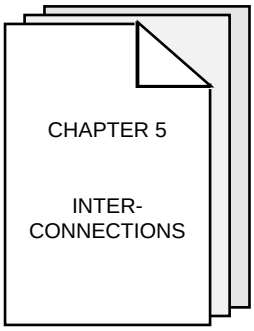
Preparing the CPU.

Preparing the compact panel.

Preparing the machine panel.

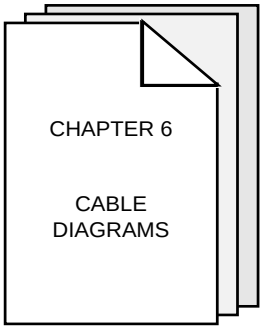
Replacing fuses.

Wiring the watchdog.



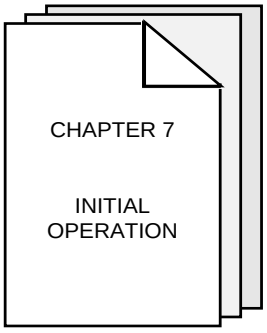
General interconnection diagram.

General data and connections:
- CPU
- Compact panel
- CNC panels
- Machine panel
- NUM diskette drive.

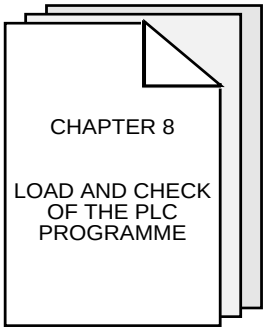


Wiring diagrams for the following cables:
- Communication
- Axes
- Analogue inputs/output and interrupt
- Inputs and outputs
- Power supply
- Video/panel.

Part Two: Commissioning



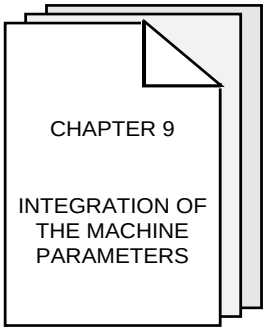
Initial operating procedure.



Reference to the PLC Function Programming Manual.

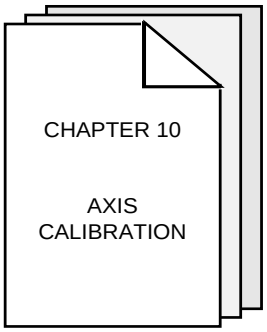
Checking instructions.

Supplements to PLC programming.

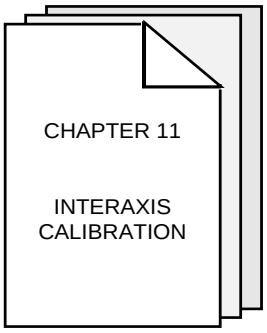


Reference to the Parameter Manual.

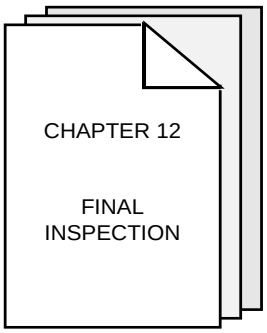
Special settings related to the NUM 1020 and 1040 CPUs.



Correction of the axis position measurement read by the coupler according to the real position on the axis.



Correction of the offsets on a slave axis according to the position on a master axis.



Recommended inspection by machining of a reference part.

Use of the Installation and Commissioning Manual

Procedures

The manual includes procedures (in particular in Chapters 10 and 11).

The actions required are presented as follows:

Reset the system. 

On the right are indicated the keys to be pressed in two possible forms:

 Square keys: correspond to keys on the operator panel.

Rectangular keys: correspond to software keys located in the bottom part of the screen and actuated by function keys (F2-F11) located under the screen.

Dealers

The list of NUM dealers is given at the end of the manual.

Questionnaire

To help us improve the quality of our documentation, we request you return to us the questionnaire at the end of this manual.

Part One

INSTALLATION

1 General Installation Instructions

1.1 Operating Conditions

CAUTION

Do not unplug any subassemblies (cards, circuits) with the system live.

Do not use measuring instruments whose output voltage is ≥ 5 VDC.

NUM equipment complies with the following standards:

	Reference standard	Level
Temperatures	IEC 1131	
Mechanical stresses	IEC1131	
Mains variation	IEC1131	
Mains brownouts	IEC1131	
Electrostatic discharge (ESD)	IEC 1000-4-2	Level 3
Electromagnetic field	IEC 1000-4-3	Level 3 (excluding video)
Fast electric transients	IEC 1000-4-4	Level 3
Electric shock	IEC 1000-4-5	Level 4
Damped ripple	IEC 1000-4-12	
Electromagnetic emissions	EN 55022	

Operating temperature range: Minimum 5 °C, maximum 55 °C.

Cooling: See Sec. 1.3.

The systems must always be installed in power cabinets equipped with:
- efficient door seals,
- air filters or air/air exchangers,
- possibly, air conditioning.

1.2 System Power Consumption

The table below specifies the power consumption of each system component:

Component	Power consumption
NUM 1020/1040 CPU (24 VDC)	40 W
Compact panel (230 VAC)	
• Panel with 10" colour CRT	60 W
• Panel with 9" monochrome CRT	30 W
50-key panels (230 VAC)	
• Panel with 10" colour CRT	60 W
• Panel with 9" monochrome CRT	30 W
QWERTY panel with 14" colour CRT (230 VAC)	100 W
Machine panel (24 VDC)	
• Single panel	3,8 W
• 32 inputs/24 outputs extension	9,8 W
Additional components (24 VDC)	
• 32-inputs interface module	24 W
• 24-output relay module	19,2 W
• NUM diskette drive	3,5 W

The system power consumption is obtained by summing the power consumptions of the system components.

1.3 System Cooling

> ⚠ **CAUTION**
>
> The life cycle of electronic equipment is closely related to its operating temperature.
>
> Compliance with the following recommendations will ensure optimal product reliability.

Determining the Air Flow Rate

The heat to be dissipated is a maximum of 40 W for the CPU and 100 W for the panel.

The dissipation can be calculated more accurately by adding together the power consumptions of the individual components (see Sec. 1.2).

The cabinet and pendant must be designed such that the temperature difference between the ambient air of the components (CNC, CRT) and the ambient air in the shop is less than 10 °C or such that the average annual temperature of the ambient air of the components does not exceed 40 °C.

The air flow rate required for correct heat dissipation is Q = 0.4 x P

where:

Q = air flow rate (l/s)

P = heat to be dissipated.

Example

For a 50-key panel with 10" colour CRT in a pendant:

P = 60 W

Q = 0.4 x 60 = 24 l/s.

REMARK This calculation should be confirmed by temperature measurements.

Recommendations

Use efficient filters on the cabinet or pendant air intakes.

Do not allow the fans to blow air directly onto the equipment.

1.4 Interconnections

1.4.1 Frame Earth and Operational Earth

Definition of the concepts of frame earth and operational earth:
- frame earth: low impedance, low frequency path used in case of failure between the electric circuit and the earth,
- operational earth: low impedance path used for equipotentiality between electric circuits. The purpose of the operational earth is to attenuate all interference and spurious voltages that may exist between units over a very wide frequency band.

These two concepts do not always require different circuits.

The frame earth earth system is provided by interconnecting all metal parts (building structure, pipework, cable trays, equipment enclosures and equipment).

The operational earth is the physical connection point (earth rod, earthing mat, building earth) to which all the frame earths must be connected.

1.4.2 Signal Earth

A distinction is made between two types of electronic equipment:
- equipment operating at relatively low frequency (a few kHz to a few hundred kHz) and low signal level,
- equipment operating at high frequency (a few tens of MHz to a few hundred MHz) and high signal levels.

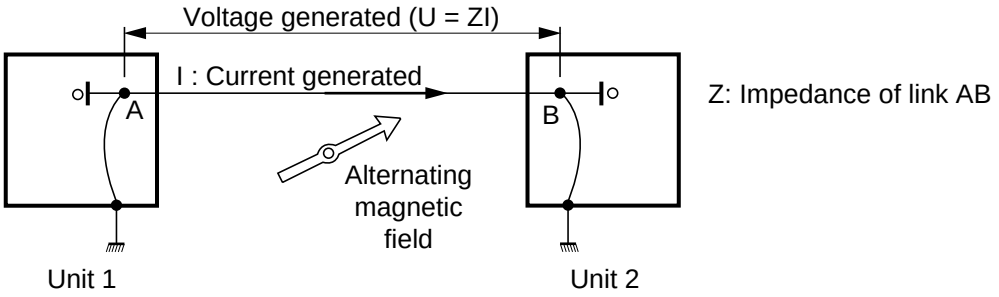
1.4.2.1 Equipment Operating at Relatively Low Frequency and Low Signal Levels

Such equipment mainly includes «analogue» systems sensitive to a few mV (or µV).

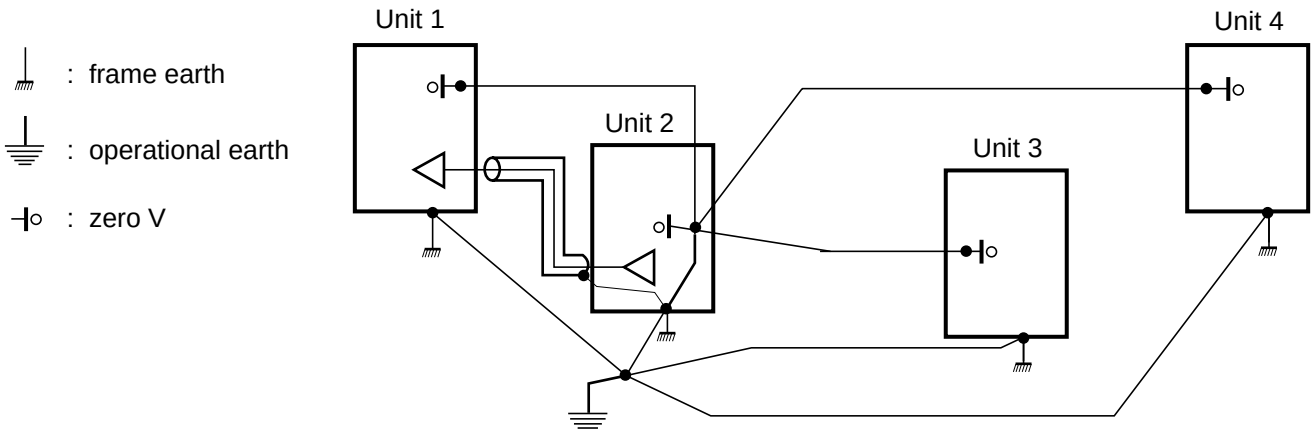
The most troublesome interference is generated by low or medium frequency electromagnetic fields captured mainly by the interconnections between units. High frequency interference is eliminated by the bandwidth of the circuits themselves or by low-pass filters.

Apply the following rules to attenuate interference:
- provide a wye connection for the signal earths and a wye connection for the frame earths with a single interconnection between the two earthing systems,
- when a sensitive wire must be protected against EMI by shielding, the shielding is considered a screen and is only earthed at one end so as not to create a loop with circulation of interference in the shielding.

Wrong: Loops between units due to interconnection of the earths and common wires



Right: Wye connection of frame earths and 0 V (signal earths)



1.4.2.2 Modern Equipment Operating at High Frequency and High Signal Levels

Such equipment includes modern «logic» equipment with electronic gates whose switching times are around 1 ns and whose signal levels are high (static switching margin from 400 mV to 10 V).

The most critical interference is electromagnetic interference at a frequency between 30 and 300 MHz.

Such interference originates in coil switching (relays, contactors, transformers, motors, transformer-supplied indicator lights, etc.), circuit breaker trip arcs, drive switching power supplies, HF systems located nearby, and electrostatic discharges generated by the operators, etc.

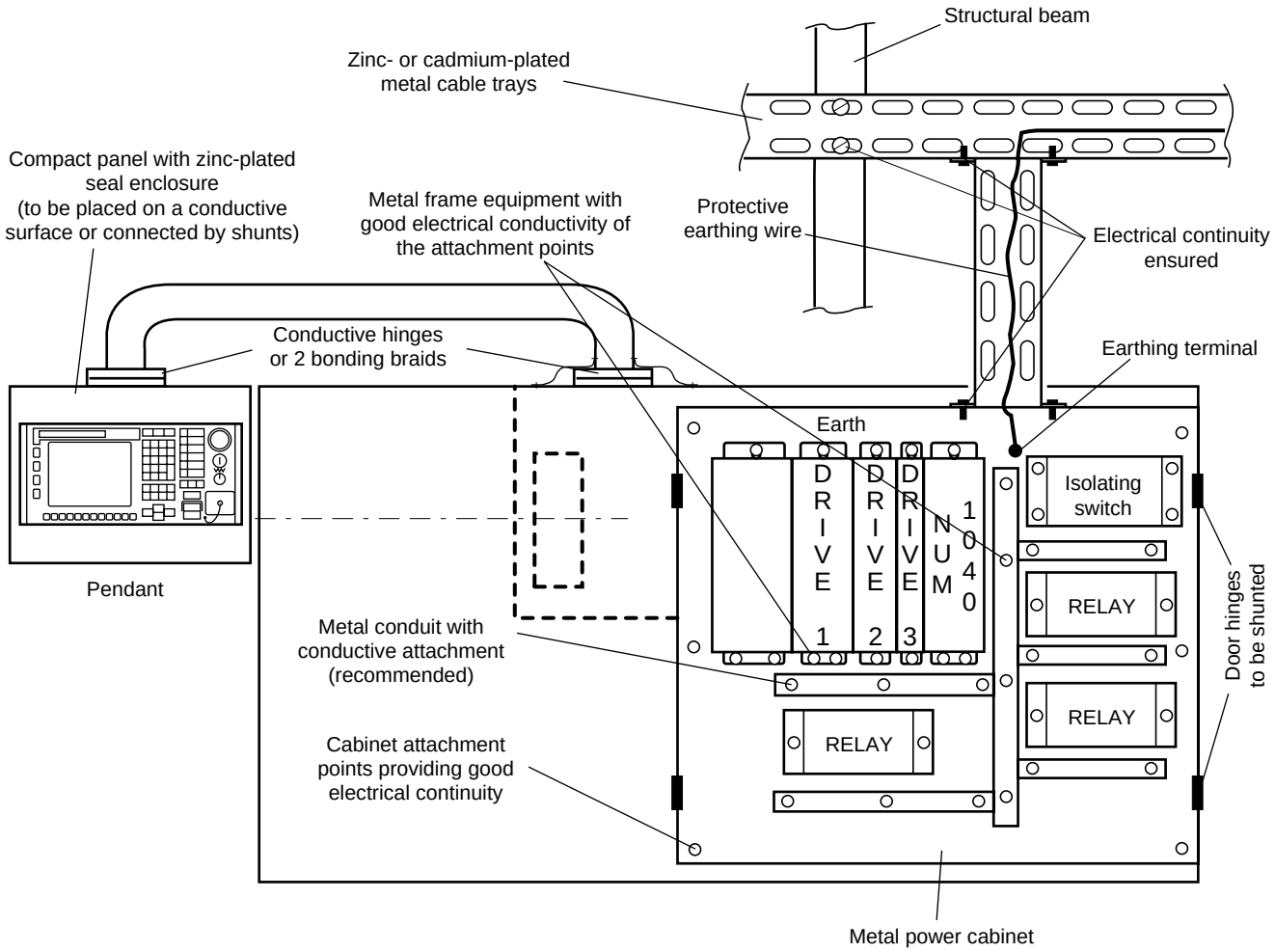
At such frequencies, the earths must be at the same potential. However, the impedance of an earthing wire becomes high at high frequencies ($Z = L\omega$). For instance, for a 2.5 mm^2 wire 1 m long whose inductance is $L \approx 1.4 \times 10^{-6}$ H, the impedance, which is only 0.09 Ω at 10 kHz becomes 90 Ω at 10 MHz - and the earthing wires are not suitable for creating a good signal earth.

It is necessary to use a meshed system to decrease interference. This means interconnecting the units with one another by the largest possible number of the shortest possible links.

This is achieved best by using metal parts interconnected by many attachment points ensuring good electrical conduction (zinc- or cadmium-plated steel, stainless steel, removal of paint, use of claws on aluminum).

If electrical continuity is not correctly provided by the mechanical link, the link must be shunted by at least two short, wide bonding braids (length/width ratio ≤ 5 with length < 20 cm).

Example of Meshed System



Rear view of a lathe

In the units, the concepts of logical 0 V and protective earth coincide, i.e. the logical 0 V is connected in many points to the frame earth.

The shieldings of logical signal cables are earthed at both ends. This contributes to the mesh and in addition, the internal electronic circuitry and the enclosure are at the same potential.

To attenuate the loop effects thus created (the captured field depends on the loop area), the cables must be attached against the conduit or metal walls. This is called cabling with "reduction effect".

In the case of separate power supply for the logical inputs and outputs, the 0 V lines of these power supplies must be earthed and the wiring must be made with "reduction effect".

REMARK: Meshing the earths does not provide a protective system. The earthing terminals on the units must be connected to the general earth electrode of the building.

1.4.3 Equipment Immunity

Equipment immunity to electromagnetic interference is guaranteed by:
- attenuating the interference generated by the sources,
- reducing the coupling between source and sink,
- increasing the immunity (hardening) of the equipment.

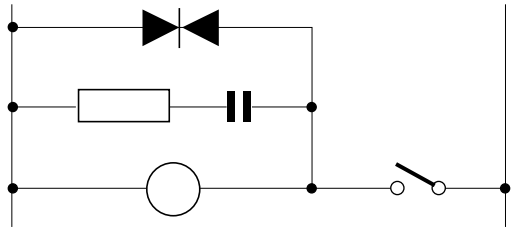
The three methods are complementary and should be applied together.

1.4.3.1 Attenuation at the Source (Interference Suppression)

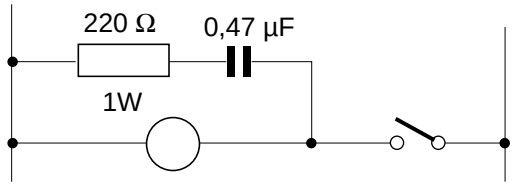
To limit the interference generated by components outside the system, make sure that:
- all the connections on terminal boards are securely attached,
- all the interference sources (relays, solenoid valves, motors, etc.) are provided with a suitable protection system.

Examples

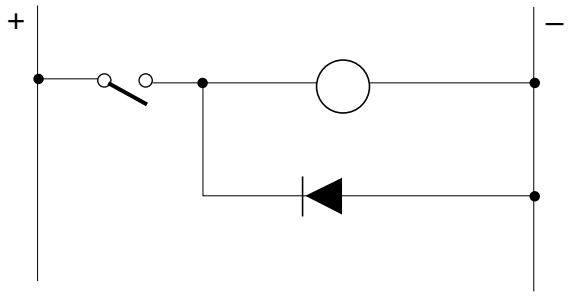
Low power AC contactor



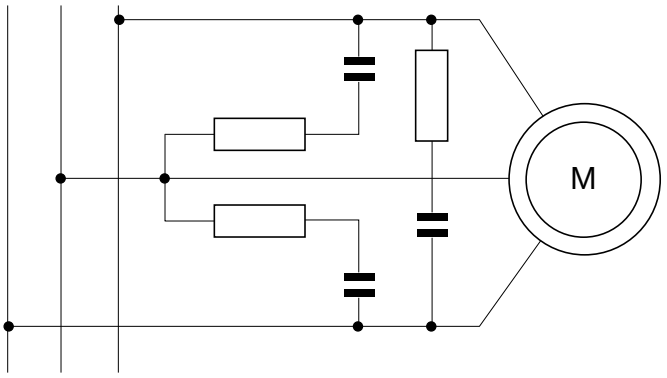
Medium and high power AC contactor



Low power DC contactor



Three-phase motor



1.4.3.2 Reduction of Couplings

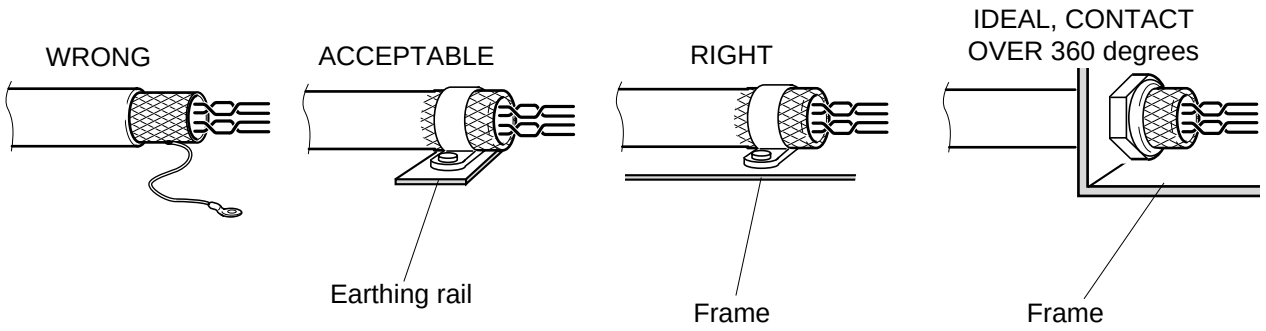
Provide a suitable earth meshing system (see Sec. 1.4.2.2) using metal parts with a conductive surface interconnected (bolted) together.

Wire with a reduction effect (low area loops):
- cables supplied against conduits and metal parts forming the frame earth,
- forward and backward travel of a signal in the same cable (twisted pair).

Earth the shielding of logic signal cables at both ends.

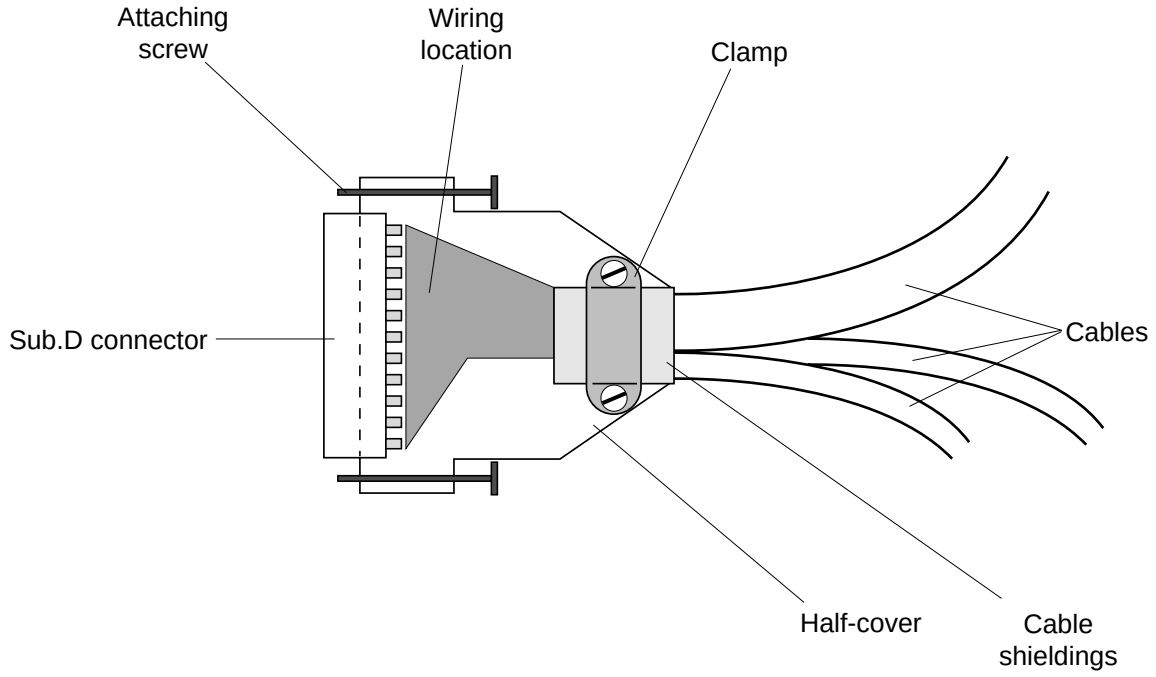
Earth the cable shielding over 360 degrees:
- with a conductive gland to penetrate through a bulkhead,
- by pinching the shielding in metal covers that are suitably earthed for connector plugs.

Connection of shielding to frame earth



Connection of cable shielding to the cover of a connector plug

Earth the cable shielding over 360 degrees: fold the shielding back onto the cable over a length of 1 cm and clamp it in the cover clamp.



Low level circuits must be separated from power circuits and circuits with interference:
- by physical separation of the cables (recommended minimum 30 cm),
- by routing in separate conduit or cable trays,
- by crossings at 90 degrees.

Analogue inputs (such as servo-drives) must be differential (common mode rejection).

Special case of servo-drive wiring

Servo-drives are low level (microvolt sensitivity), low frequency systems. It is therefore recommended to protect the link by a screen earthed only on the CNC side (see Sec. 1.4.2.1) and to provide double shielding on the cable earthed at both ends to serve for bonding.

When these recommendations cannot be applied (unavailability of cable with double shielding, etc.), bonding must be given precedence by using a cable with single shielding earthed at both ends.

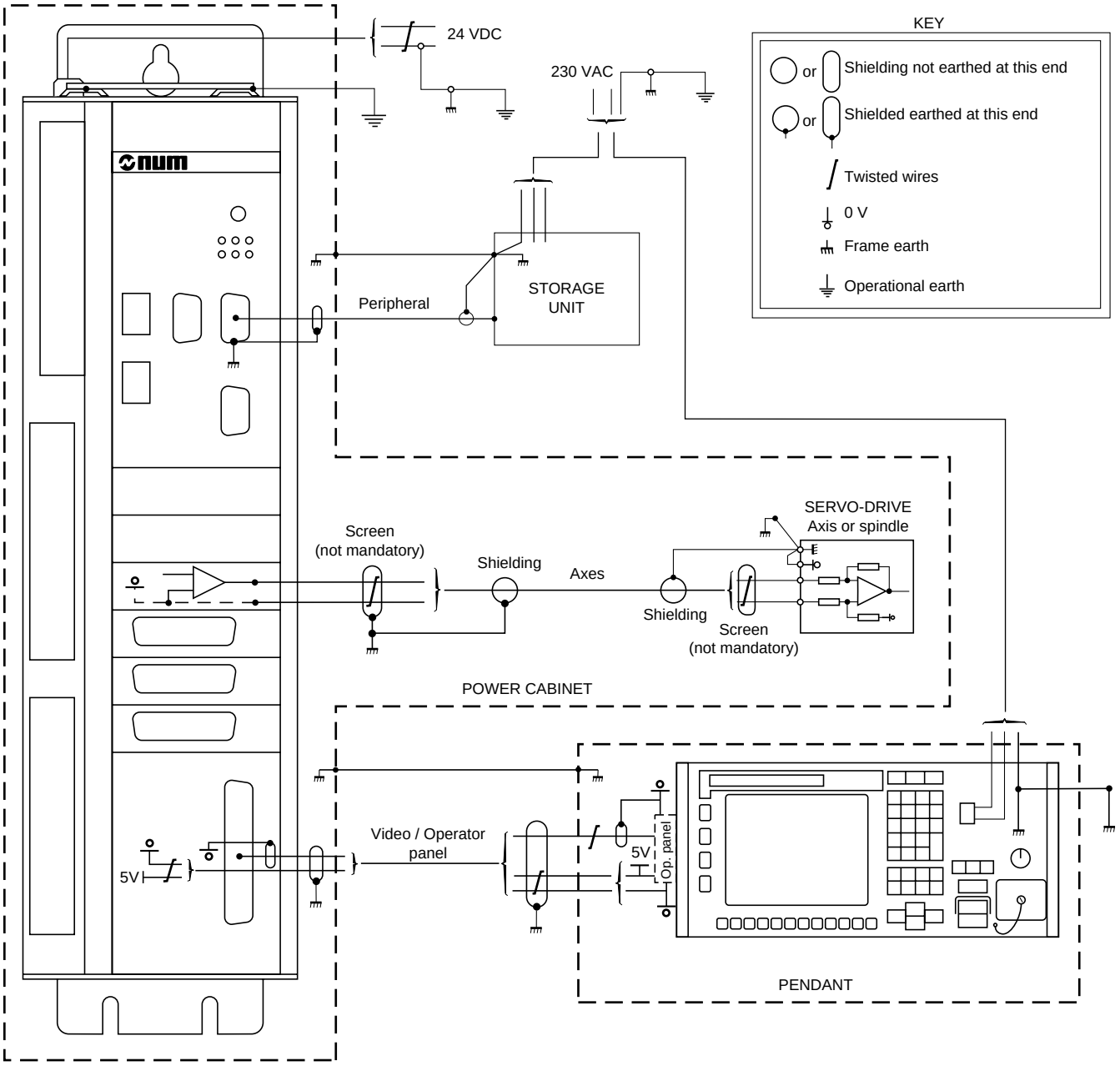
1.4.3.3 Equipment Hardening

Hardening is a feature integrated in the equipment design. Special care was taken with equipment immunity:

- multilayer cards with internal ground plane,
- stainless steel enclosure around the system and front panels in good contact with the enclosure so that the assembly forms an excellent Faraday cage,
- metal connector receptacles electrically connected to the front panels and provided with metal covers on which the shielding is earthed over 360 degrees,
- high level mains filtering on the power supply input,
- optoisolated binary inputs and outputs with physical separation from interference circuits.

All these measures give the equipment excellent immunity to electromagnetic interference.

1.4.4 Diagram of the 0 V, Frame Earth and Operational Earth



CAUTION

The 0 V lines of the 24 VDC power supplies must mandatorily be connected to the frame earth.

1.5 NUM Operator Panel Colours

The colours used for the NUM 1020 / 1040 operator panels are from standard colour ranges:

Colour	Use	Standard
Dark grey	Background	RAL 7021
Medium grey	Keys	RAL 7036
Light grey	Keys	RAL 7032
Red	Side trim	PANTONE WARM RED C

1.6 Screen Saver

The CNC has a screen saver designed to extend the screen life. When it is activated by the PLC programme, the screen saver clears the screen after 5 minutes of no action on the keyboard. Pressing any key redisplays the previously active page.

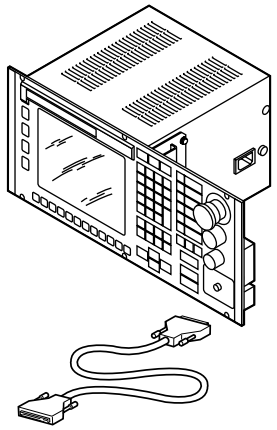
It is recommended to activate the screen saver by the PLC programme. This is done by setting the SC_SAVE bit (%W5.7).

2 General System Description

2.1 System Components

2.1.1 Operator Panels

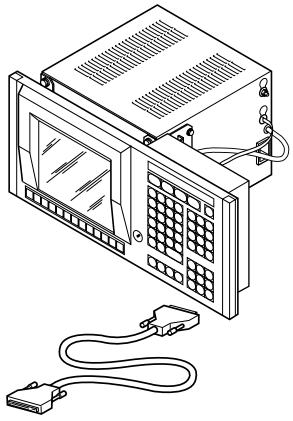
2.1.1.1 Compact Panels



10" Colour and 9" Monochrome Compacts Operator Panels

Subassemblies	Weight (kg)
Panel	11
Video cable	

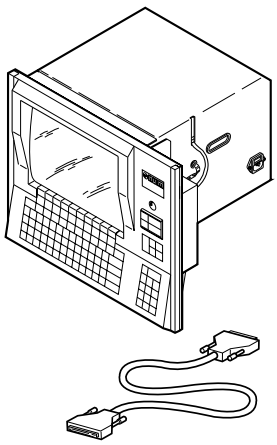
2.1.1.2 50-Key Panels



10" Colour and 9" Monochrome Operator Panels

Subassemblies	Weight (kg)
Panel	10,7
Video cable	

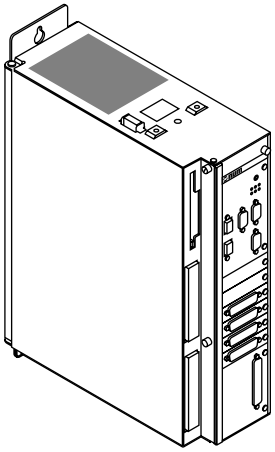
2.1.1.3 QWERTY Panel



14" Colour Operator Panel

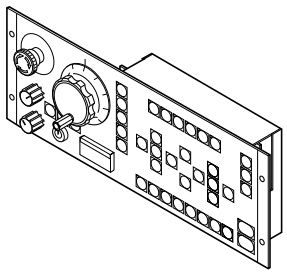
Subassemblies	Weight (kg)
Panel	16,5
Vidéo cable	

2.1.2 1020 or 1040 Rack



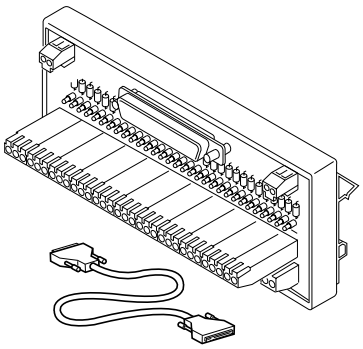
Weight: 6 kg

2.1.4 Machine Panel



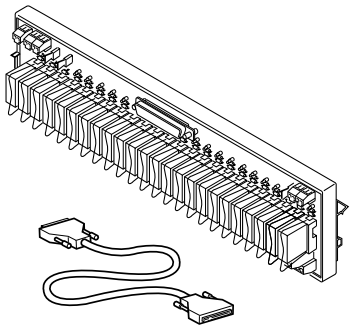
Subassemblies	Weight (kg)
Machine panel	2.200
Optical fibres	
Machine panel extension (optional)	0.300
Handwheel (optional)	0.515

2.1.5 Additional Components



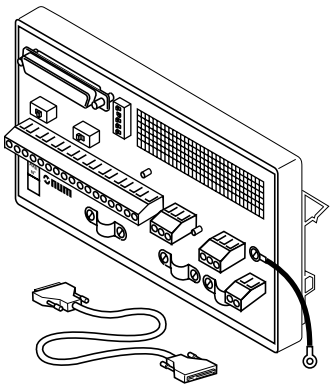
32-Input Interface Module

Subassemblies	Weight (kg)
Interface module	0.300
Input/output card connecting cable	



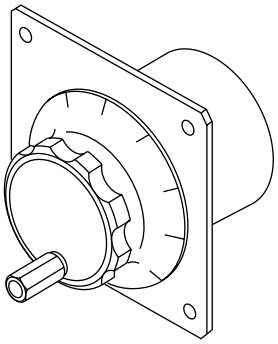
24-Output Relay Module

Subassemblies	Weight (kg)
Relay module	1.050
Input/output card connecting cable	



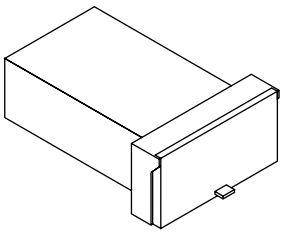
Axis Interface Module

Subassemblies	Weight (kg)
Axis interface module	0.230
Axis interface connecting cable	



Handwheel

Weight: 0.615 kg

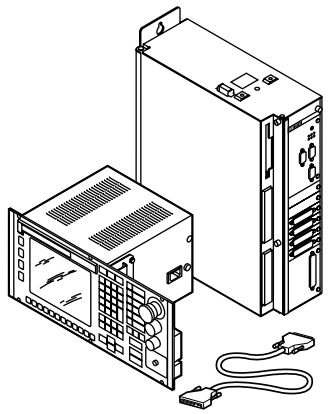


NUM Diskette Drive

Subassemblies
Diskette drive
Serial interface cable

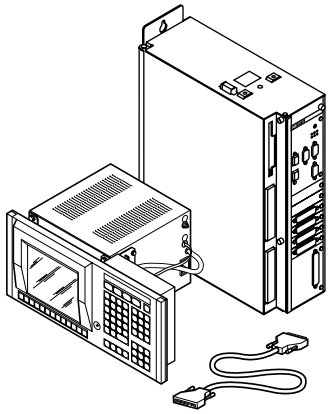
2.2 Basic Configuration

2.2.1 Basic 1020 Configuration



NUM 1020 CPU
Compact panel + video cable

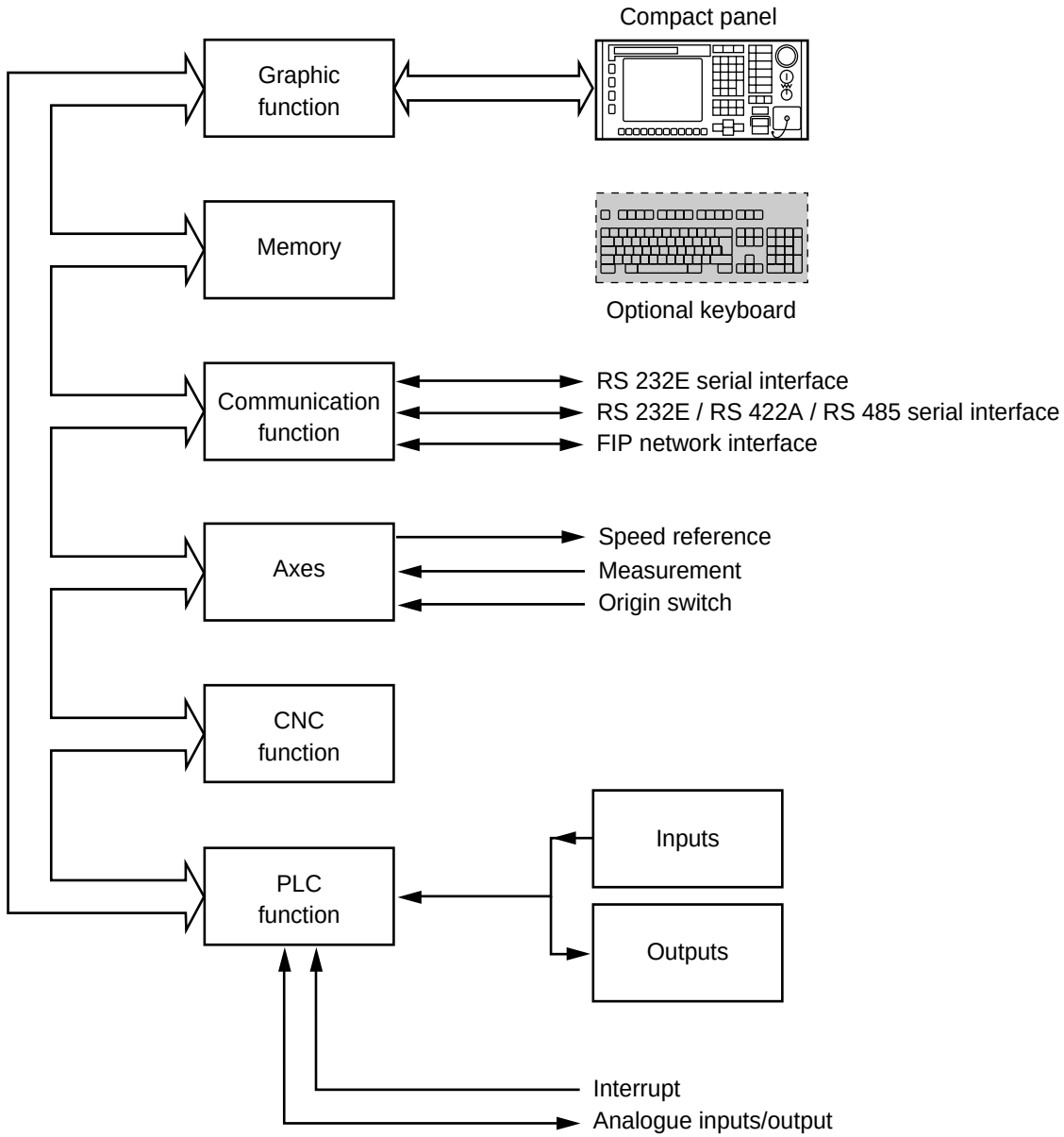
2.2.2 Basic 1040 Configuration



NUM 1040 CPU
Panel (compact, 50-key or QWERTY) + video cable
Machine panel (optional)

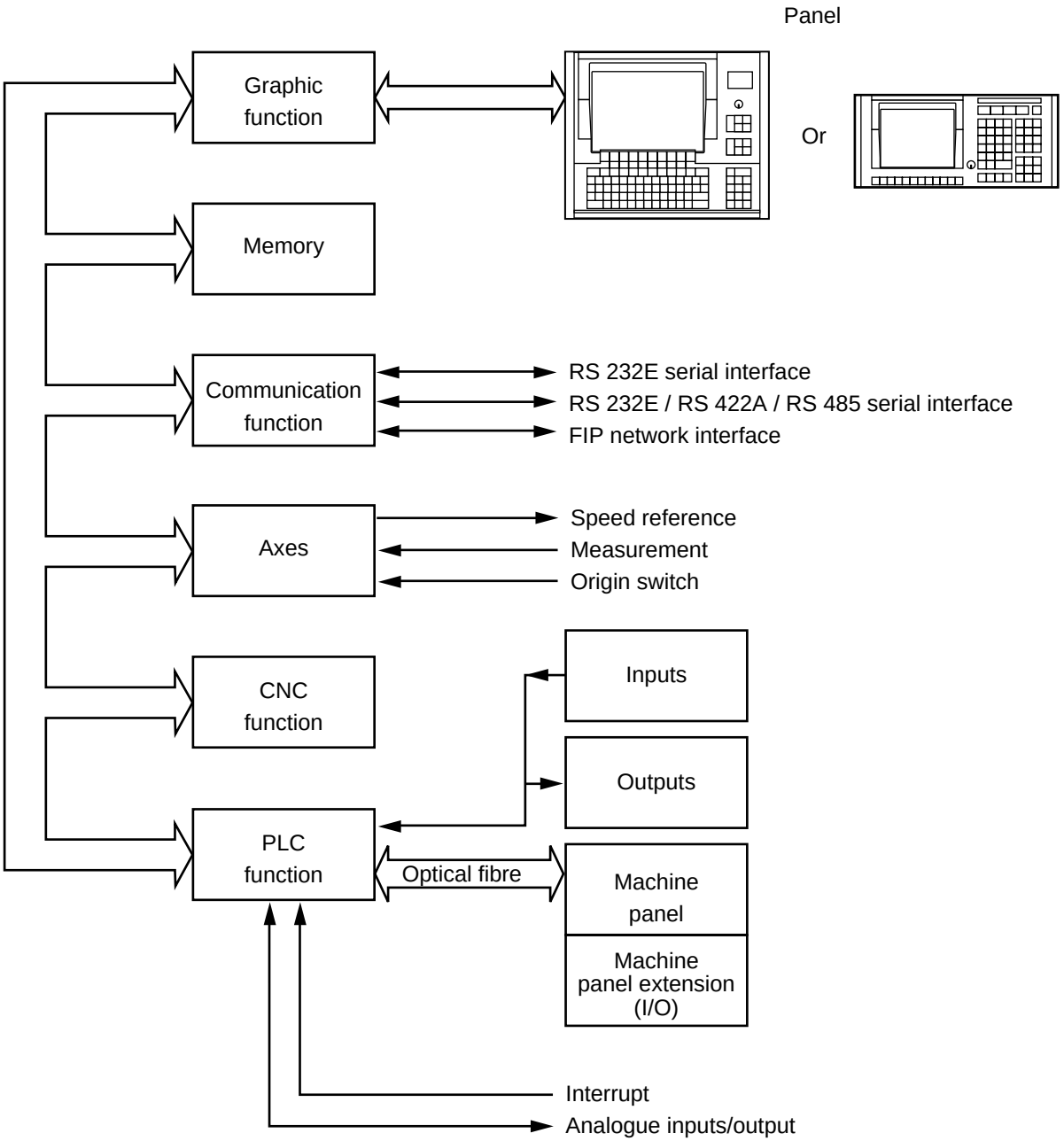
2.3 System Architecture

2.3.1 1020 or 1040 System with Compact Panel



REMARK *A machine panel cannot be used with the compact panel.*

2.3.2 1040 System with CNC Panel

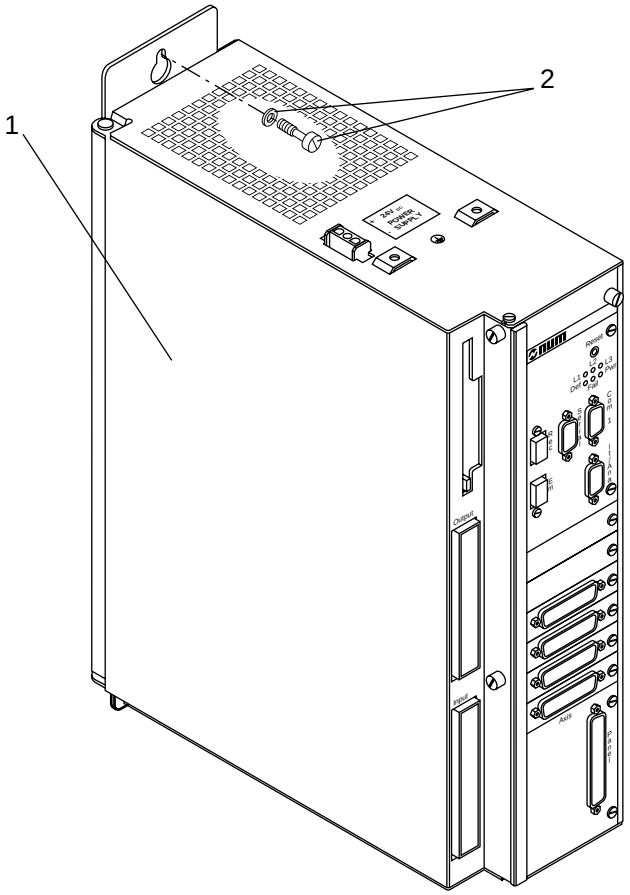


3 Overall Dimensions - Installation

3.1 NUM 1020 and 1040 CPUs

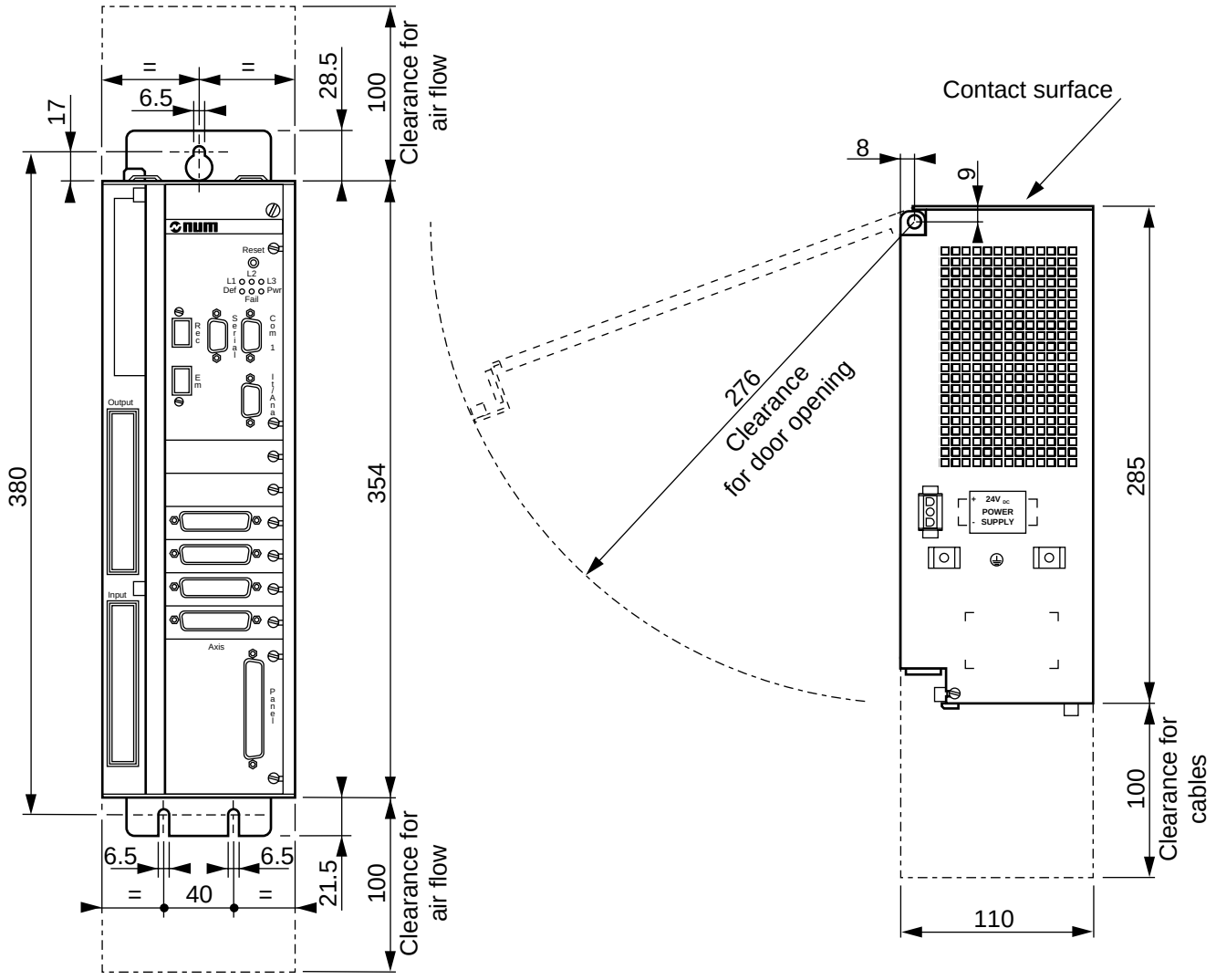
Weight: 6 kg.

3.1.1 CPU Mounting Parts



1 - CPU
2 - Attaching screw and washer (3)

3.1.2 Overall Dimensions and Attachments of the CPU



Front view

Top view

REMARK *It is not necessary to open the door except to add axis cards or an SRAM memory chip or adjust the transmit power of the optical fibre line.*

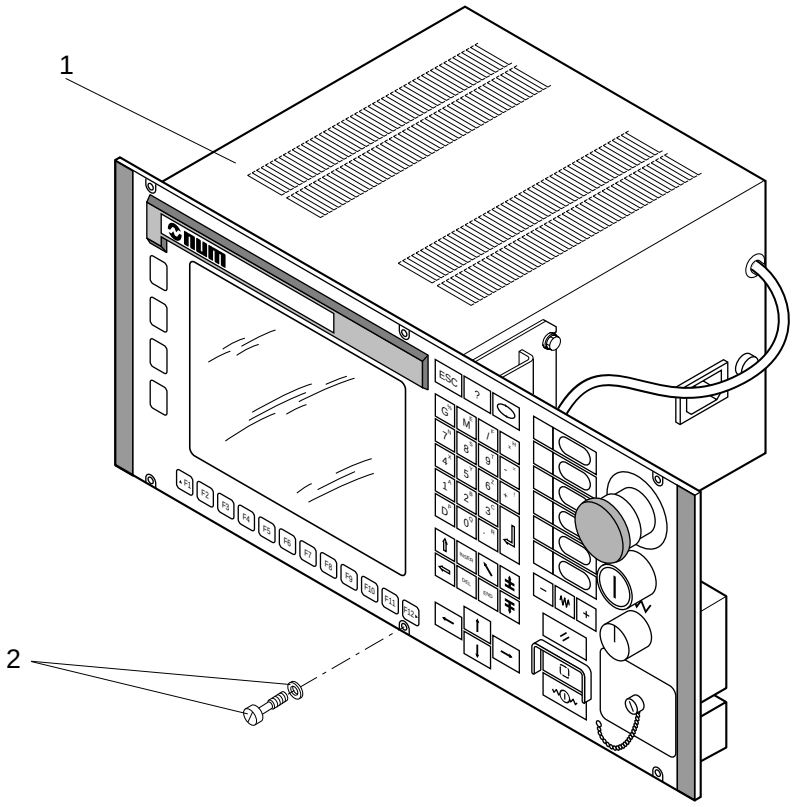
⚠ CAUTION

For correct ventilation, the CPU must be installed vertically.

3.2 Compact Panel

Weight: 11 kg.

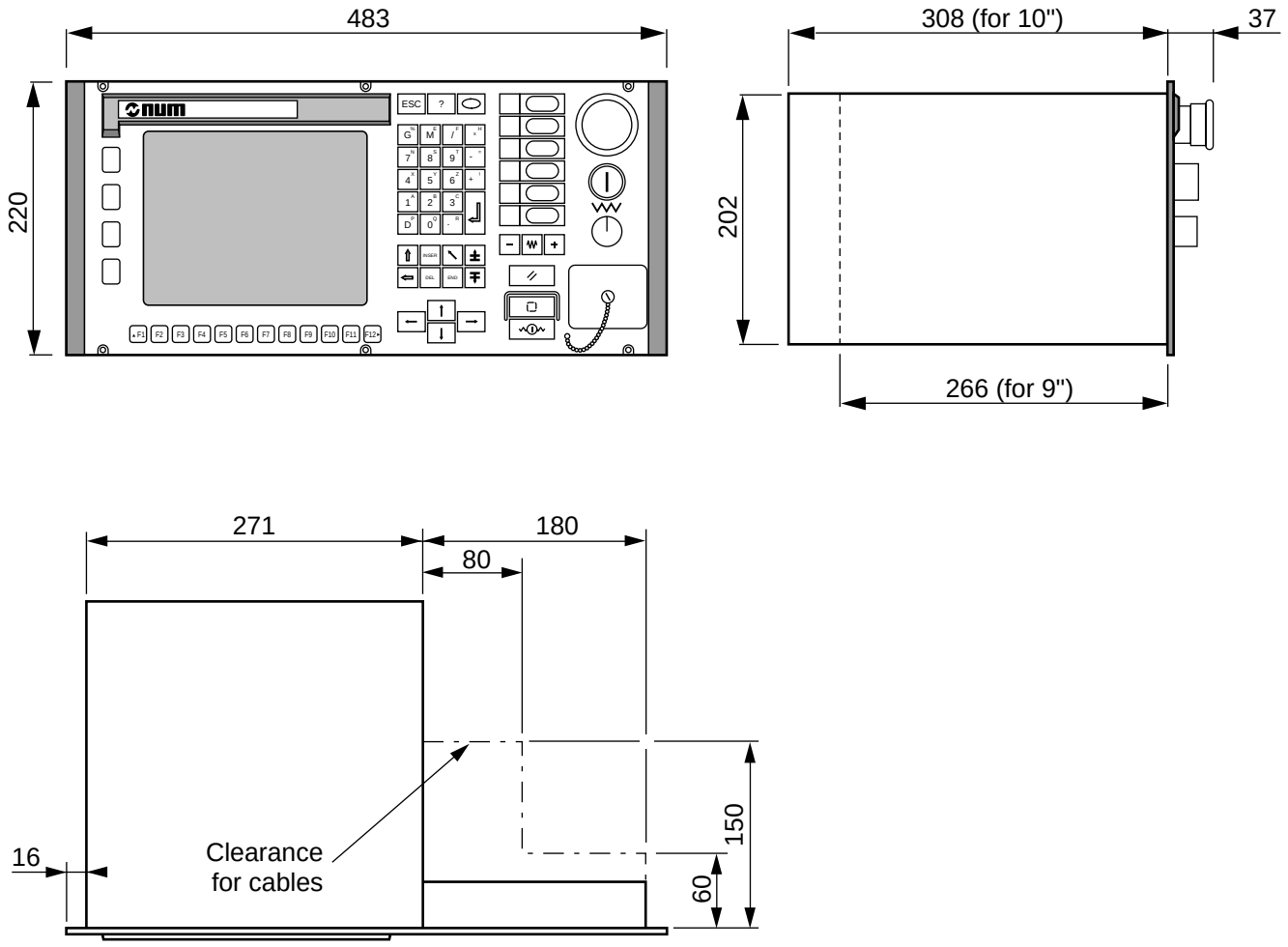
3.2.1 Panel Mounting Parts



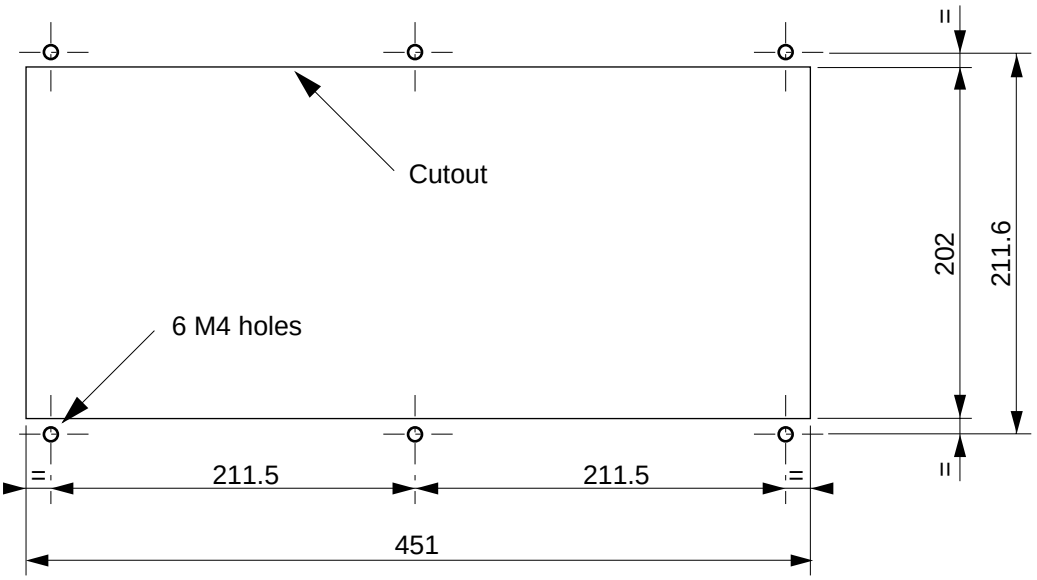
1 - Panel
2 - Panel attaching screw and washer (6)

> **CAUTION**
>
> The panel is not sealed unless the cover is installed over the front panel connectors.

3.2.2 Overall Dimensions of the Compact Panel



3.2.3 Cutouts for Compact Panel Mounting



REMARK *The cutout dimensions are the same as for the 50-key panels. Only the attachment holes differ between the two types of panels.*

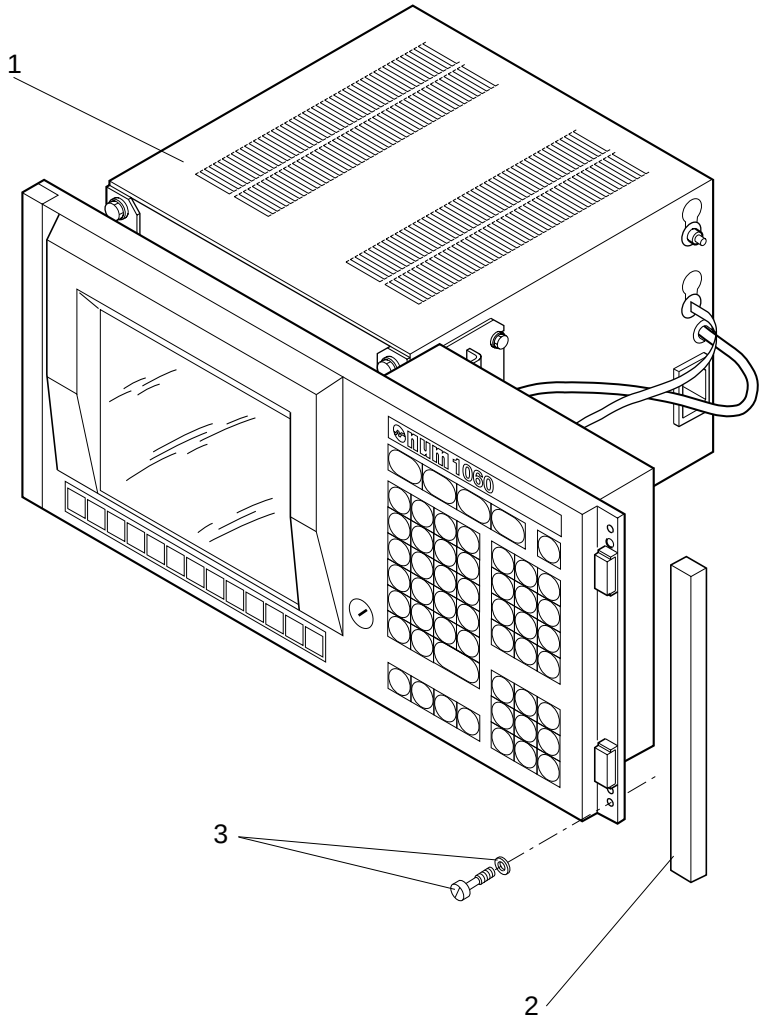
CAUTION

It is recommended to make sure the enclosure over the rear part of the panel provides IP65 insulation.

3.3 9" Monochrome and 10" Colour

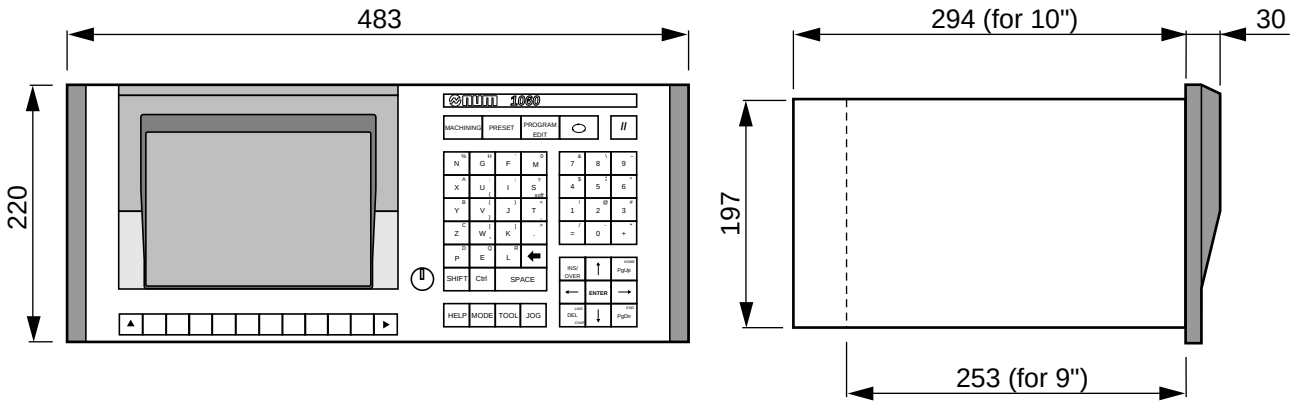
Weight: 10.7 kg.

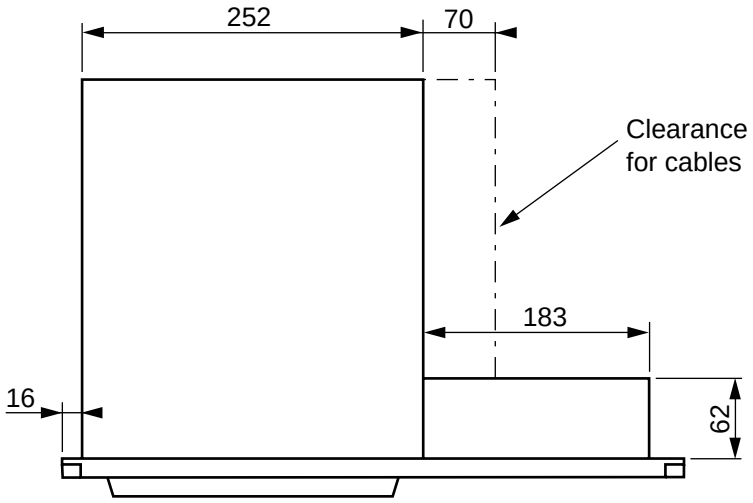
3.3.1 Panel Mounting Parts



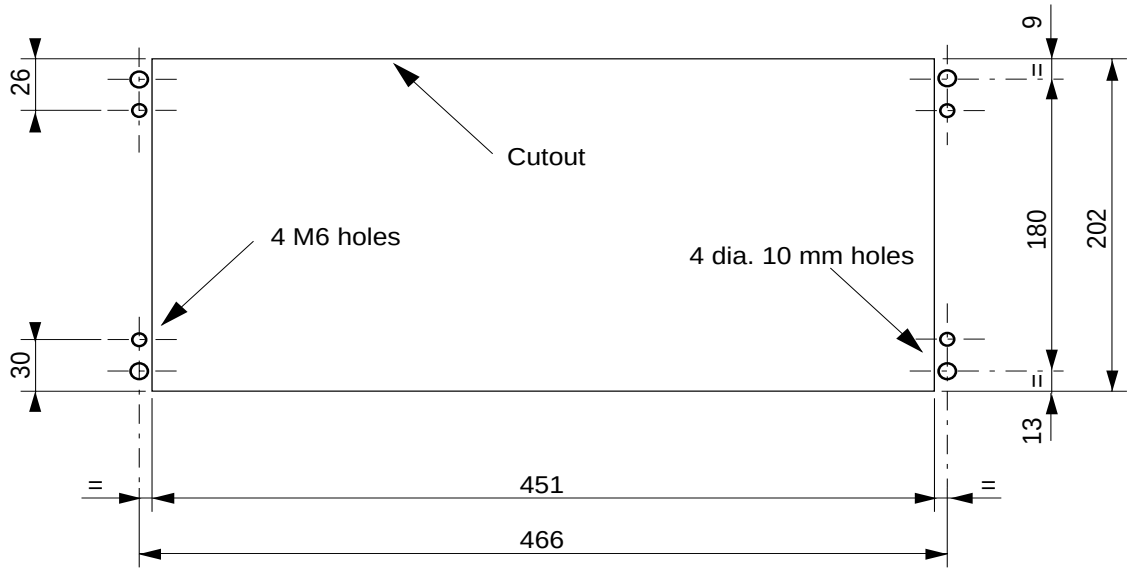
1 - Panel
2 - Edge trim
3 - Panel attaching screw and washer (4)

3.3.2 Overall Dimensions of the Panels





3.3.3 Cutouts for Panel Mounting



REMARK *The cutout dimensions are the same as for the compact panel. Only the attachment holes differ between the two types of panels.*

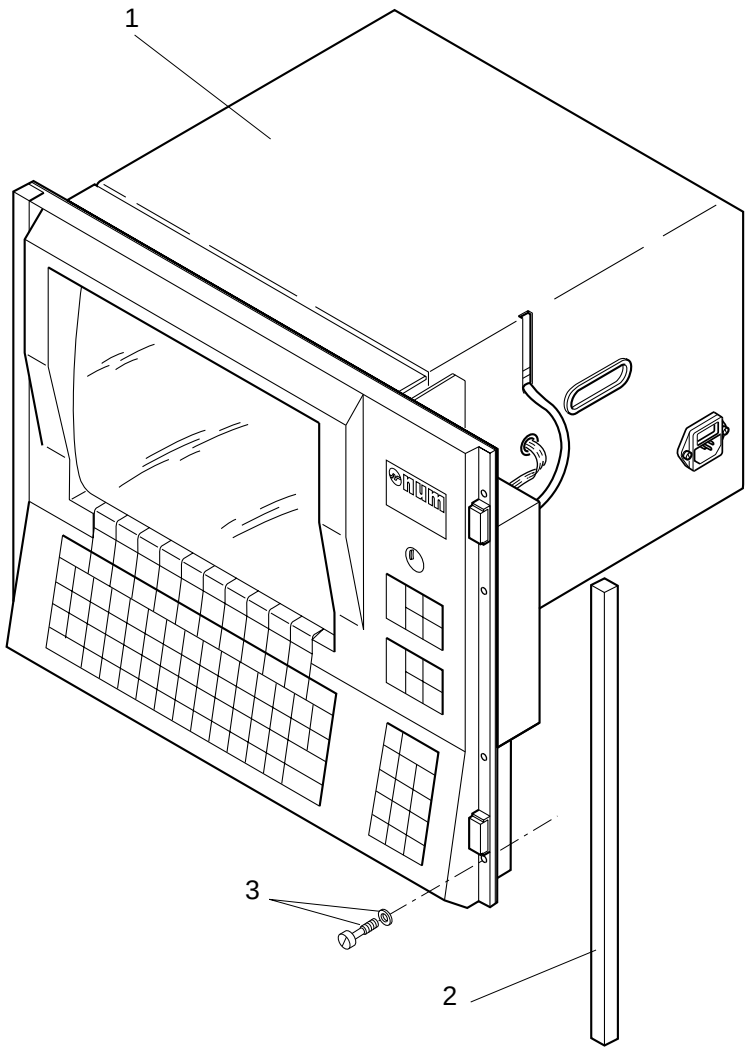
CAUTION

It is recommended to make sure the enclosure over the rear part of the panel provides IP65 insulation.

3.4 14" Colour QWERTY Panels

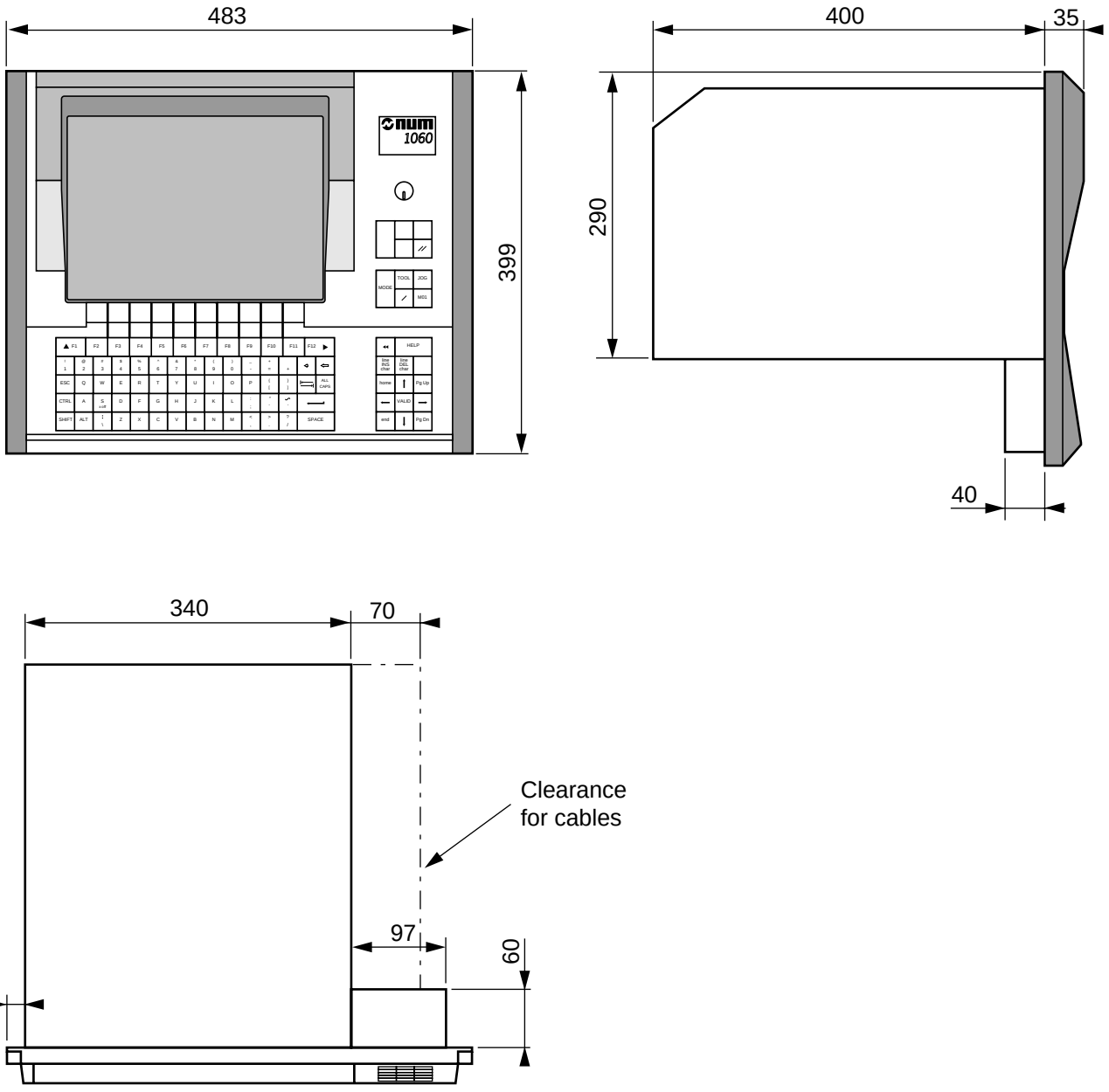
Weight: 16.5 kg.

3.4.1 Panel Mounting Parts

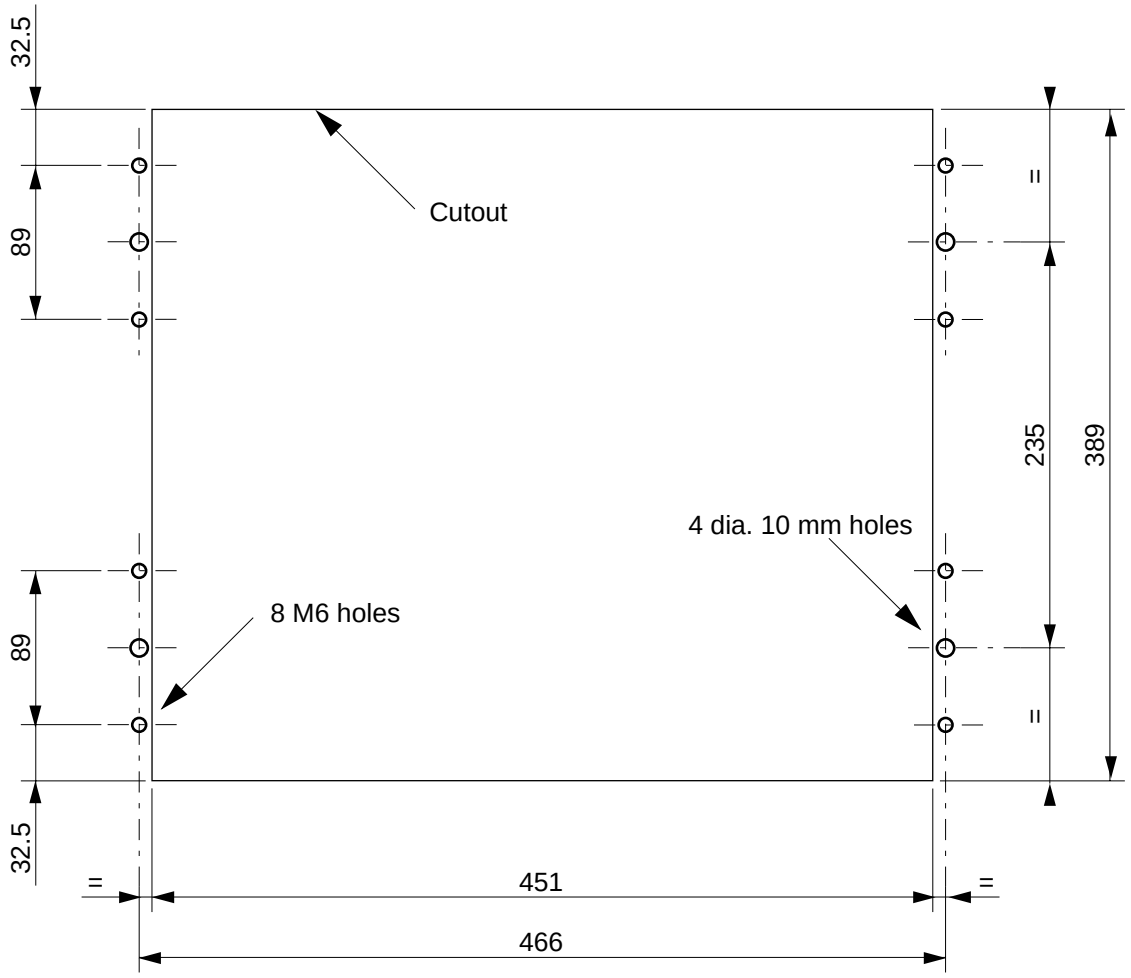


1 - Panel
2 - Edge trim
3 - Panel attaching screw and washer (8)

3.4.2 Overall Dimensions of the Panel



3.4.3 Cutouts for Panel Mounting



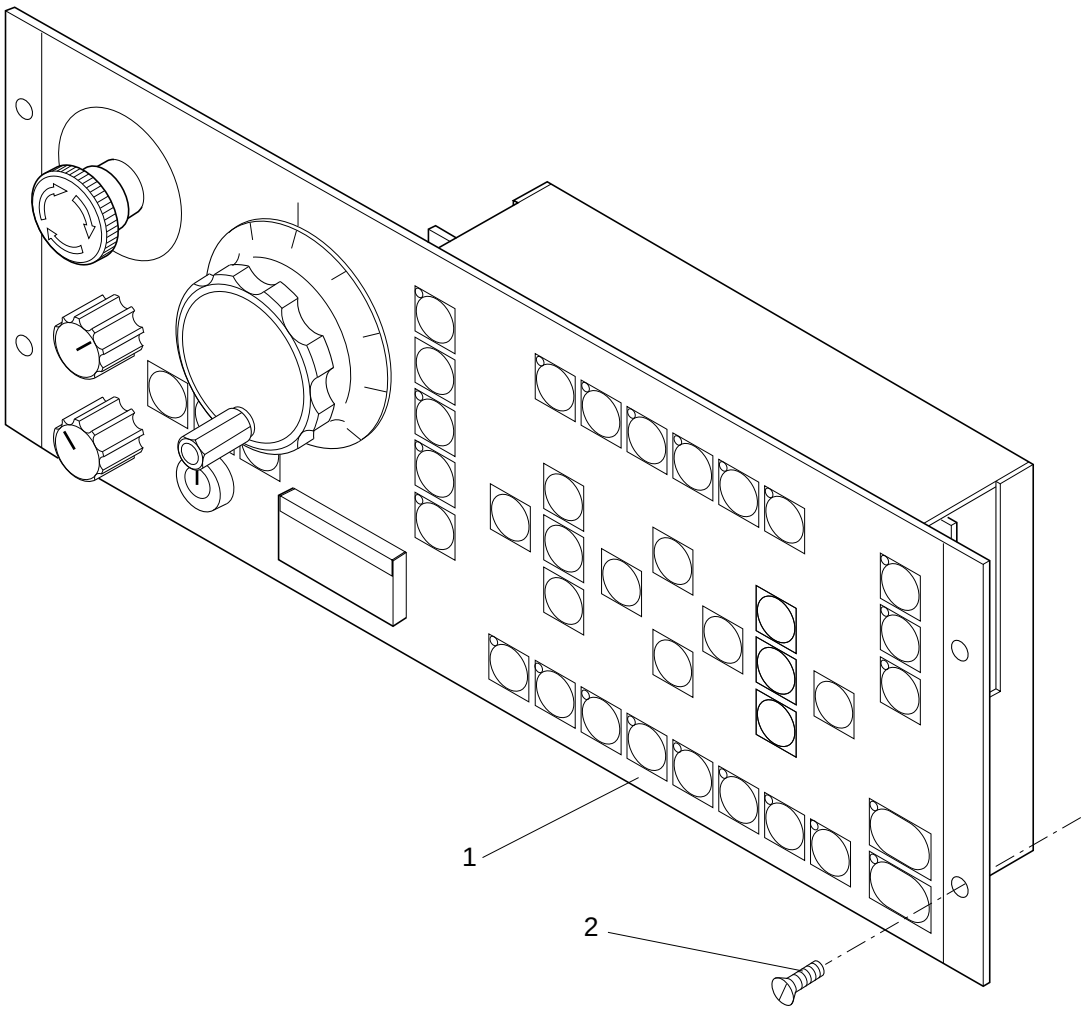
CAUTION

It is recommended to make sure the enclosure over the rear part of the panel provides IP65 insulation.

3.5 Machine Panel

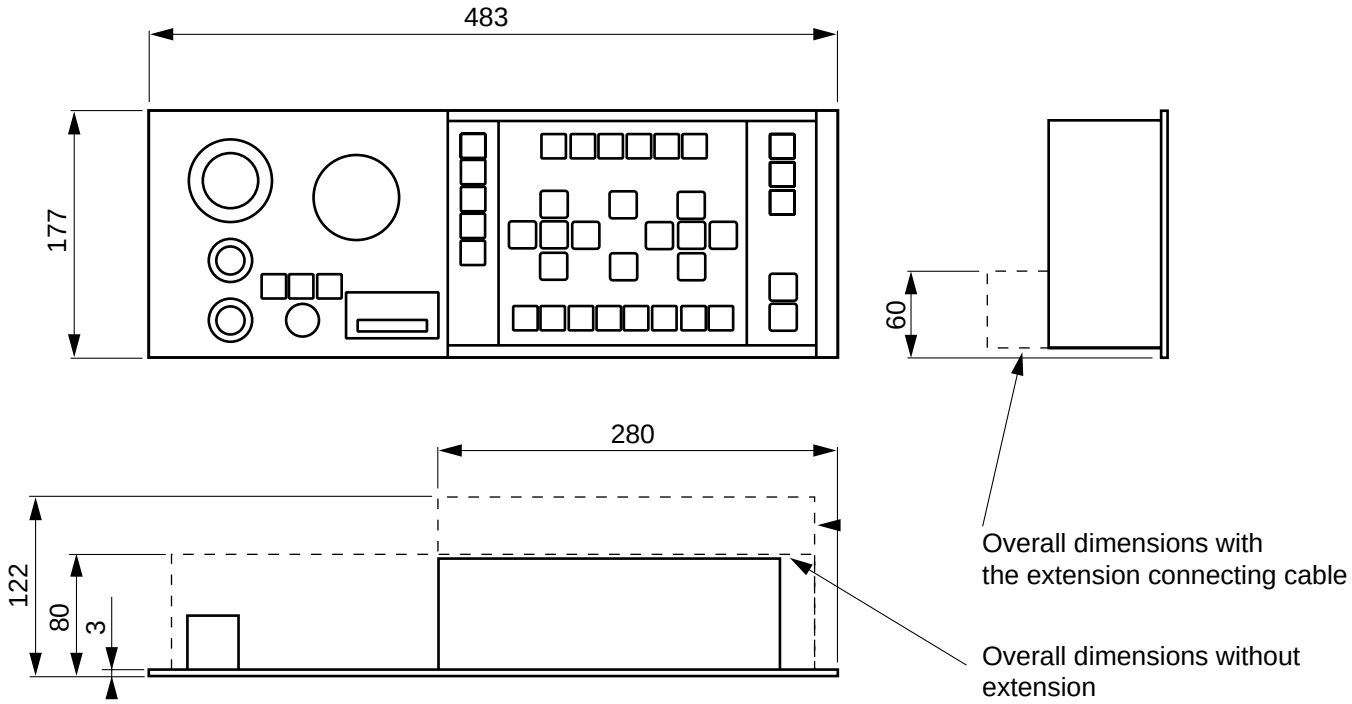
Weight: 2.200 kg unequipped (add 0.300 kg for the extension and 0.515 kg for the handwheel).

3.5.1 Machine Panel Mounting Parts

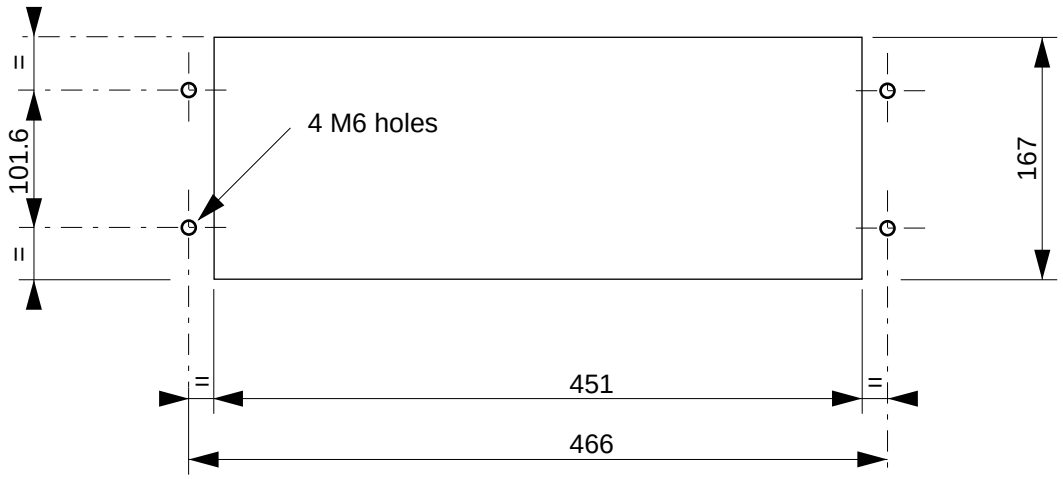


1 - Machine panel
2 - Machine panel attaching screw (4)

3.5.2 Overall Dimensions of the Machine Panel



3.5.3 Cutouts for Machine Panel Mounting



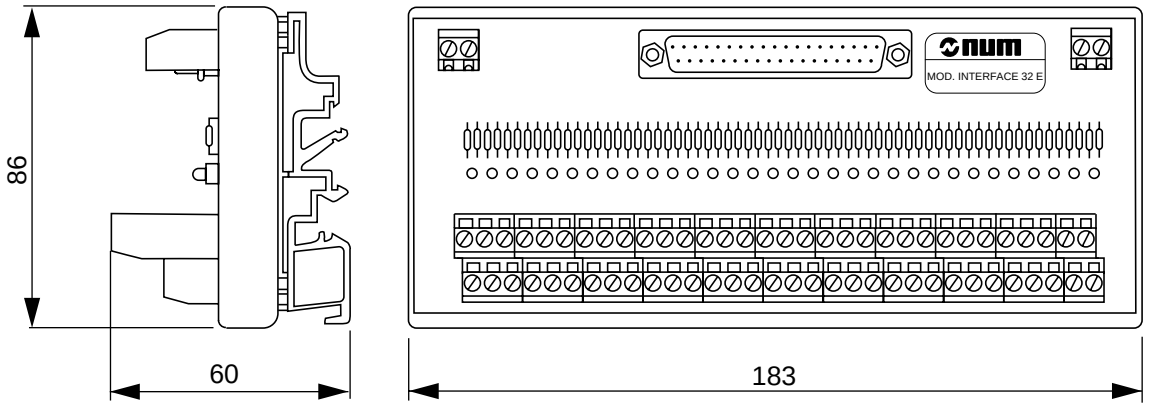
CAUTION

It is recommended to make sure the enclosure over the rear part of the panel provides IP65 insulation.

3.6 Additional Components

3.6.1 Mounting of the 32-Input Interfacing Module

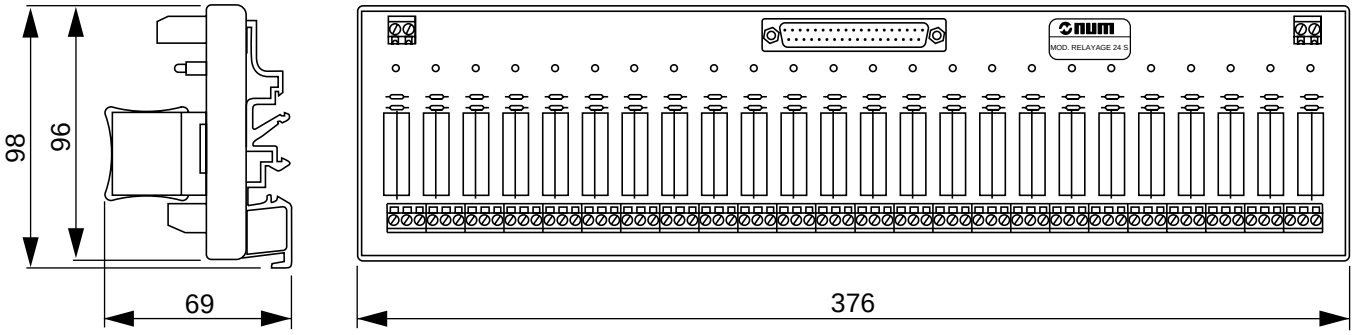
Weight: 0.300 kg.



Mounted by snapping to extrusions complying with standards EN 50022 (or NF C 63-015) and EN 50035 (or NF C 63-018).

3.6.2 Mounting of the 24-Output Relay Module

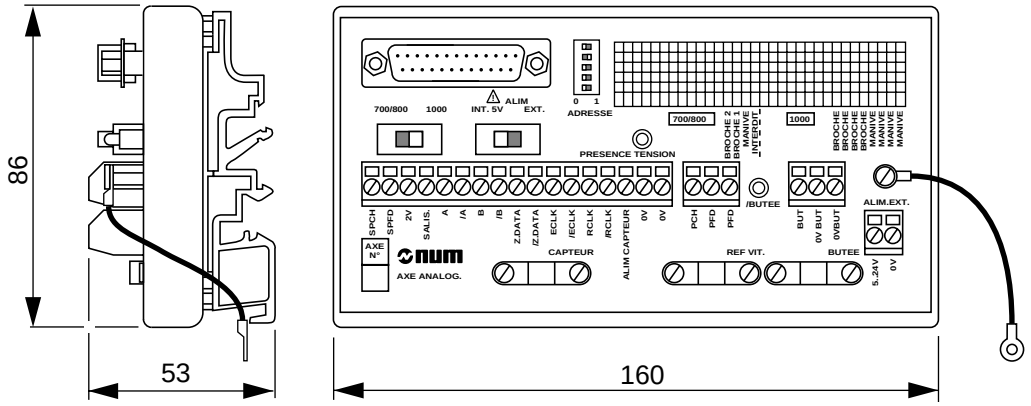
Weight: 1.050 kg.



Mounted by snapping to extrusions complying with standards EN 50022 (or NF C 63-015) and EN 50035 (or NF C 63-018).

3.6.3 Mounting of the Axis Connection Module

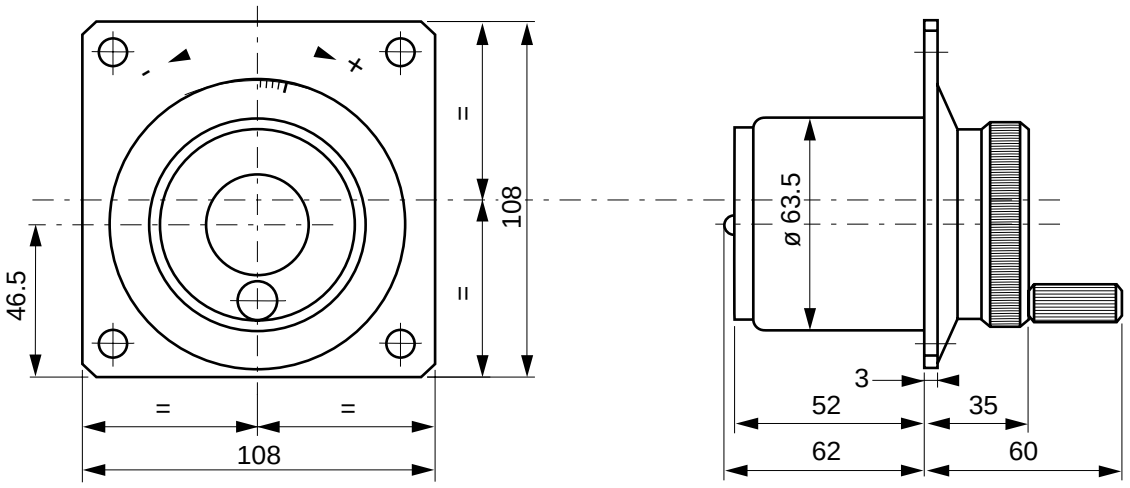
Weight: 0.230 kg.



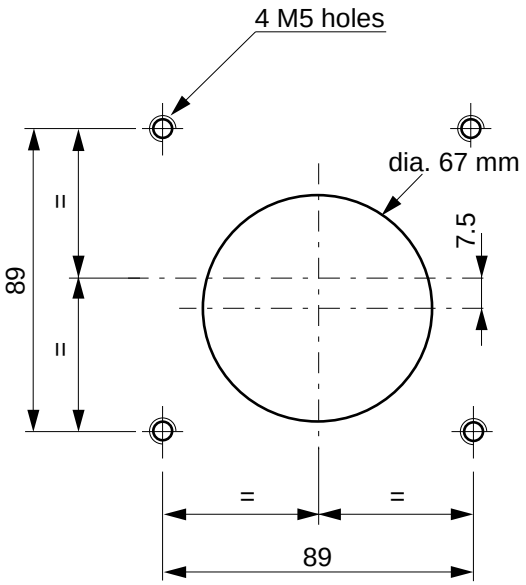
Mounted by snapping to extrusions complying with standards EN 50022 (or NF C 63-015) and EN 50035 (or NF C 63-018).

3.6.4 Handwheel Mounting

Overall dimensions

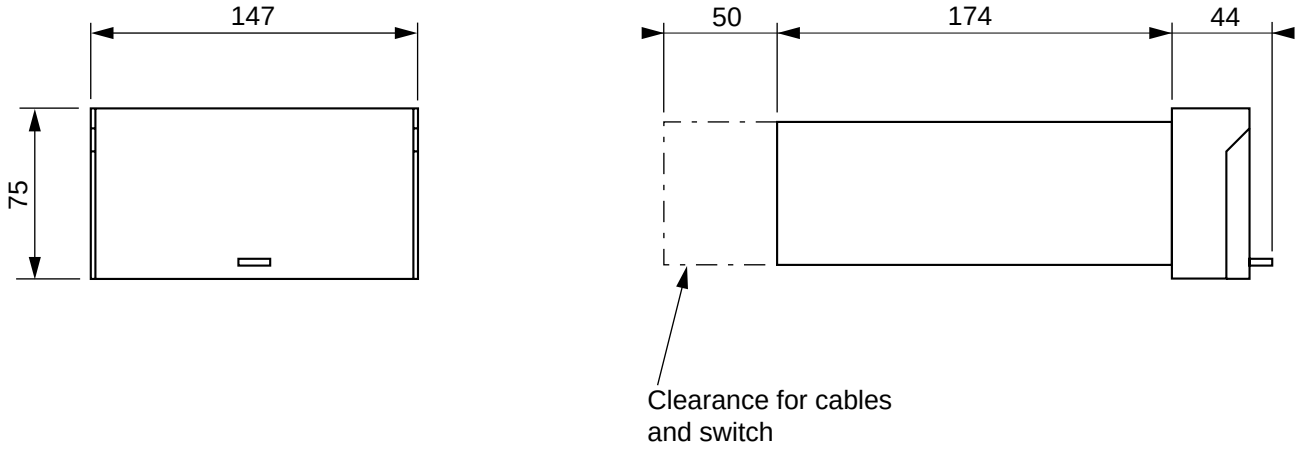


Holes and cutout

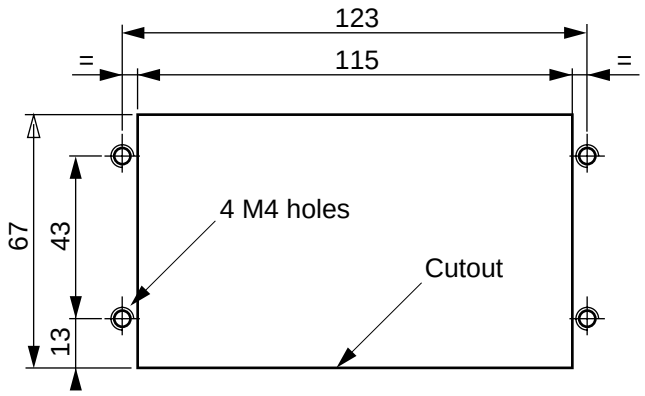


3.6.5 Mounting of the NUM Diskette Drive

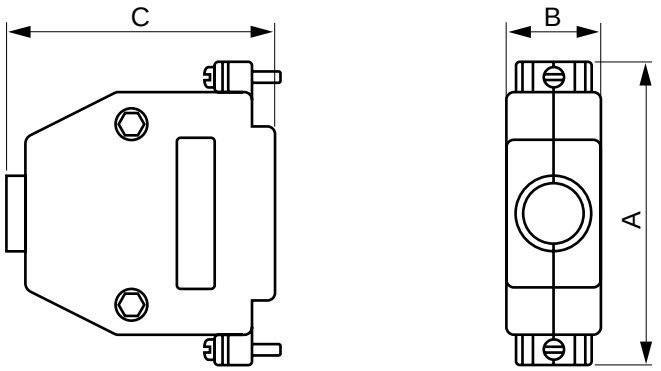
Overall dimensions



Holes and cutout



3.6.6 Overall Dimensions of the Sub.D Connector Covers (Cables)



Number of contacts	A	B	C
9	31	16	41
15	53	16	38
25	53	16	45
37	70	24	51

REMARK *The dimensions given in the table are rounded off and correspond to the product line of a particular supplier. They could differ slightly for other suppliers.*

4 Component Preparation

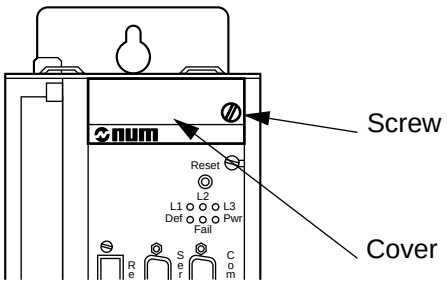
4.1 Preparing the CPU

Operations that can be performed on the CPU:
- Adding axis cards (see Sec. 4.1.3),
- Adding an SRAM memory module (see Sec. 4.1.4),
- Adjusting the optical fibre transmit power (see Sec. 4.1.5),
- Replacing or installing the battery (see Sec. 4.1.6).

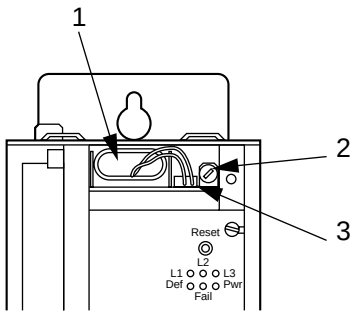
The first three operations require opening the cover plate (see Sec. 4.1.2) and the last requires opening the fuse/battery cover (see Sec. 4.1.1).

4.1.1 Opening the Fuse/Battery Cover

Remove the screw and take off the cover.



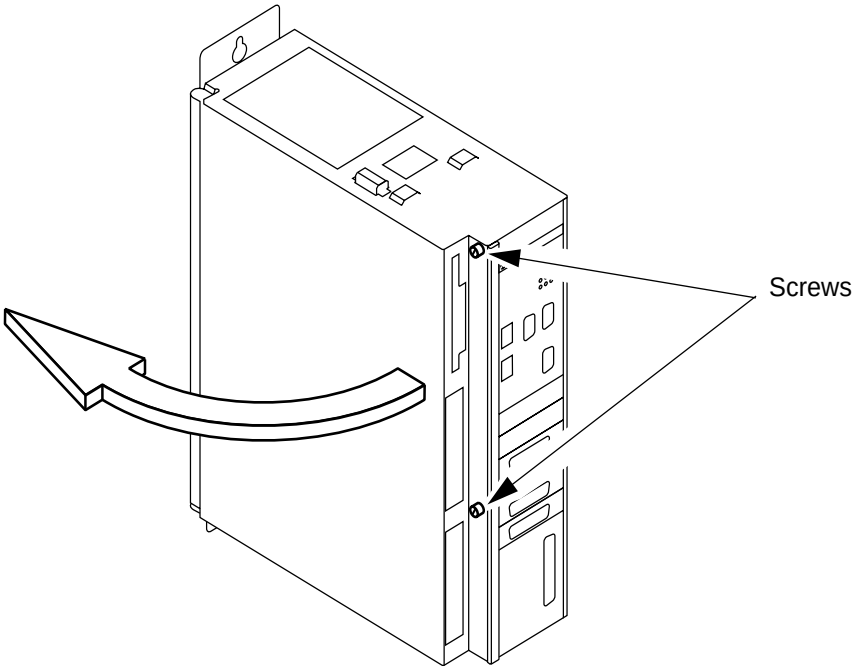
Location of the fuse and battery:



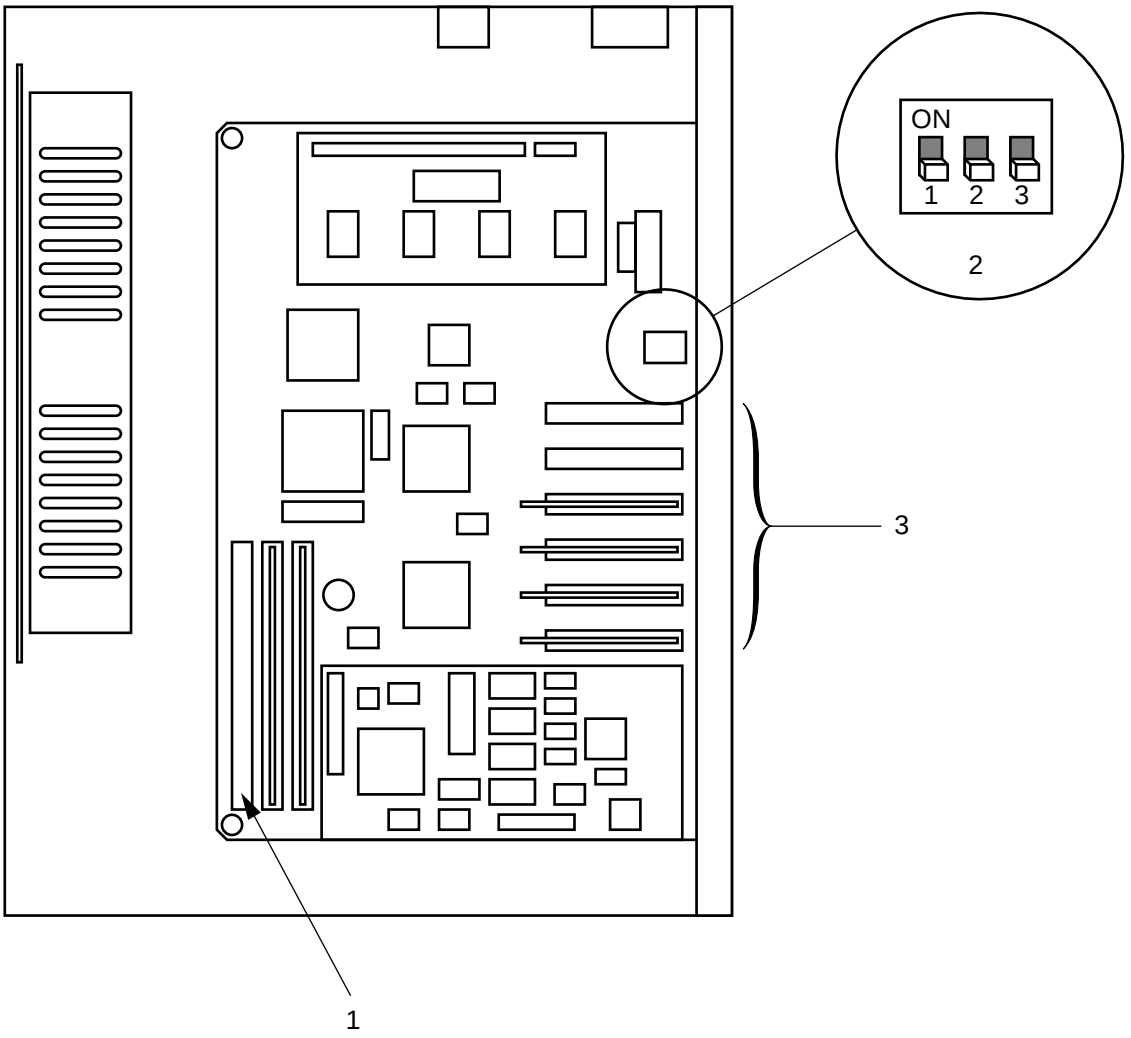
1 - Battery
2 - Fuse
3 - Battery connector

4.1.2 Opening the Cover Plate

Remove the two screws and swing open the cover plate.



Location of the items concerned by the work:

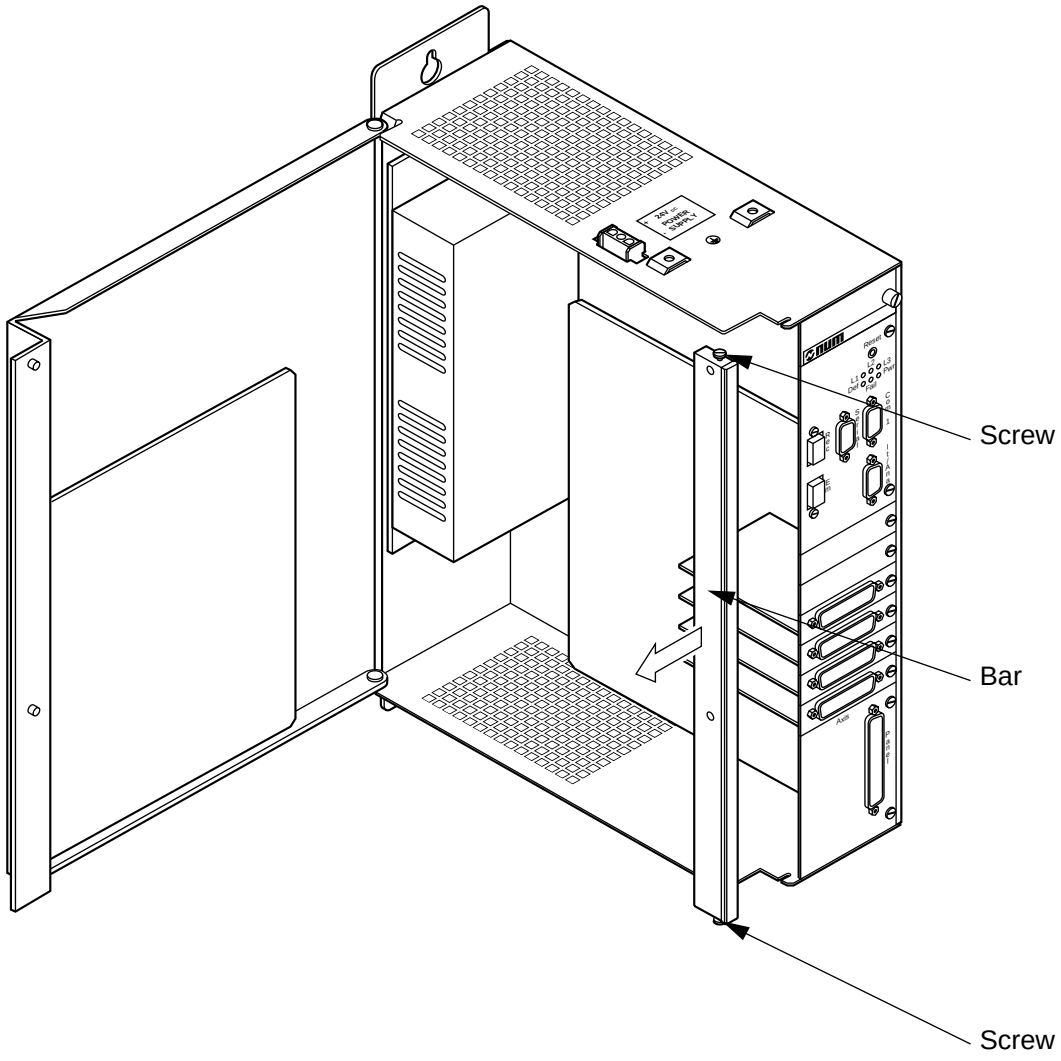


1 - Slot for SRAM memory module
2 - Optical fibre transmit power adjustment switches
3 - Axis cards

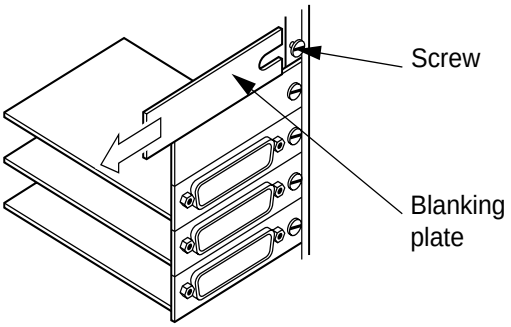
4.1.3 Adding Axis Cards

Refer to the layout diagram (see Sec. 4.1.2).

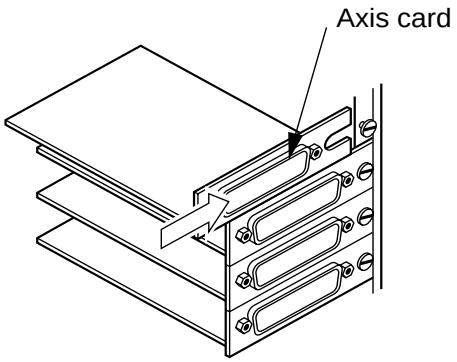
Remove the two screws and take off the card retaining bar.



Remove the screw and remove the card slot blanking plate.



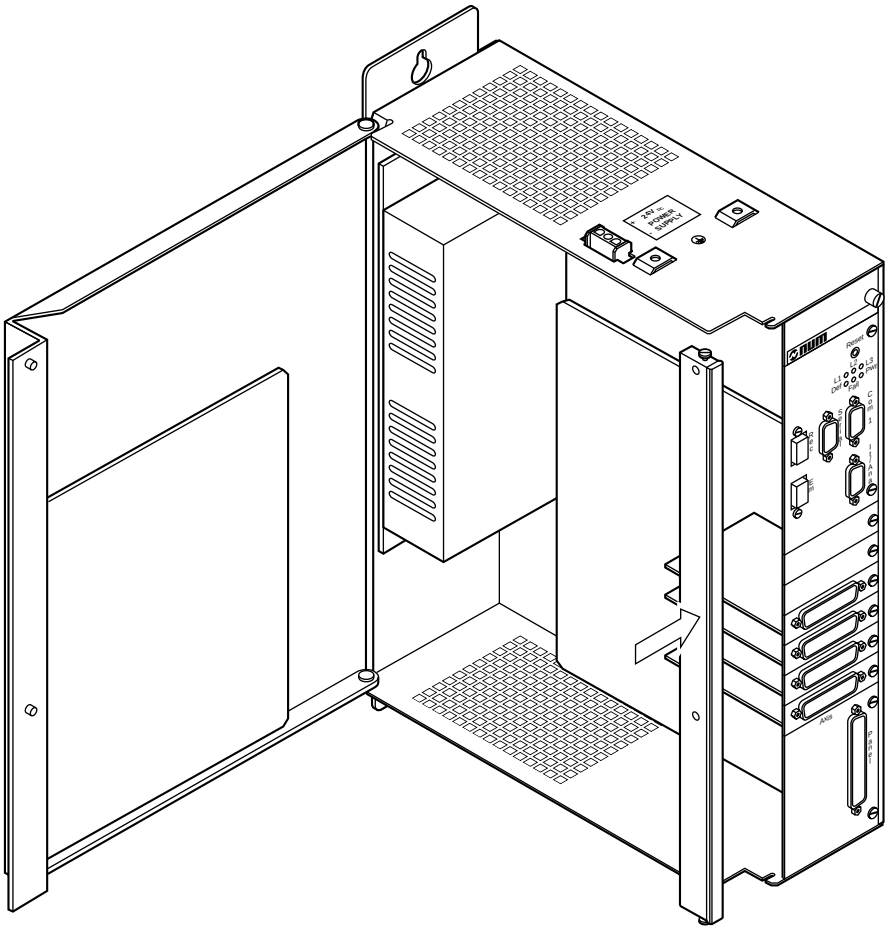
Install the new card and tighten the screw.



⚠ CAUTION

When inserting a new card, push it straight into the connector so as not to damage the connector pins.

Install the bar and tighten the screws.

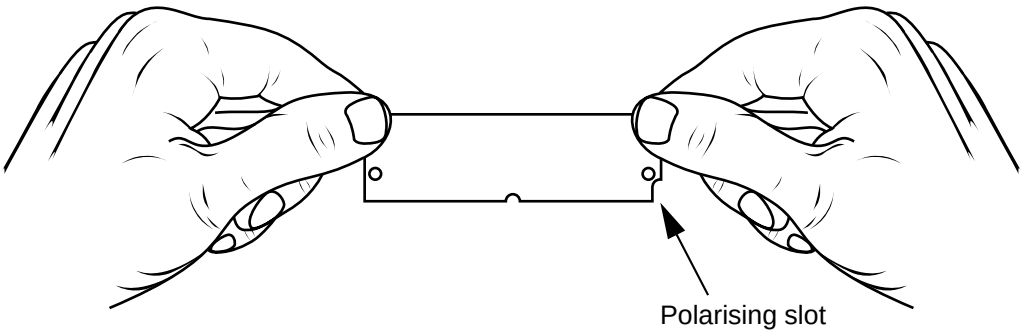


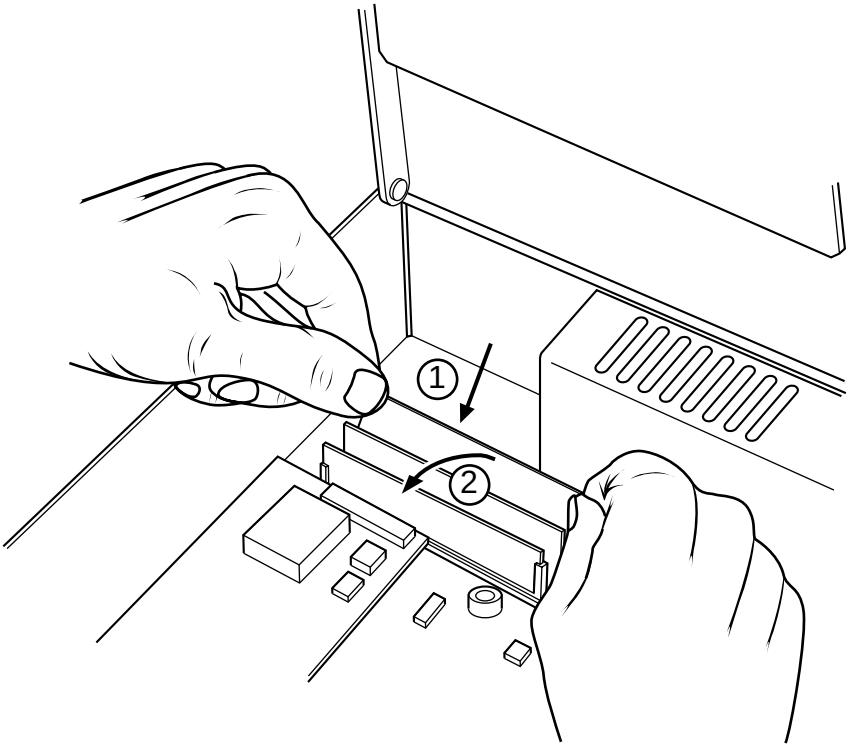
4.1.4 Adding an SRAM Memory Module

Refer to the layout diagram (see Sec. 4.1.2).

Position the module at a slant into the connector with the polarising slot located on the right (1).

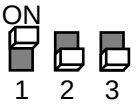
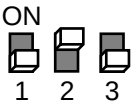
Swing the module up to a vertical position until it snaps in place (2).





4.1.5 Adjusting the Optical Fibre Transmit Power

The adjustment is made on switches (see Sec. 4.1.2) according to the length of the optical fibre cable:

Optical fibre cable length	Switch setting
L ≤ 15 m	
15 m < L ≤ 30 m	
L > 30 m	

4.1.6 Replacing or Installing the Battery

Refer to the layout diagram (see Sec. 4.1.1).

CAUTION

The battery must be replaced within 15 minutes so as not to lose the data present in the RAM. A special capacitor powers the SRAM modules while the battery is being replaced.

Remove the battery from its housing and take off the connector.

Connect the new battery, making sure the connector is correctly installed, and install the battery.

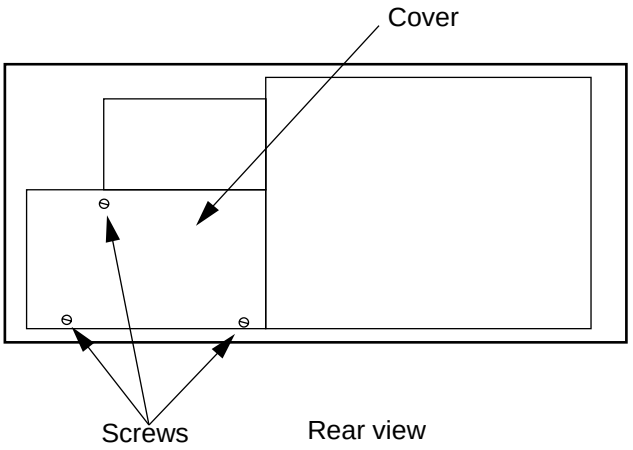
4.2 Preparing the Compact Panel

Operations that can be performed on the compact panel:
- Relocation of the DIN connector (see Sec. 4.2.2),
- Installation of the key customisation label (see Sec. 4.2.3).

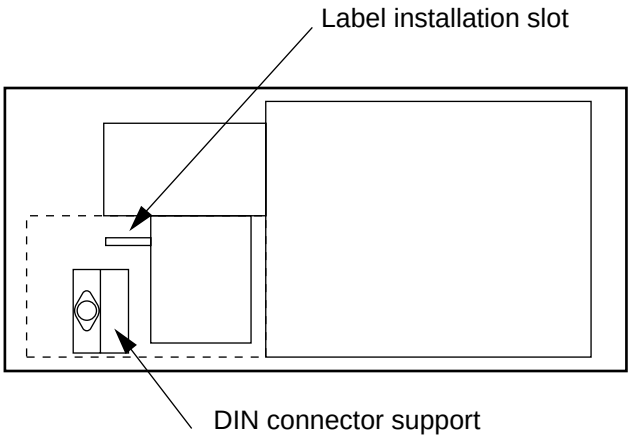
These operations require removing the rear cover (see Sec. 4.2.1).

4.2.1 Removing the Rear Cover

Remove the three screws and take off the cover.



Location of the items concerned by the operations:

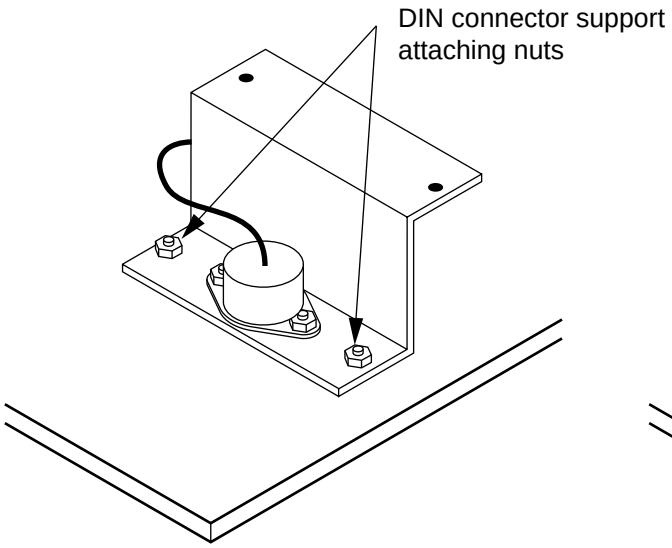


4.2.2 Relocating the Keyboard Connector

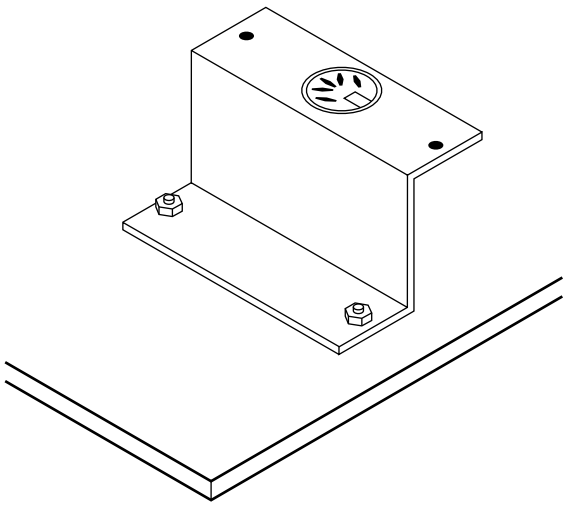
The compact panel is equipped with a keyboard connector (5-contact DIN connector) accessible on the front after removing the cover.

This location of the DIN connector corresponds to occasional use of a PC type keyboard (seal not ensured when the cover is removed).

For permanent connection of a PC type keyboard, the DIN connector can be moved to the back of the panel:



DIN connector located on the front



DIN connector relocated on the back of the panel

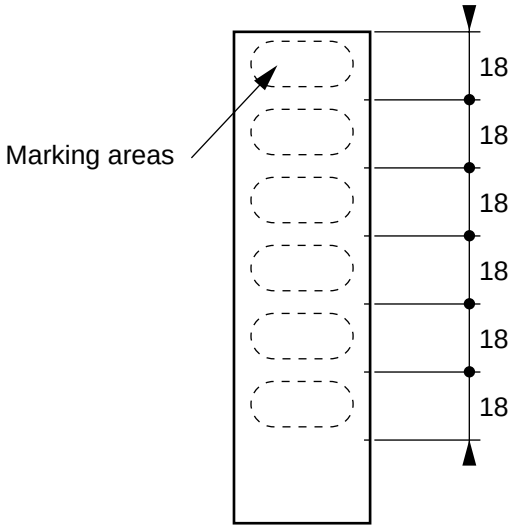
Unscrew the two DIN connector support attaching nuts.

Turn over the support and reinstall the nuts.

4.2.3 Installing the Key Customisation Label

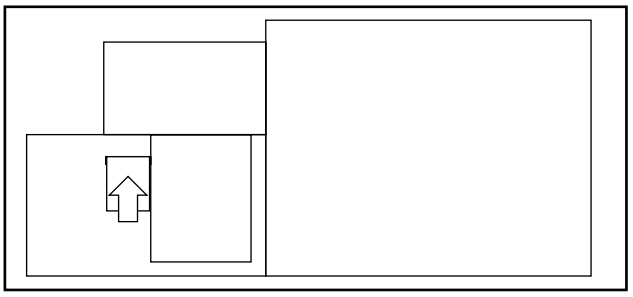
The compact panel has six cutomisable keys. The key assignments are identified by a label at the rear of the panel.

Customising the Label Supplied with the Compact Panel:



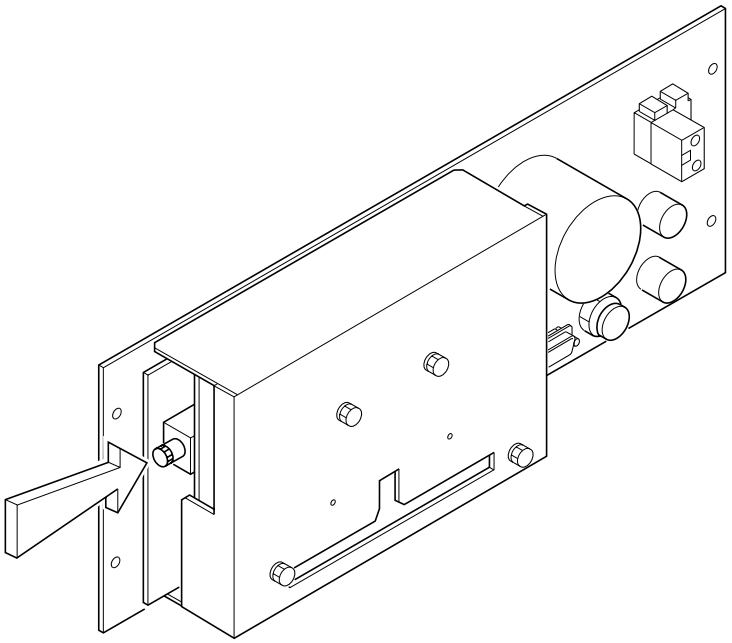
The label can be customised by transfers (Letraset type), Universe 54 font, pitch 12.

Installing the Label on the Rear of the Compact Panel:



4.3 Preparing the Machine Panel

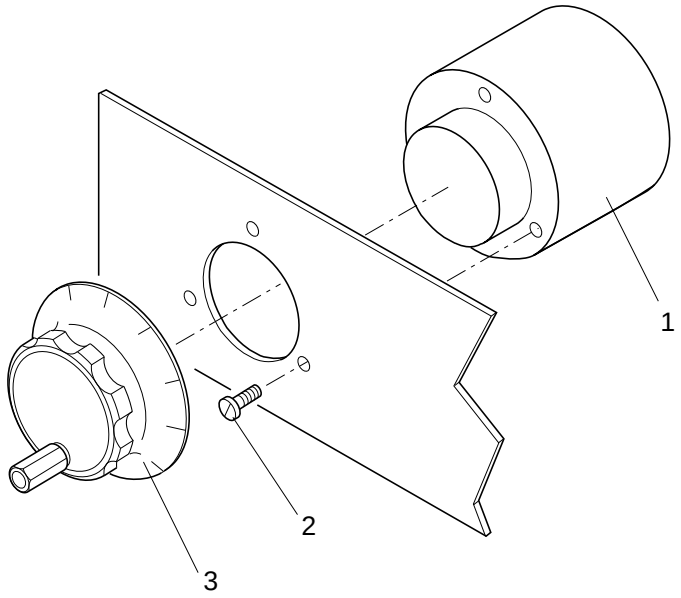
4.3.1 Assigning an Address to the Panel



Set the address on the thumbwheel: address 1 to 4, different for each panel.

4.3.2 Installing the Handwheel

The handwheel is installed on the machine panel without its bezel (remove the cap by cutting the plastic pins with cutting pliers):



1 - Handwheel body
2 - Attaching screw (3)
3 - Bezel attached by two screws

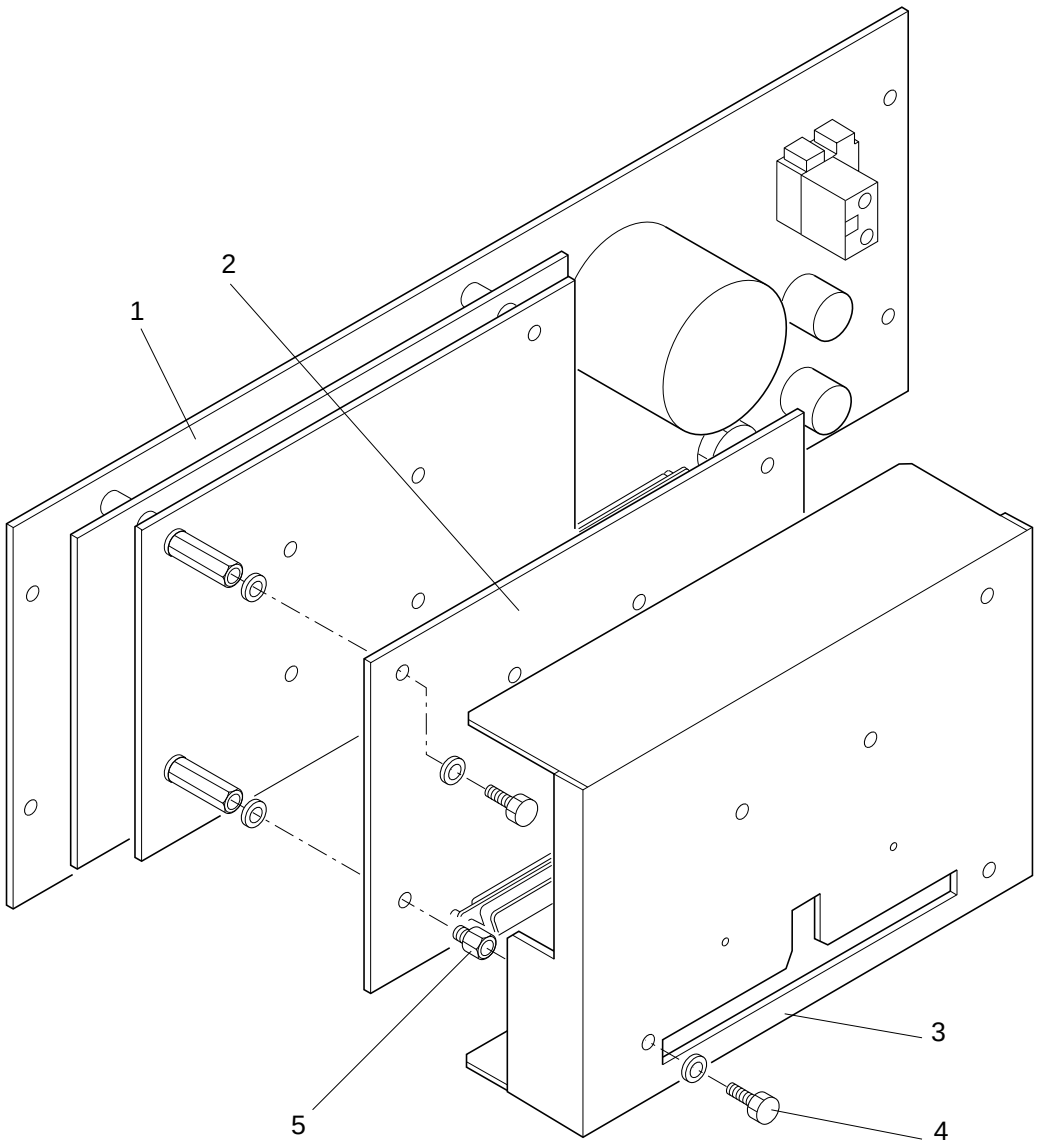
CAUTION

The handwheel could interfere with installation of the key labels.
It is therefore recommended to install the labels (see Sec. 4.3.5) before the handwheel.

4.3.3 Installing the Machine Panel Extension

The machine panel extension is installed at the rear of the machine panel.

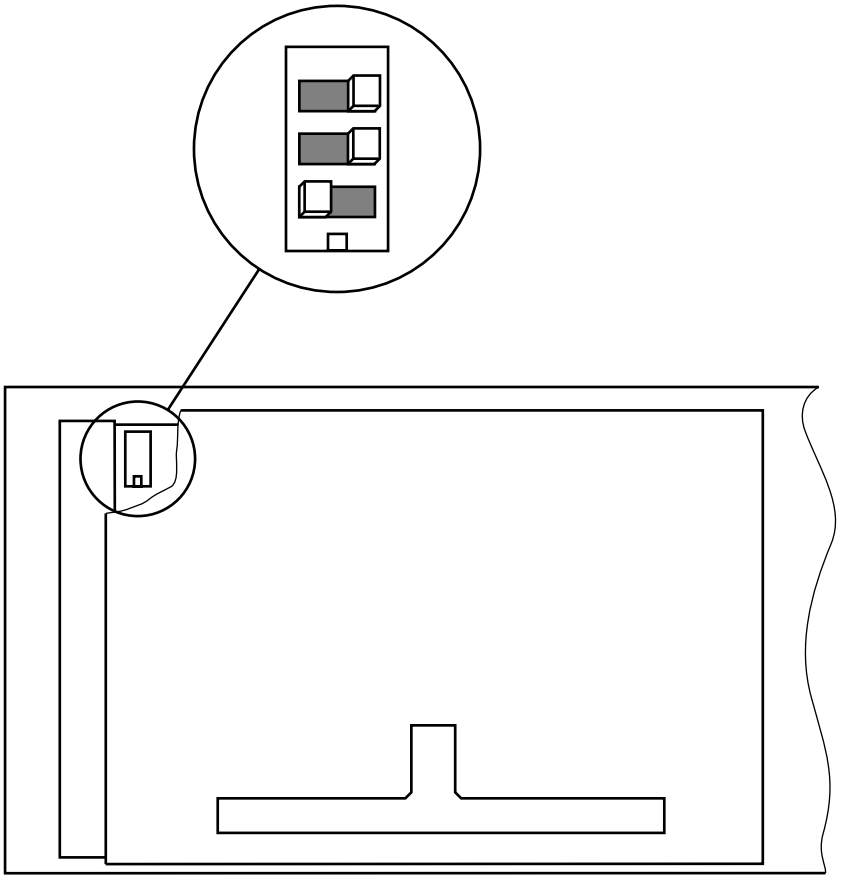
It requires removing the enclosure.

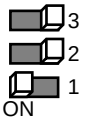
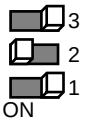
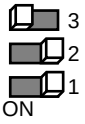


1 - Machine panel
2 - Machine panel extension
3 - Enclosure
4 - Screws (8)
5 - Spacers (5)

4.3.4 Setting the Optical Fibre Transmit Power

The setting is made on the rear of the machine panel according to the optical fibre cable length:



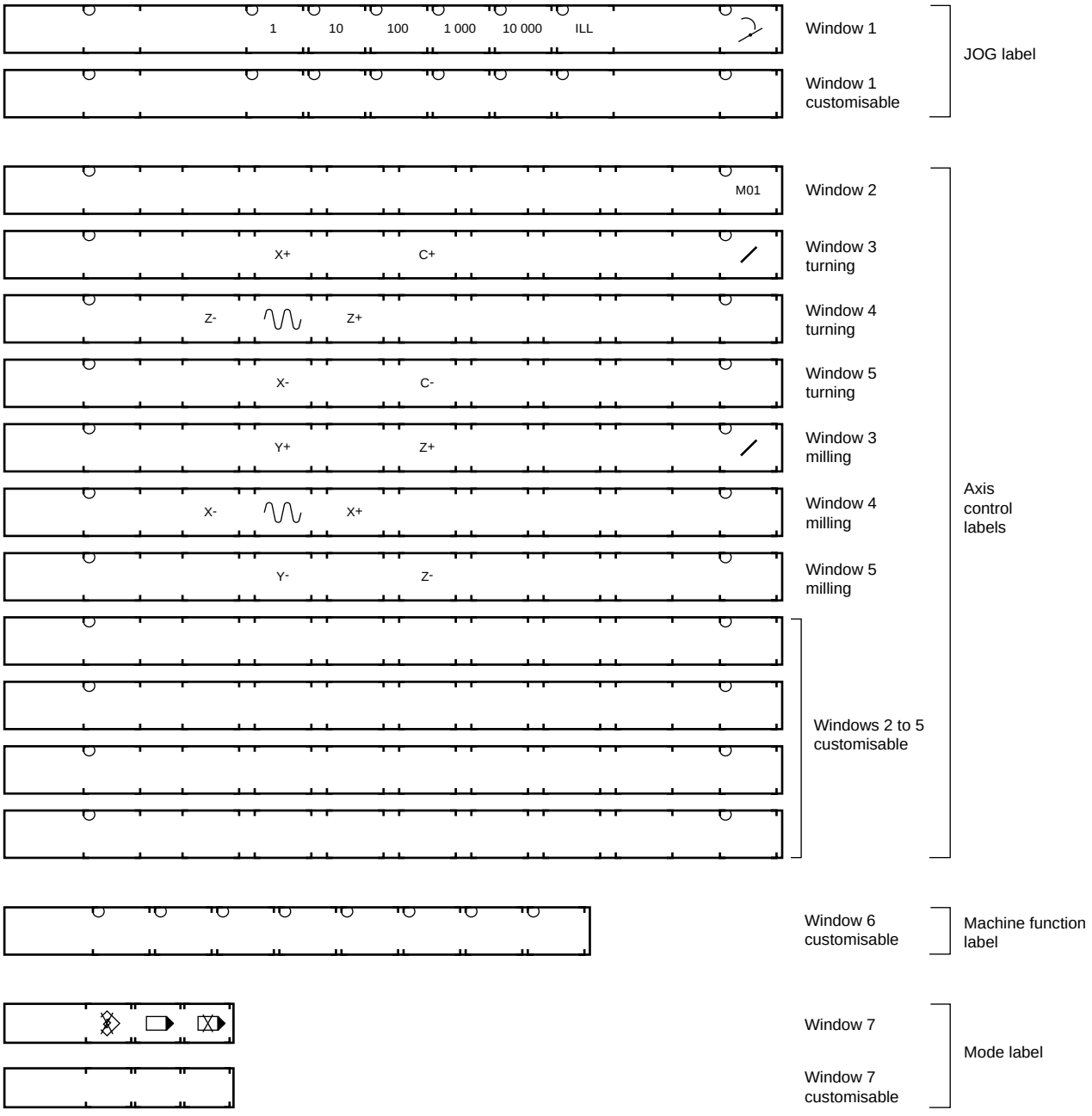
Optical fibre cable length	Switch settings
L ≤ 15 m	
15 m < L ≤ 30 m	
L > 30 m	

4.3.5 Installing the Key Labels

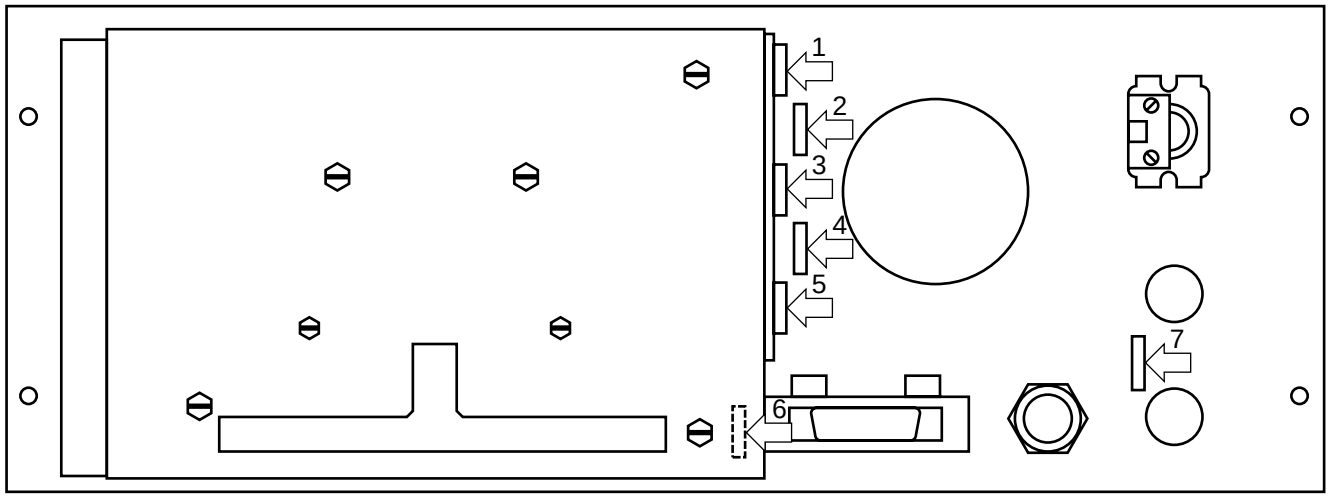
The keys on the machine panel are not engraved. Their assignment is specified by installing a set of labels in windows 1 to 7 at the rear of the machine panel.

These labels can be:
- The standard labels provided by NUM
- Labels customised for the user.

Set of Labels Supplied with the Machine Panel



Installing the Labels at the Rear of the Machine Panel:



Customising the Labels

The labels can be customised by transfers (Letraset type), Universe 54 font pitch 12.

4.4 General Operations

4.4.1 Replacing Fuses

Accessible fuses:

Location	Characteristics
1020/1040 CPU	Slow-blow 2 A, 5 x 20 glass fuses
10" compact panel	Fast-blow 2 A, 250 V, 5 x 20 glass fuse
10" 50-key panel	Fast-blow 2 A, 250 V, 5 x 20 glass fuse
Machine panel	Fast-blow 500 mA, 250 V, 5 x 20 glass fuse

4.4.1.1 1020/1040 CPU Fuses

Refer to the layout diagram (see Sec. 4.1.1)

Unscrew the fuse-holder cover (quarter-turn fastener).

Replace the blown fuse.

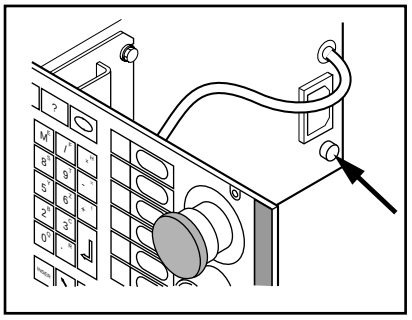
Install and screw on the fuse-holder cover.

4.4.1.2 10" Compact Panel Fuse

Unscrew the fuse-holder cover (quarter-turn fastener).

Replace the blown fuse.

Install and screw on the fuse-holder cover.

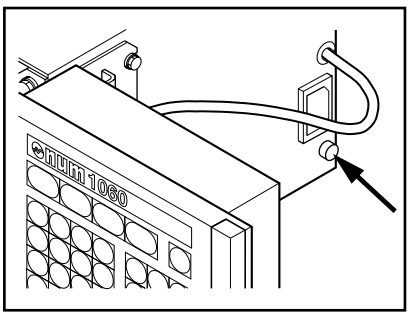


4.4.1.3 10" 50-Key Panel Fuse

Unscrew the fuse-holder cover (quarter-turn fastener).

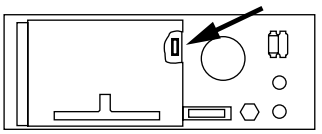
Replace the blown fuse.

Install and screw on the fuse-holder cover.



4.4.1.4 Machine Panel Fuse

Replace the blown fuse.



Rear view

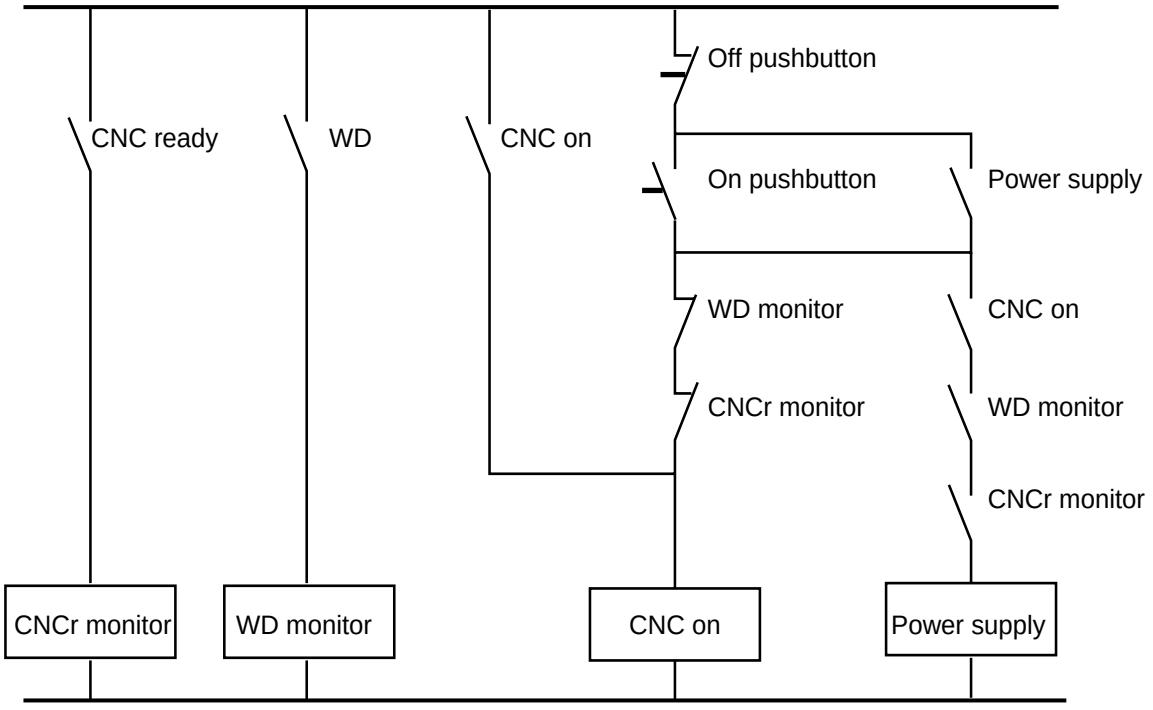
4.4.2 Wiring of the Watchdog, Safety Daisy Chain

The watchdog (WD) is the machine processor status signal. When WD = 0, the machine processor is faulty and the programmed safety devices are therefore triggered.

The watchdog output is set by PLC programming: WD is the first output (OUT.0) of the CPU or machine panel extension.

> ⚠ **CAUTION**
>
> The CNC may continue to control the axes when WD = 0, which could cause problems (collisions, etc.).
>
> The WD output must therefore be wired in the safety chain so that when WD = 0, power supply to the axes is cut off.
>
> The system should remain on, to allow troubleshooting and setting of certain logic inputs (which are not the only possible cause of failure).

Recommended safety daisy chain:



CNCr: CNC ready

This diagram is used to check that the WD and CNCr relays are not operated at power on.

No timeoutre used.

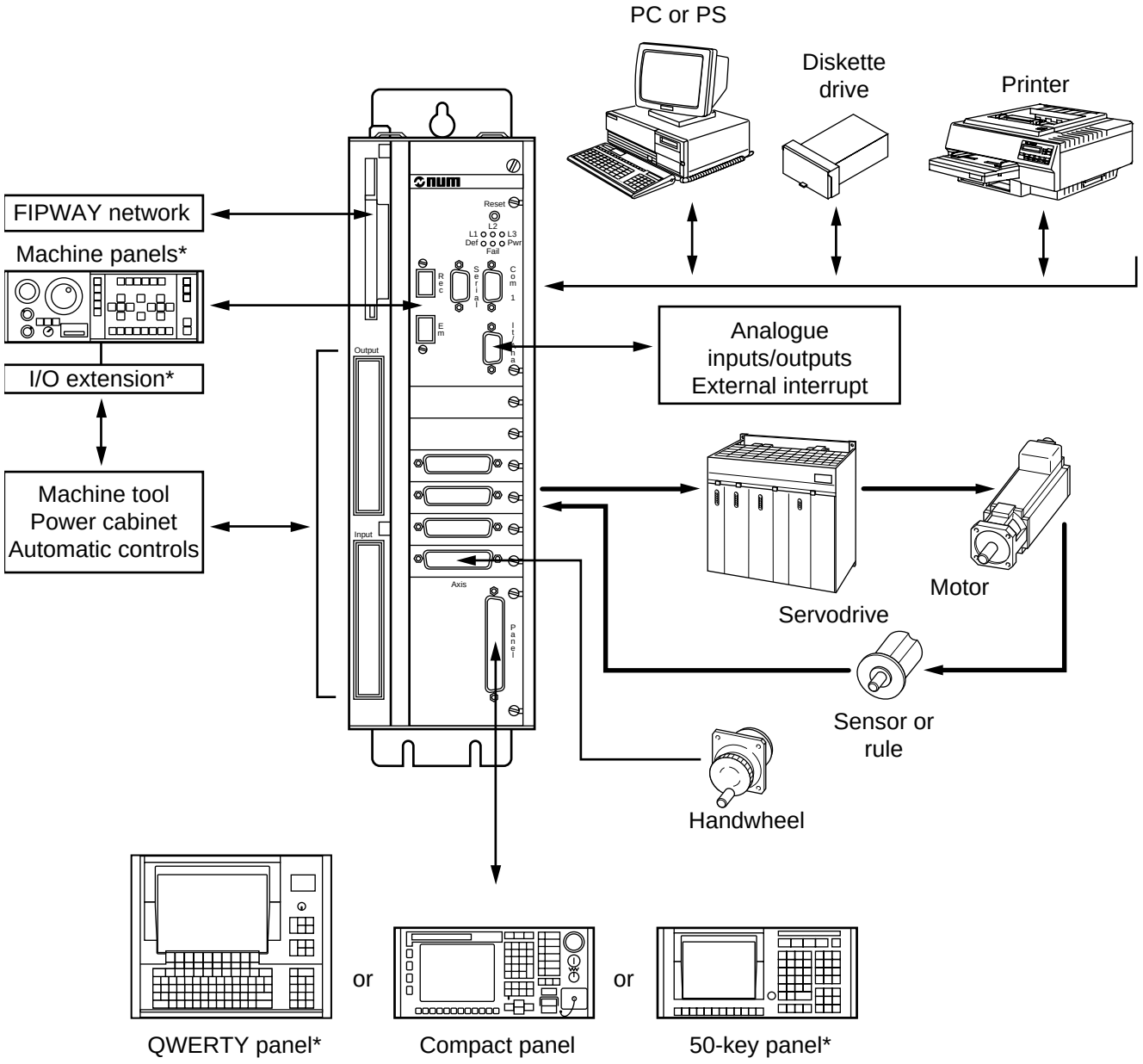
Powering up of the CNC is not enabled unless the watchdog and CNCr relay are deenergised.

When the CNC is on, the PLC programme closes the CNCr relay.

Power application is determined by the presence of WD and CNCr.

5 Interconnections

5.1 CNC/Peripheral Interconnections



* Not available on NUM 1020

REMARK *A machine panel cannot be used with the compact panel.*

5.2 NUM 1020 and 1040 CPUs

The NUM 1020 and 1040 CPUs are 68020 microprocessor-based 32-bit processors.

Communication function

The NUM 1020 and 1040 CPUs can communicate with peripherals via the Com 1 serial (RS 232E) and Serial (RS 232E, RS 422A or RS 485) lines.

PLC function

The NUM 1020 and 1040 CPUs manage the machine environment via inputs and outputs:
- 32 inputs and 24 outputs with the 32-24 I/O card, or
- 64 inputs and 48 outputs with the 64-48 I/O card.

The machine panel extension can manage an additional number of 32 inputs and 24 outputs (1040 only).

An analogue I/O connector allows connection of the NUM 1020 and 1040 CPUs to:
- one interrupt input
- one analogue output
- two analogue inputs.

CNC function

The NUM 1020 and 1040 CPUs use the CNC software to manage part programmes and machining data, compute paths and speeds and monitor axis movements.

Panel management function

The NUM 1020 and 1040 CPUs manage the VDU and keyboard.

Mass memory function

The NUM 1020 and 1040 CPUs store the operating programmes in REPROM, and the machine processor programmes and user files in RAM with backup.

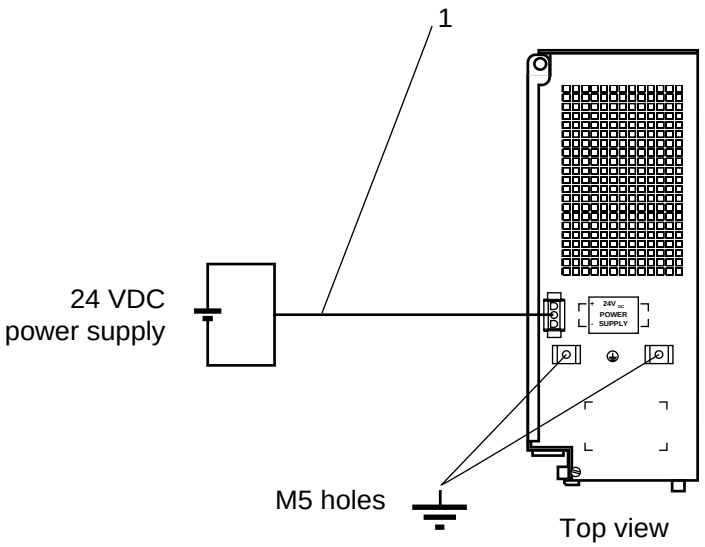
Backup for the files in RAM is provided by a battery with an operating time of 18 months.

⚠ CAUTION

The battery must mandatorily be replaced (see Secs. 4.1.1 and 4.1.6) after 18 months of use (connected).

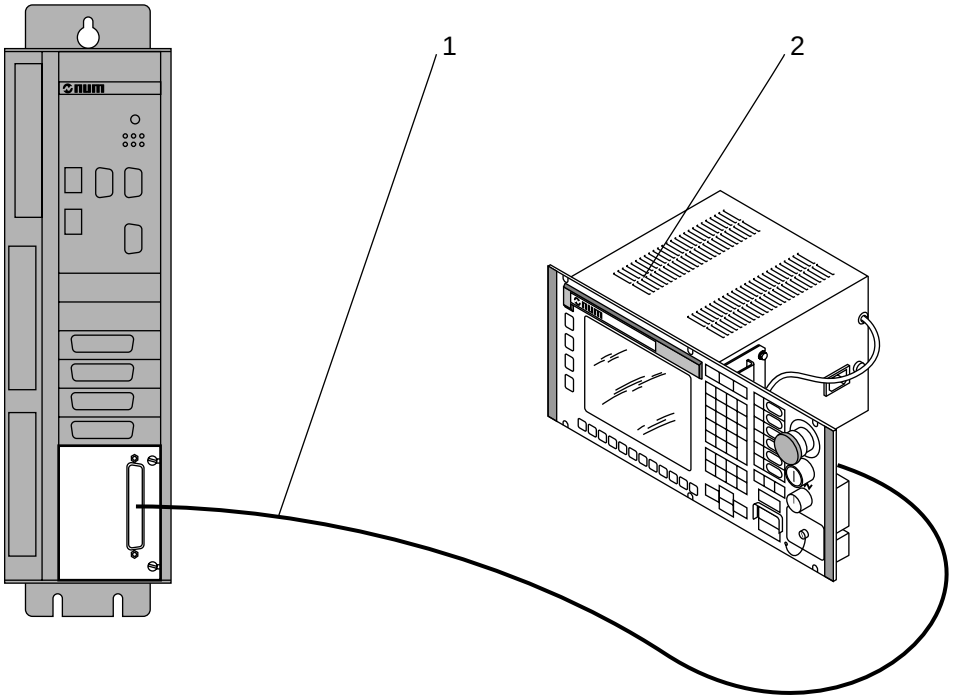
5.2.1 Power Supply

Power supply voltage	24 VDC nominal (19.2-30 VDC)
Maximum power	40 W



1 - Power cable (see Sec. 6.5.1)

5.2.2 Connection to the Compact or CNC Panels



1 - Video/panel cable (for lengths, see tables)
2 - Compact of CNC panel

The minimum video cable curve radius is 110 mm.

The video/panel cables are available in two versions:
- video interconnection kit (for wiring, see Sec. 6.6),
- video cable assembled.

Video interconnection kits:

Length	P/N	Length	P/N
5 m *	206203223	30 m	206203231
10 m *	206203225	40 m	206203233
15 m	206203227	to order	206203235
20 m	206203229		

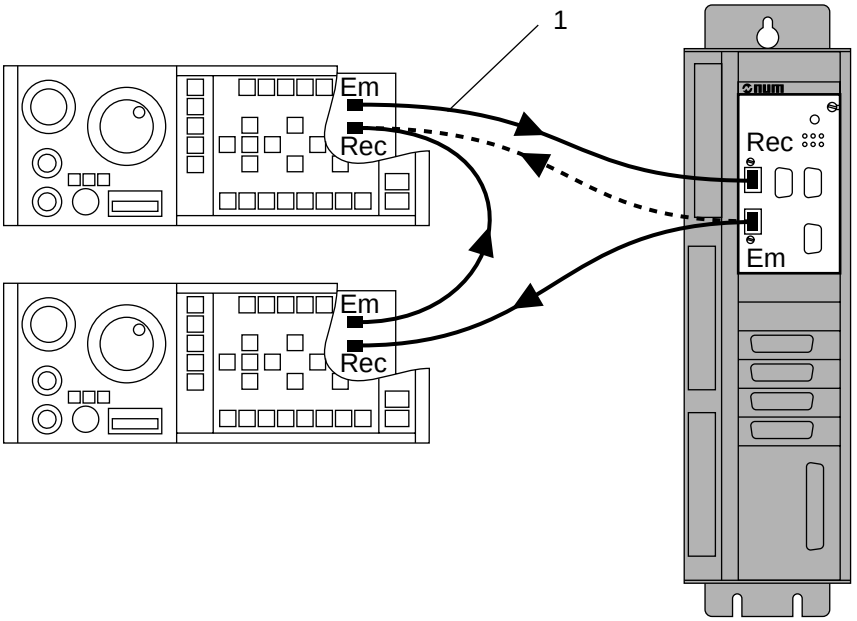
* Only the 5 and 10 m cables can be used to the compact panel.

Assembled video cables:

Length	P/N	Length	P/N
5 m	206202394	10 m	206202395

5.2.3 Optical Fibre Connecting Cable to the Machine Panels

The CPU is connected to the machine panels by an optical fibre ring as shown below:



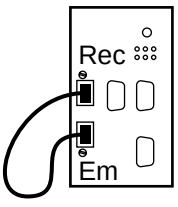
1 - Optical fibre

The minimum optical fibre cable curve radius is 50 mm.

The transmit power must be set according to the length of the optical fibre connecting the transmitter of an item to the receiver of the next item (see Sec. 4.1.5 for the CPU and Sec. 4.3.4 for the machine panels).

The machine panel addresses are set on a thumbwheel (see Sec. 4.3.1).

When the optical fibre link is not used (CPU with optical fibre function), the transmitter must be connected to the receiver by an optical fibre shunt:



5.2.4 Analogue Inputs/Output and Interrupt

5.2.4.1 General

Analogue Inputs

Two inputs can be dedicated to connection of resistive potentiometers	
Typical potentiometer rating	10 kΩ
Resolution	0.4 percent full scale
Power supply	+ 5 V

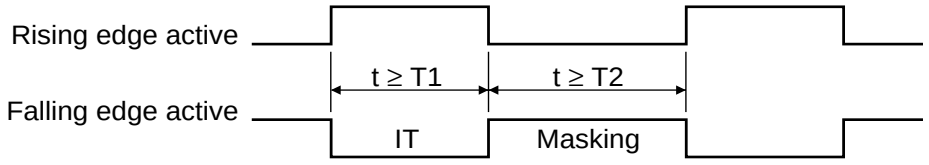
Analogue output

Output voltage	- 10 / + 10 V
Minimum load	2 kΩ
Resolution	20 mV

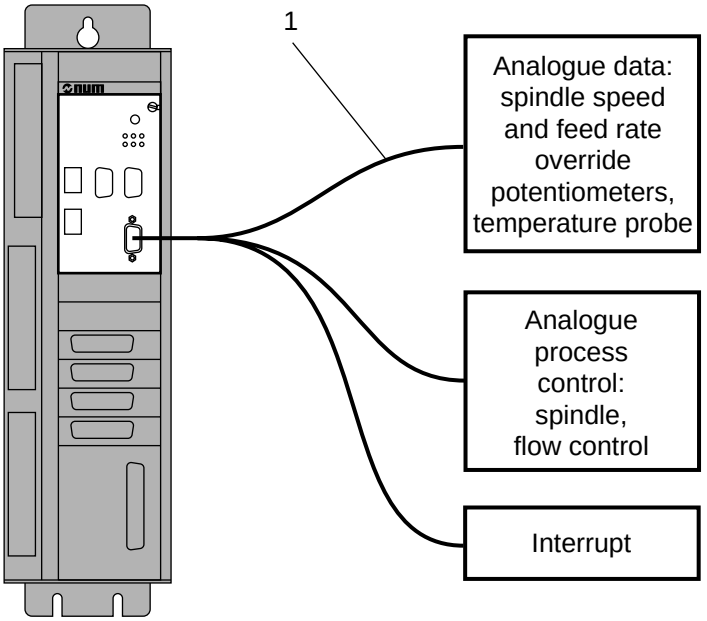
External Interrupt

Maximum current draw	20 mA
Minimum current required	10 mA
Input on 5 V	Logic "0" between 0 and 1 V Logic "1" between 3.5 and 5.5 V
Input on 24 V	Logic "0" between 0 and 4.7 V Logic "1" between 18 and 27 V
IT time	Programmable: T1 = 0,5/250/500/2220/4440 ms
Masking between two ITs	Programmable: T2 = 1/500/1000/4000/8000 ms

Interrupt timing diagram:



5.2.4.2 Analogue/IT Link Connecting Diagram



1 - Analogue I/O - interrupt cable (see Sec. 6.3)

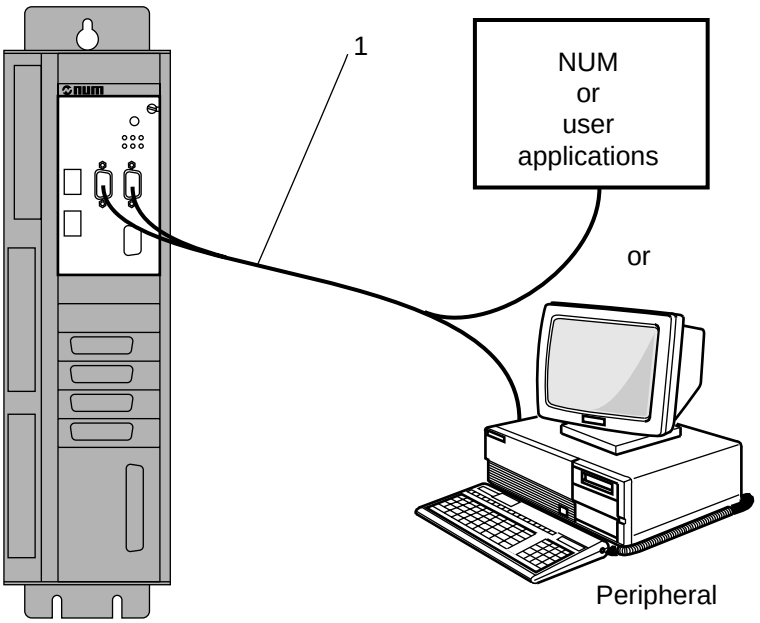
5.2.5 Communications

5.2.5.1 General

Serial line	RS 232E (Com 1)
Multistandard serial line	RS 232E, RS 422A or RS 485 (Serial)
Data rate	300 to 38.400 bauds (the data rate is limited to 19,200 bauds if two serial lines are used)

The serial lines allow the CPU to exchange data with peripherals such as a PC or PS, a diskette drive and/or printer.

5.2.5.2 Serial Line Connection Diagram



1 - Serial interface cable
- RS 232E (Com 1 or Serial: see Sec. 6.1.1)
- RS 422A (Serial only: see Sec. 6.1.2)
- RS 485 (Serial only: see Sec. 6.1.3)

5.2.6 Incremental and Absolute Axis Encoder Cards

5.2.6.1 General

Number of axes controlled	Maximum 6
Servo-drive analogue output	1 -10 V/+10 V 14-bit + sign output per axis
Switch contact	1 24 V input per axis (19.2 to 30 V including 5% ripple)
Switch input impedance	2.15 kΩ* (2 to 2.4 kΩ)
Switch input current	11 mA minimum * (7.5 mA on the old interface models)

* for interfaces with index E or above (interface P/N 204 203 382)

The axis interfaces allow the CNC to control the axes: control of the servo-drives and processing of the encoder data.

There are three types of axis measurements:
- Incremental measurement,
- absolute measurement by SSI (serial synchronous interface) link,
- measurement by rule with encoded distance reference marks.

5

Position Sensors Approved by NUM

Incremental sensors: ROD 428B (HEIDENHAIN, DG 60L (STEGMANN), ENH 2E7C55 (CODECHAMP) and C3158-05 (MCB).

Incremental rule with encoded distance reference marks: LS 706C + EXE 612 (HEIDENHAIN).

Absolute single- or multiturn SSI (Synchronous Serial Interface) sensors: ROC 424 (HEIDENHAIN), AG 66 and AG 661 (STEGMANN).

Combined sensors (SSI + incremental): ECN 1313 + IBV 610, EQN 1325 + IBV 650, ROC 412 + IBV 610 and RCN 619 (HEIDENHAIN).

Requirements Concerning Sensors and Their Power Supply

The installation of a sensor is subjected to several requirements:
- minimum sensor power supply voltage (see Sec. 5.2.6.2),
- maximum frequency above which the signals provided by the sensor are no longer counted with accuracy by the system (incremental channels, see Sec. 5.2.6.3),
- maximum available current for supply of the sensors (see Sec. 5.2.6.6).

These requirements determine:
- the minimum power cable size,
- the maximum cable lengths,
- the need or not for an external power supply.

In the case of incremental and semiabsolute sensors, the origin switch must be set after installation.

Consumption of the Axis Interface Module

The specific consumption of the axis interface module is:
- 14 mA maximum on the sensor power supply ("Power on" LED),
- 7 mA maximum on the switch power supply ("/SWITCH" LED)

5.2.6.2 Voltage Across the Sensor

When installing a position sensor, it is necessary to provide the minimum power supply voltage related to the type of sensor used.

5 VDC Sensors

When the NUM power supply is used, the voltage across the sensor is given by the equation:

$Vs = 4.95 - (0.45 + 36.8 \times 10^{-3} \times L/S) \times I$

where:
- Vs (in V) is the voltage across the sensor,
- L (in m) is the cable length (one way only),
- S (in mm^2) is the power conductor cross-sectional area,
- I (in A) is the current through the sensor.

The minimum wire size of the power supply conductors is calculated from the maximum current through the sensor, the minimum voltage across the sensor and the required wire length.

It is recommended not to use wires with a cross-sectional area above 2.624 mm^2. If a larger size is required, the use of an external power supply located near the sensor can reduce the required wire size.

Example of a 5 V ± 5 percent sensor, current rating 220 mA

The computed voltage (Vs) must not be less than 4.75 V.

The table below gives the calculation results obtained for different cable lengths using the NUM power supply:

Cable length	Minimum cross-sectional area	Voltage across the sensor
20 m	1.65 mm^2	4.753 V
30 m	2.624 mm^2	4.758 V

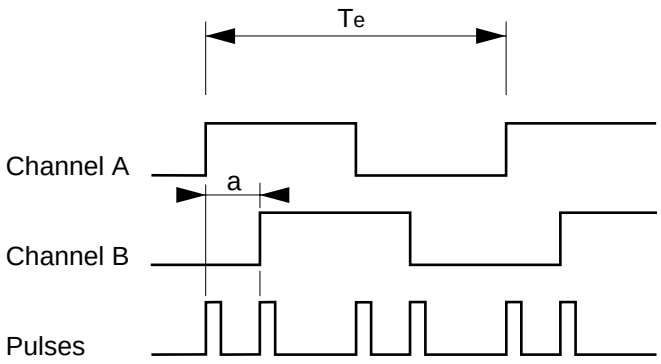
Above 30 m, the wire size required would be above 2.624 mm^2. In this case, use an external power supply whose characteristics provide a minimum voltage of 4.75 V across the sensor while preserving a reasonable wire size.

Sensors Requiring a Power Supply Voltage Above 5 VDC

The use of an external power supply is mandatory.

5.2.6.3 Maximum Incremental Sensor Channel Output Frequency (Incremental or Combined Sensors)

The diagram below shows the waveform of the signal on sensor channels A and B:



T_e : signal period on one of the channels

a : time between two edges

The sensor channel output frequency $f_e = 1 / T_e$

Extreme values allowing correct signal detection by the system:
- Maximum frequency: $f_{e\,max} = 1.8$ MHz
- Minimum time between two edges: $a_{min} = 138$ ns.

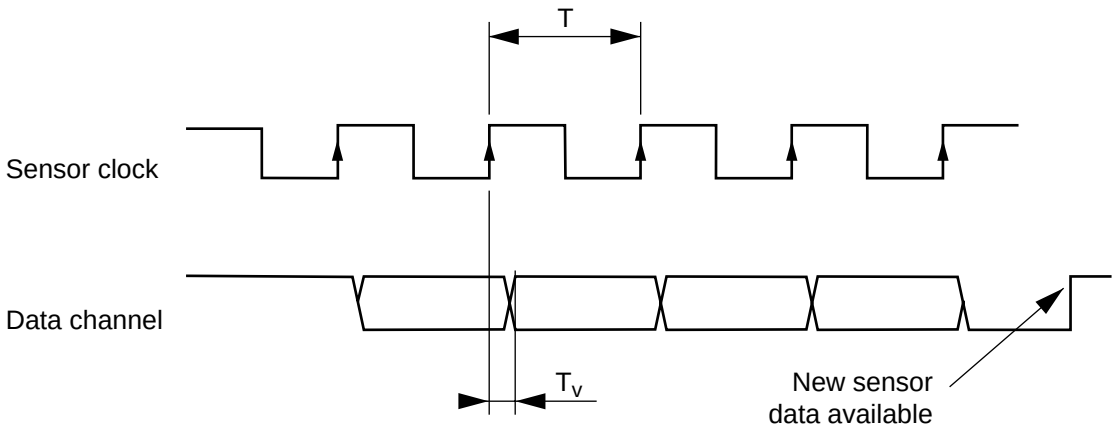
The minimum time between two edges allowing correct signal detection by the system depends on the length and type of cable used. The table below gives the results of tests conducted with [4 x (2 x 0.14 mm^2)] shielded cables connecting the sensor to the axis encoder card and using an external power supply:

Cable length	Minimum time between two edges
10 m	147 ns
20 m	156 ns
50 m	250 ns

5.2.6.4 Setting the Reference Signal (Rules with Encoded Distance Reference Marks)

The reference signal (Z pulse) must be set for an electrical angle of 90 degrees. This setting can be made on the EXE or IBV units.

5.2.6.5 Synchronous Serial Interface Timing Diagram



f_{clock} = 1/T: minimum 100 kHz, maximum 2 MHz

Tv: minimum 50 ns, maximum T

synchronisation and data bits: maximum 32 bits

status bits: maximum 4 bits

parity bit: maximum 1 bit.

REMARK *The synchronisation bits are leading 0's in the frame (not present in mode encoders).*

Depending on the clock frequency and sensor cable length L, the clock output is connected to the clock input on the interface or the sensor:

Sensor clock frequency	Connection to interface	Connection to sensor
100 kHz	L < 400 m	L < 400 m
200 kHz	L < 200 m	L < 250 m
400 kHz	L < 60 m	L < 150 m
500 kHz	L < 50 m	L < 100 m
800 kHz	L < 30 m	L < 85 m
1 MHz	L < 20 m	L < 75 m
1.6 MHz	L < 5 m	L < 60 m
2 MHz	----	L < 50 m

5.2.6.6 Maximum Available Current per Axis

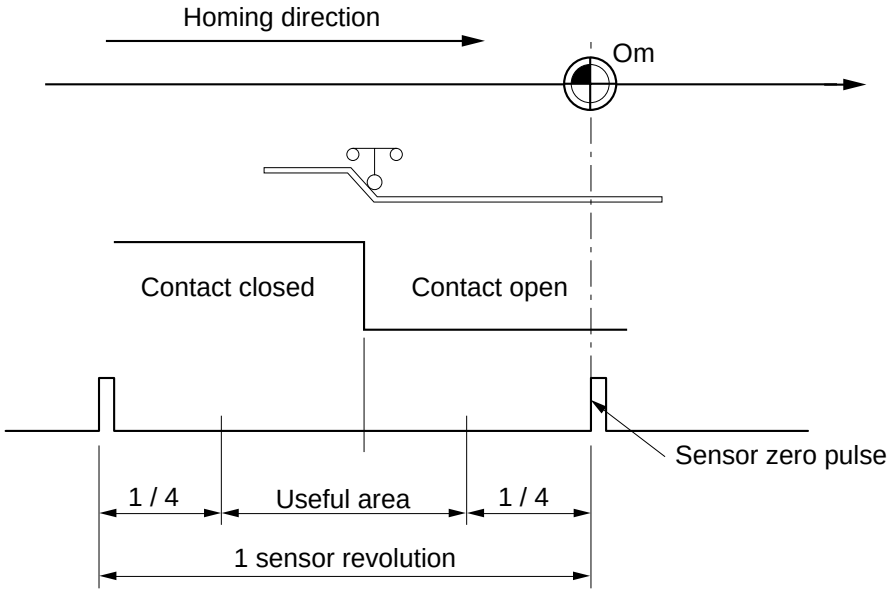
Each axis interface can supply a maximum of 350 mA.

The current draw of all the sensors connected cannot exceed 1.5 A.

Above these values, an external power supply should be used.

5.2.6.7 Setting the Origin Switch

Homing is carried out on the zero pulse following opening of the origin switch:

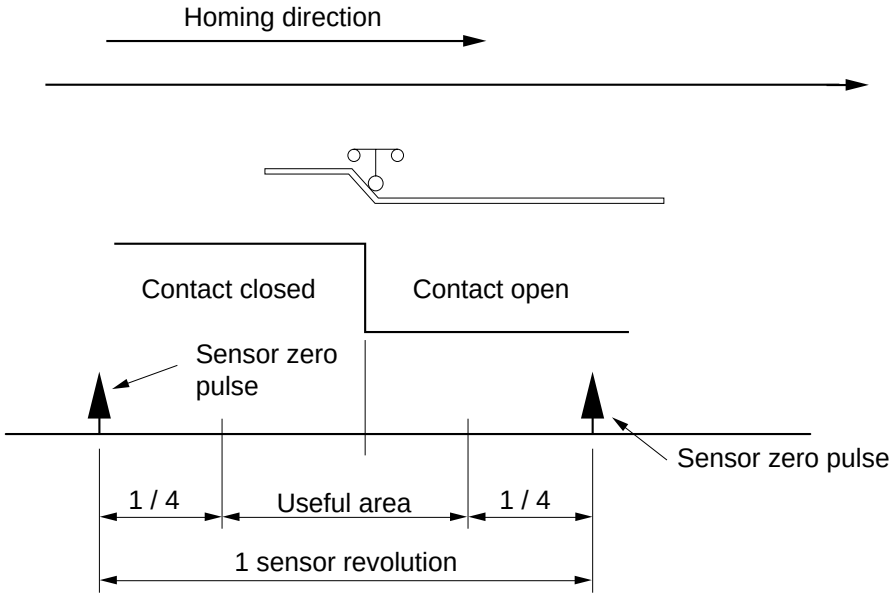


The switch must be set so that the contact opens between one-quarter and three-quarters of the distance separating two zero pulses. This is to avoid coincidence between switch operation and the zero pulse, which could cause a random shift by a distance equal to that separating two zero pulses.

The switch size should be such that the contact opens before detection of the sensor zero pulse and remains open until the axis stops after detection of the zero pulse.

5.2.6.8 Setting the Origin Switch (SSI or Combined Sensor with semiabsolute Measurement)

The axis travel exceeds the sensor measurement travel. Homing is carried out on opening of the origin switch. It is used to identify the sensor revolution on which the switch operates:



The electrical contact opening signal must be clean, without bounce.

The switch must be set so that the contact opens between one-quarter and three-quarters of the distance separating two zero pulses. This is to avoid coincidence between switch operation and the zero pulse, which could cause a random shift by a distance equal to that separating two zero pulses.

The switch size should be such that the contact opens before detection of the sensor zero pulse and remains open until the axis stops after detection of the open contact on the switch input.

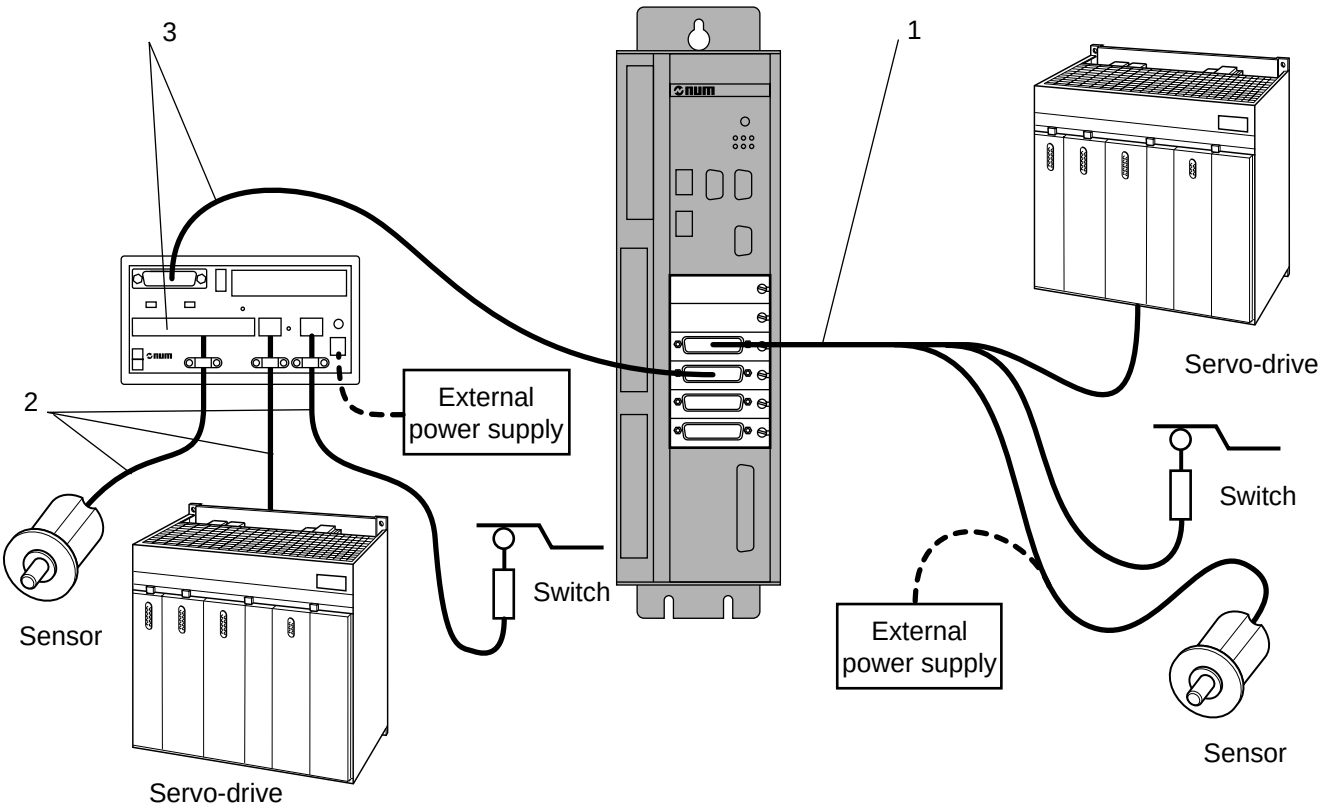
5.2.6.9 Homing of SSI or Combined Sensors with Absolute Measurement

The axis travel is less than the sensor measurement travel. Homing is made at any point of the axis travel at power on or after a reset of the CNC.

The axis connector switch input should not be wired.

REMARK The sensor zero pulse must be outside the axis travel.

5.2.6.10 Axis Connection Diagram



Connection of an axis to an axis interface

1 - Axis cable (see table)

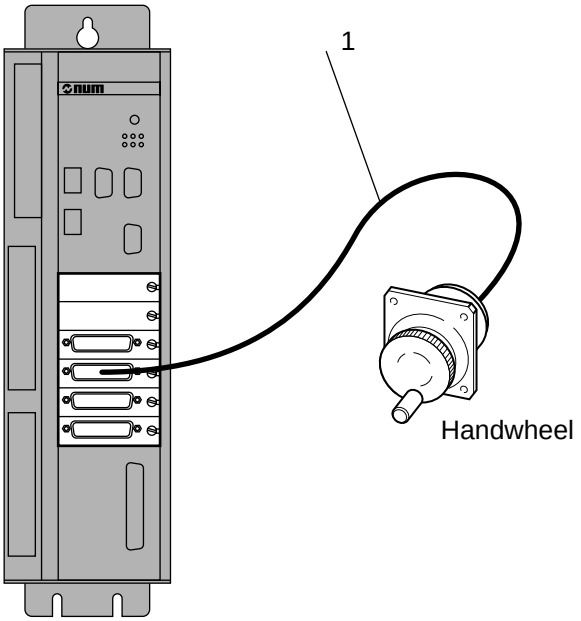
Connection of an axis via an axis interface module

2 - Axis cables (see table)

3 - Axis interface module (P/N 263900000) and cable 1.5 m long (P/N 260900000)

Axis type	Power supply	Cable alone (see Sec.)	Cable with interface module (see Sec.)
Encoded	supplied by the interface external	6.2.1.1 6.2.1.1 and 6.2.6	6.2.1.2 and 6.2.7 same as cable alone
Absolute SSI measurement	supplied by the interface external	6.2.2.1 6.2.2.1 and 6.2.6	6.2.2.2 and 6.2.7 same as cable alone
Semiabsolute SSI measurement	supplied by the interface external	6.2.3.1 6.2.3.1 and 6.2.6	6.2.3.2 and 6.2.7 same as cable alone
Combined: SSI + incremental Sinusoidal pulses	supplied by the interface external	6.2.4.1 6.2.4.1 and 6.2.6	6.2.4.2 and 6.2.7 same as cable alone
Combined: SSI + incremental Square pulses	supplied by the interface external	6.2.5.1 6.2.5.1 and 6.2.6	6.2.5.2 and 6.2.7 same as cable alone

5.2.6.11 Handwheel Connection Diagram



1 - Handwheel cable
- with nondifferential outputs (see Sec. 6.2.8)
- with differential outputs (see Sec. 6.2.9)

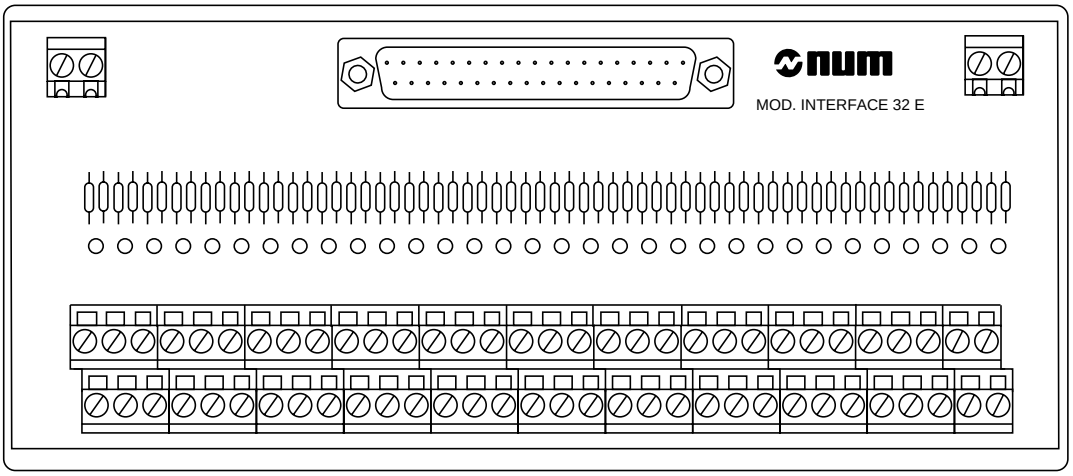
5.2.7 Discrete Inputs

The NUM 1020 and 1040 CPUs receive input signals via the front panel Input connector. There can be 32 inputs (32-24 I/O card) or 64 inputs (64-48 I/O card). The inputs can be wired via an interface module (see Sec. 5.2.7.2) or directly on the connector (see Sec. 5.2.7.4).

5.2.7.1 Input Characteristics

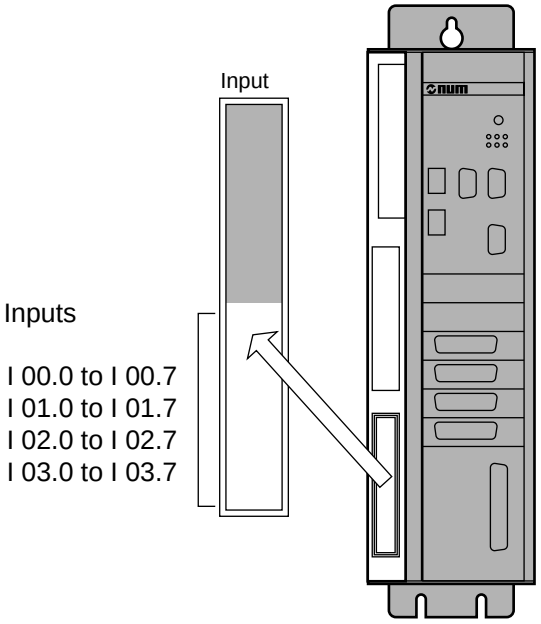
32-24 I/O card	32 inputs: I 00.0 to I 03.7
64-48 I/O card	64 inputs: I 00.0 to I 07.7

Input characteristics via the 32-input interface module

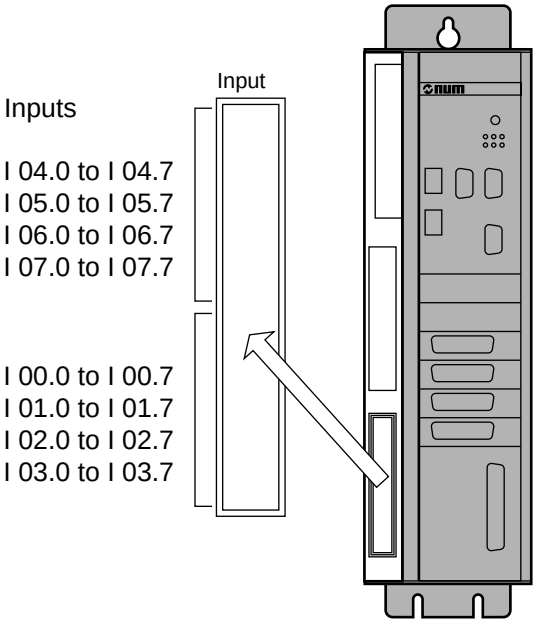


32 discrete inputs	Complying with IEC 1131 type 2
Power consumption	30 W maximum (all inputs switched)
Input ratings Nominal voltage Maximum current	 24 VDC 30 mA per input
Operating ranges	low level: 0 to 5 V high level: 11 to 30 V
Delay	5 ms ± 10 %
Wire size	0.2 to 2.5 mm^2 multistrand or 0.2 to 4 mm^2 single strand
Display	32 LEDs (LED lit: high level)

Characteristics of the inputs wired to the connector



With 32-24 I/O card

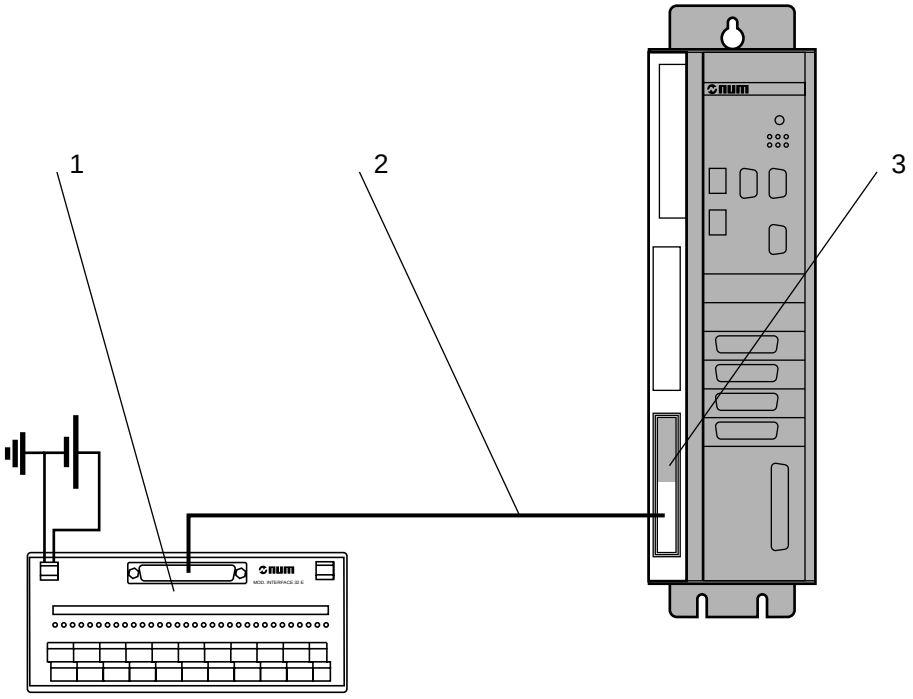


With 64-48 I/O card

Discrete inputs	Complying with IEC 1131 type 1
Input interface	
Nominal voltage	24 VDC (external power supply)
Voltage limits	15-30 VDC
Internal consumption	Maximum 30 mA
Input ratings	
Nominal voltage	24 VDC
Maximum current	8 mA per input
Operating ranges	low level: 0-9 (current $\leq$ 2 mA) high level: 12-30 V (current > 4 mA)
Input impedance	4.7 kohms
Reverse voltage withstand	30 VDC continuous
Response time	4.7 ms
Scanning time	2.6 ms
Sensor common	Positive power supply terminal
Logic	Positive (current sink)

5.2.7.2 Connection Diagram for Inputs with Interface Module

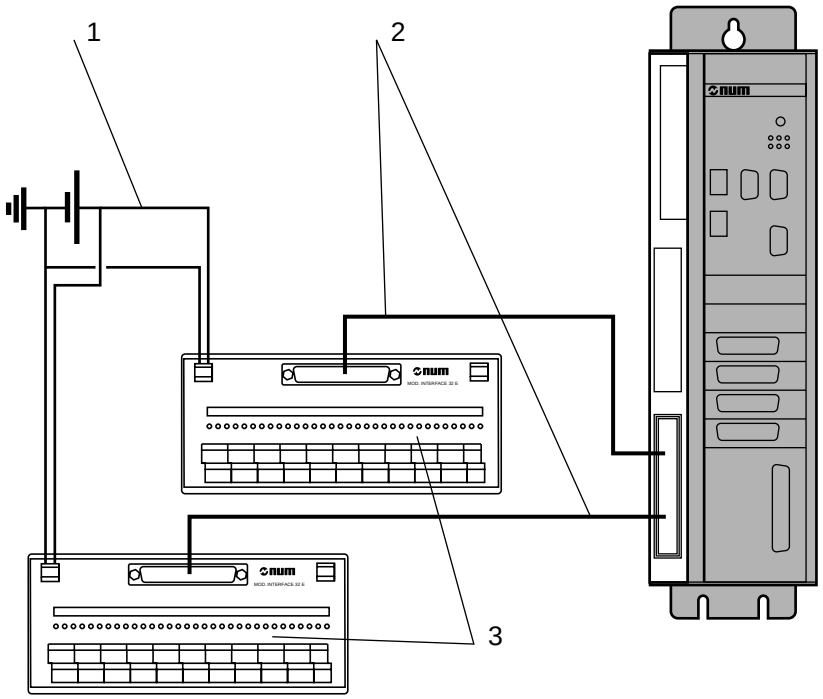
With 32-24 I/O Card



1 - 32-input interface module (P/N 263900001)
See Sec. 5.2.7.3: Interface module connections and customisation
2 - Card/Interface module connecting cable
- Length 1 m (P/N 263203077)
- Length 2 m (P/N 263203078)
- Length 5 m (P/N 263203611)

See Sec. 6.4.3: Customising the input and output cables
3 - Leave the cover in place on the top part of the connector

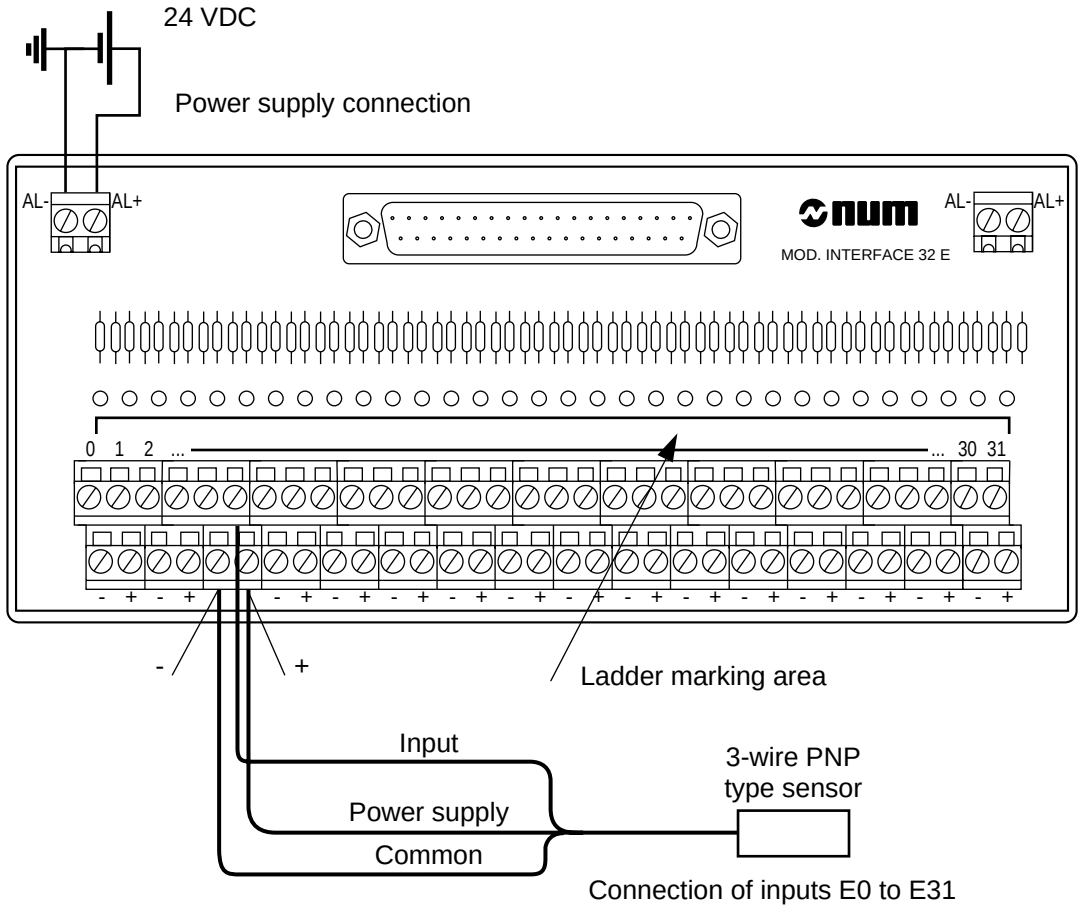
With 64-48 I/O Card



1 - Power supply common to the two interface modules
2 - Card/Interface module connecting cable
  - Length 1 m (P/N 263203077)
  - Length 2 m (P/N 263203078)
  - Length 5 m (P/N 263203611)

  See Sec. 6.4.3: Customising the input and output cables
3 - 32-input interface module (P/N 263900001)
  See Sec. 5.2.7.3: Interface module connections and customisation

5.2.7.3 Interface Module Connections and Customisation



Input Connection

Three-wire sensors must be wired to one of the 32 inputs (E00 to E31) and to the power supply line (+) and common wire (-) closest to this input.

Two-wire sensors must be wired to one of the 32 inputs and to the power supply line (+) closest to this input.

All the power supply lines (+) are interconnected. All the common wires (-) are interconnected.

Power Supply Connection

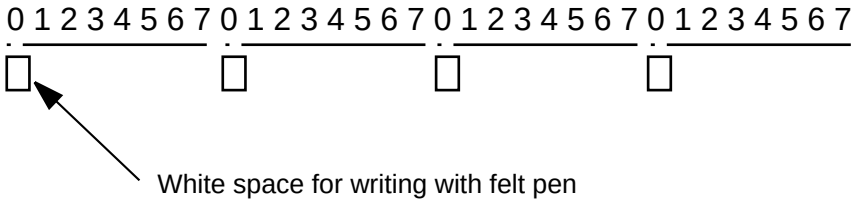
The interface module must be connected to a 24 VDC power supply on terminals AL- and AL+ of one of the two power supply terminal boards.

Customising the Interface Modules - Correspondence with Ladder Notation

An interface module can be connected to the low part of the input connector (first 32 inputs) or the high part of the connector (next 32 inputs, only with a 64-48 I/O card). The table below gives the correspondence between the marking of the interface module terminals and the connector inputs:

Input	E0 to E7	E8 to E15	E16 to E23	E24 to E31
High part: First 32 inputs	I 00.0 to I 00.7	I 01.0 to I 01.7	I 02.0 to I 02.7	I 03.0 to I 03.7
Low part: Next 32 inputs (64-48 I/O card)	I 04.0 to I 04.7	I 05.0 to I 05.7	I 06.0 to I 06.7	I 07.0 to I 07.7

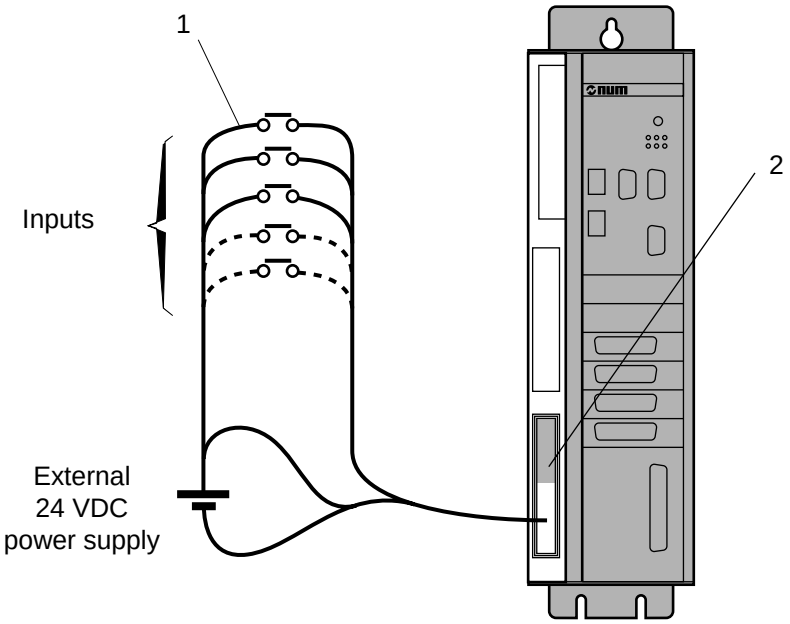
The interface module includes a marking area for Ladder notation. Detail of the marking area:



The numbers to be written in the marking area are:
- 0, 1, 2 and 3 when the interface module is connected to the low part of the input connector
- 4, 5, 6 and 7 when the interface module is connected to the high part of the input connector.

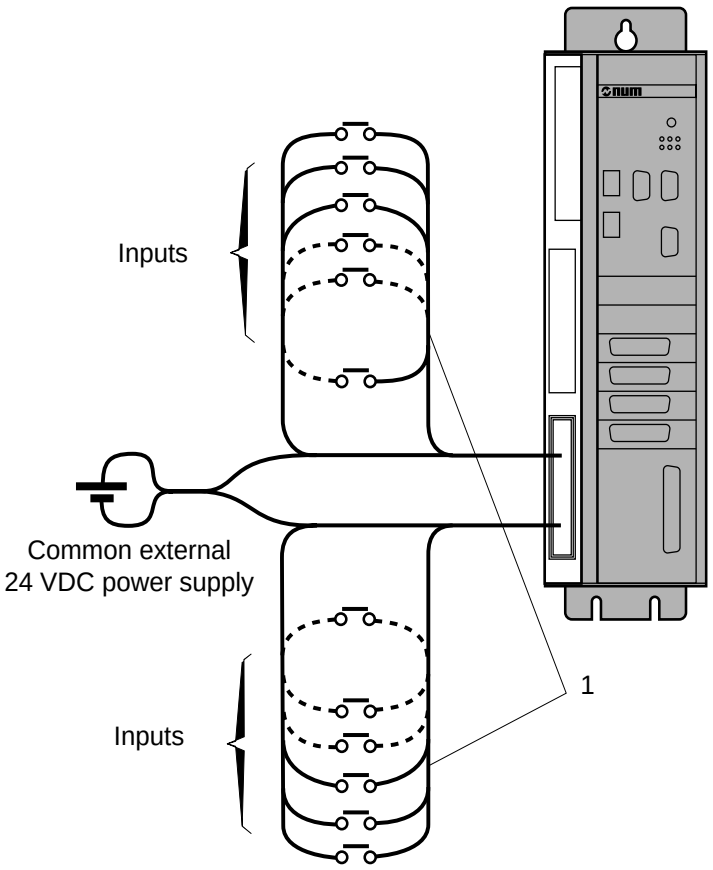
5.2.7.4 Connection Diagram for Inputs without Interface Module

With 32-24 I/O Card



1 - 32-input cable (see Sec. 6.4.1)
2 - Leave the protection in place on the top part of the connector

With 64-48 I/O Card



1 - 32-input cable (see Sec. 6.4.1)

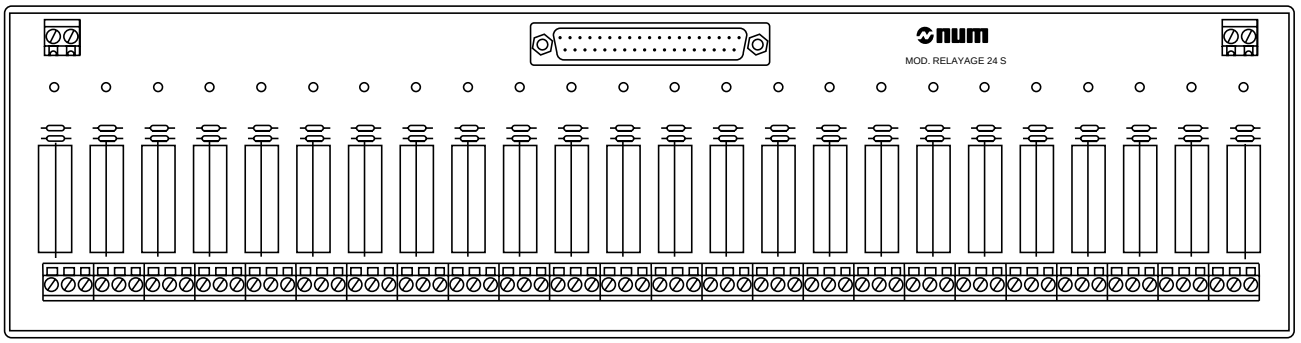
5.2.8 Outputs

The NUM 1020 and 1040 CPUs send output signals via the front panel Output connector. There can be 24 outputs (32-24 I/O card) or 48 outputs (64-48 I/O card). The outputs can be wired via a relay module (see Sec. 5.2.8.2) or directly to the connector (see Sec. 5.2.8.4).

5.2.8.1 Output Characteristics

32-24 I/O card	24 outputs: O 00.0 to O 02.7
64-48 I/O card	48 outputs: O 00.0 to O 05.7

Characteristics of the Outputs Wired via the 24-Output Relay Module



24 relayed outputs	Outputs and complemented outputs
Power consumption	24 W maximum (all outputs switched)
Power supply current	1.1 A
Isolation voltage between inputs (Sub.D) and outputs	4 kV
Isolation with respect to the rail	2.5 kV
Wire size	0.2 to 2.5 mm^2 multistrand or 0.2 to 4 mm^2 single strand
Display	24 LEDs (LED lit: high level)

Relay Characteristics

Maximum output current	8 A
Thermal current	see derating curve
Operating voltages	24 or 48 VDC 24, 48, 110 or 230 VAC
Maximum voltages	250 VAC 125 VDC
Mechanical life	30,000,000 operations
Electrical endurance	See below
Response time at 20°C at nominal voltage	pick-up: 10 ms drop-out: 5 ms bounce: 10 ms

Electrical Endurance versus Load

The numbers of operations are statistical values given only for reference.

AC voltage: resistive load (category AC1)

Voltage	Current	Number of operations
24 to 250 V	5 A	200 000
24 to 250 V	2 A	1 000 000

AC voltage, inductive load, 0.3 < power factor < 0.7 (category AC11)

Voltage	Current	Number of operations
24 to 250 V	2 A	500 000
24 to 250 V	1 A	2 000 000
24 to 250 V	0.4 A	5 000 000

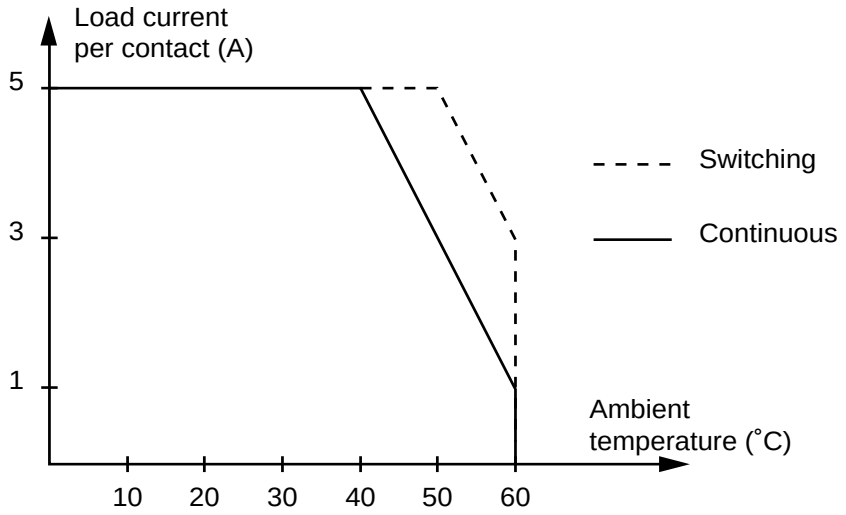
DC voltage, resistive load (category DC1)

Voltage	Current	Number of operations
24 V	1 A	1 000 000

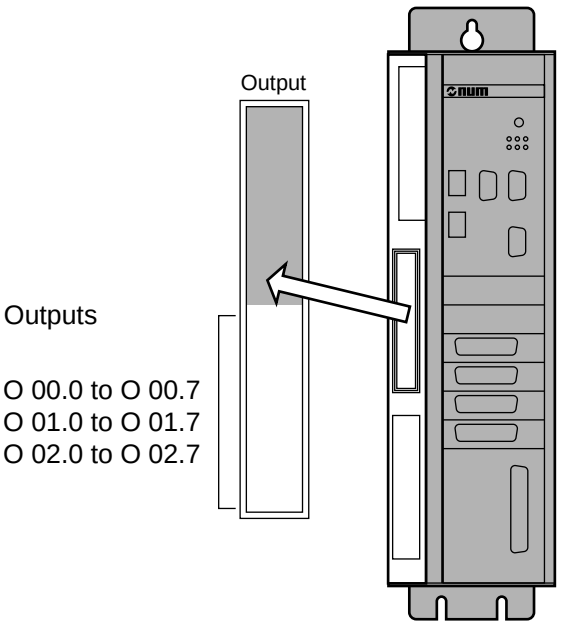
DC voltage, inductive load, L/R = 40 ms (category DC11)

Voltage	Current	Number of operations
24 V	1 A	250 000
48 V	0.4 A	250 000

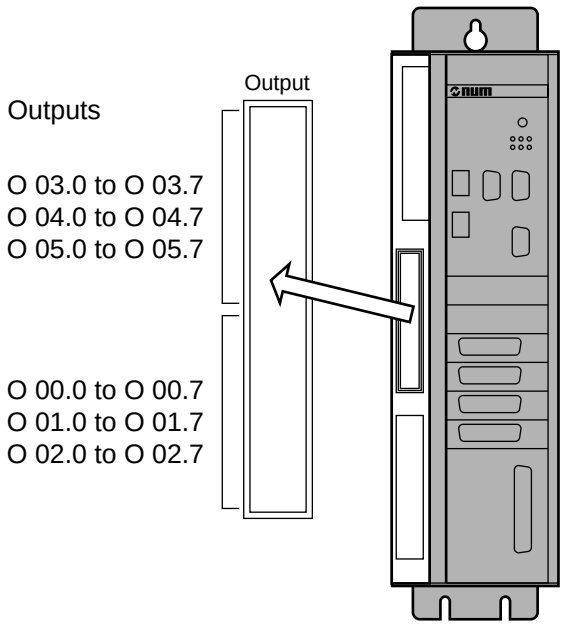
Derating Curve



Characteristics of the Outputs Wired to the Connector



With 32-24 I/O card

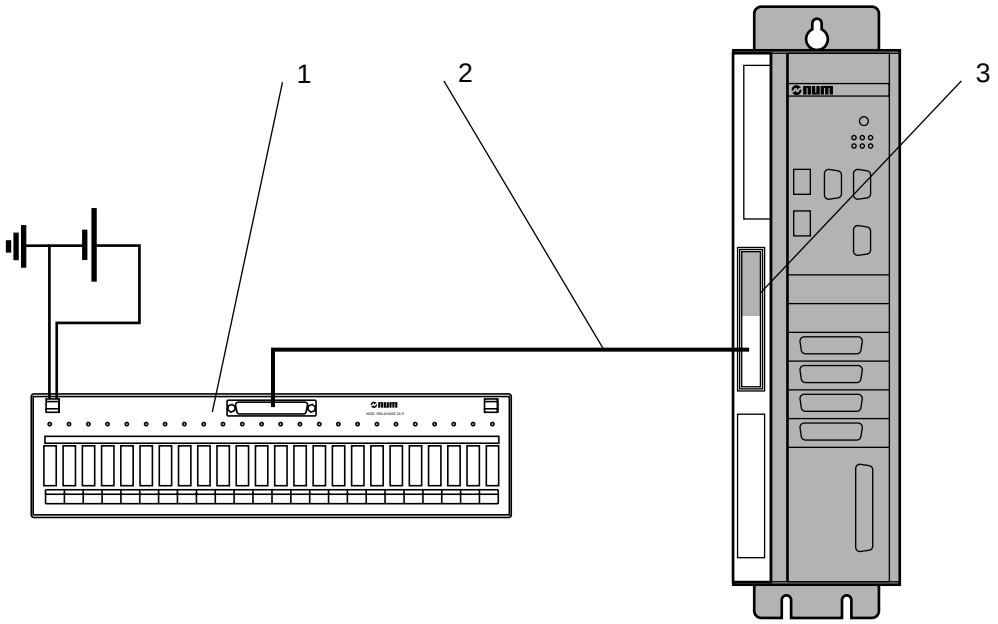


With 64-48 I/O card

Open-collector discrete outputs	
Output interface	
Nominal voltage	24 VDC (external power supply)
Voltage limits	15-30 VDC
Internal consumption	30 mA maximum
Output ratings	
Nominal voltage	24 VDC (external power supply)
Rated current	80 mA per output
Limit values	
Voltage	17-30 VDC
Current	1 A for t < 10 ms (per output)
Response time	300 µm
High-level overshoot voltage	0.8 V maximum
Low-level leakage current	0.1 mA maximum
Protections	
Overloads and short-circuit	Thermal with trip by group of 8 outputs indicated by group of 16 outputs
Inductive overvoltage	Discharge diode
Pole reversal	Reverse-wired parallel diode
50 Hz isolation voltage	2500 Vrms between groups of channels and internal bus
Sensor common	Negative power supply terminal
Logic	Positive (current source)

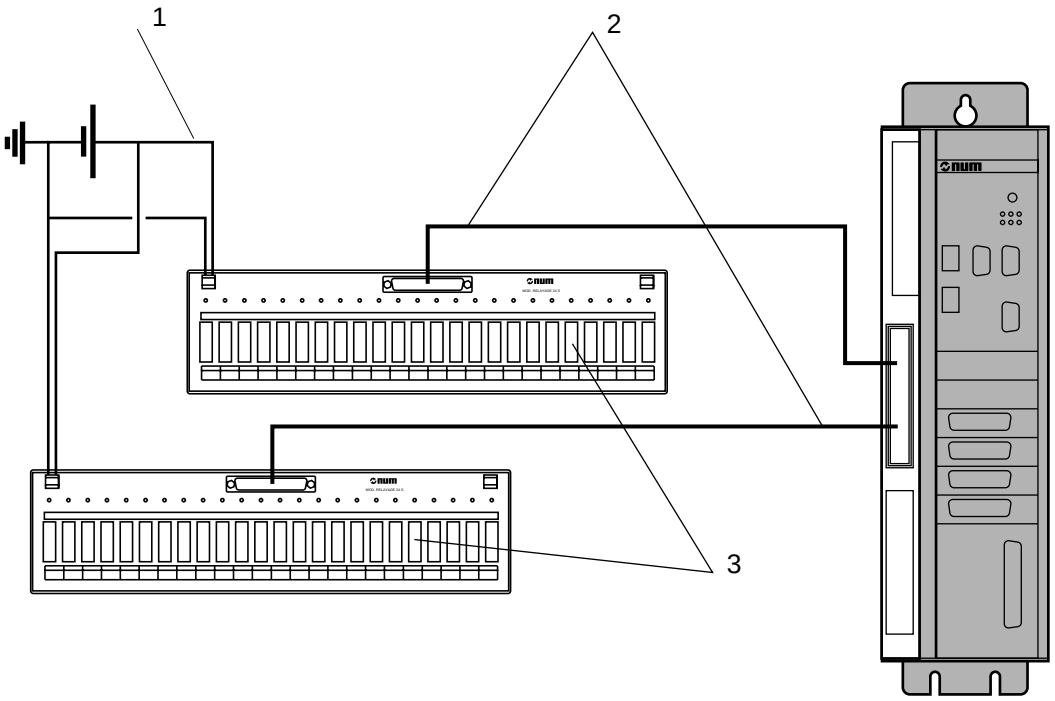
5.2.8.2 Output Connection Diagram with Relay Module

With 32-24 I/O Card



1 - 24-output relay module (P/N 263900002)
See Sec. 5.2.8.3: Relay module connections and customisation
2 - Card/relay module connecting cable:
- Length 1 m (P/N 263203079)
- Length 2 m (P/N 263203080)
- Length 5 m (P/N 263203612)
See Sec. 6.4.3: Customising the input and output cables
3 - Leave the protection in place on the top part of the connector

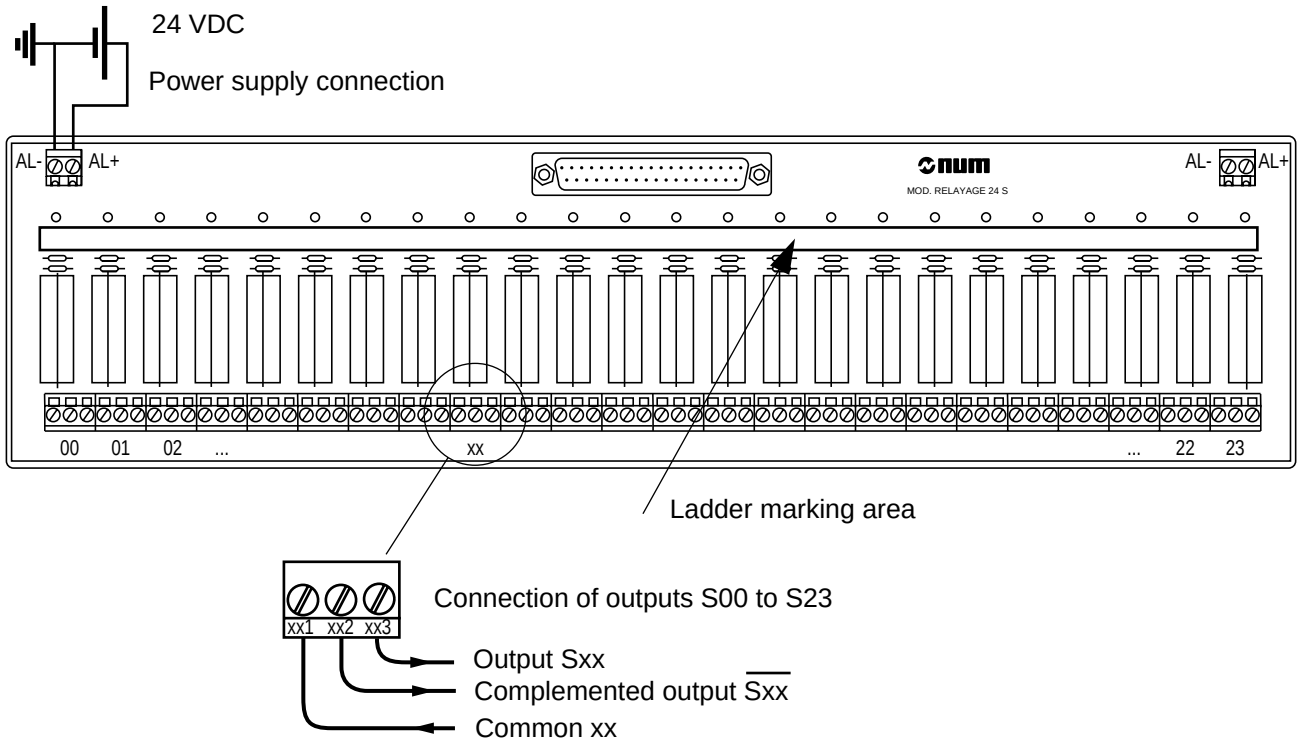
With 64-48 I/O Card



1 - Power supply common to both relay modules
2 - Card/relay module connecting cable:
  - Length 1 m (P/N 263203079)
  - Length 2 m (P/N 263203080)
  - Length 5 m (P/N 263203612)

  See Sec. 6.4.3: Customising the input and output cables
3 - 24-output relay module (P/N 263900002)
  See Sec. 5.2.8.3: Relay module connections and customisation

5.2.8.3 Relay Module Connections and Customisation



Output Connection

The 24 outputs S00 to S23 (and their complements) are available on the relay module output terminal board.

Power Supply Connection

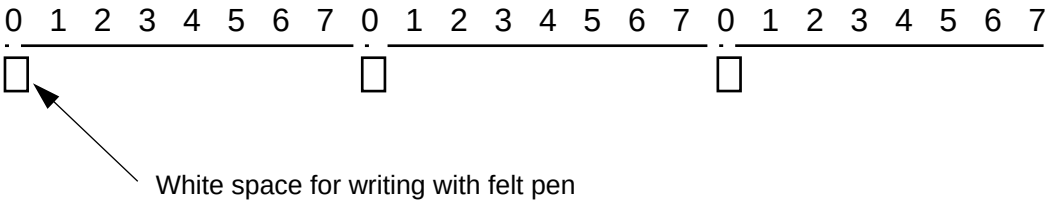
The relay module must be connected to a 24 VDC power supply on terminals AL- and AL+ of one of the two power supply terminal boards.

Customising the Relay Modules - Correspondence with Ladder Notation

A relay module can be connected to the low part of the input connector (first 24 outputs) or the high part of the connector (next 24 outputs, only with a 64-48 I/O card). The table below gives the correspondence between the marking of the relay module terminals and the connector inputs:

Output	S00 to S07	S08 to S15	S16 to S23
High part: First 24 outputs	O 00.0 to O 00.7	O 01.0 to O 01.7	O 02.0 to O 02.7
Low part: Next 24 outputs (64-48 I/O card)	O 03.0 to O 03.7	O 04.0 to O 04.7	O 05.0 to O 05.7

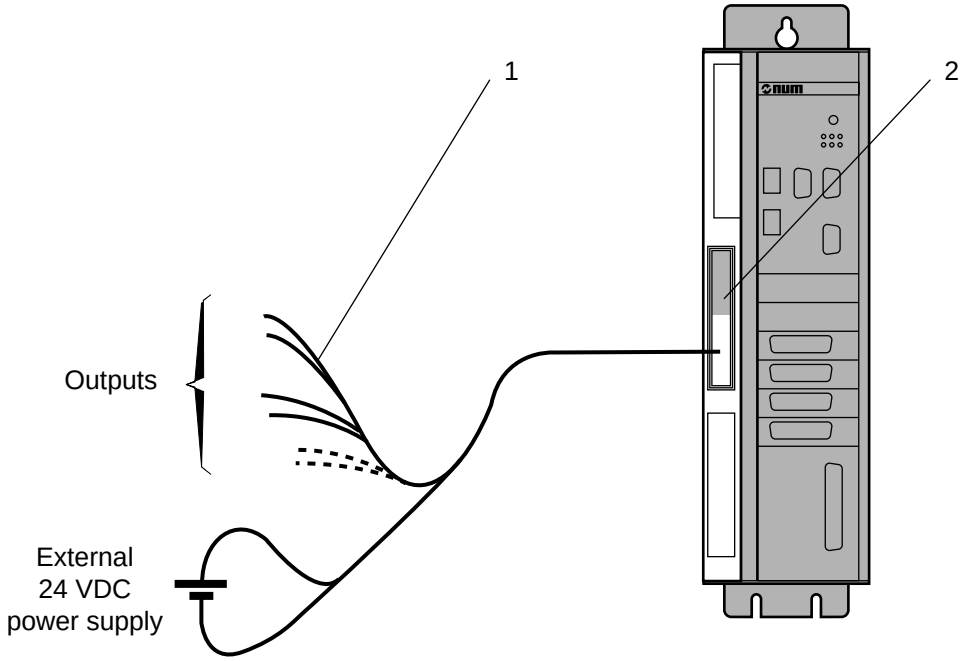
The relay module includes a marking area for Ladder notation. Detail of the marking area:



The numbers to be written in the marking area are:
- 0, 1 and 2 when the relay module is connected to the low part of the output connector
- 3, 4 and 5 when the relay module is connected to the high part of the output connector.

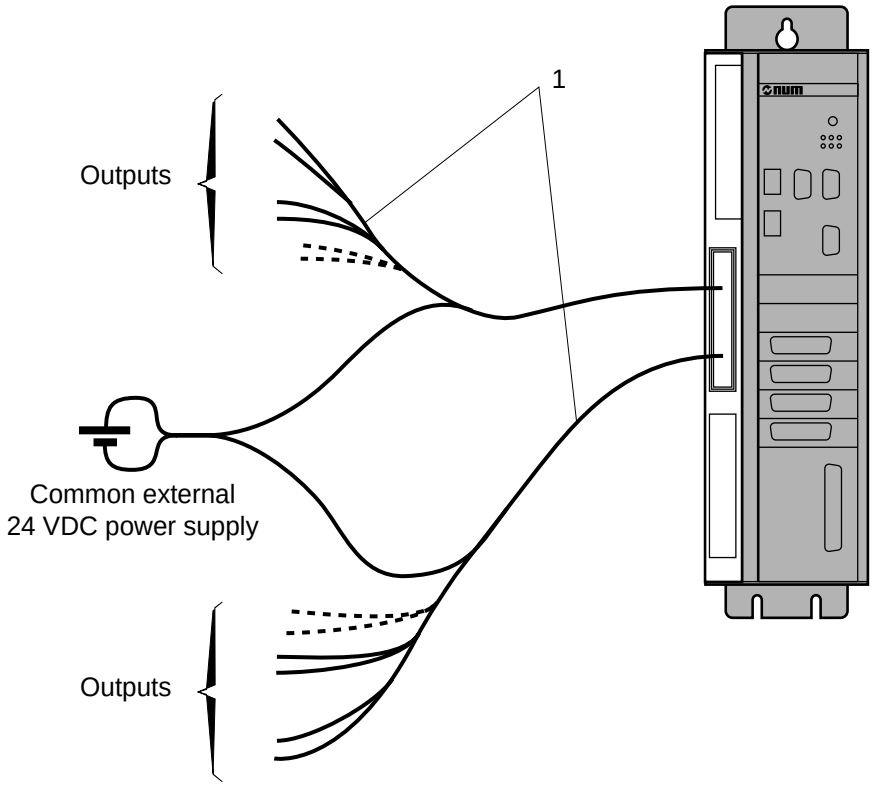
5.2.8.4 Connection Diagram for Outputs without Relay Module

With 32-24 I/O Card



1 - 24-output cable (see Sec. 6.4.2)
2 - Leave the protection in place on the top part of the connector

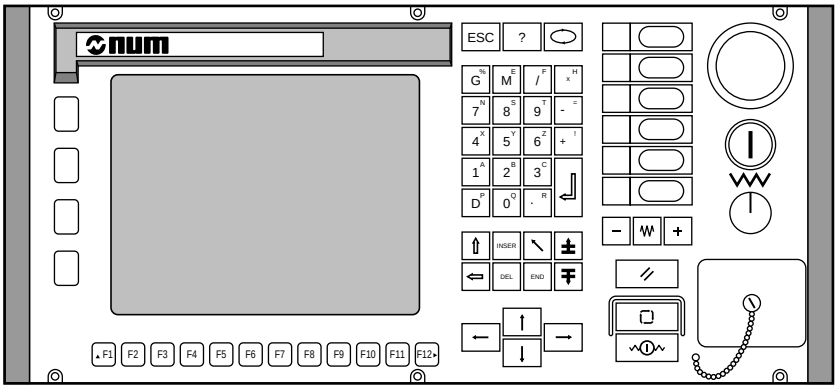
With 64-48 I/O Card



1 - 24-output cable (see Sec. 6.4.2)

5.3 Compact Panel

5.3.1 General



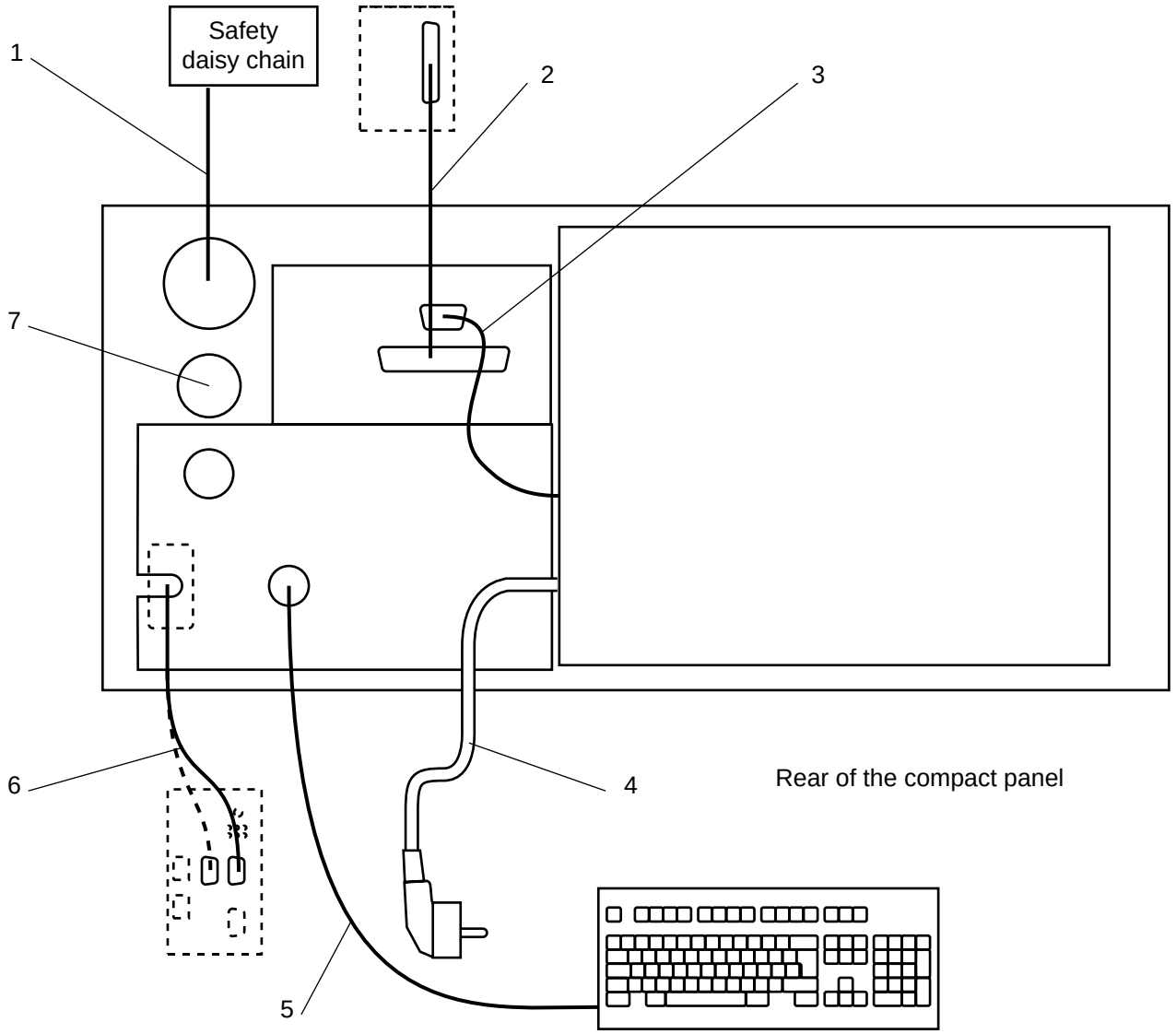
Compact panel	Screen type	Maximum VDU power consumption
	10" colour	60 W
	9" monochrome	30 W
Power supply	230 VAC 50/60 Hz	

The compact panel is the interface between the operator and the system.

The compact panel communicates with the CPU via a video cable.

The compact panel performs the following functions:
- display on VDU,
- access to the CNC menus,
- axis control,
- settings (homing, etc.),
- programme or MDI block execution (cycles, feed stop),
- special functions by programmable keys,
- machine power on,
- feed rate override by potentiometer,
- emergency stop,
- remote serial line (wiring optional),
- possible connection of an AZERTY or QWERTY keyboard.

5.3.2 Compact Panel Connection Diagram

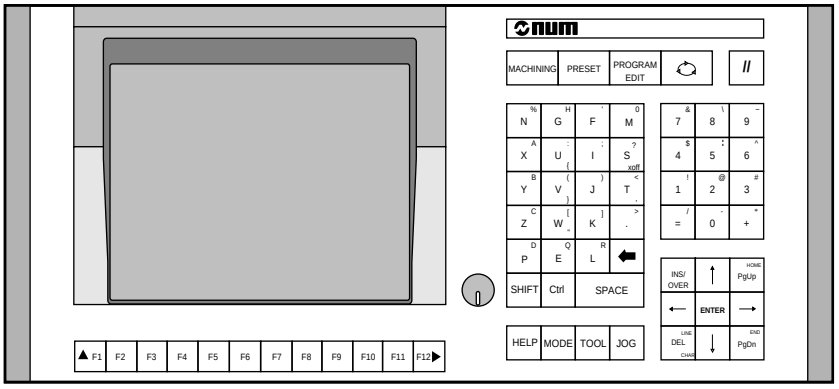


1 - Emergency stop wiring (Telemecanique P/N XB2-BS542)
2 - Video cable
3 - VDU video cable
4 - Power cable (see Sec. 6.5.2)
5 - Keyboard connection (on front or rear)
6 - Serial line relay cable:
  - RS 232E line (see Sec. 6.1.4.1)
  - RS 422A or 485 line (see Sec. 6.1.4.2)
7 - On/Off switch wiring (P/N ZB2-BW061)

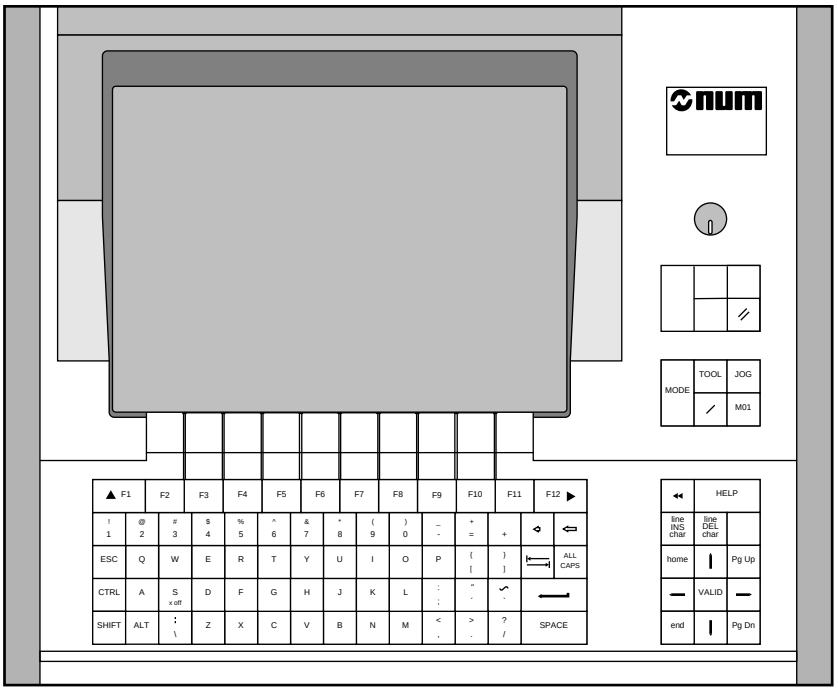
5.4 CNC Panels

5.4.1 General

50-key panel



QWERTY panel

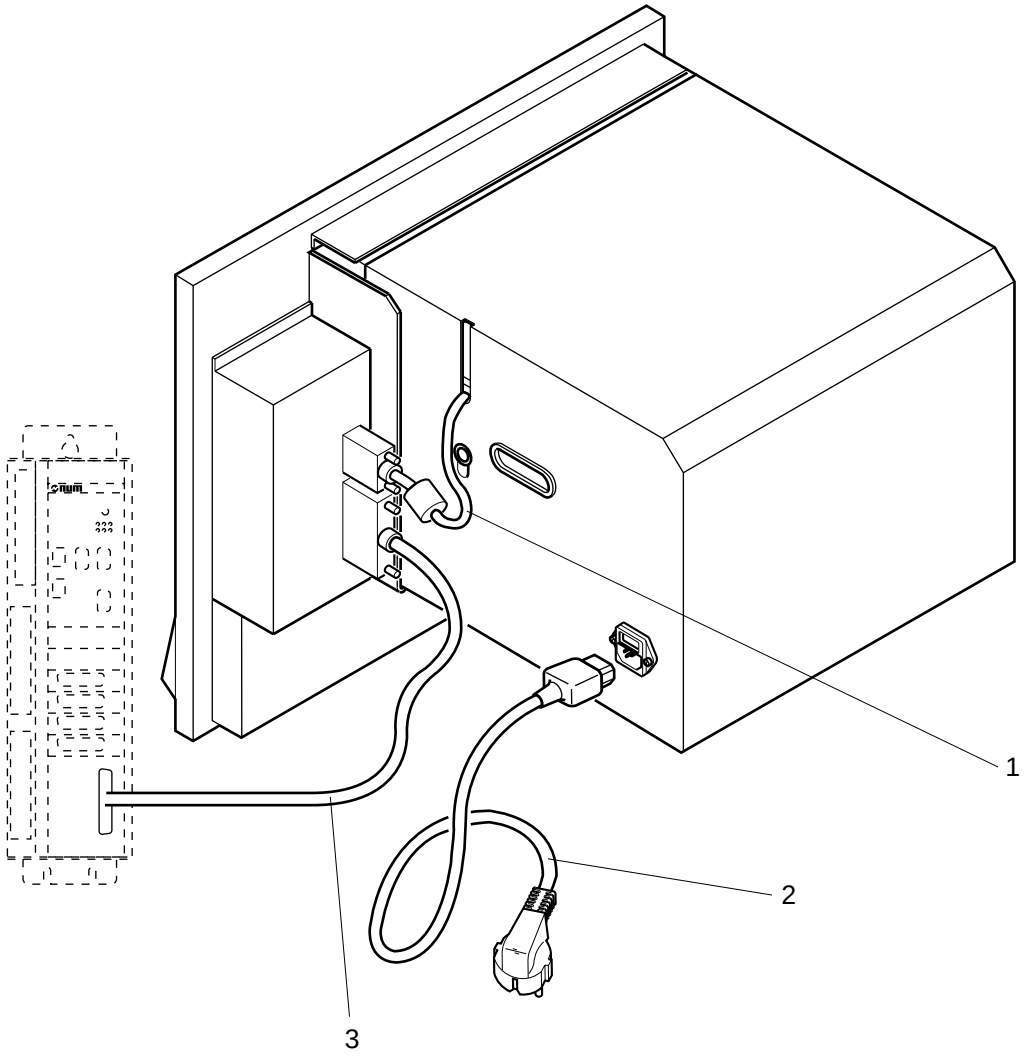


Panel type	Screen type	Maximum VDU power consumption
50-key panel	10" colour	60 W
	9" monochrome	30 W
QWERTY panel	14" colour	100 W
Power supply	230 VAC 50/60 Hz	

The panel provides the interface between the user and system:
- display on the VDU,
- user actions on the keyboard.

The panel communicates with the CNC processor card via a video cable.

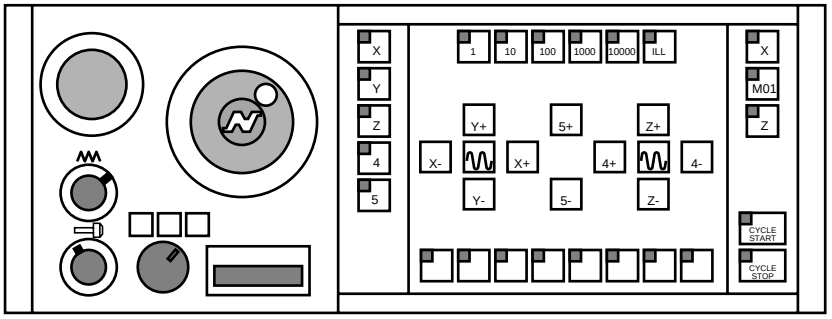
5.4.2 Panel Connection Diagram



1 - VDU video cable
2 - Power cable (see Sec. 6.5.2)
3 - Video cable

5.5 Machine Panel

5.5.1 General



Power consumption	3.8 W maximum
Max. current rating	500 mA
Nominal voltage	24 VDC (external power supply)
Limit values	17 V minimum 30 V maximum

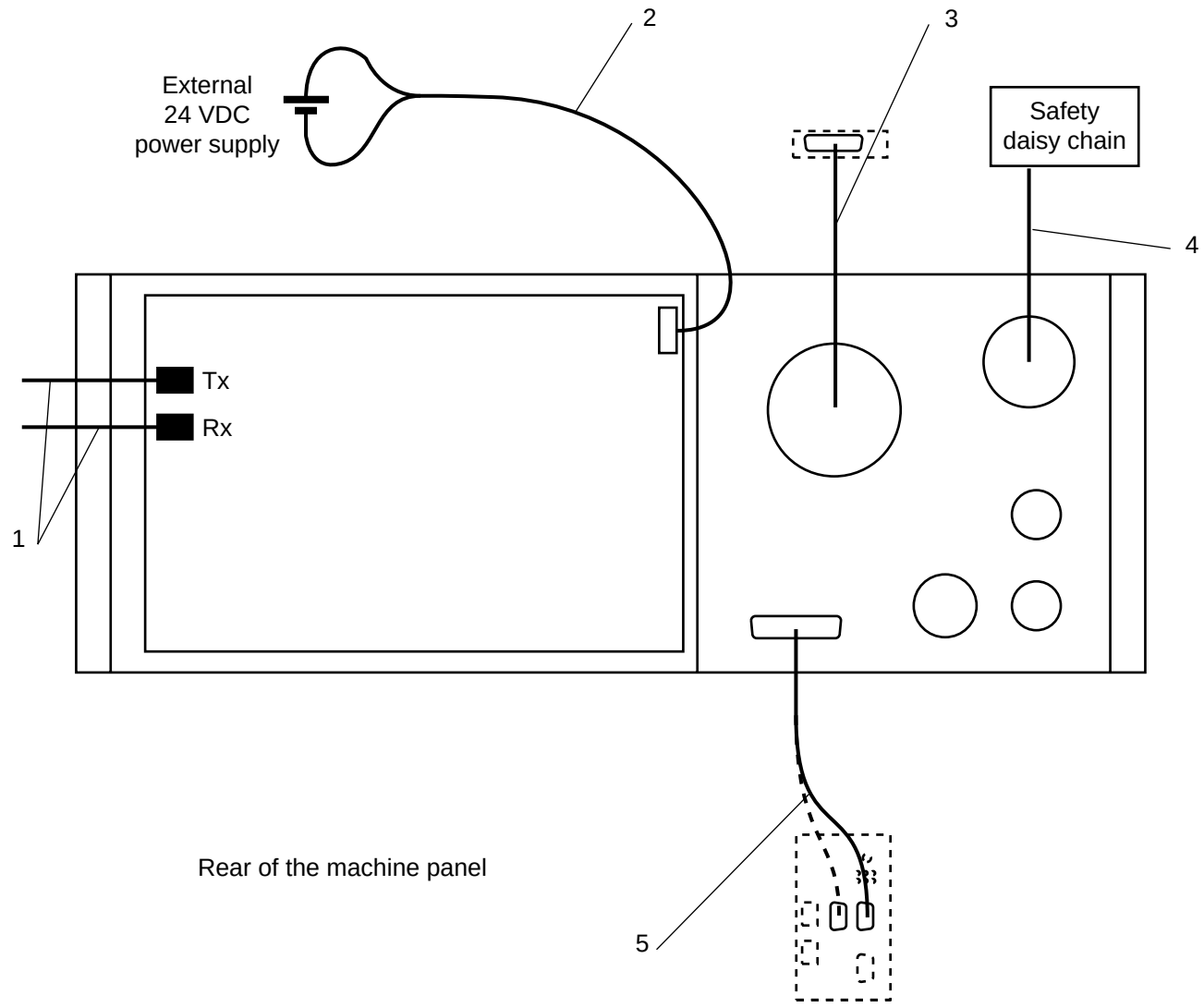
The machine panel provides the following functions:
- axis controls,
- machining (cycle start, cycle stop, axis recall, M01 and block skip enable),
- feed rate and spindle speed override by potentiometer,
- mode locking by key switch,
- emergency stop,
- remote serial line (wiring optional,)
- axis control by handwheel (optional).

The machine panel can also provide special functions using unassigned keys and LEDs.

In addition, 32 inputs and 24 outputs can be added by using the machine panel extension card.

The machine panel is connected by a fibre optic line to the machine processor via the serial bus.

5.5.2 Machine Panel Connection Diagram



1 - Optical fibre line to CPU
2 - Power cabme (see Sec. 6.5.3)
3 - Handwheel cable
4 - Emergency stop wiring (P/N XB2-BS542)
5 - Relay wiring of a serial line:
  - RS 232E line (see Sec. 6.1.5.1)
  - RS 422A or 485 line (see Sec. 6.1.5.2)

5.5.3 Machine Panel Extension

5.5.3.1 General

Internal consumption	520 mA maximum
Location	at the rear of the machine panel
Nominal voltage	24 VDC (external power supply)
Limit values	15 VDC minimum 30 VDC maximum

Inputs

32 discrete inputs	
Current rating	12.8 mA per input
Operating range	low level: 0 to 5 V high level: 11 to 30 V
Input impedance	2060 ohms (low level) 1800-2060 ohms (high level)
Reverse voltage withstand	30 VDC continuous
Logic	positive (current sink)

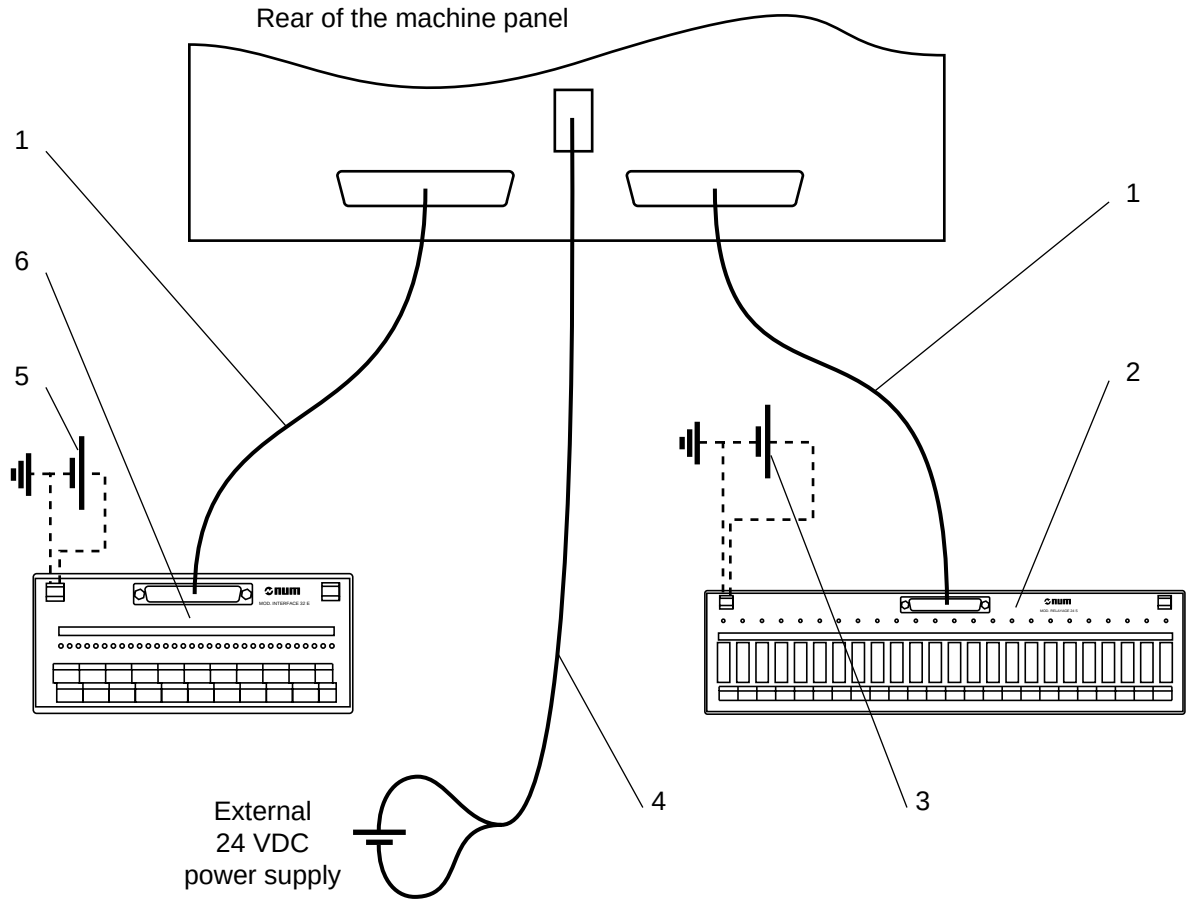
Outputs

24 open-collector discrete outputs	
Maximum current rating Limit value	200 mA per output 3 A per output for t < 10 µs
Protection	short-circuit inductive overvoltage
High level overshoot voltage	0.5 V maximum
Low level leakage current	0.3 mA maximum
Logic	positive (current source)

The machine panel extension is designed for logic data transfers between a second machine panel dedicated to the customer and the PLC application via the NUM machine panel.

The machine panel extension can:
- Communicate with the CPU via the NUM machine panel and optical fibre link
- Receive input signals from pushbuttons via the 32-input connector
- Send output signals to LEDs via the 24-output connector.

5.5.3.2 Connection Diagram of the Machine Panel Extension with Remote Modules



1 - Machine panel extension/remote module connecting cable:
- Length 1 m (P/N 263202928)
- Length 2 m (P/N 263202929)

2 - 24-output relay module (P/N 263900002, see Sec. 5.2.8.3: Connecting the module)

3 - Power supply via the relay module (excludes power supply via the central connector of interface module)

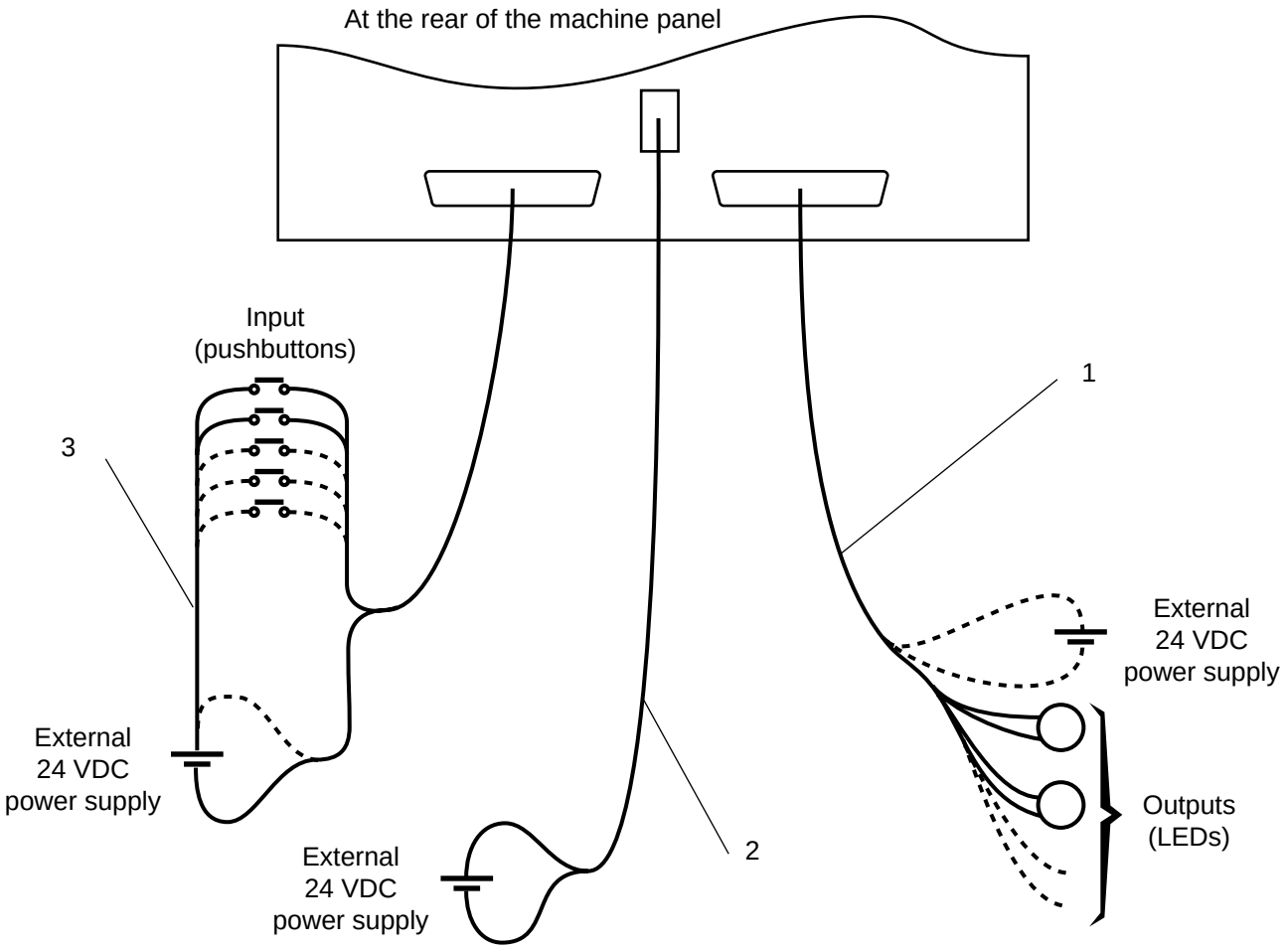
4 - Power cable (see Sec. 6.5.3: excludes power supply via the relay module or interface module)

5 - Power supply via the interface module (excludes power supply via the central connector or relay module)

6 - 32-input interface module (P/N 263900001, see Sec. 5.2.7.3: Connecting the module)

REMARK *The power supply must be provided to the machine panel extension by one and only one of cables 3, 4 or 5.*

5.5.3.3 Machine Panel Extension Connection Diagram without Remote Modules

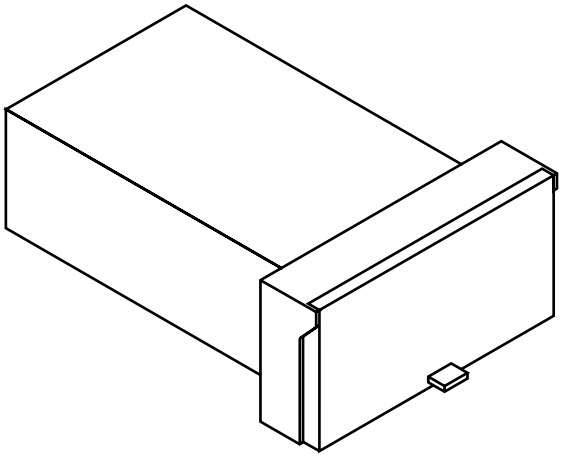


1 - 24-output cable with or without power supply (see Sec. 6.4.5)
2 - Power cable (only when the general power supply is not provided by one of the input or output cables: see Sec. 6.5.3)
3 - 32-input cable with or without general power supply (see Sec. 6.4.4)

REMARK *The power supply must be provided to the machine panel extension by one and only one of cables 1, 2 or 3.*

5.6 NUM Diskette Drive

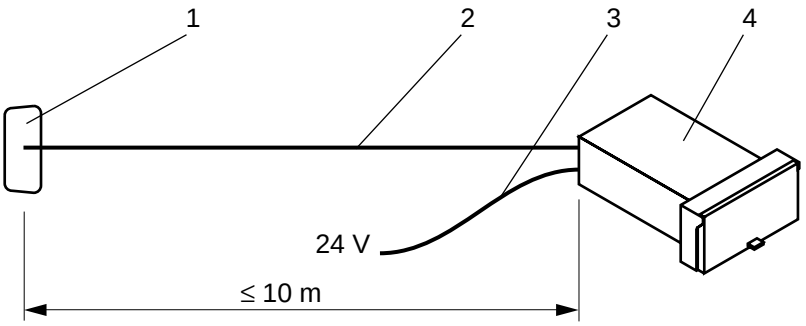
5.6.1 General



Power consumption	3.5 W maximum
Nominal voltage	24 VDC (external power supply)
Limit values	19.2 V minimum 30 V maximum

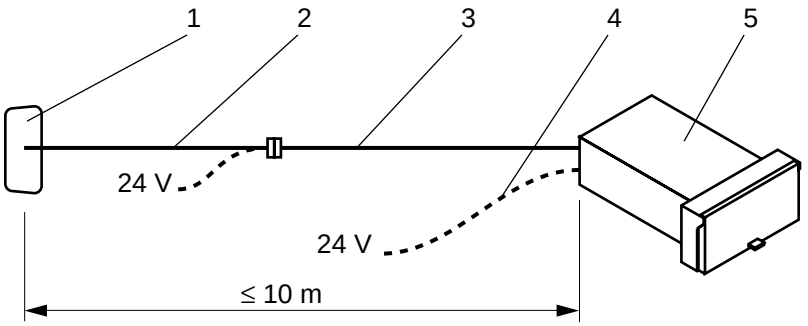
5.6.2 Connections of the NUM Diskette Drive

5.6.2.1 Connection of the NUM Diskette Drive to an RS 232E Line



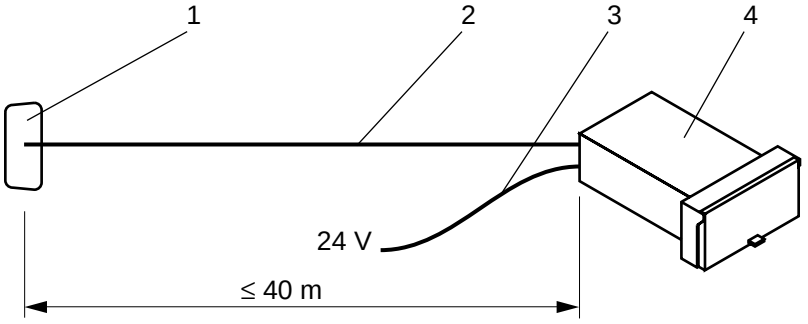
1 - RS 232E line (Com 1)
2 - RS 232E serial interface cable (see Sec. 6.1.6)
3 - Drive power cable (see Sec. 6.5.4)
4 - NUM diskette drive

5.6.2.2 Connection of the NUM Diskette Drive with a Remote RS 232E Line



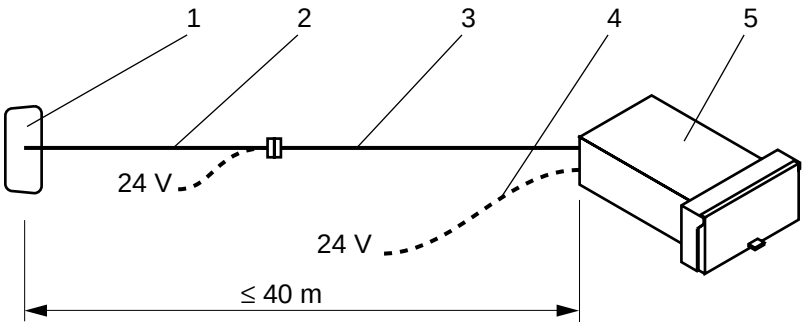
1 - RS 232E line (Com 1)
2 - Cable for remote RS 232E line with or without power supply:
  - to compact panel (see Sec. 6.1.4.1)
  - to machine panel (see Sec. 6.1.5.1)
3 - RS 232E serial interface cable (see Sec. 6.1.6) or cable supplied (P/N 206203324, only on machine panel)
4 - Drive power supply cable (only when cable (2) does not provide the power supply: see Sec. 6.5.4)
5 - NUM diskette drive

5.6.2.3 Connection of the NUM Diskette Drive to an RS 422A Line



1 - RS 422A line (Serial)
2 - RS 422A serial interface cable (see Sec. 6.1.7)
3 - Drive power cable (see Sec. 6.5.4)
4 - NUM diskette drive

5.6.2.4 Connection of the NUM Diskette Drive with a Remote RS 422A Line

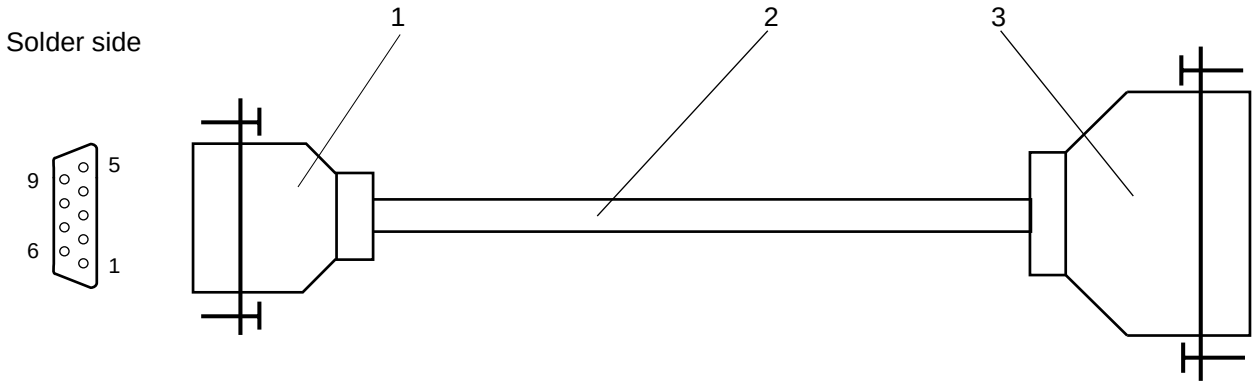


1 - RS 422A line (Com 1)
2 - Cable for remote RS 422A line with or without power supply:
  - to compact panel (see Sec. 6.1.4.2)
  - to machine panel (see Sec. 6.1.5.2)
3 - RS 422A serial interface cable (see Sec. 6.1.7) or cable supplied (P/N 206203324, only on machine panel)
4 - Drive power supply cable (only when cable (2) does not provide the power supply: see Sec. 6.5.4)
5 - NUM diskette drive

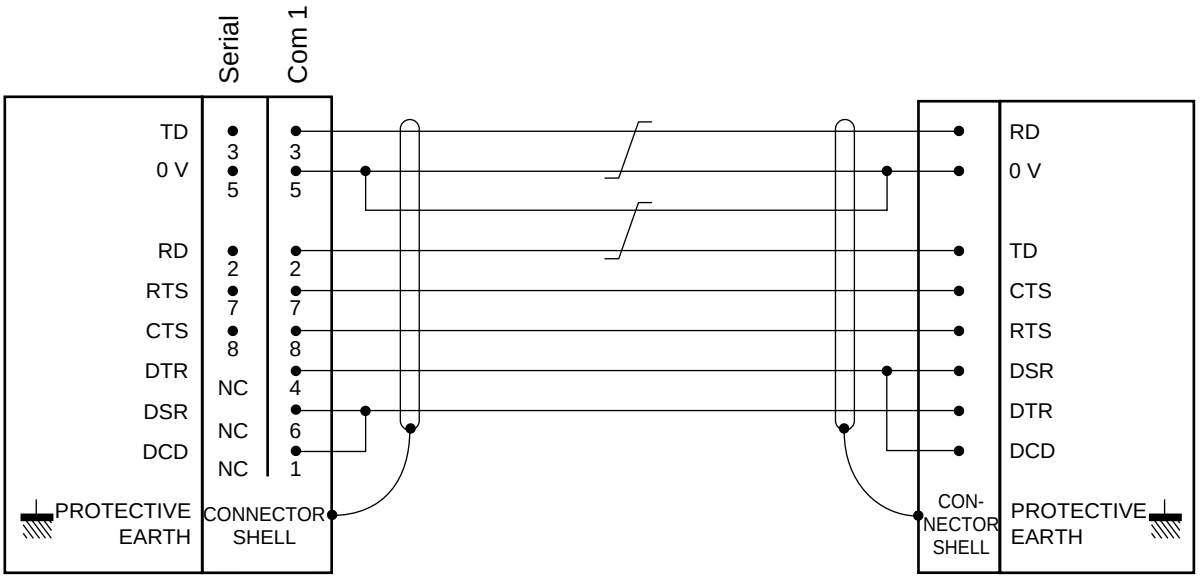
6 Cable Diagrams

6.1 Communication Cables

6.1.1 RS 232E Serial Interface Cable



1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 4 isolated conductors (minimum wire size 0.14 mm²)
3 - Connector plug depending on peripheral

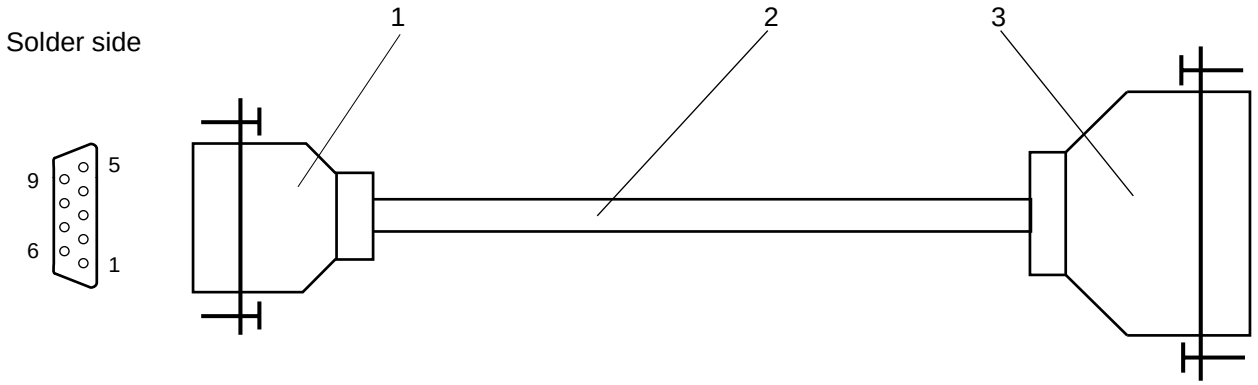


Pins 1, 4 and 6 are not wired for connection to the Serial connector.

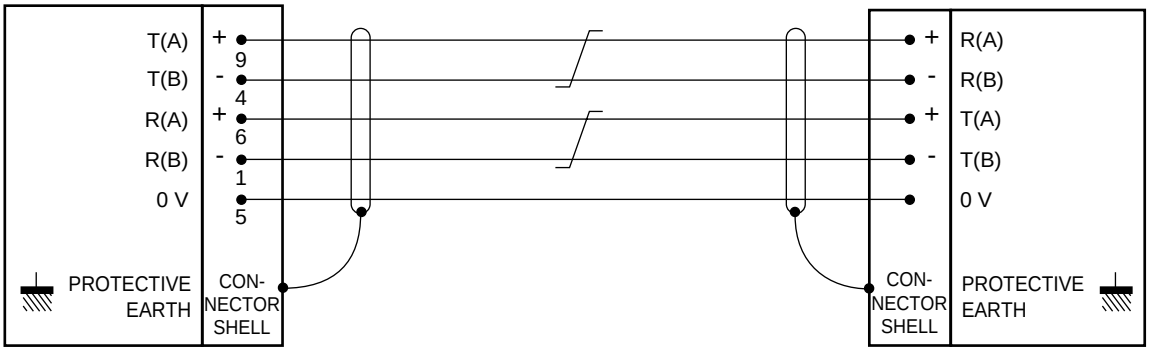
⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.2 RS 422A Serial Interface Cable



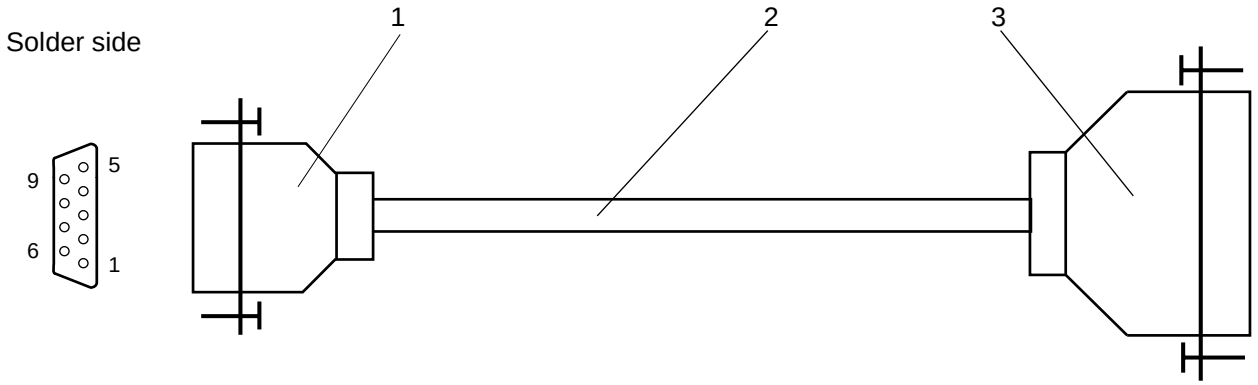
1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 1 isolated conductor (minimum wire size 0.14 mm²)
3 - Connector plug depending on peripheral



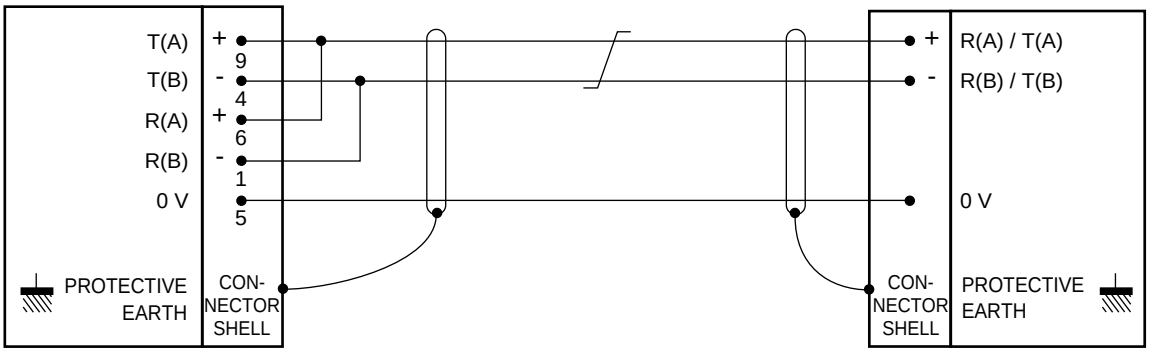
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.3 RS 485 Serial Interface Cable



1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 1 twisted pair and 1 isolated conductor (minimum wire size 0.14 mm²)
3 - Connector plug depending on peripheral

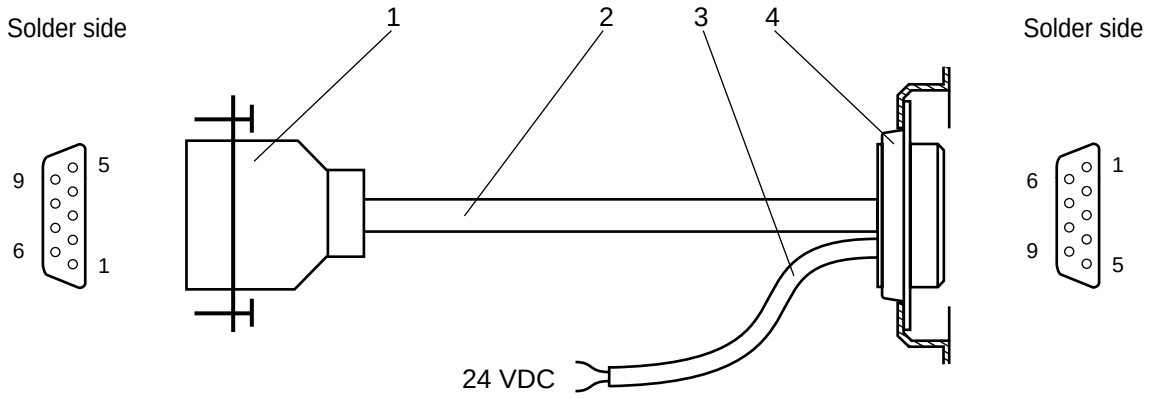


CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.4 Serial Line Relay Cable Connected to Compact Panel

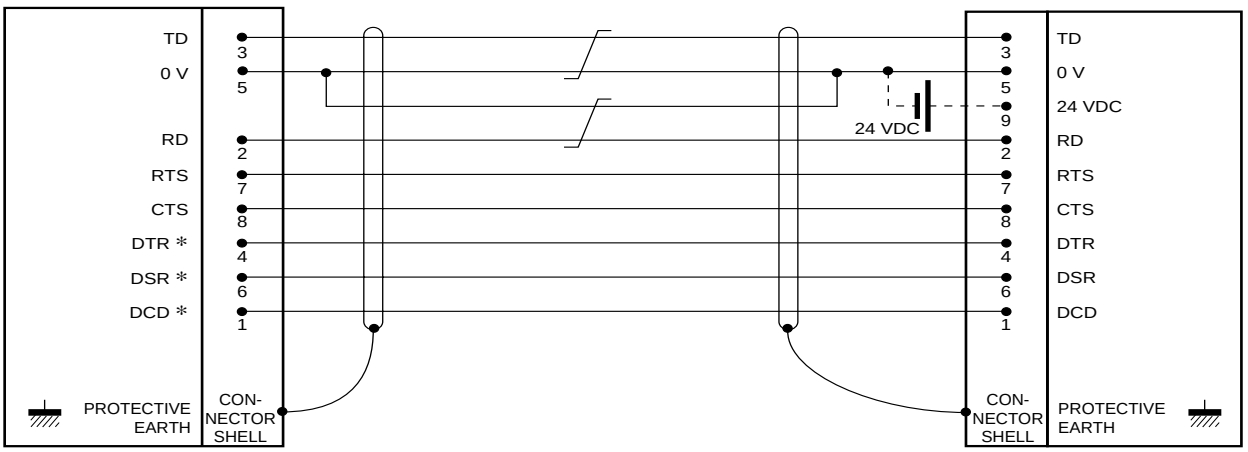
6.1.4.1 RS 232E Line Relay Cable Connected to Compact Panel



1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 5 isolated conductors (minimum wire size 0.14 m^2)
3 - 2-wire cable (optional, for power supply of the NUM diskette drive)
4 - Remote 9-contact female Sub.D connector

CAUTION

If the 24 VDC cable is wired (for occasional connection of the NUM diskette drive), do not connect the peripheral for which contact 9 is used (e.g. signal RI of the PC standard).

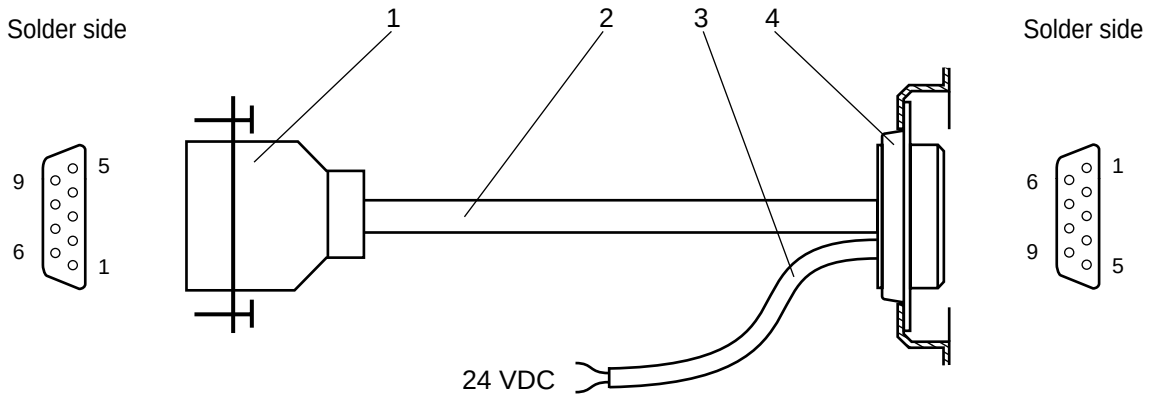


* Signals present only on Com 1

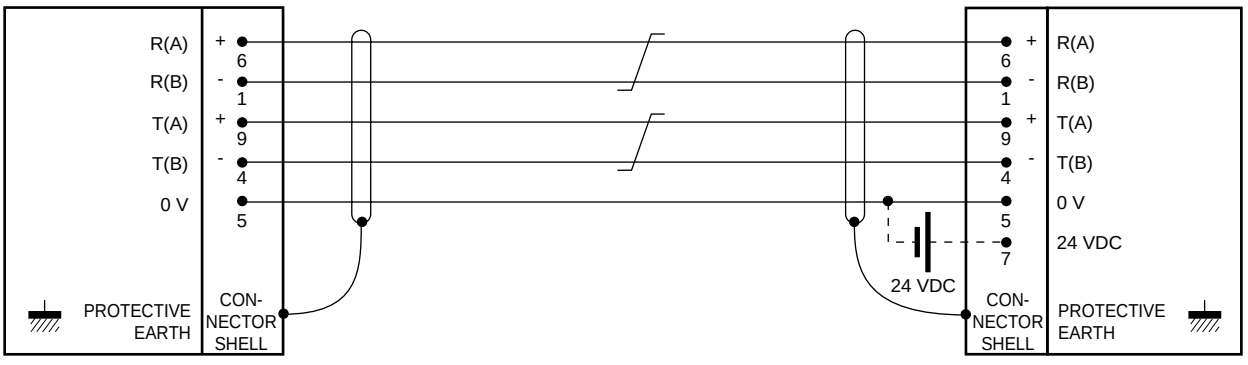
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.4.2 RS 422A or RS 485 Line Relay Cable Connected to Compact Panel



1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 1 isolated conductor (minimum wire size 0.14 m^2)
3 - 2-wire cable (optional, for power supply of the NUM diskette drive)
4 - Remote 9-contact female Sub.D connector

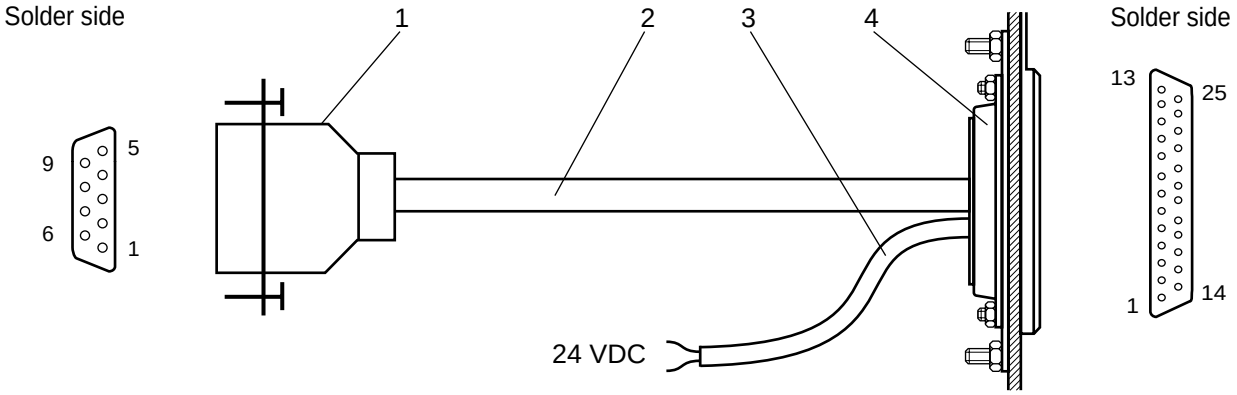


CAUTION

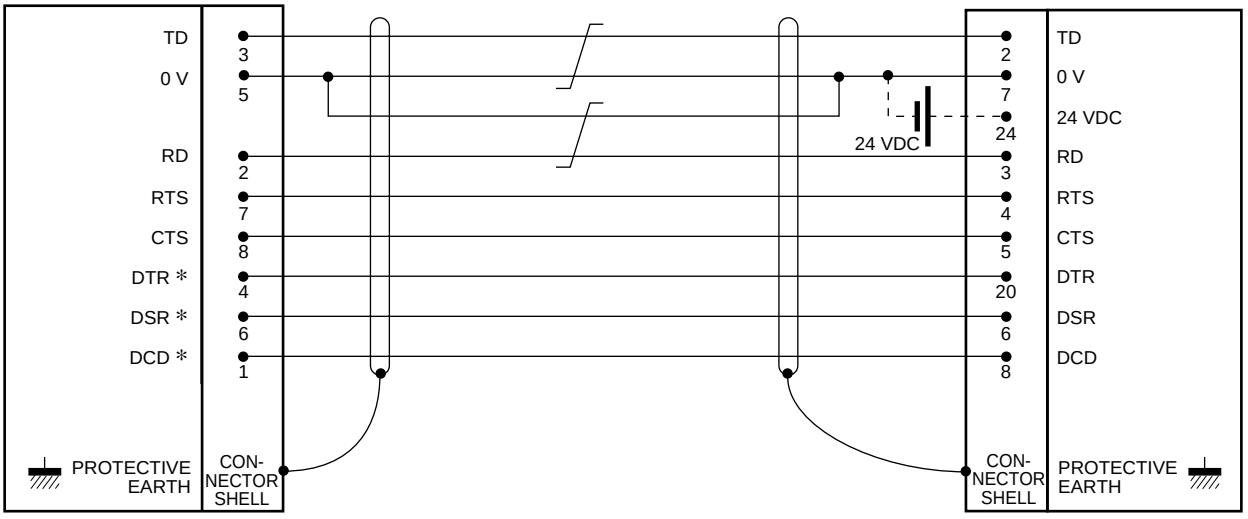
For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.5 Serial Line Relay Cable Connected to Machine Panel

6.1.5.1 RS 232E Line Relay Cable Connected to Machine Panel



1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 5 isolated conductors (minimum wire size 0.14 m^2)
3 - 2-wire cable (optional, for power supply of the NUM diskette drive)
4 - Remote 25-contact female Sub.D connector

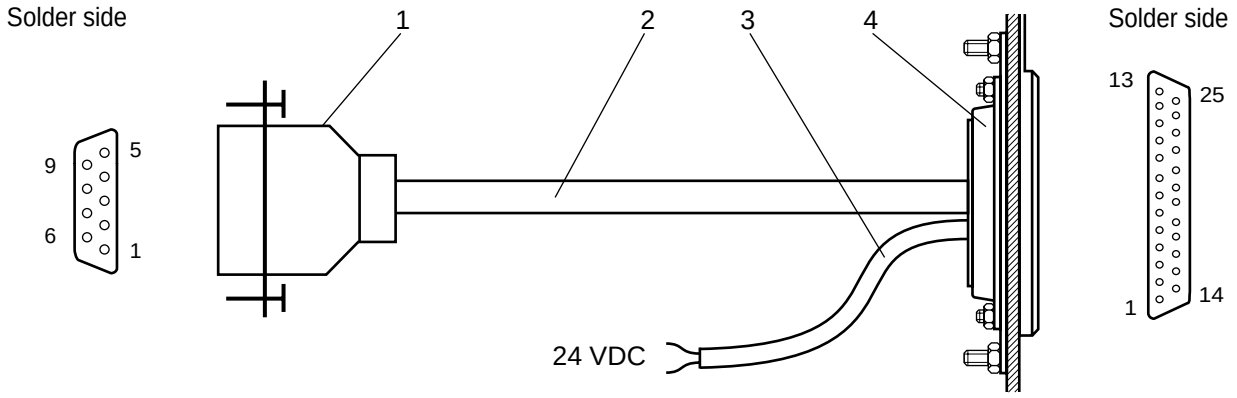


* Signals present only on Com 1

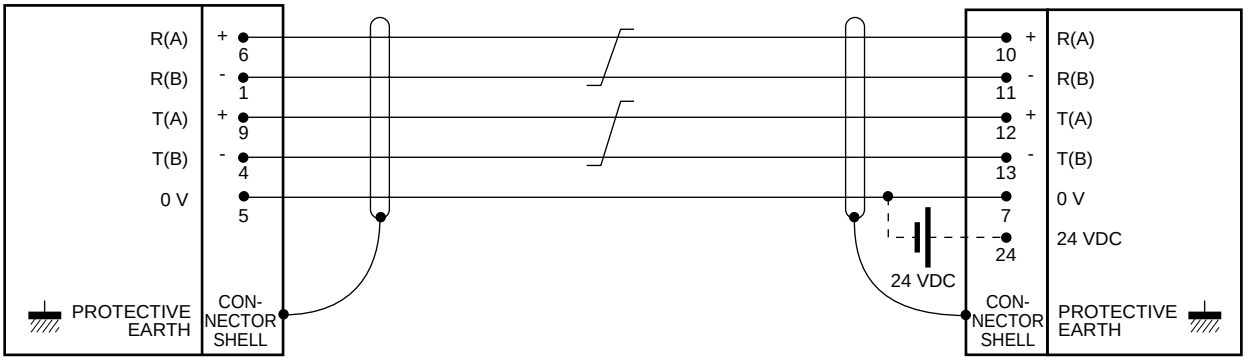
⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.5.2 RS 422A or RS 485 Line Relay Cable Connected to Machine Panel



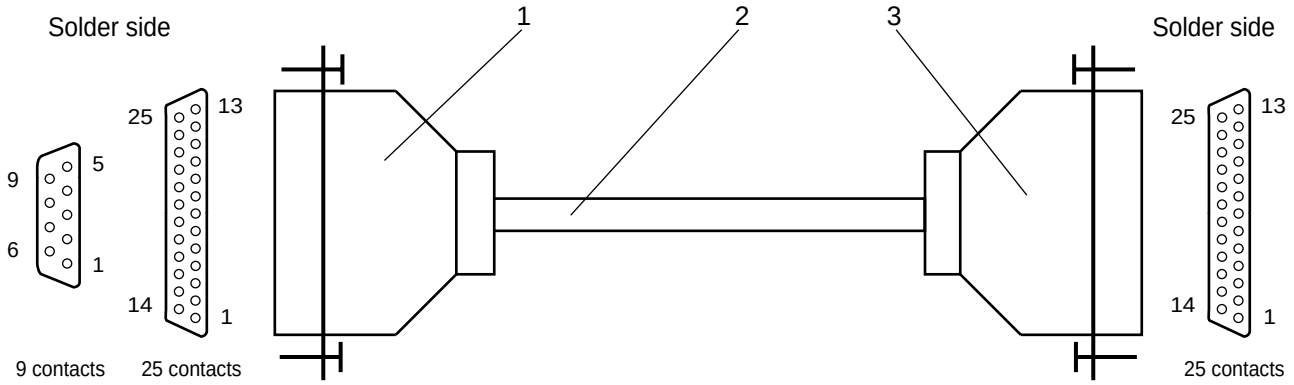
1 - 9-contact male Sub.D connector on CPU side
2 - Shielded cable with 2 twisted pairs and 1 isolated conductor (minimum wire size 0.14 m^2)
3 - 2-wire cable (optional, for power supply of the NUM diskette drive)
4 - Remote 25-contact female Sub.D connector



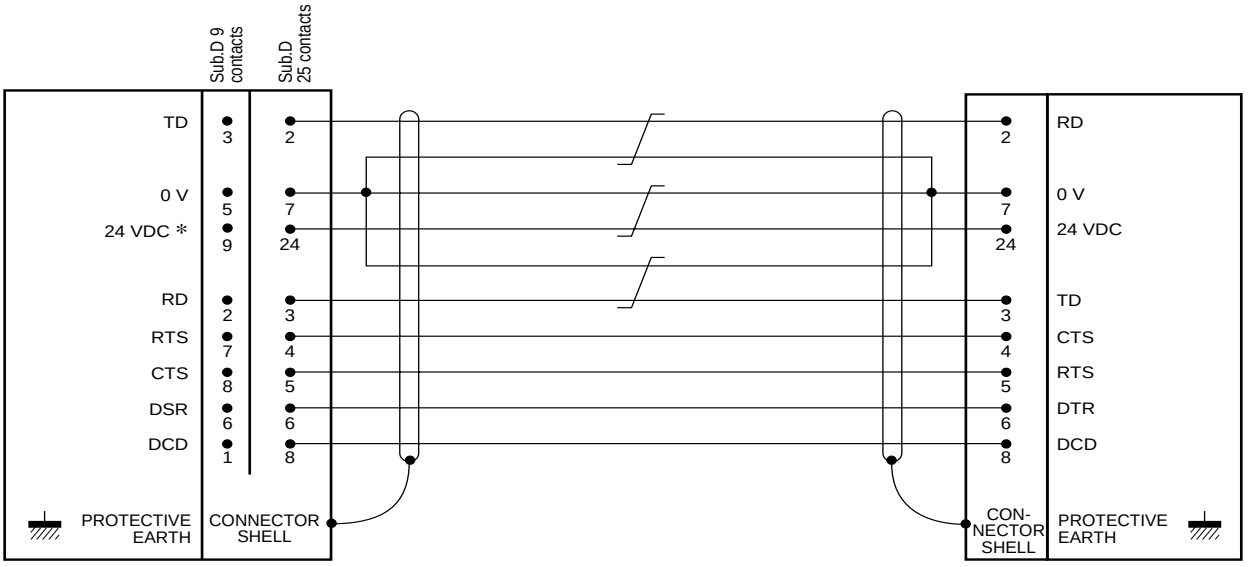
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.1.6 RS 232E Serial Interface Cable for NUM Diskette Drive

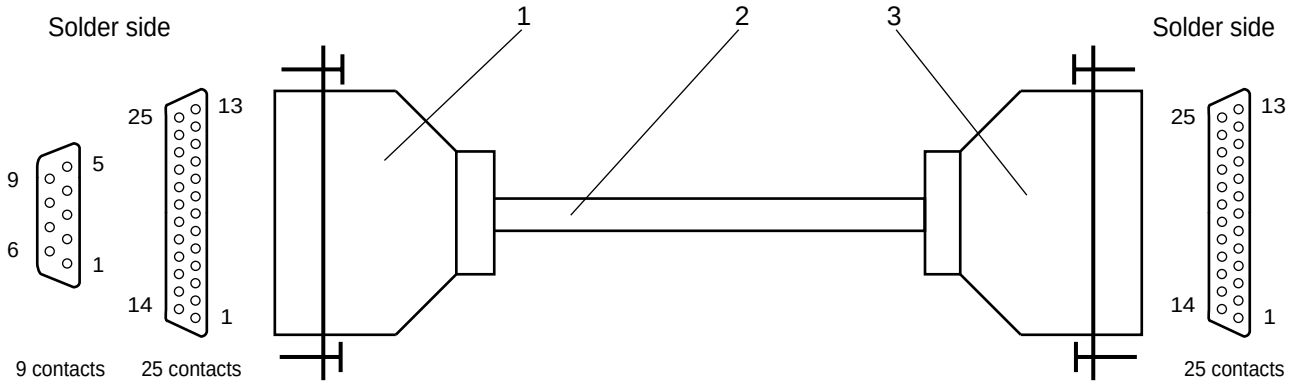


1 - 9- or 25-contact male Sub.D connector (CPU or remote connector)
2 - Shielded cable with 3 twisted pairs and 4 isolated conductors (minimum wire size 0.14 mm²)
3 - 25-contact female Sub.D connector on NUM drive side

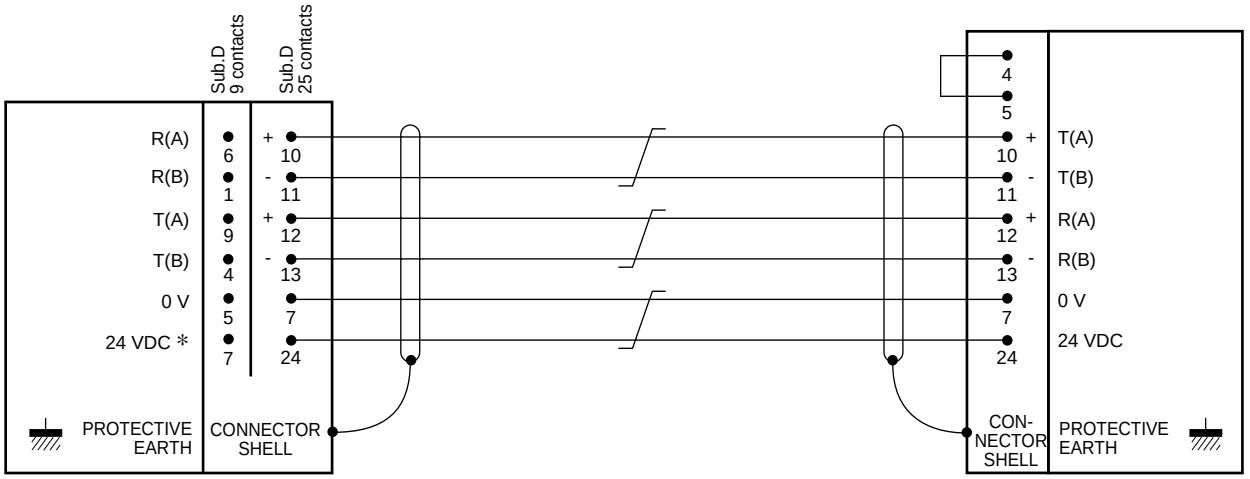


* Connection with twisted pair used only when the remote connector supplies the 24 VDC power supply to the NUM diskette drive.

6.1.7 RS 422A Serial Interface Cable for NUM Diskette Drive



1 - 9- or 25-contact male Sub.D connector (CPU or remote connector)
2 - Shielded cable with 3 twisted pairs (minimum wire size 0.14 mm^2)
3 - 25-contact female Sub.D connector on NUM drive side



* Connection with twisted pair used only when the remote connector supplies the 24 VDC power supply to the NUM diskette drive.

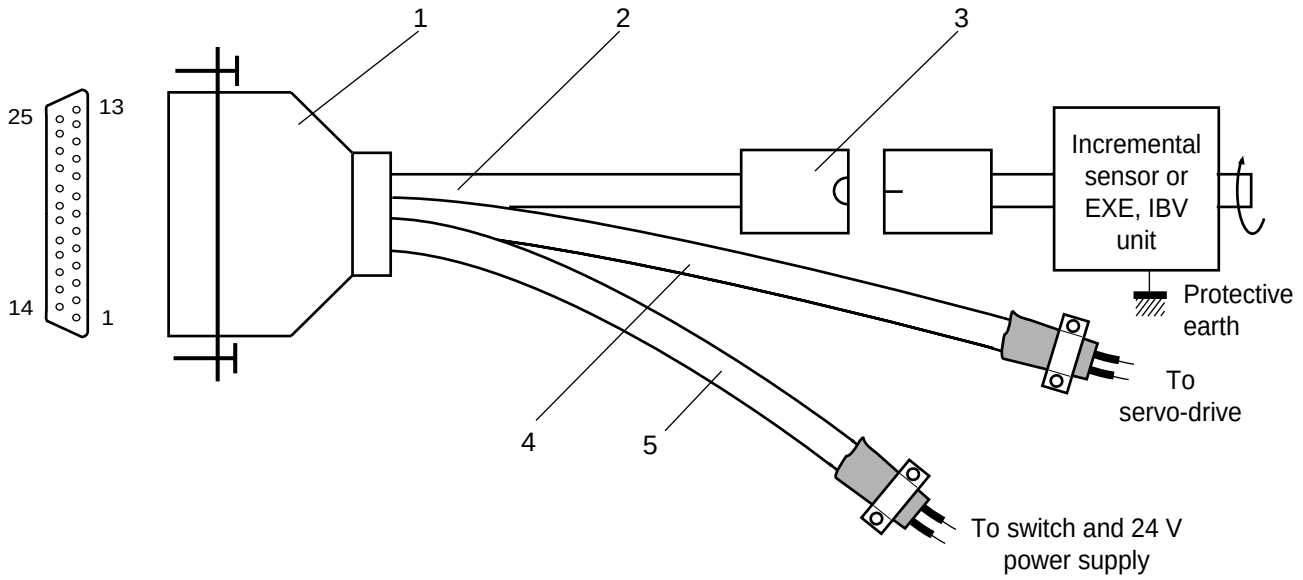
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.2 Axis Cables

6.2.1 Incremental Axis Encoder

6.2.1.1 Incremental Axis Encoder Connected to the Interface - Power Supply Provided by the Interface

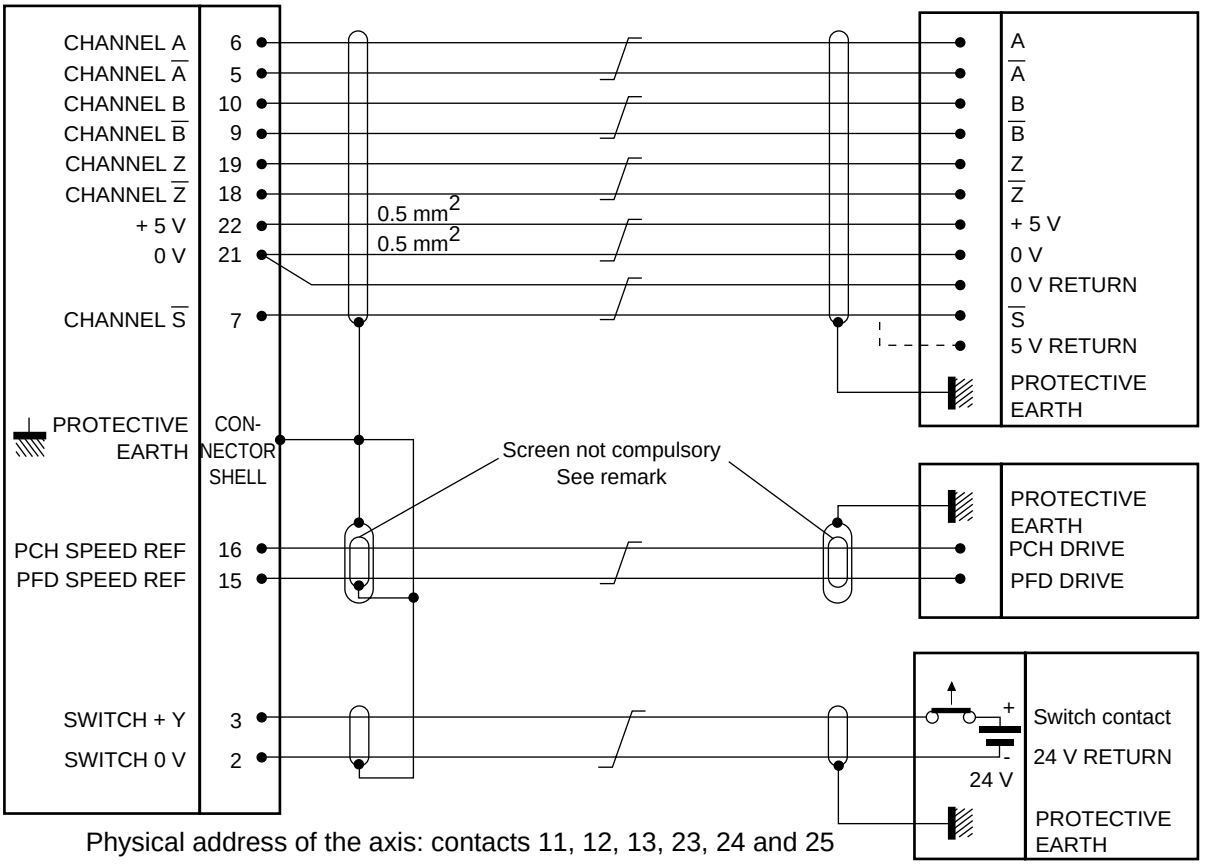


1 - 25-contact male Sub.D connector plug
2 - Shielded cable [4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
3 - Connector
4 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
5 - 1 twisted pair shielded cable (2 x 0.22 mm^2)

When the wire size is not suitable for installing the wires in the Sub.D connector, the cable can be made using the alternate arrangement described in Sec. 6.10.2.1.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



Physical address of the axis: contacts 11, 12, 13, 23, 24 and 25

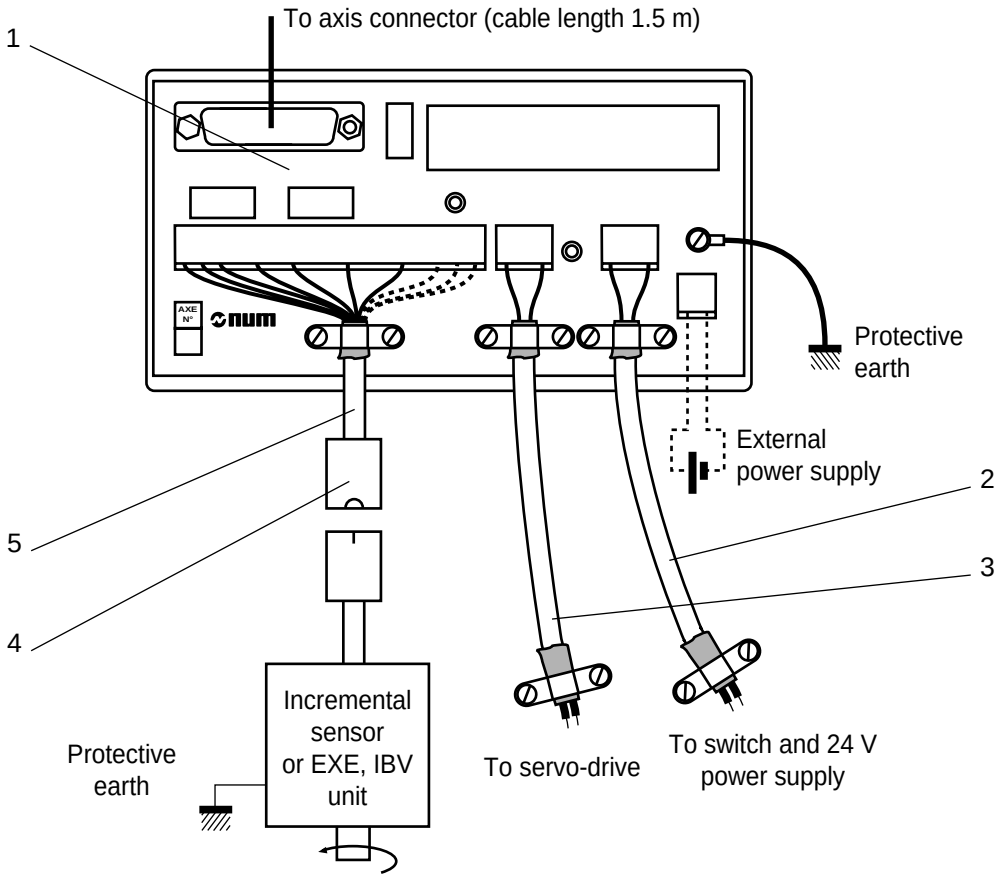
The physical address of the axis is obtained by the wiring of contacts 11, 12, 13, 23, 24 and 25 (see Sec. 6.2.10.2).

The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Contact $\overline{S}$ is present on sensors with poor signal errors. When the sensor does not include this signal, contact 7 on the CNC side must be connected to the sensor 5 V return.

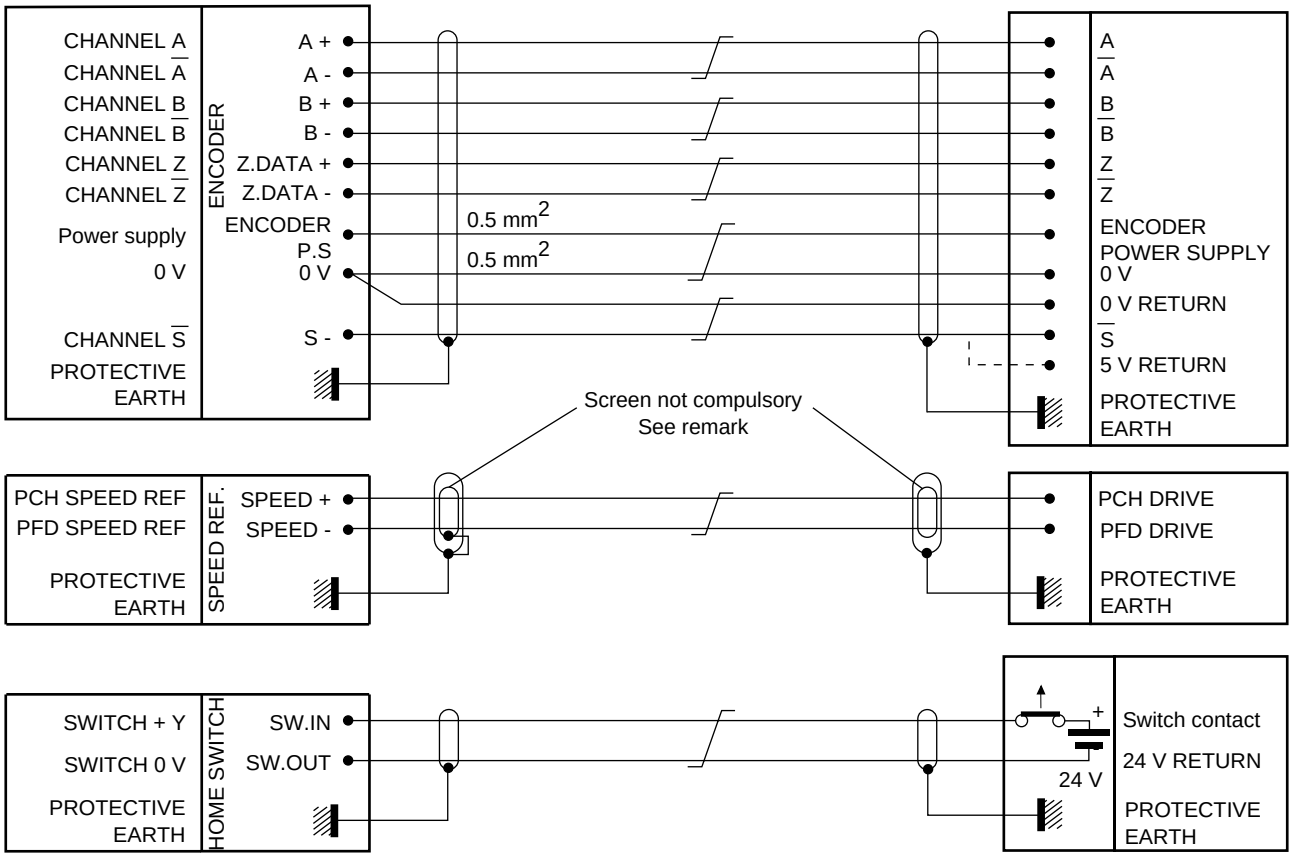
6.2.1.2 Incremental Axis Encoder Connected to an Axis Interface Module



1 - Axis interface module
2 - 1 twisted pair shielded cable (2 x 0.22 mm^2)
3 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
4 - Connector
5 - Shielded cable [4 x (2 x 0.14 mm^2) + 1 x 0.5 mm^2]

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



The physical address of the axis is obtained by switches (see Sec. 6.2.7).

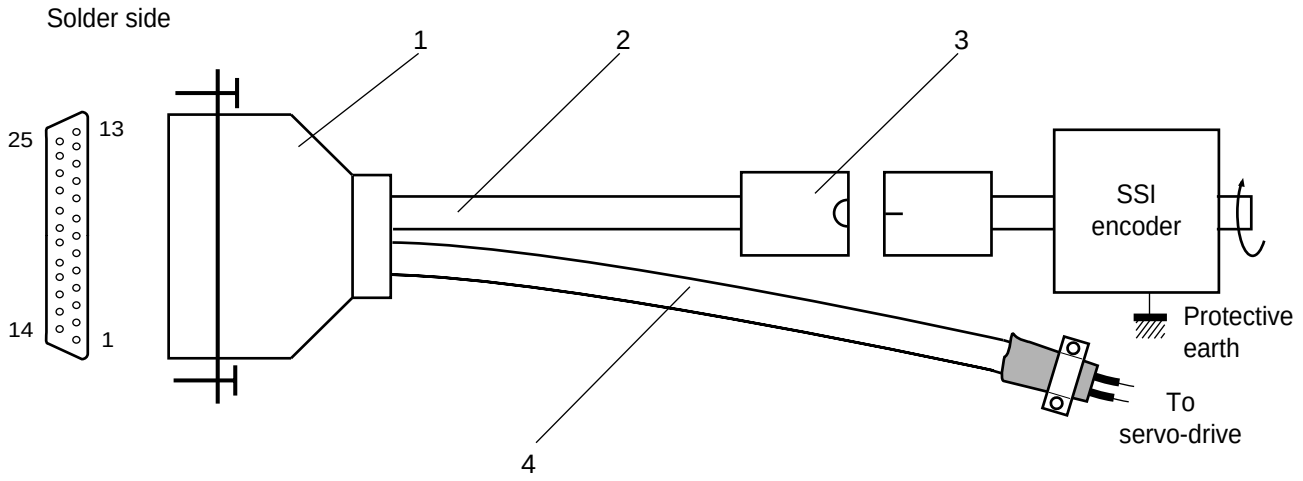
The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Contact $\overline{S}$ is present on sensors with poor signal errors. When the sensor does not include this signal, contact 7 on the CNC side must be connected to the sensor 5 V return (5V sensors only).

6.2.2 Absolute SSI Axis Encoder

6.2.2.1 Absolute SSI Axis Encoder Connected to the Axis Interface - Power Supply Provided by the Interface

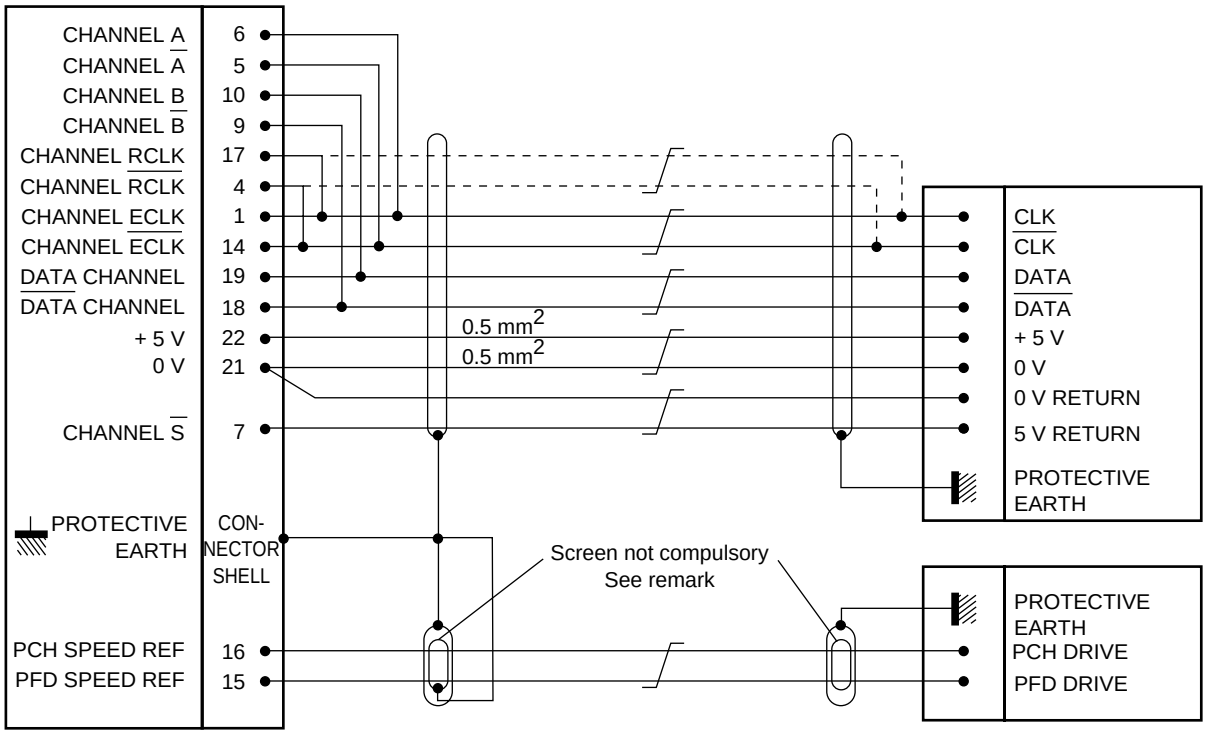


1 - 25-contact male Sub.D connector plug
2 - Shielded cable [3 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
or [4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
3 - Connector
4 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)

When the wire size is not suitable for installing the wires in the Sub.D connector, the cable can be made using the alternate arrangement described in Sec. 6.2.10.1.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



Physical address of the axis: contacts 11, 12, 13, 23, 24 and 25

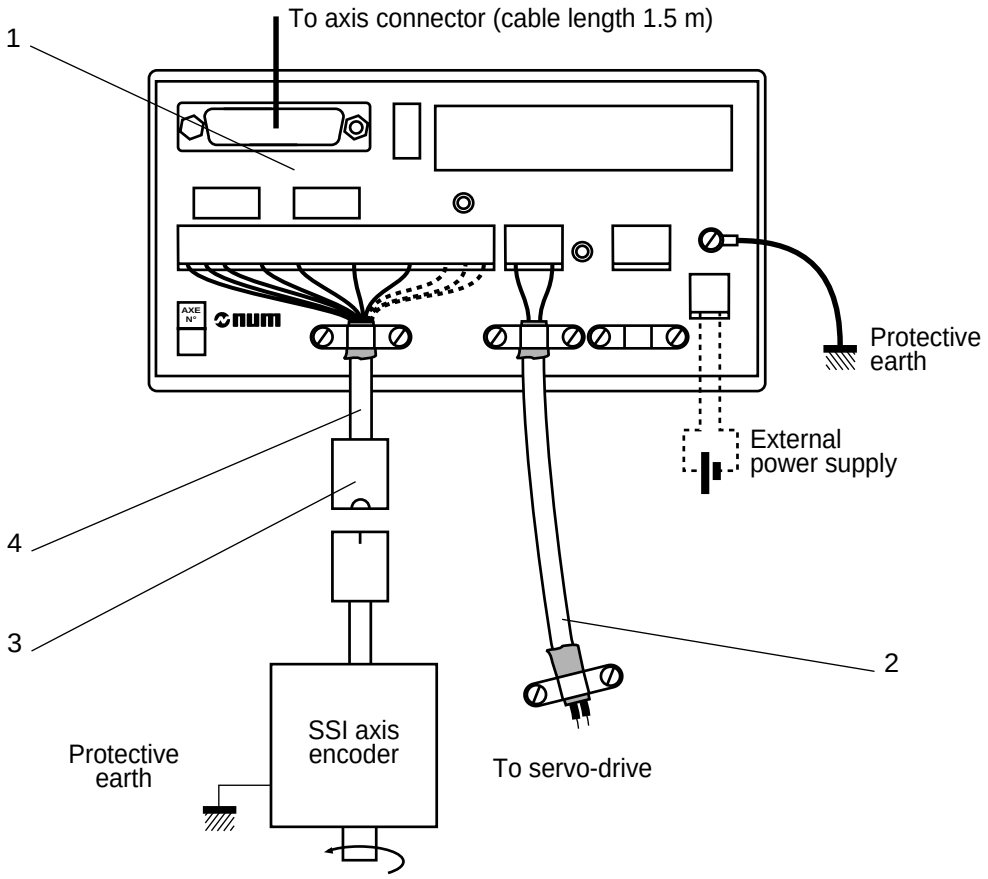
The physical address of the axis is obtained by the wiring of contacts 11, 12, 13, 23, 24 and 25 (see Sec. 6.2.10.2).

The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

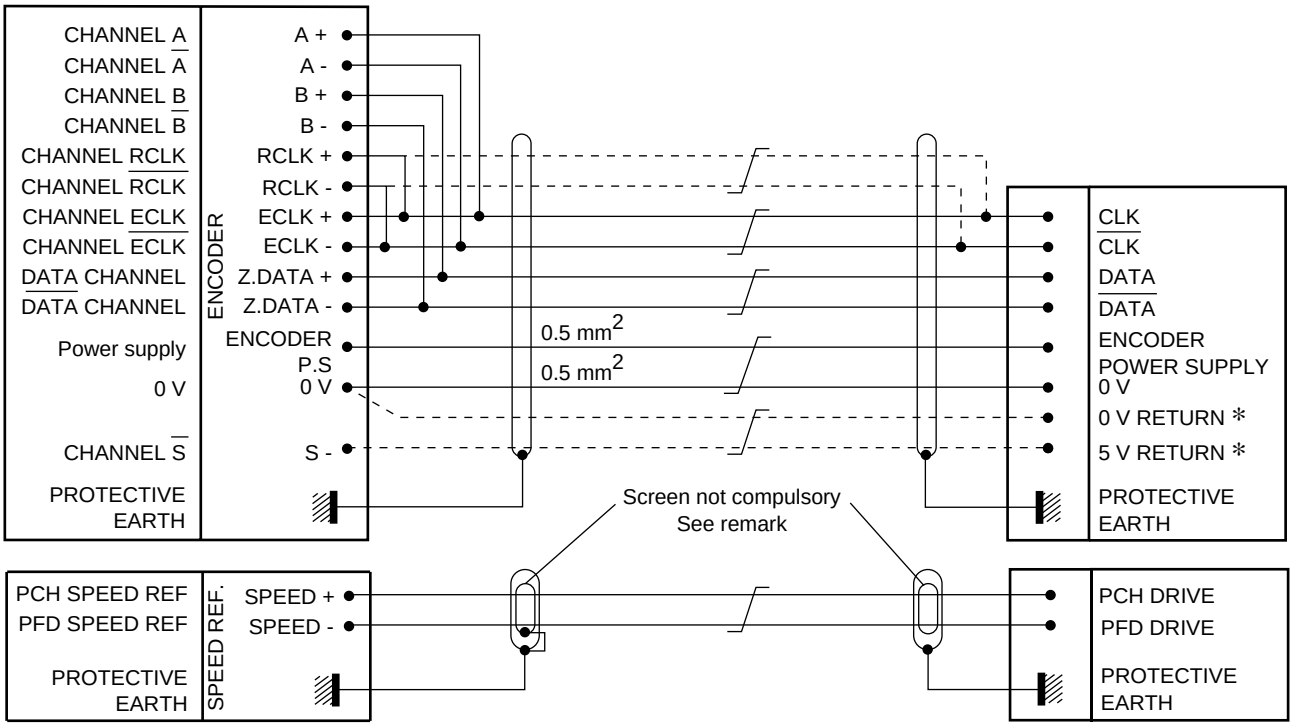
6.2.2.2 Absolute SSI Axis Encoder Connected to an Axis Interface Module



1 - Axis interface module
2 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
3 - Connector
4 - Shielded cable [3 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
or [4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]

CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



6

* 5 V encoders only.

The physical address of the axis is obtained by switches (see Sec. 6.2.7).

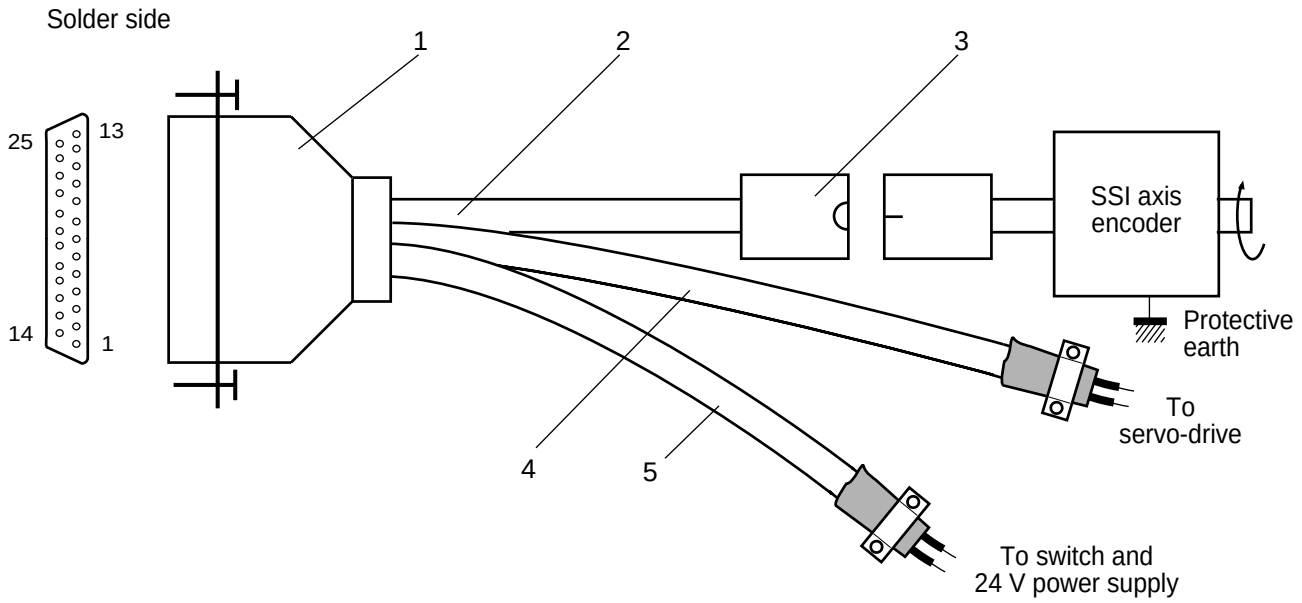
The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

6.2.3 Semiabsolute SSI Axis Encoder

6.2.3.1 Semiabsolute SSI Axis Encoder Connected to the Axis Interface - Power Supply Provided by the Interface

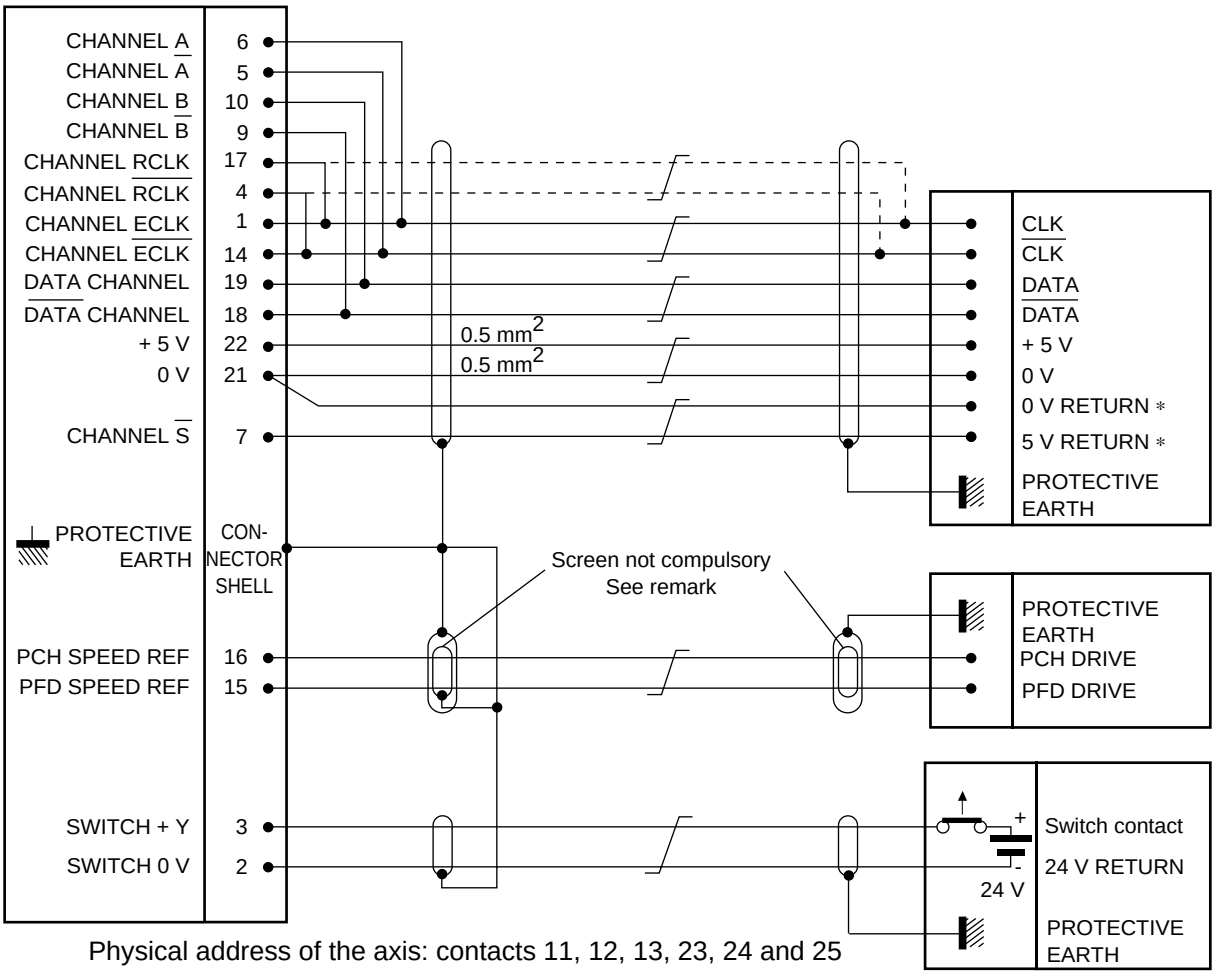


1 - 25-contact male Sub.D connector plug
2 - Shielded cable [3 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
or [4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
3 - Connector
4 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
5 - 1 twisted pair shielded cable (2 x 0.22 mm^2)

When the wire size is not suitable for installing the wires in the Sub.D connector, the cable can be made using the alternate arrangement described in Sec. 6.2.10.1.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



Physical address of the axis: contacts 11, 12, 13, 23, 24 and 25

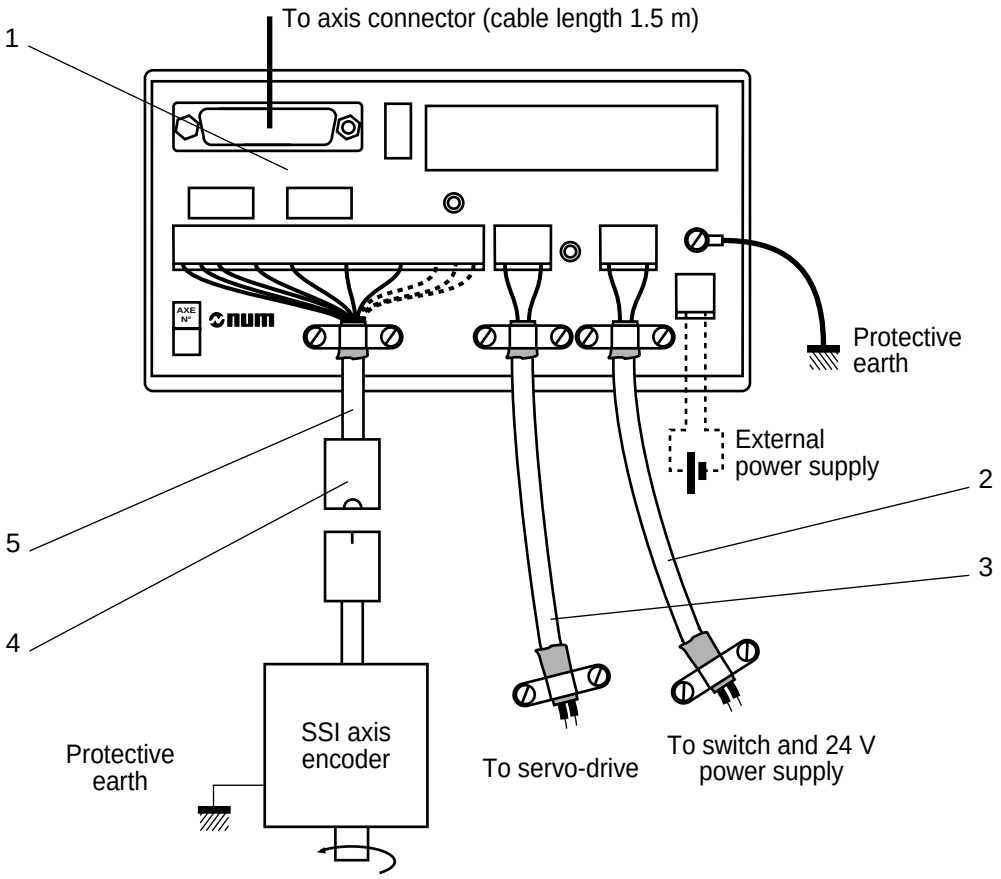
The physical address of the axis is obtained by the wiring of contacts 11, 12, 13, 23, 24 and 25 (see Sec. 6.2.10.2).

The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

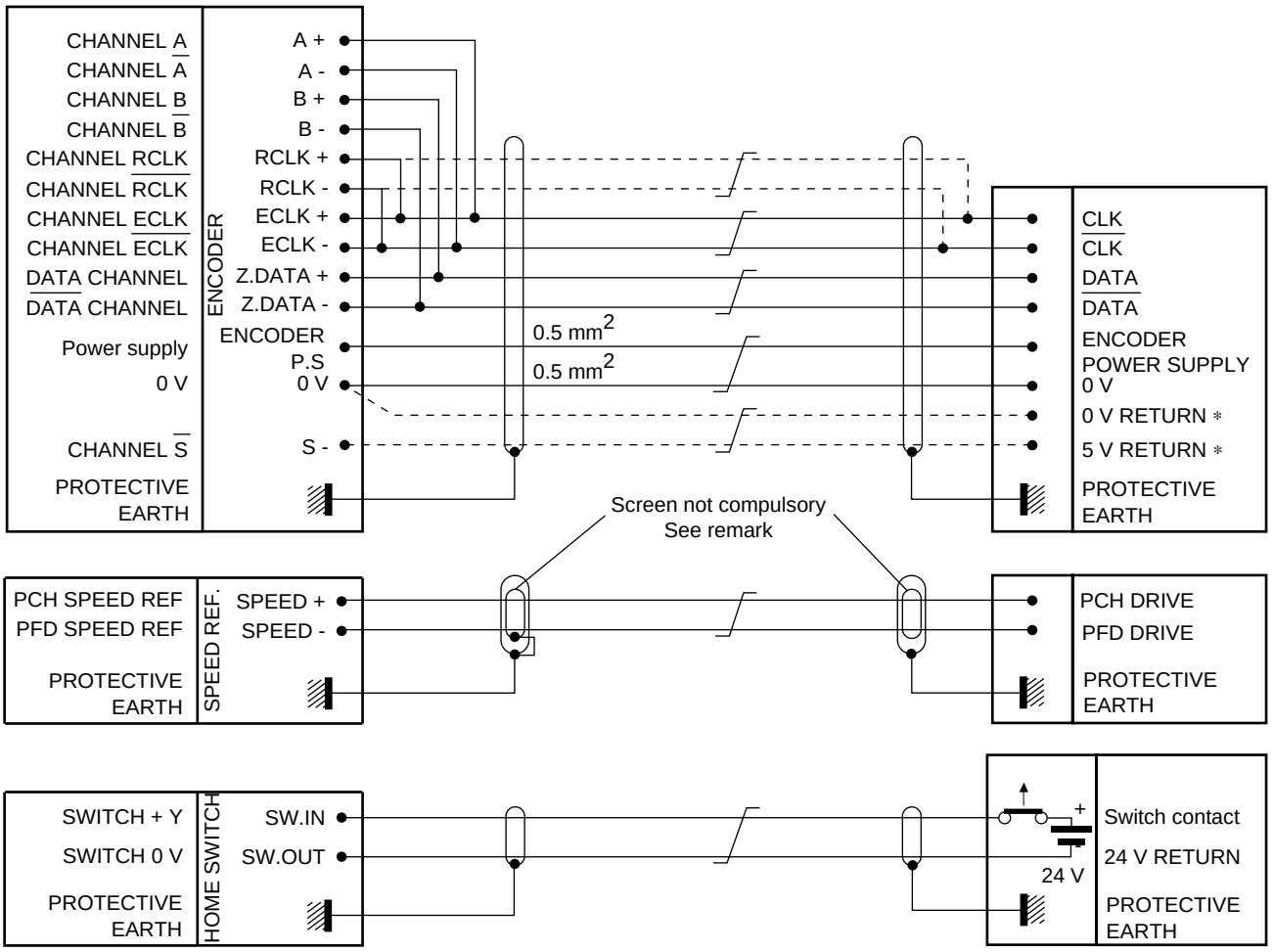
6.2.3.2 Semiabsolute SSI Axis Encoder Connected to an Axis Interface Module



1 - Axis interface module
2 - 1 twisted pair shielded cable (2 x 0.22 mm^2)
3 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
4 - Connector
5 - Shielded cable [3 x (2 x 0.14 mm^2) + 2 x 0.5 mm2]
or [4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



* 5 V encoders only.

The physical address of the axis is obtained by switches (see Sec. 6.2.7).

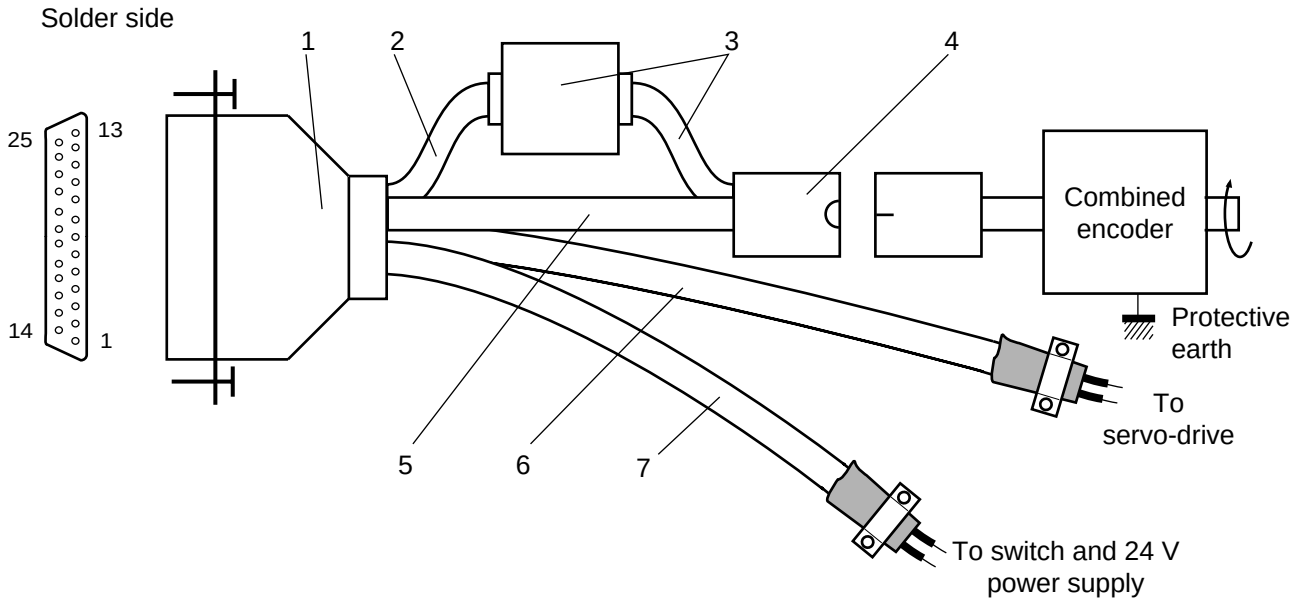
The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

6.2.4 Combined Axis Encoder: SSI + Incremental - Sinusoidal Pulses

6.2.4.1 Combined Axis Encoder: SSI + Incremental - Sinusoidal Pulses -Connected to the Axis Interface - Power Supply Provided by the Interface



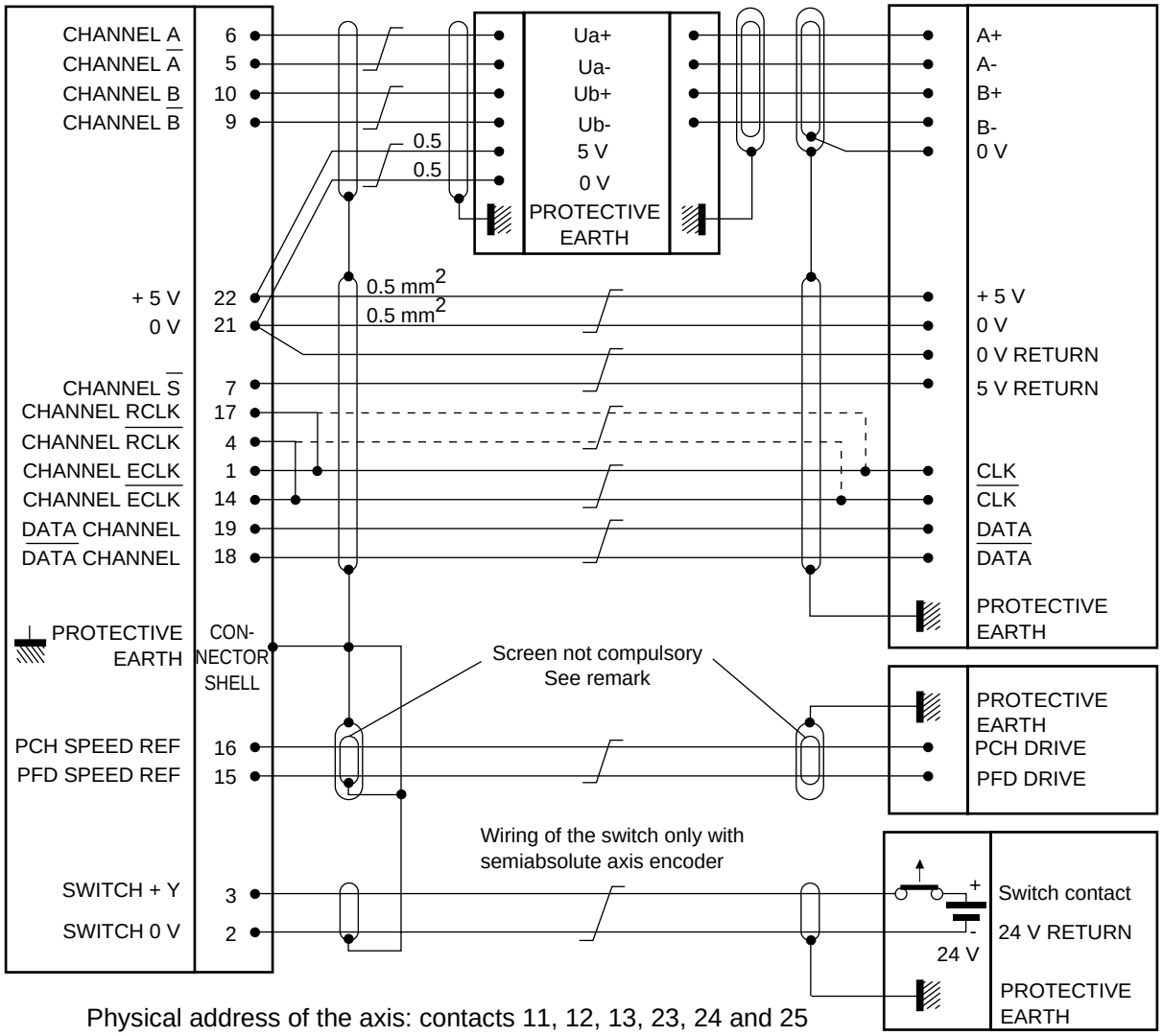
1 - 25-contact male Sub.D connector plug
2 - Shielded cable [2 x (2 x 014 mm^2) + 2 x 0.5 mm^2]
3 - Interpolation and shaping unit with associated cable
4 - Connector
5 - Shielded cable [3 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2] or
[4 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
6 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
7 - 1 twisted pair shielded cable (2 x 0.22 mm^2) ∗

∗ The switch and cable (7) are only used with semiabsolute axis encoders..

When the wire size is not suitable for installing the wires in the Sub.D connector, the cable can be made using the alternate arrangement described in Sec. 6.2.10.1.

CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



Physical address of the axis: contacts 11, 12, 13, 23, 24 and 25

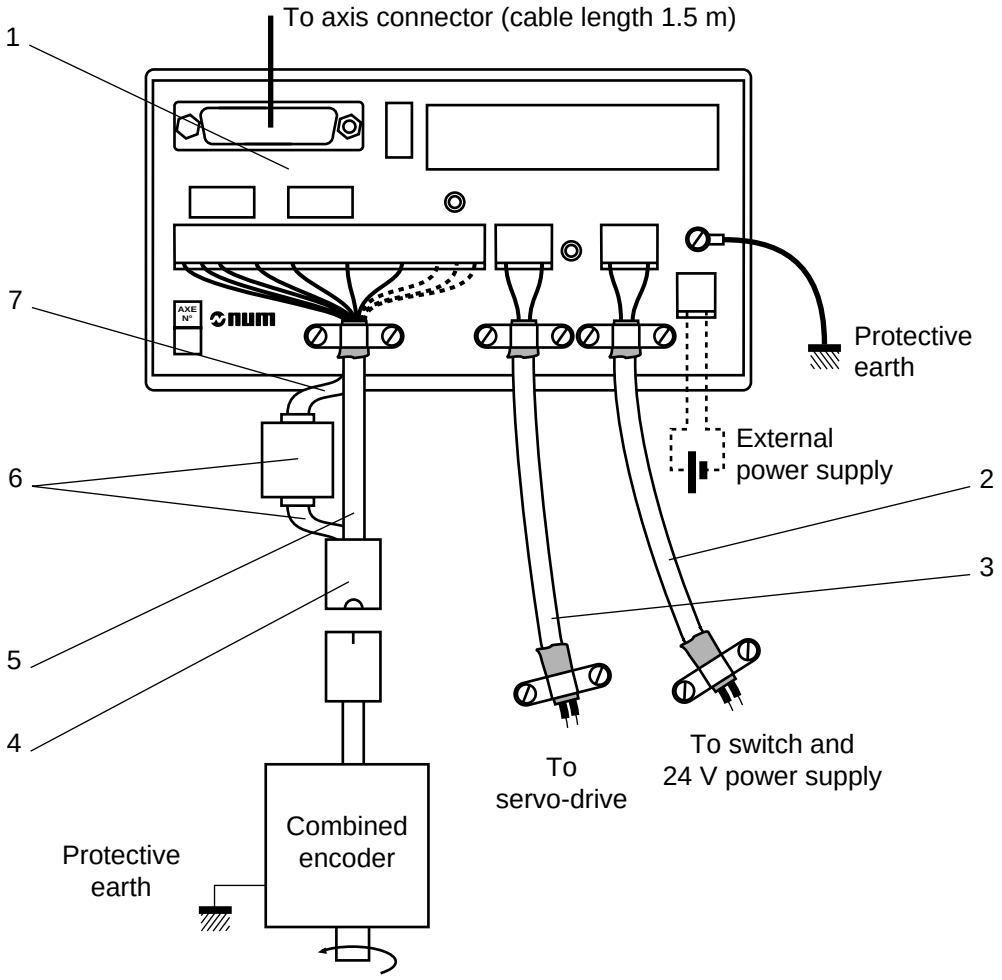
The physical address of the axis is obtained by the wiring of contacts 11, 12, 13, 23, 24 and 25 (see Sec. 6.2.10.2).

The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

6.2.4.2 Combined Axis Encoder: SSI + Incremental - Sinusoidal Pulses - Connected to an Axis Interface Module

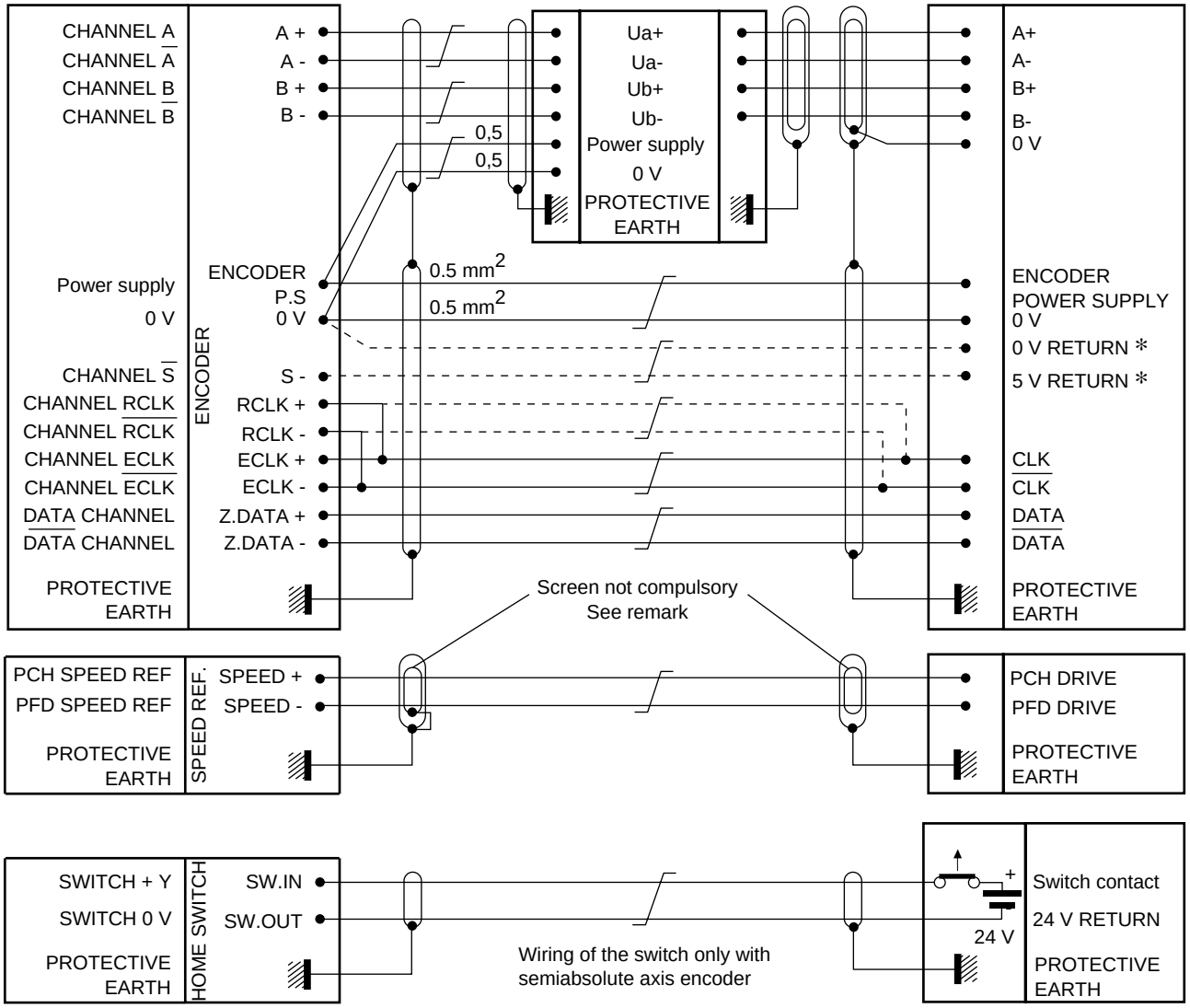


1 - Axis interface module
2 - 1 twisted pair shielded cable (2 x 0.22 mm²) ∗
3 - 1 twisted pair cable with double shielding (2 x 0.22 mm²)
4 - Connector
5 - Shielded cable [3 x (2 x 0.14 mm²) + 2 x 0.5 mm²]
or [4 x (2 x 0.14 mm²) + 2 x 0.5 mm²]
6 - Interpolation and shaping unit with associated cable
7 - Shielded cable {2 x (2 x 014 mm²) + 2 x 0.5 mm²]

∗ The switch and cable (2) are only used with semiabsolute axis encoders.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



* 5 V encoders only

The physical address of the axis is obtained by switches (see Sec. 6.2.7).

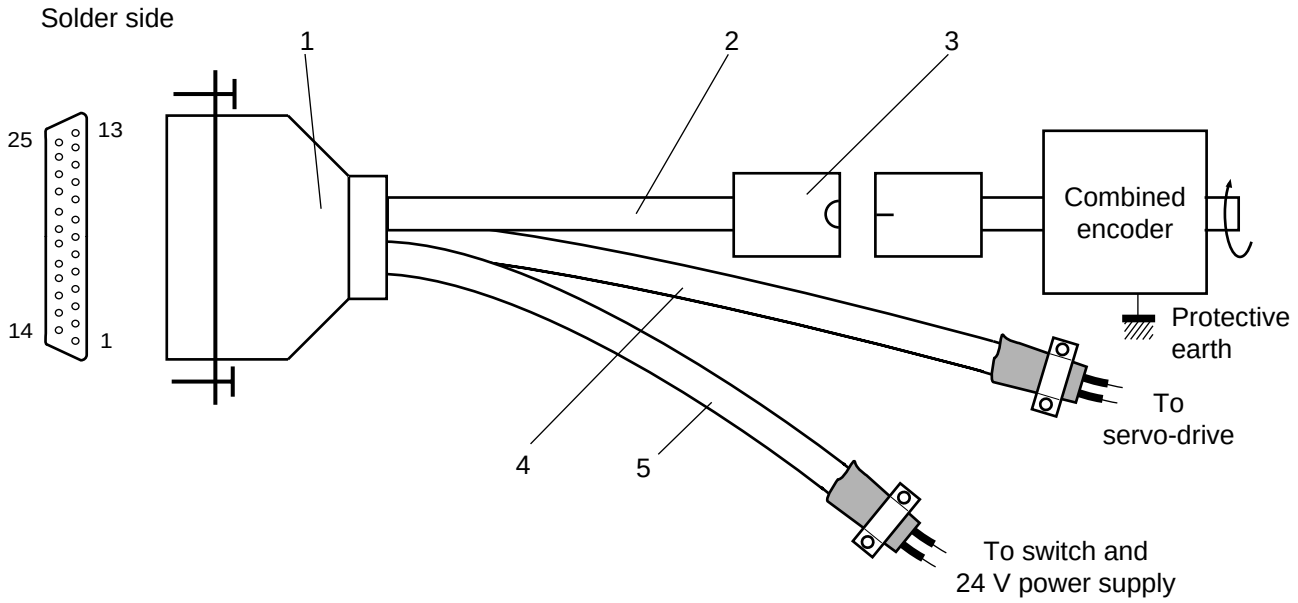
The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

6.2.5 Combined Axis Encoder: SSI + Incremental - Square Pulses

6.2.5.1 Combined Axis Encoder: SSI + Incremental - Square Pulses - Connected to the Axis Interface - Power Supply Provided by the Interface



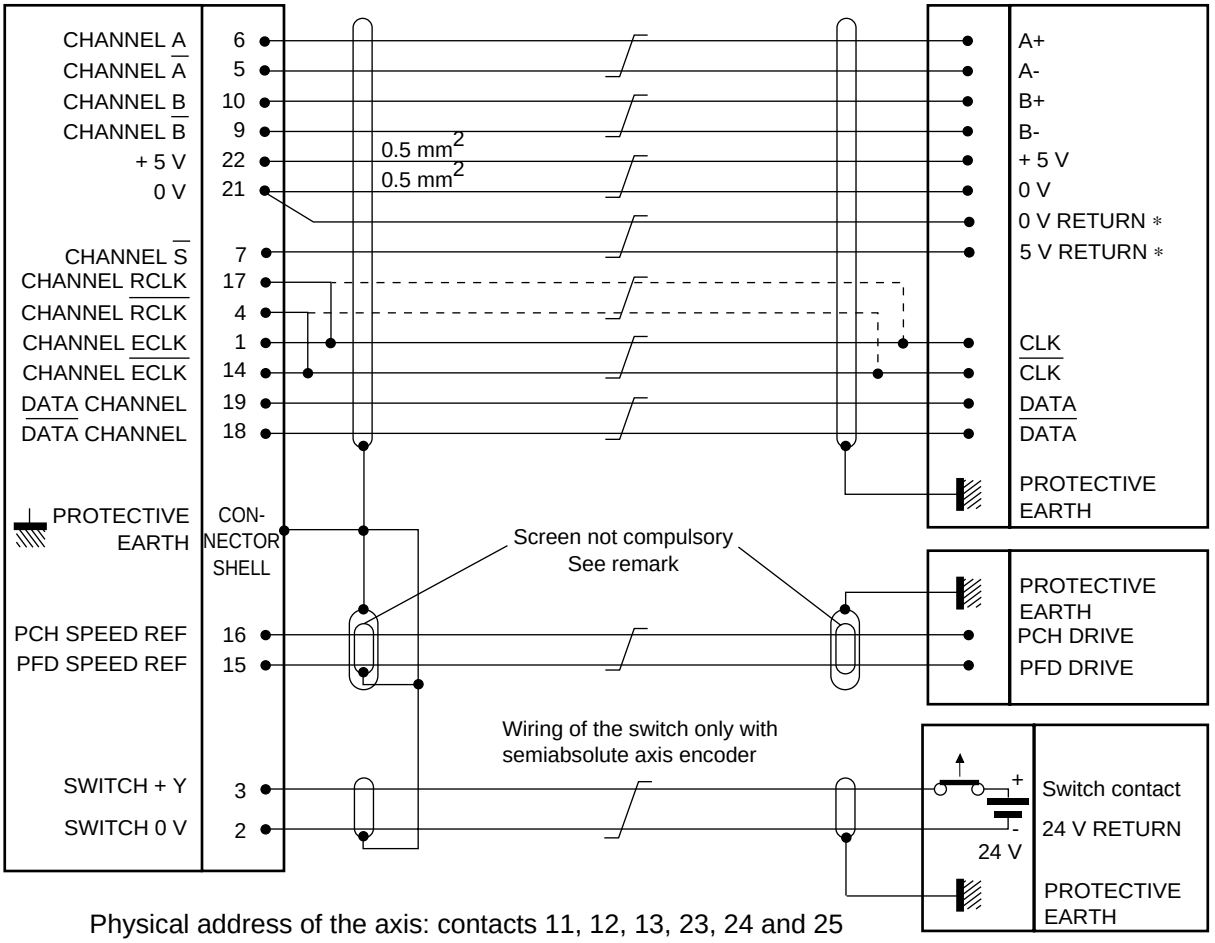
1 - 25-contact male Sub.D connector plug
2 - Shielded cable [5 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2] or (6 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]
3 - Connector
4 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
5 - 1 twisted pair shielded cable (2 x 0.22 mm^2) *

* The switch and cable (5) are only used with semiabsolute axis encoders.

When the wire size is not suitable for installing the wires in the Sub.D connector, the cable can be made using the alternate arrangement described in Sec. 6.2.10.1.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



Physical address of the axis: contacts 11, 12, 13, 23, 24 and 25

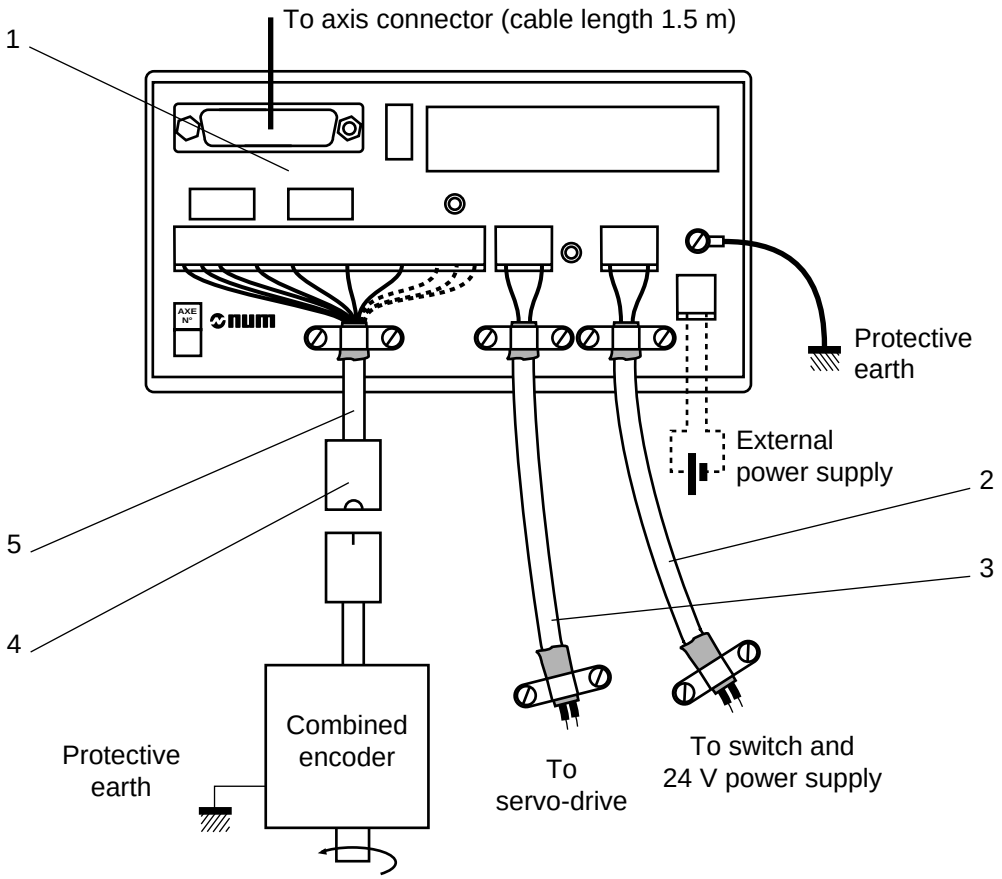
The physical address of the axis is obtained by the wiring of contacts 11, 12, 13, 23, 24 and 25 (see Sec. 6.2.10.2).

The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

6.2.5.2 Combined Axis Encoder: SSI + Incremental - Square Pulses - Connected to an Axis Interface Module

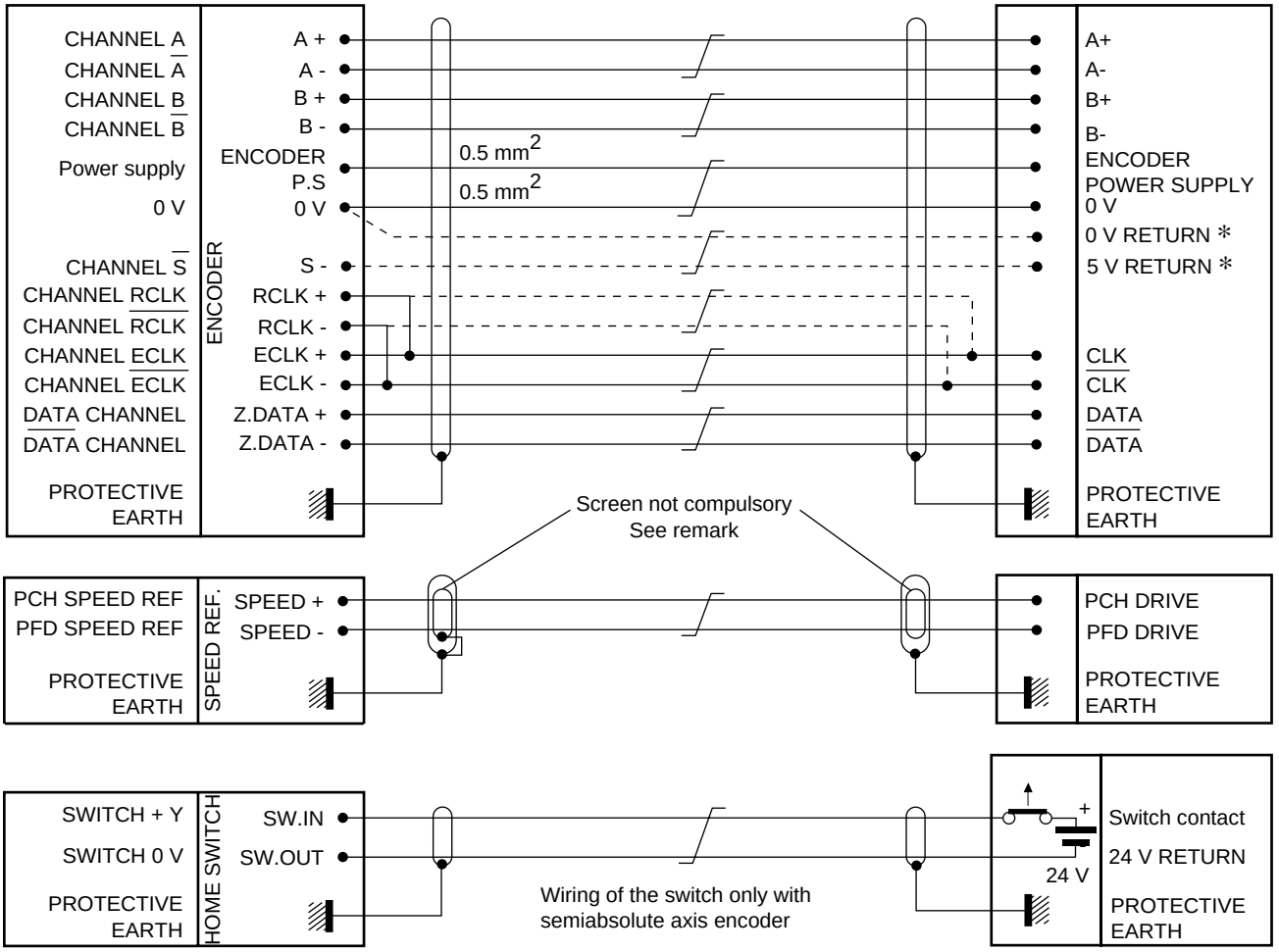


1 - Axis interface module
2 - 1 twisted pair shielded cable (2 x 0.22 mm^2) *
3 - 1 twisted pair cable with double shielding (2 x 0.22 mm^2)
4 - Connector
5 - Shielded cable [5 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2] or [6 x (2 x 0.14 mm^2) + 2 x 0.5 mm^2]

* The switch and cable (2) are only used with semiabsolute axis encoders.

⚠ CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



* 5 V encoders only

The physical address of the axis is obtained by switches (see Sec. 6.2.7).

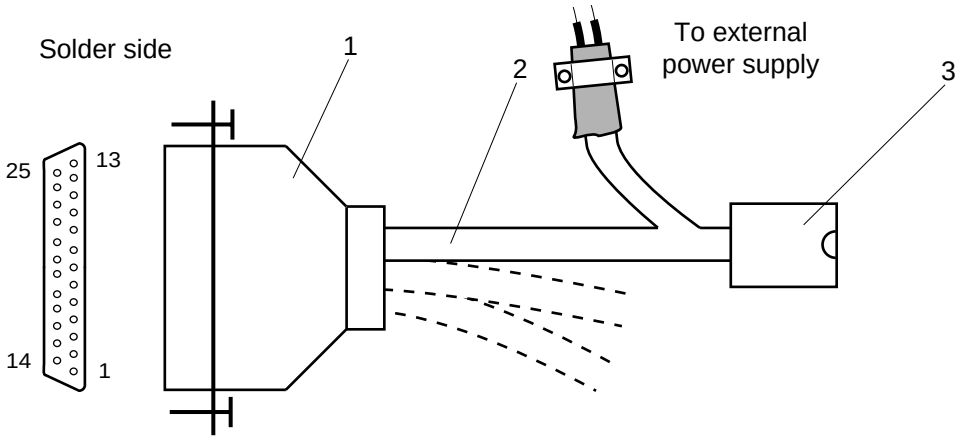
The wiring of channels A, B, $\overline{A}$, $\overline{B}$ and $\overline{S}$ allows detection of a wiring or encoder fault. This requires enabling the poor signal and/or encoder channel complementarity check (parameters P25 and P26 - refer to the Parameter Manual).

REMARKS *If the interference level is low, the cable with double shielding (servo-drive cable) can be replaced by a cable with single shielding connected at both ends to the protective earth.*

Depending on the frequency and the cable length, the connection of RCLK to ECLK is made on the axis connector or on the encoder (see table, Sec. 5.2.6.5).

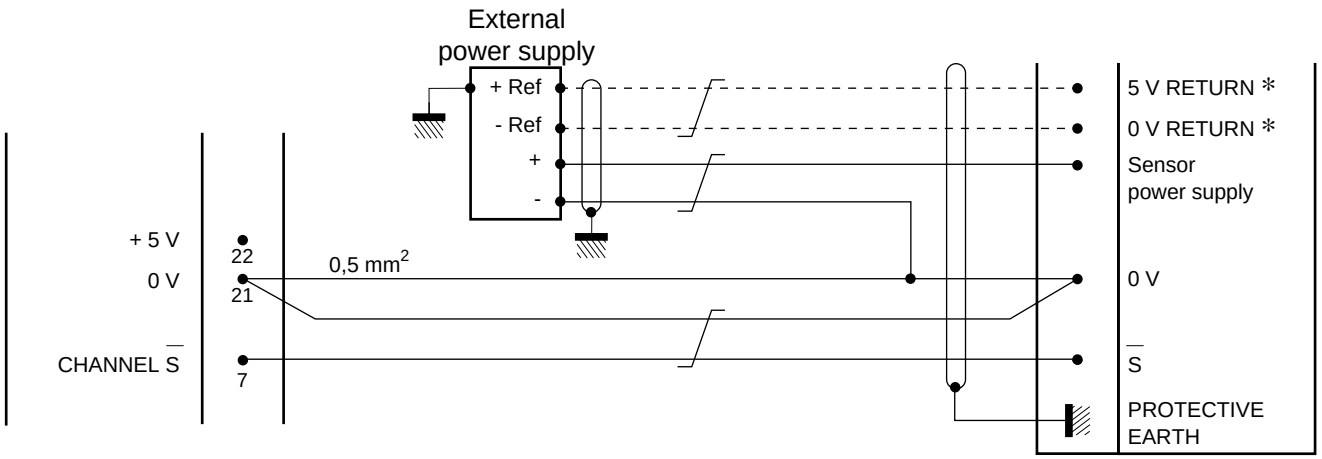
6.2.6 Axes With External Power Supply

When an external power supply is used (case of sensors > 5 V or 5 V sensors for which the axis interface cannot supply sufficient voltage because of the distance, for instance), the cables must be adapted to take this power supply into account. Only the differences from the cables for encoders supplied by the axis interface are described below.



1 - 25-contact male Sub.D connector plug
2 - Sensor cable
3 - Connector

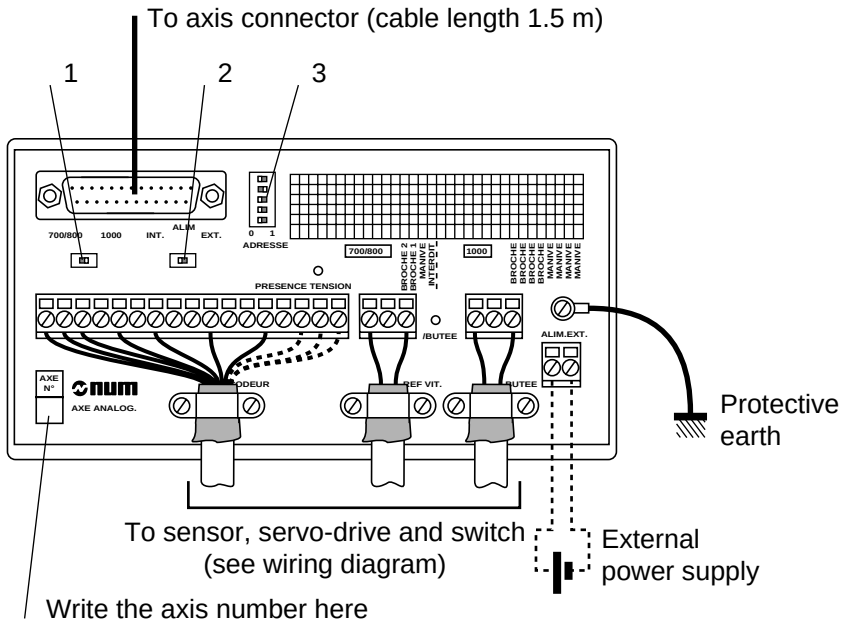
The following wiring is different from that of a sensor supplied by the axis interface:



* On 5 V encoders only.

REMARK *This section does not concern axes wired via an axis interface module and requiring an external power supply (see axis wiring and Sec. 6.2.7).*

6.2.7 Settings on an Axis Interface Module



Selecting the System

The NUM 1020 and NUM 1040 CNCs are part of the 1000 range. The switch must therefore be set as follows:

700/800 ■□ 1000

Selecting the Power Supply

5 VDC Power Supply

The choice of supplying a 5 VDC encoder by the axis interface or by an external power supply depends on the encoder current draw:

Encoder current draw	Power supply	Switch setting
≤ 250 mA	Internal	POWER SUPPLY INT. ■□ EXT.
> 250 mA	External (0.5 to 2.5 mm² wires)	POWER SUPPLY INT. □■ EXT.

The selection of an internal or external power supply also depends on the distance to the encoder (see Sec. 5.2.6.2).

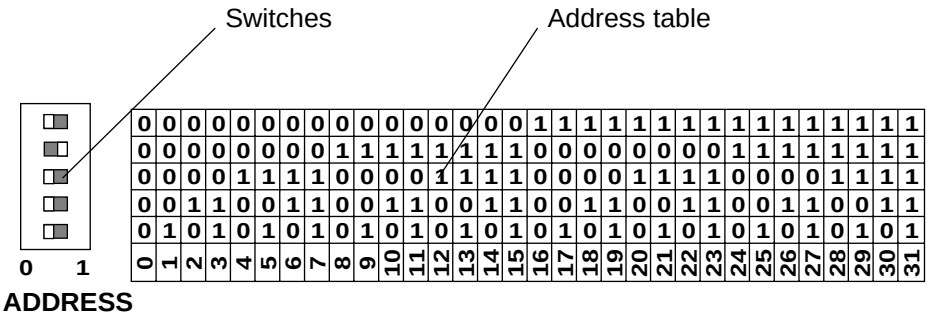
Power Supply Above 5 VDC

Since the axis interface cannot supply a voltage above 5 VDC, the supply must be external in this case (0.5 to 2.5 mm2 wires). The switch must therefore be set as follows:

POWER SUPPLY
INT. □■ EXT.

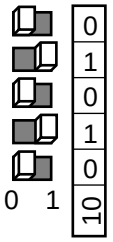
Setting the Physical Address of the Axis

The physical address of the axis is set on 5 switches using the code given in the address table below:



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

For instance, the following switch setting corresponds to address 10:



REMARKS *Two axes cannot have the same address. The system ignores axes with identical addresses.*

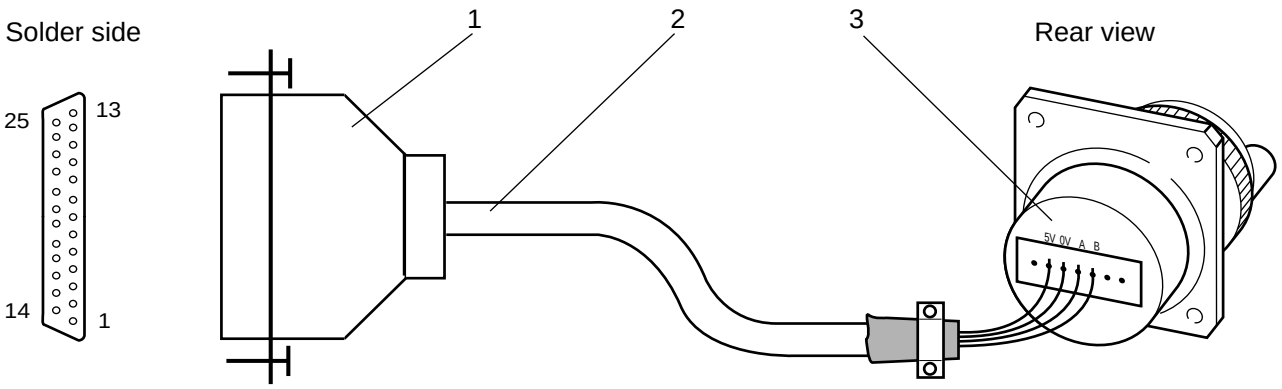
The addresses assigned to the PLC axes must be the highest addresses.

Physical addresses 24 to 27 are reserved for spindles 1 to 4.

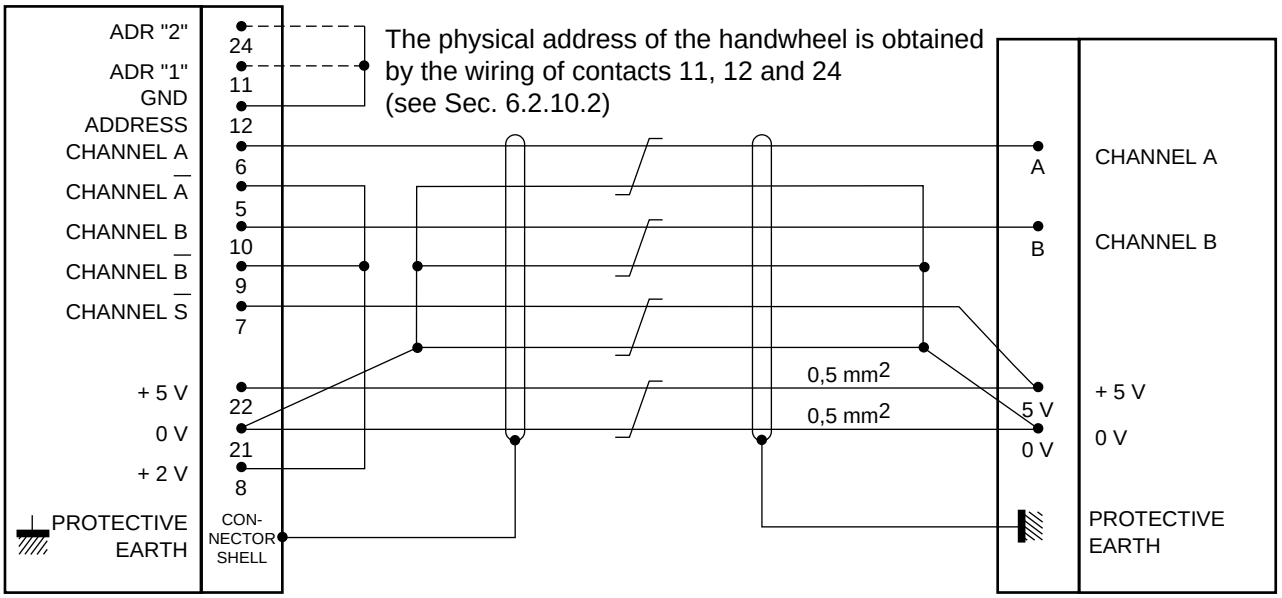
Physical addresses 28 to 30 are reserved for handwheels 1 to 3.

Address 31 is not used.

6.2.8 Handwheels With Non-Differential Outputs



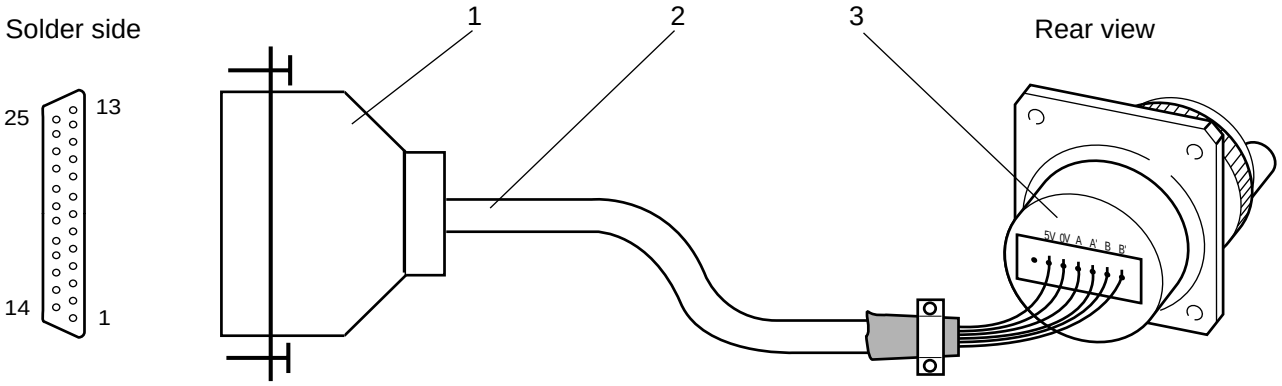
1 - 25-contact male Sub.D connector plug
2 - Shielded cable with three pairs twisted around one pair
[3 x (2 x 0.14 mm²) + (2 x 0.5 mm²)]
3 - Handwheel with non-differential outputs



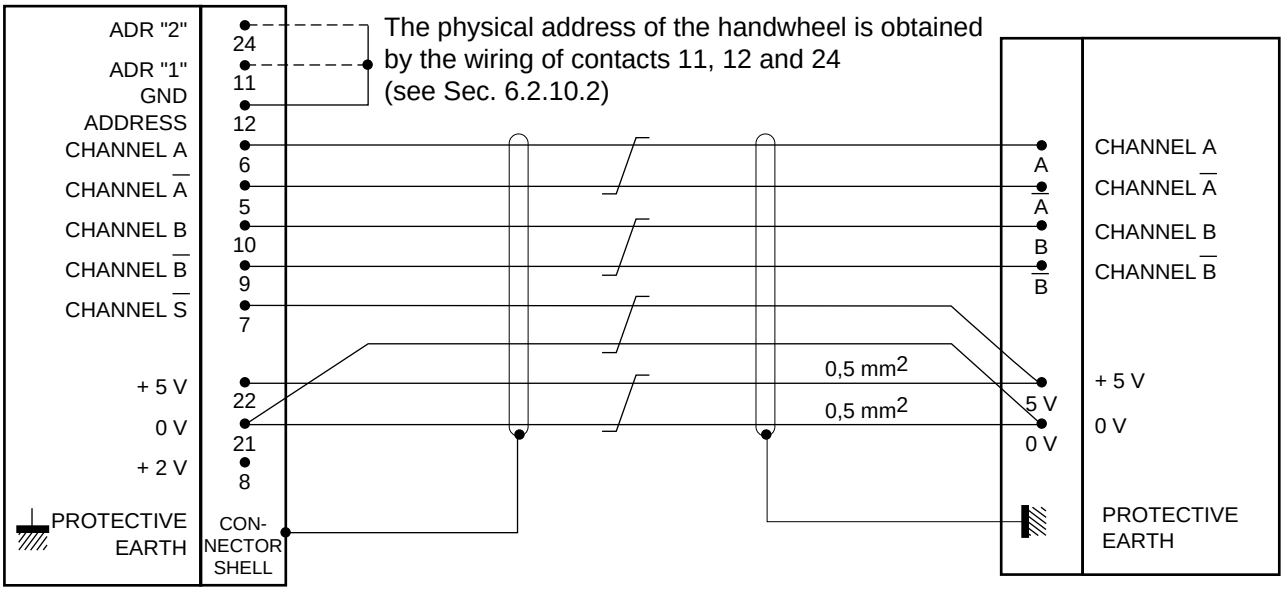
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.2.9 Handwheels With Differential Outputs



1 - 25-contact male Sub.D connector plug
2 - Shielded cable with three pairs twisted around one pair [3 x (2 x 0.14 mm²) + (2 x 0.5 mm²)]
3 - Handwheel with differential outputs



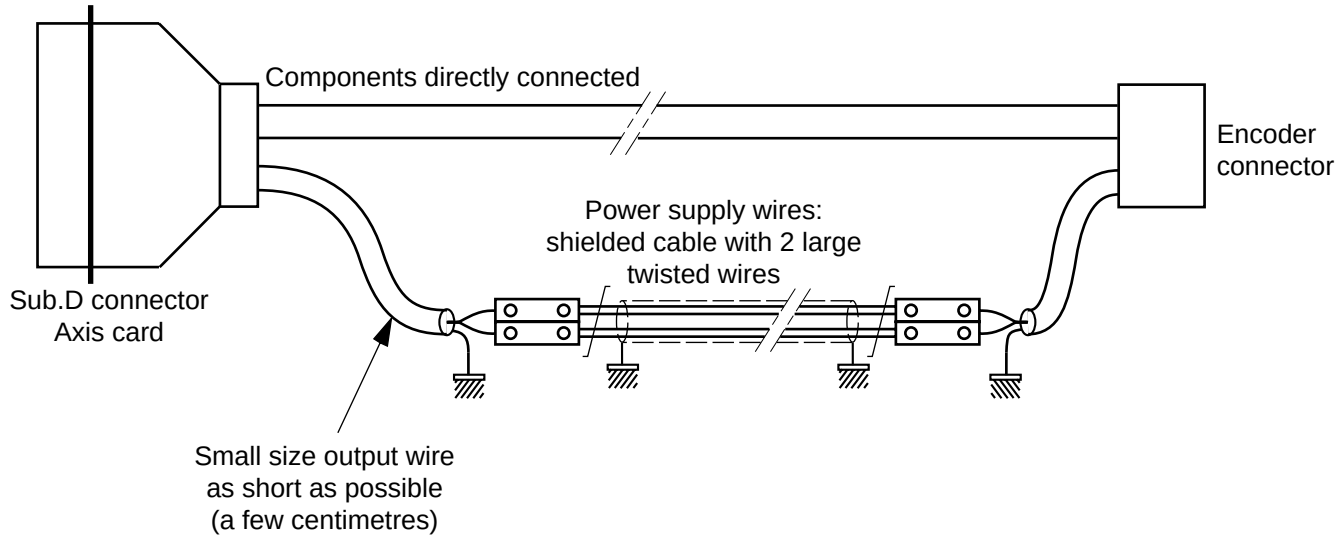
CAUTION

For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.

6.2.10 General Information on Axis Cables

6.2.10.1 Alternate Wiring With Power Supply Provided by the Card

When the power supply wire size is not suitable for installing the wires in the Sub.D connector, the wiring can be carried out as follows:



6.2.10.2 Physical Addresses of the Axes

Each axis must be assigned an address in order to be recognised by the system.

The physical address of an axis is set by the wiring of contacts 11, 12, 13, 23, 24 and 25:

The physical address of an axis is the sum of the weights of the contacts not connected to contact 12: not connected = set.

REMARKS *Two axes cannot have the same address. The system ignores axes with identical addresses.*

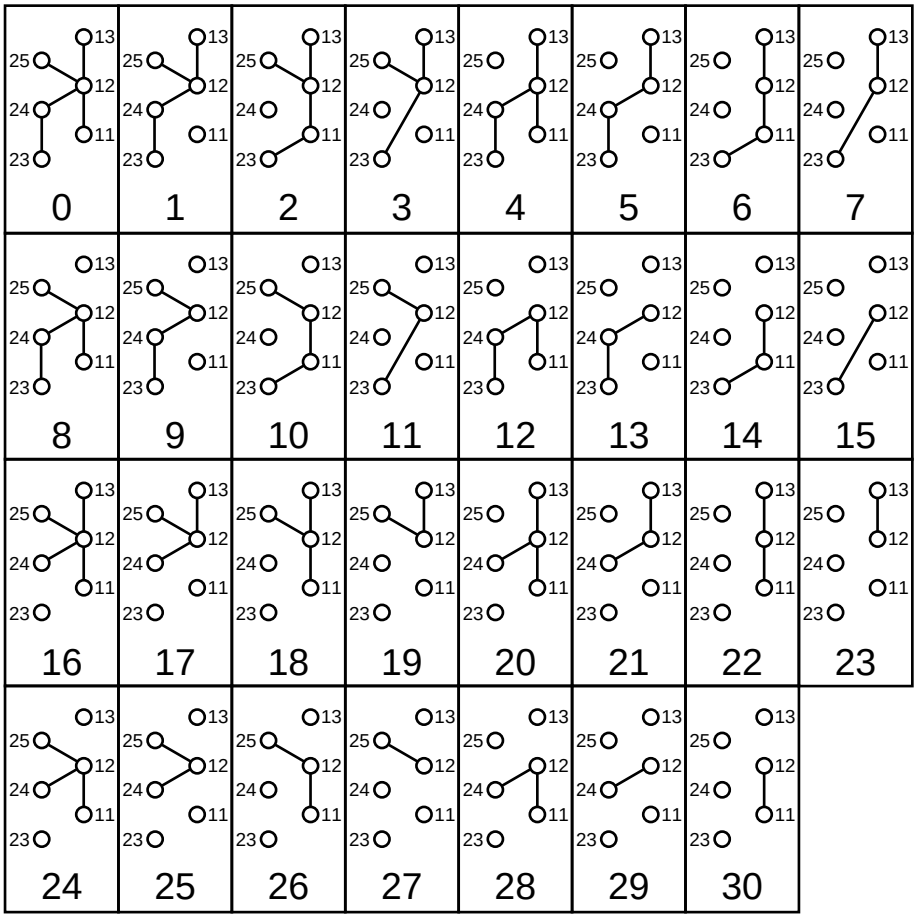
The addresses assigned to the PLC axes must be the highest addresses.

Physical addresses 24 to 27 are reserved for spindles 1 to 4.

Physical addresses 28 to 30 are reserved for handwheels 1 to 3.

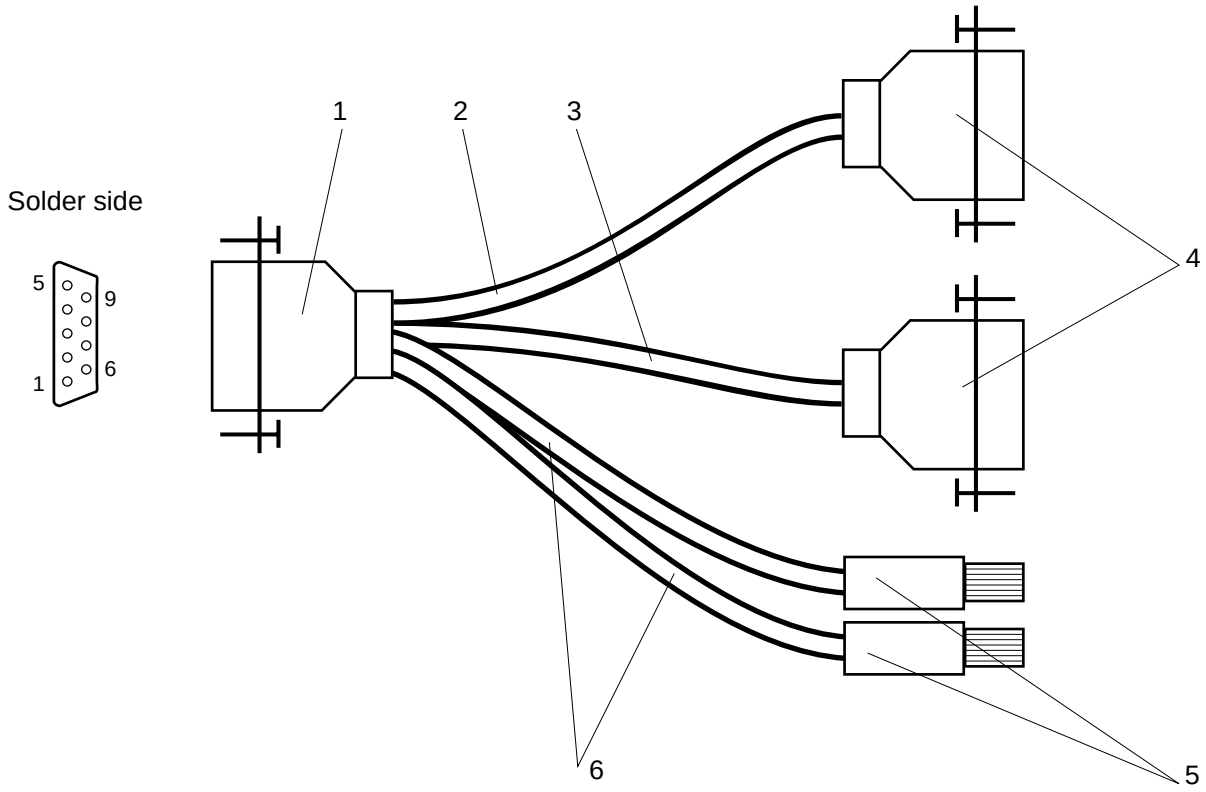
Address 31 (no contact connected to contact 12) is not used.

Axis Address Wiring



6.3 Analogue I/O and Interrupt Cable

6.3.1 Recommended Cable

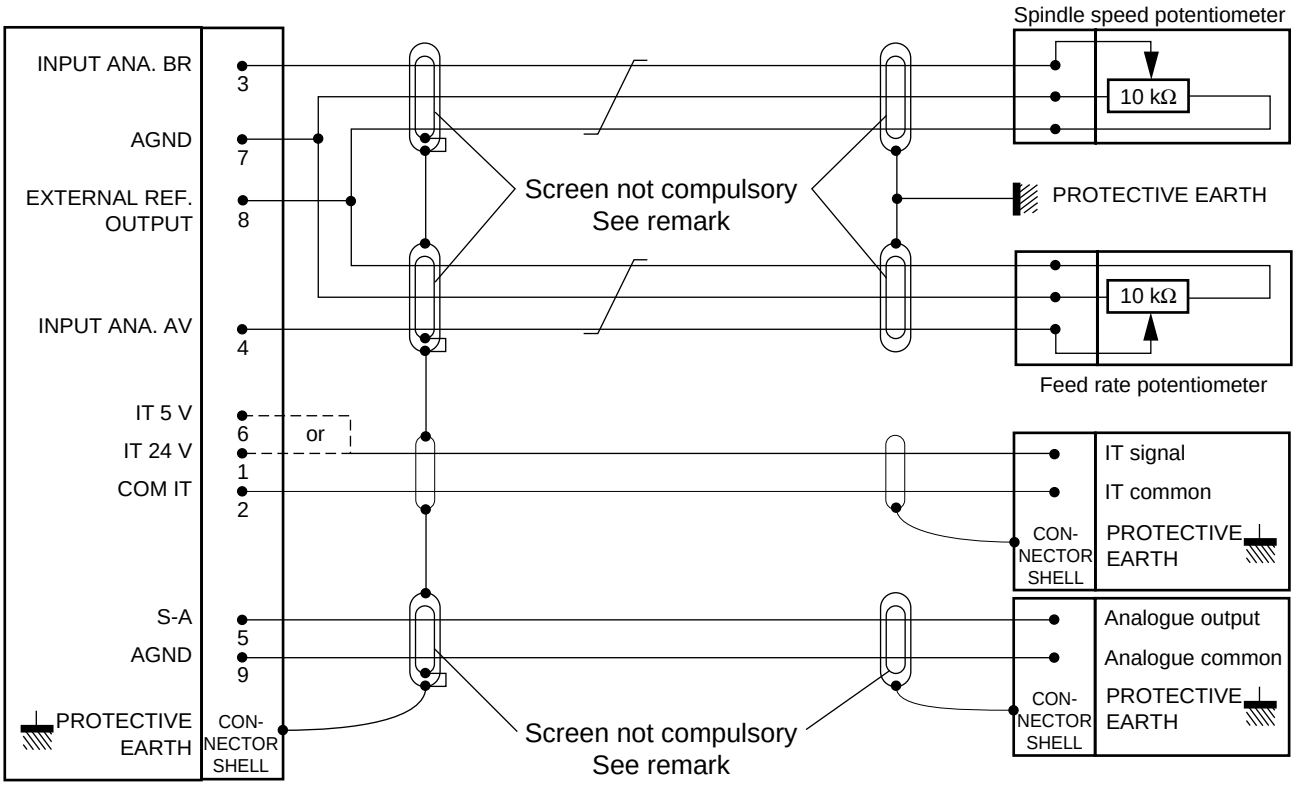


1 - 9-contact female Sub.D connector plug
2 - Shielded 2-wire (2 x 0.22 mm^2) cable
3 - 1 pair cable with double shielding (2 x 0.22 mm^2)
4 - Interrupt and analogue output connector plugs
5 - Spindle speed and feed rate override potentiometers (or other analogue inputs)
6 - 2 cables with 3 twisted pairs and double shielding (3 x 0.22 mm^2)

When the Sub.D connector cannot accommodate two shielded cables (5), the wiring can be made using the alternate arrangement described in Sec. 6.3.2.

⚠ CAUTION

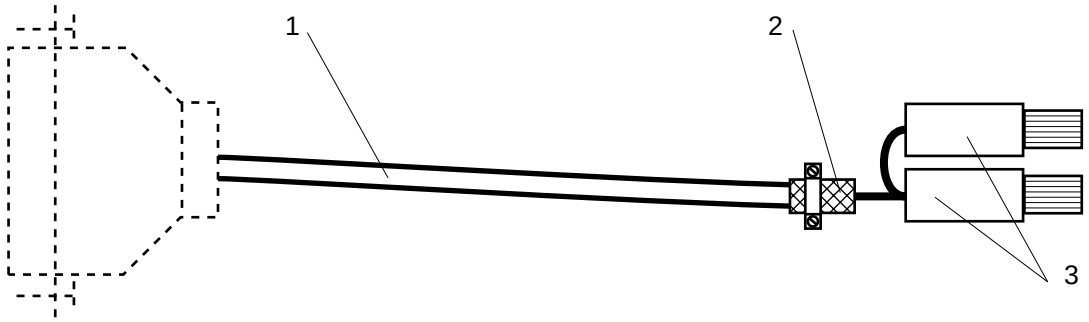
For correct interference suppression in the system, the cable shielding must be earthed in accordance with the instructions of Section 1.4.3.2.



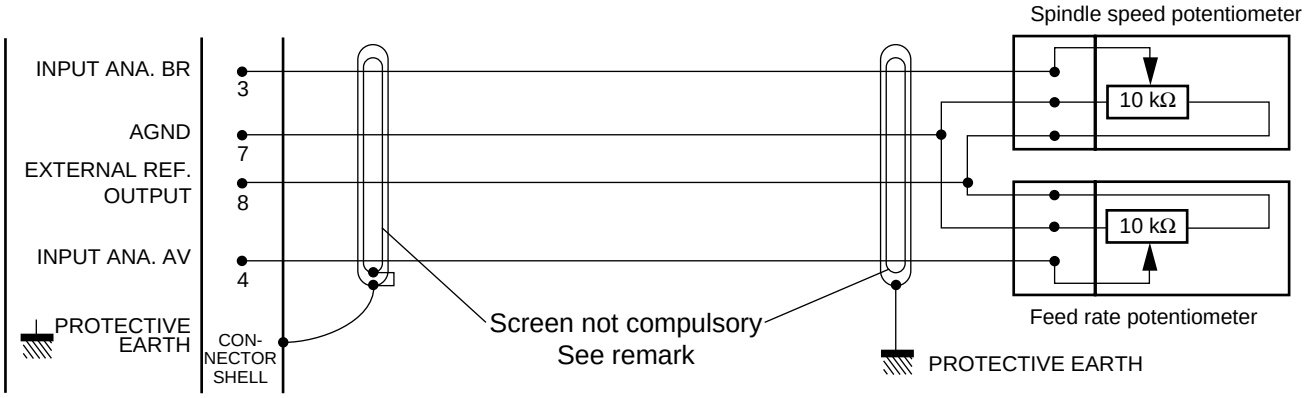
REMARK *If the interference level is low, the analogue output cable with double shielding can be replaced by a cable with single shielding connected at both ends to the protective earth.*

6.3.2 Alternate Wiring of the Analogue Inputs

When the Sub.D connector cannot accommodate two input cables, the wiring can be made with a single cable including both analogue inputs. This section describes only the differences in wiring.



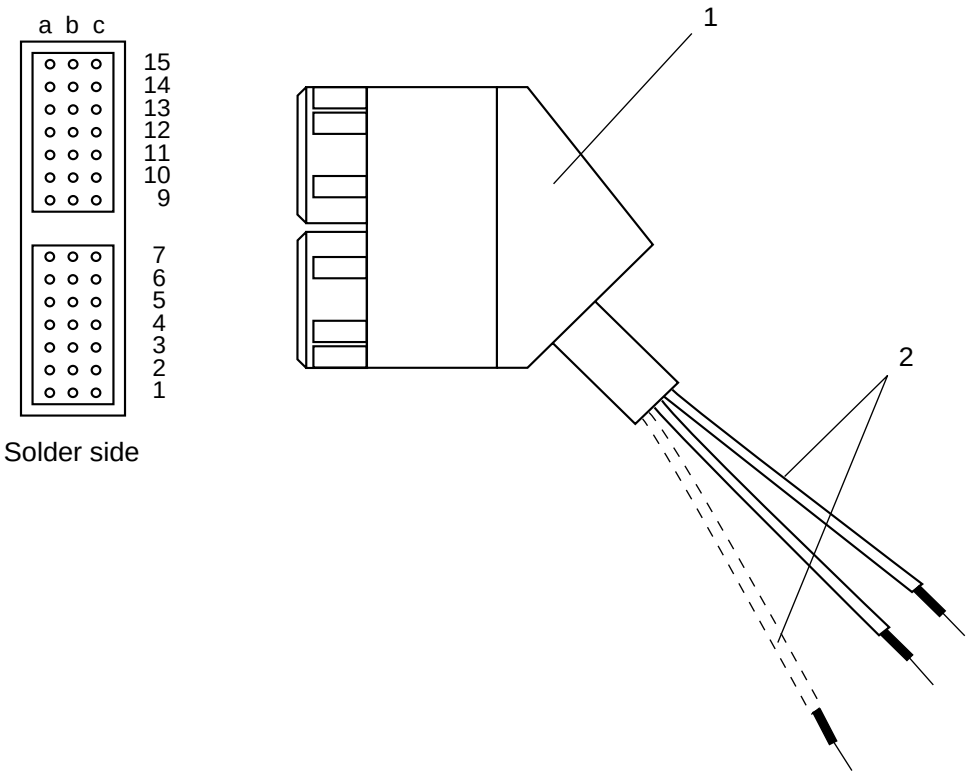
1 - 4-wire cable with double shielding (4 x 0.22 mm²)
2 - Bonding braid connected to machine frame
3 - Spindle speed and feed rate override potentiometers



REMARK *If the interference level is low, the analogue output cable with double shielding can be replaced by a cable with single shielding connected at both ends to the protective earth.*

6.4 Input and Output Cables

6.4.1 32-Input Cables



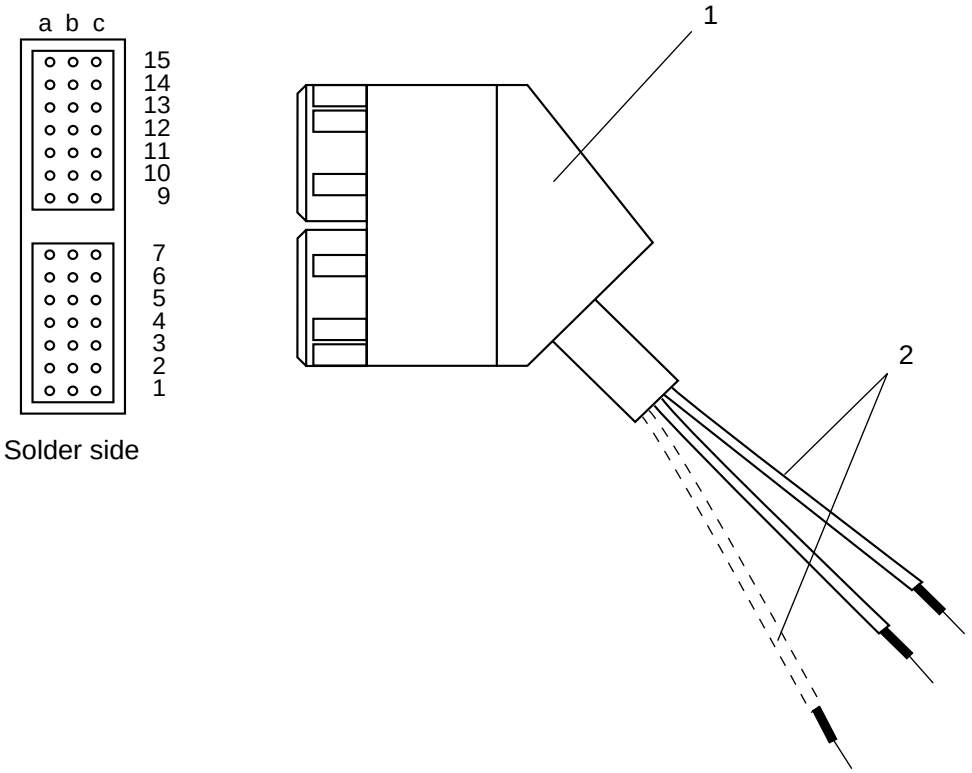
1 - Connector (see Sec. 6.4.3 for cable customisation)
2 - Input and external power supply wires

REMARK *Hole c7 is capped on the input cable connector.*

Low part	High part	Contact
P24VE	P24VE	a12
I 00.0	I 04.0	a1
I 00.1	I 04.1	c1
I 00.2	I 04.2	b1
I 00.3	I 04.3	c2
I 00.4	I 04.4	b2
I 00.5	I 04.5	c3
I 00.6	I 04.6	b3
I 00.7	I 04.7	c4
GND	GND	a2
I 01.0	I 05.0	b4
I 01.1	I 05.1	c5
I 01.2	I 05.2	b5
I 01.3	I 05.3	c6
I 01.4	I 05.4	b6
I 01.5	I 05.5	b7
I 01.6	I 05.6	a6
I 01.7	I 05.7	a7
GND	GND	a3
I 02.0	I 06.0	a9
I 02.1	I 06.1	c9
I 02.2	I 06.2	b9
I 02.3	I 06.3	c10
I 02.4	I 06.4	b10
I 02.5	I 06.5	c11
I 02.6	I 06.6	b11
I 02.7	I 06.7	c12
GND	GND	a4
I 03.0	I 07.0	b12
I 03.1	I 07.1	c13
I 03.2	I 07.2	b13
I 03.3	I 07.3	c14
I 03.4	I 07.4	b14
I 03.5	I 07.5	c15
I 03.6	I 07.6	b15
I 03.7	I 07.7	a15
GND	GND	a5

REMARK *All the commons are interconnected on the card.*

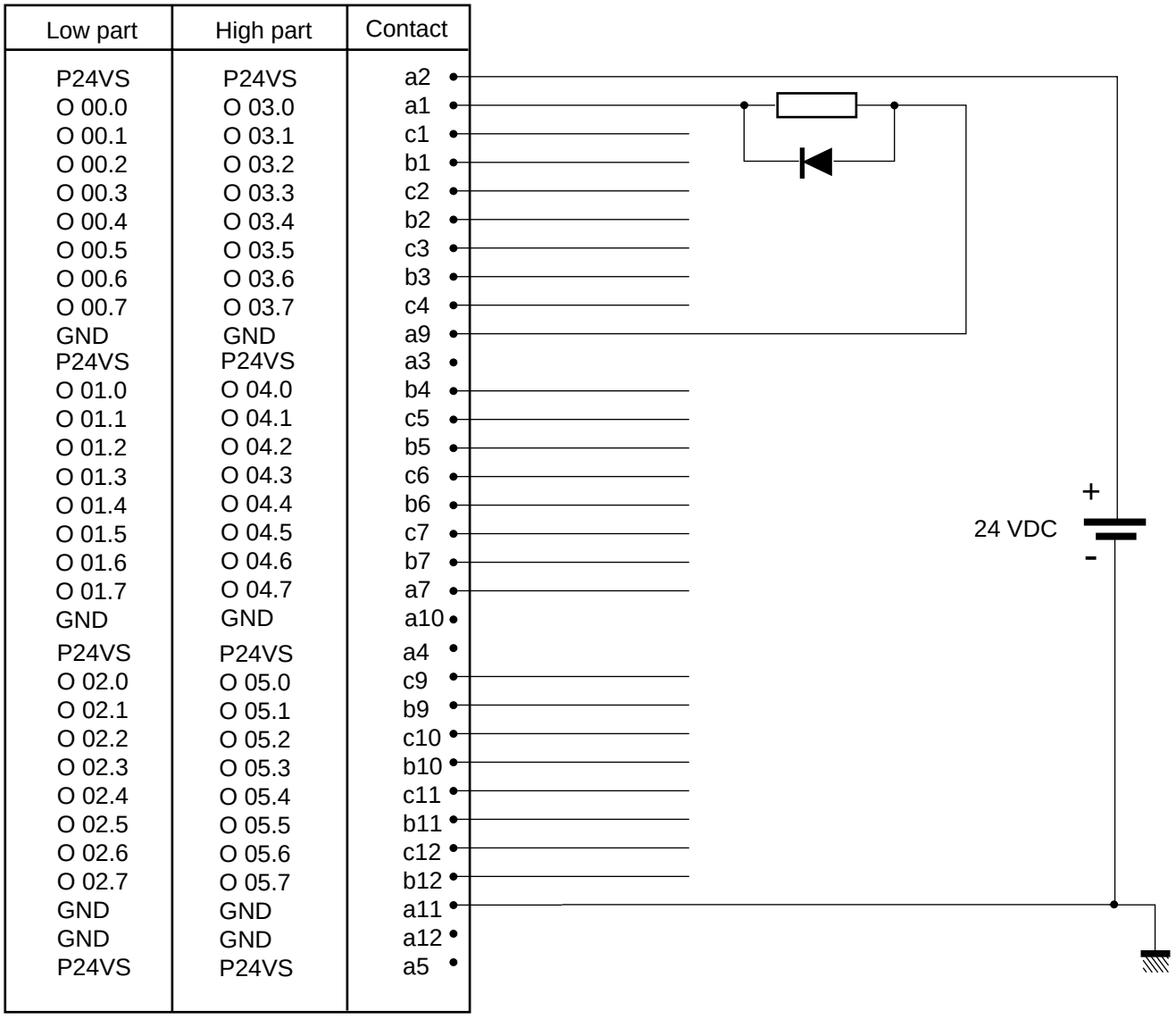
6.4.2 24-Output Cable



1 - Connector (see Sec. 6.4.3 for cable customisation)
2 - Output and external power supply wires

REMARK *Hole c15 is capped on the output cable connector.*

Low part	High part	Contact
P24VS	P24VS	a2
O 00.0	O 03.0	a1
O 00.1	O 03.1	c1
O 00.2	O 03.2	b1
O 00.3	O 03.3	c2
O 00.4	O 03.4	b2
O 00.5	O 03.5	c3
O 00.6	O 03.6	b3
O 00.7	O 03.7	c4
GND	GND	a9
P24VS	P24VS	a3
O 01.0	O 04.0	b4
O 01.1	O 04.1	c5
O 01.2	O 04.2	b5
O 01.3	O 04.3	c6
O 01.4	O 04.4	b6
O 01.5	O 04.5	c7
O 01.6	O 04.6	b7
O 01.7	O 04.7	a7
GND	GND	a10
P24VS	P24VS	a4
O 02.0	O 05.0	c9
O 02.1	O 05.1	b9
O 02.2	O 05.2	c10
O 02.3	O 05.3	b10
O 02.4	O 05.4	c11
O 02.5	O 05.5	b11
O 02.6	O 05.6	c12
O 02.7	O 05.7	b12
GND	GND	a11
GND	GND	a12
P24VS	P24VS	a5

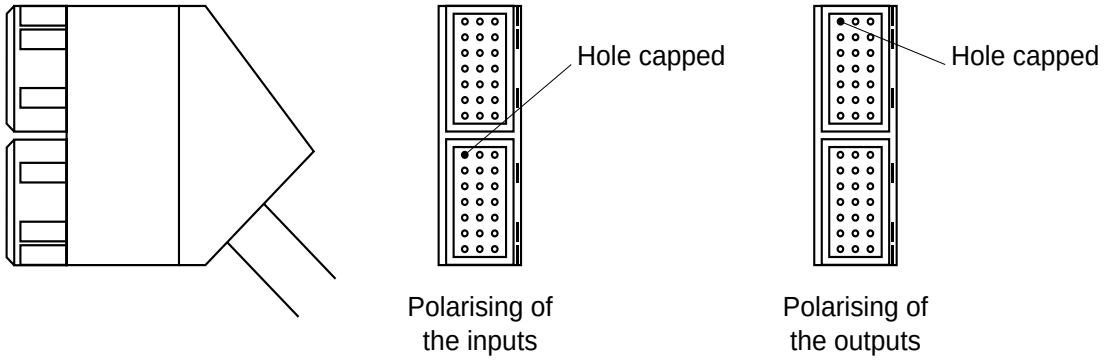


REMARK *All the common wires are interconnected on the card as are all the P24VS power supply wires.*

6.4.3 Customising the Cables - Polarising Pegs

6.4.3.1 Polarising the Input and Output Cables

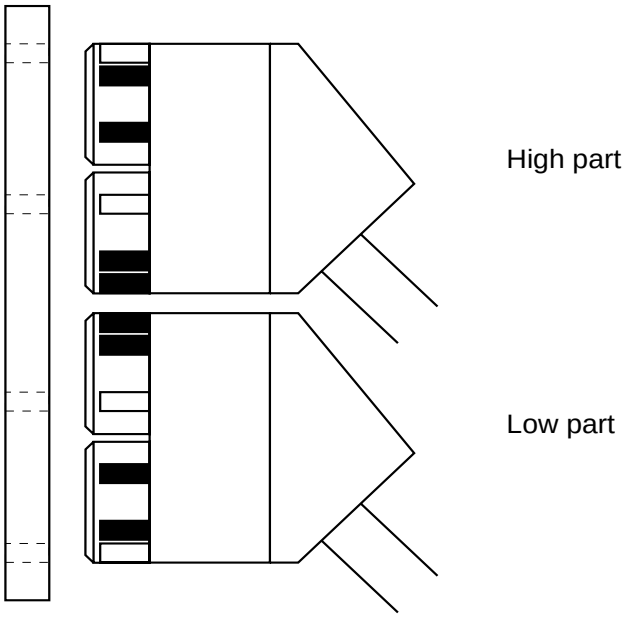
The input and output cables are differentiated:
- by marking with the words "ENTREES" (inputs) or "SORTIES" (outputs)
- by polarising:



The capped holes in the connector plugs correspond to a missing contact in the card connector receptacle.

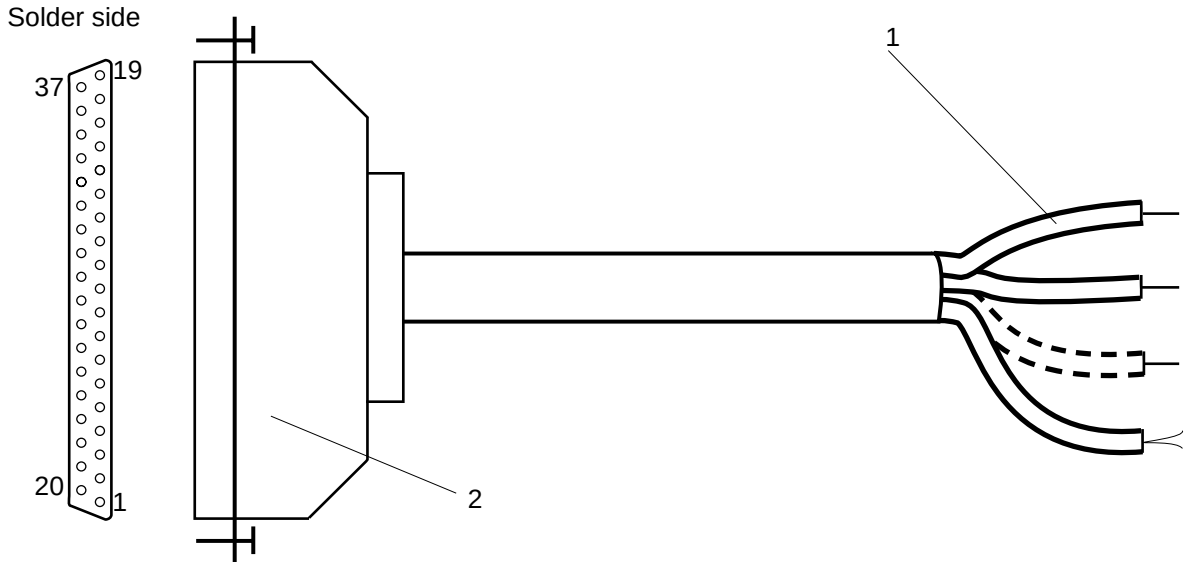
6.4.3.2 Customising the Cables of the High or Low Part

The cables must be customised according as they occupy the high or low part of the connector:

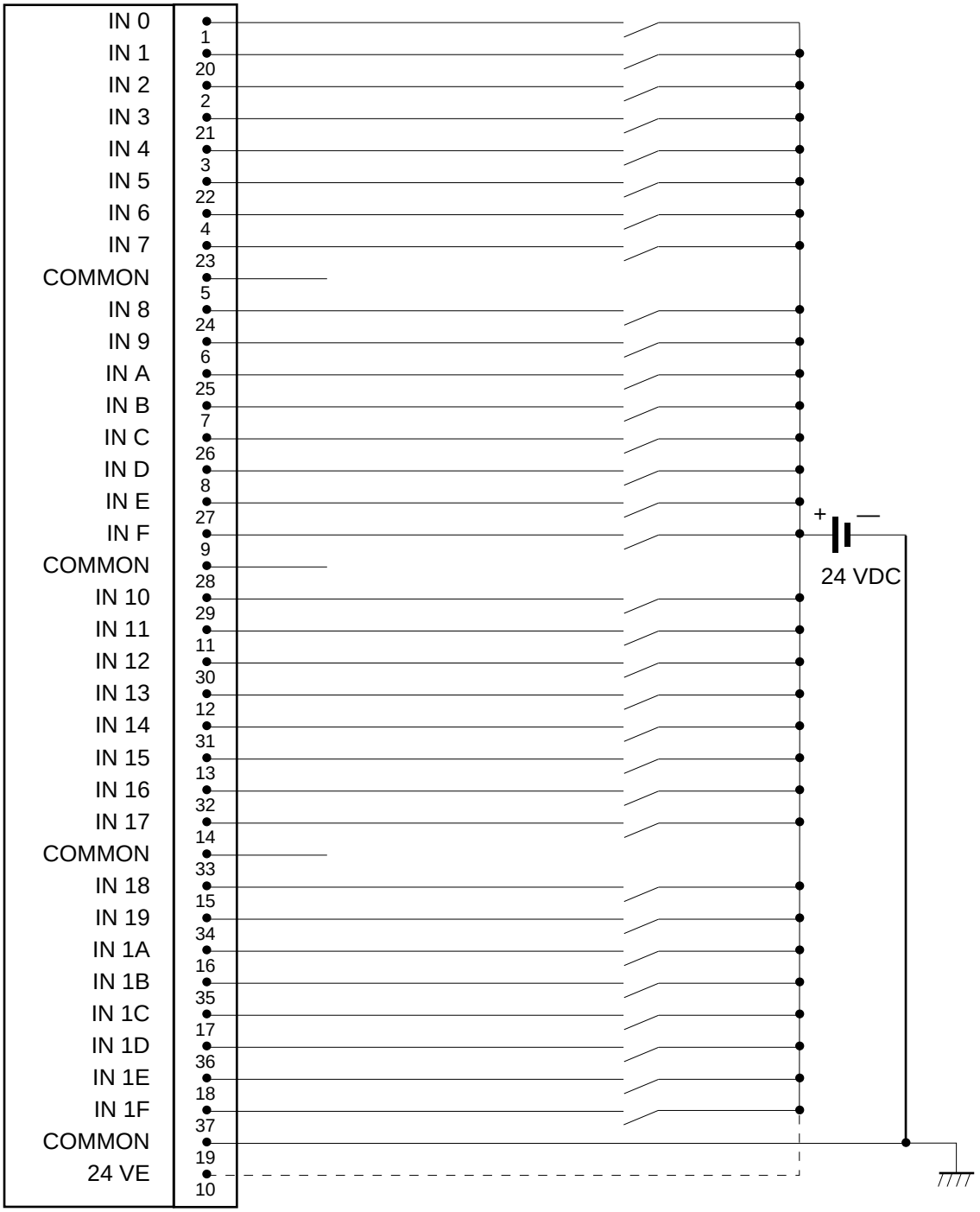


To customise the cables, break off the tabs shown in black.

6.4.4 Machine Panel Extension 32-Input Cable (with or without External Power Supply)



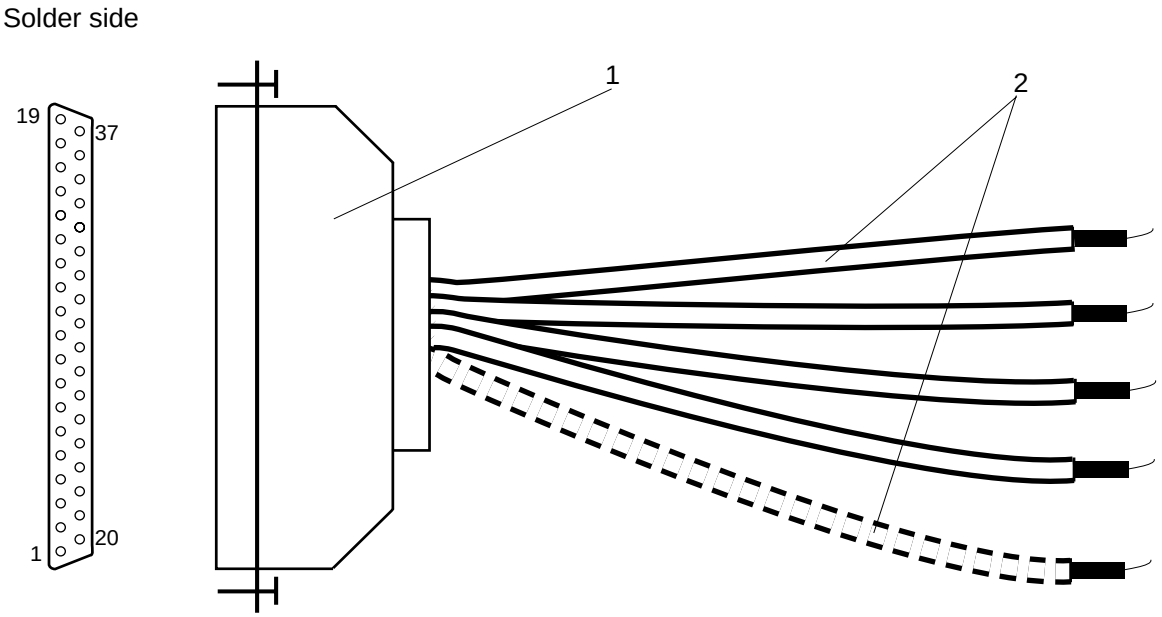
1 - Input (and external power supply) wires
2 - 37-contact male Sub.D connector plug



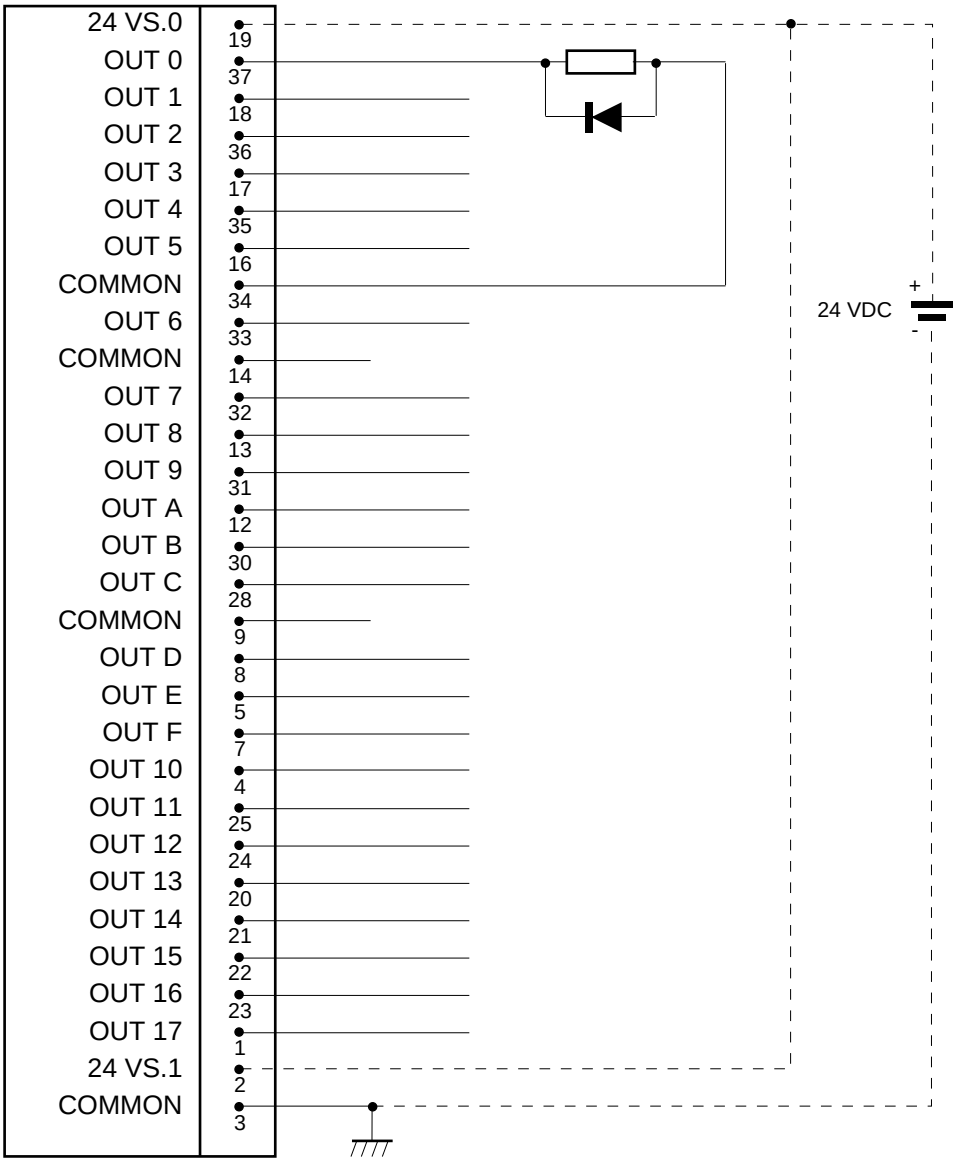
REMARKS *Contact 10 is not connected unless the 32-input cable provides the general power supply for the machine panel extension.*

All the commons are interconnected on the machine panel extension.

6.4.5 Machine Panel Extension 24-Output Cable



1 - 37-contact female Sub.D connector plug
2 - Output and external power supply wires



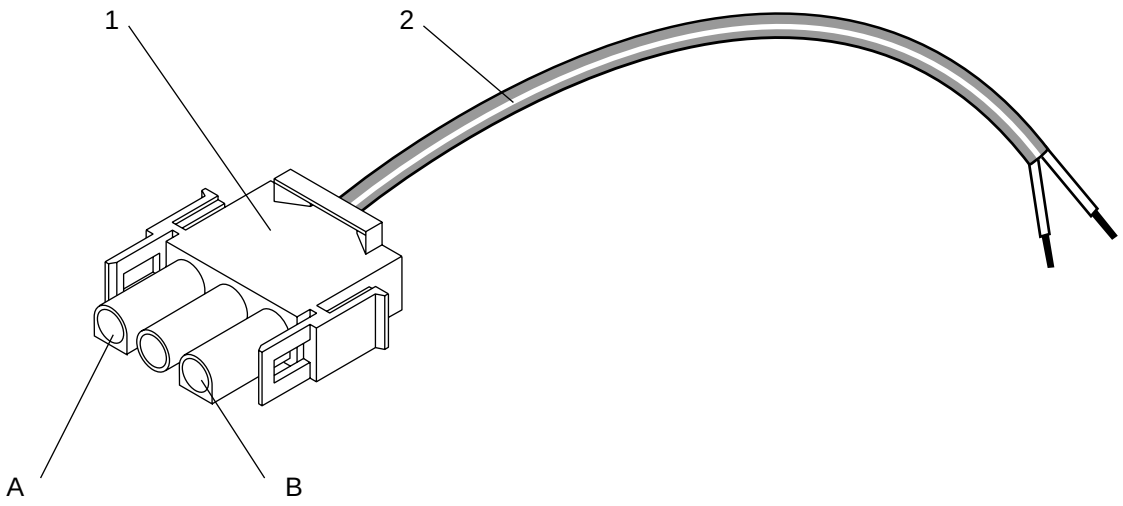
REMARKS *The power supply is not connected unless the 24-output cable provides the general power supply for the inputs (or the machine panel extension).*

In this case, the 24 VDC can be connected to only one of contacts 2 or 19.

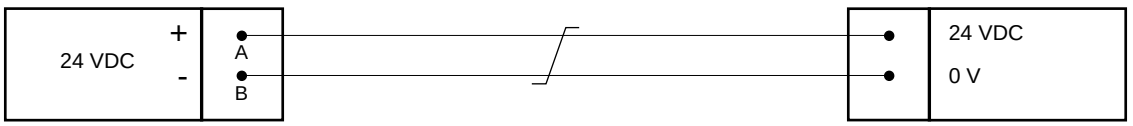
All the commons are interconnected on the machine panel extension.

6.5 Power Cables

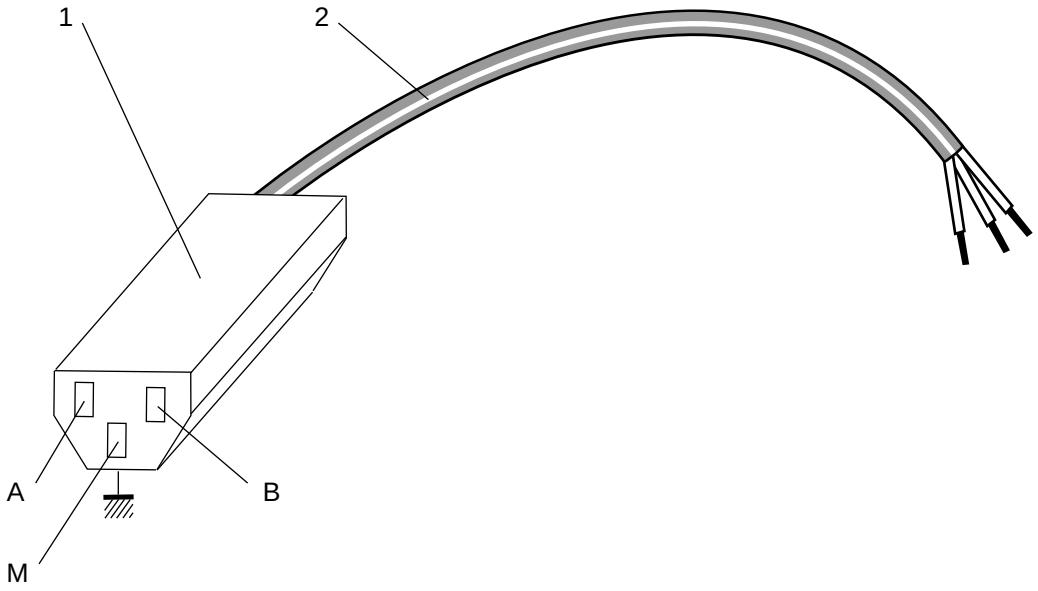
6.5.1 CPU Power Cable



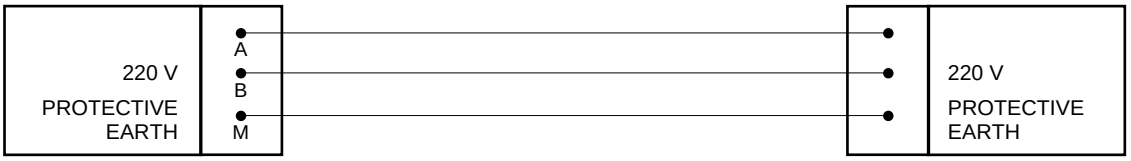
1 - 3-contact connector equipped with 2 male crimped contacts (A and B)
2 - Twisted 2-wire cable (2 x 0.6 mm²)



6.5.2 Mains Power Cable

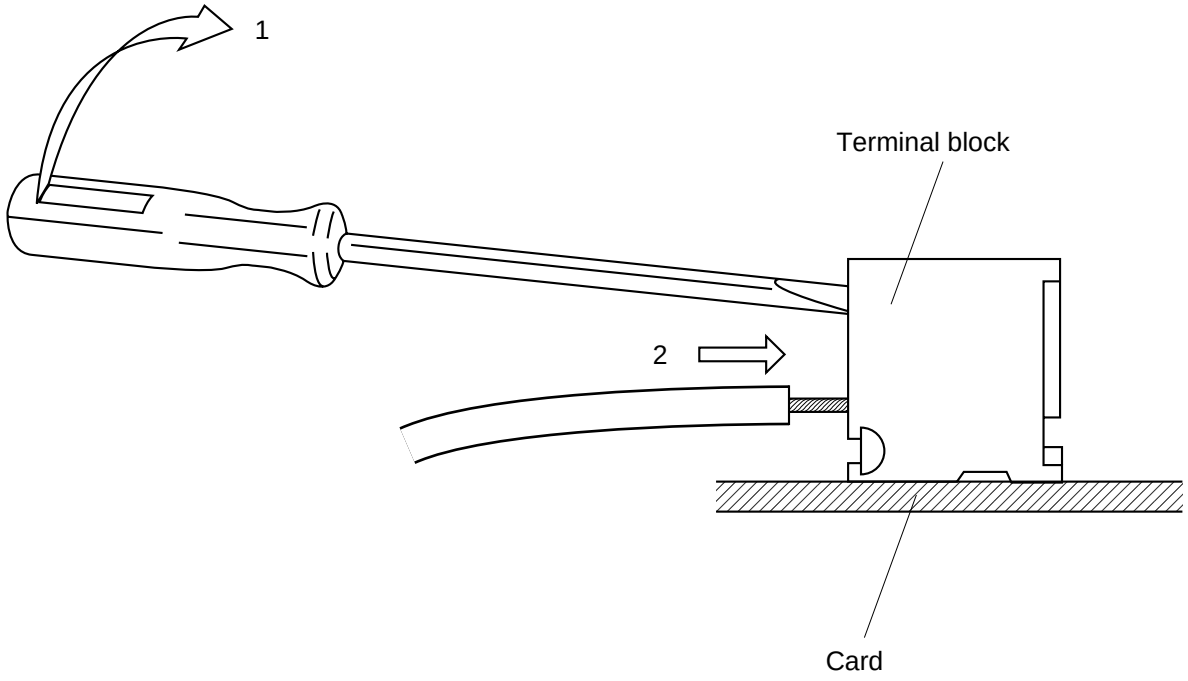


1 - Female mains power connector
2 - 3-wire cable (3 x 1.3 mm^2)



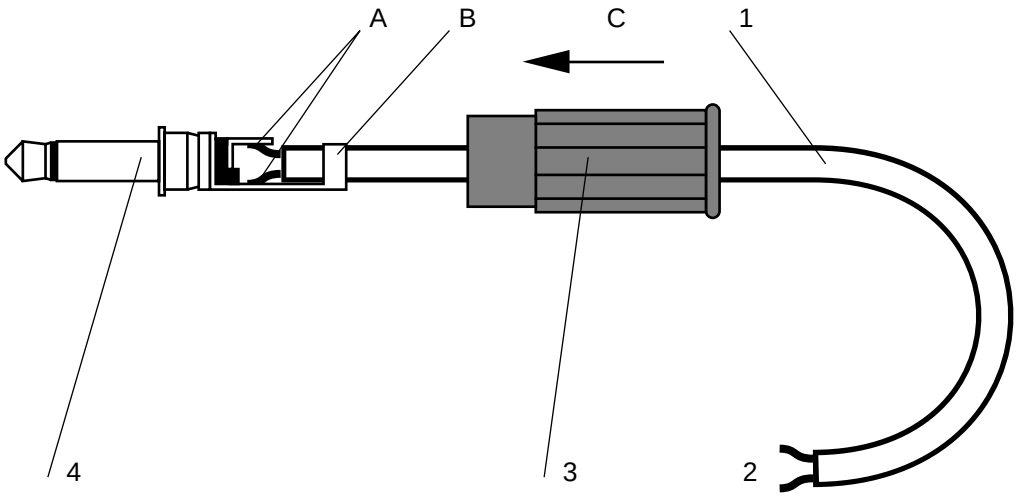
6.5.3 Machine Panel and Extension Power Cable

Wiring the two wires of the power supply cable:



Wiring instructions:
- open the terminal by turning the screwdriver (1),
- insert the wire (2),
- remove the screwdriver to clamp the wire.

6.5.4 NUM Diskette Drive Power Cable

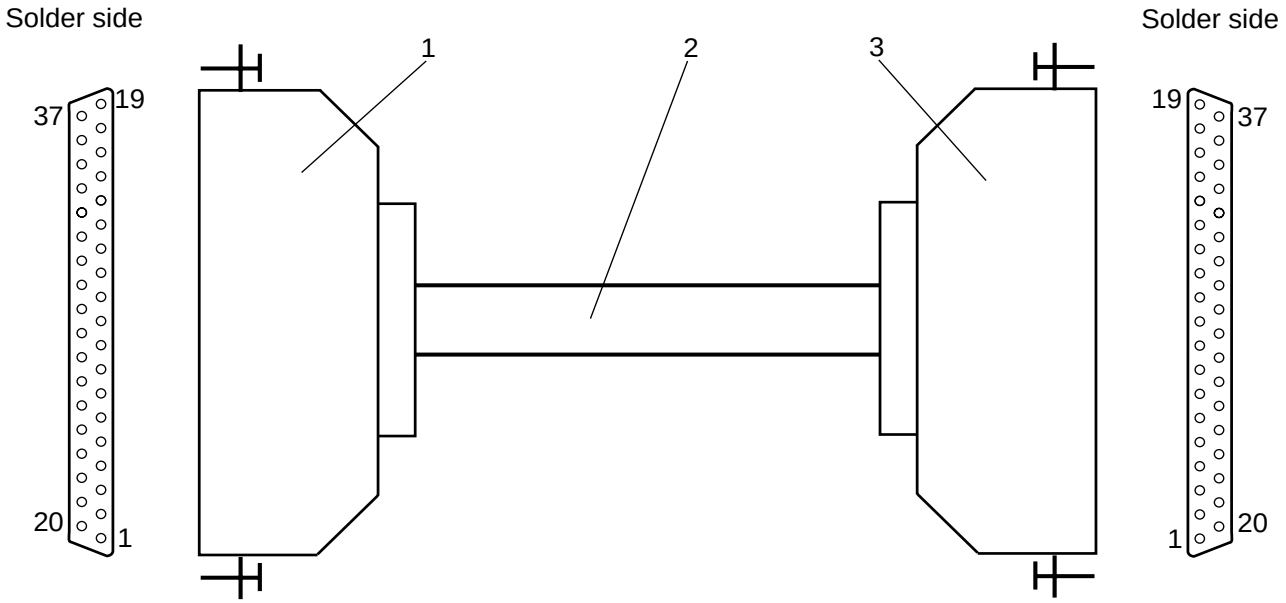


1 - 2-wire cable
2 - 24 VDC power supply (limit values: 19.2-30 V), polarity unimportant
3 - Jack insulator
4 - Jack connector

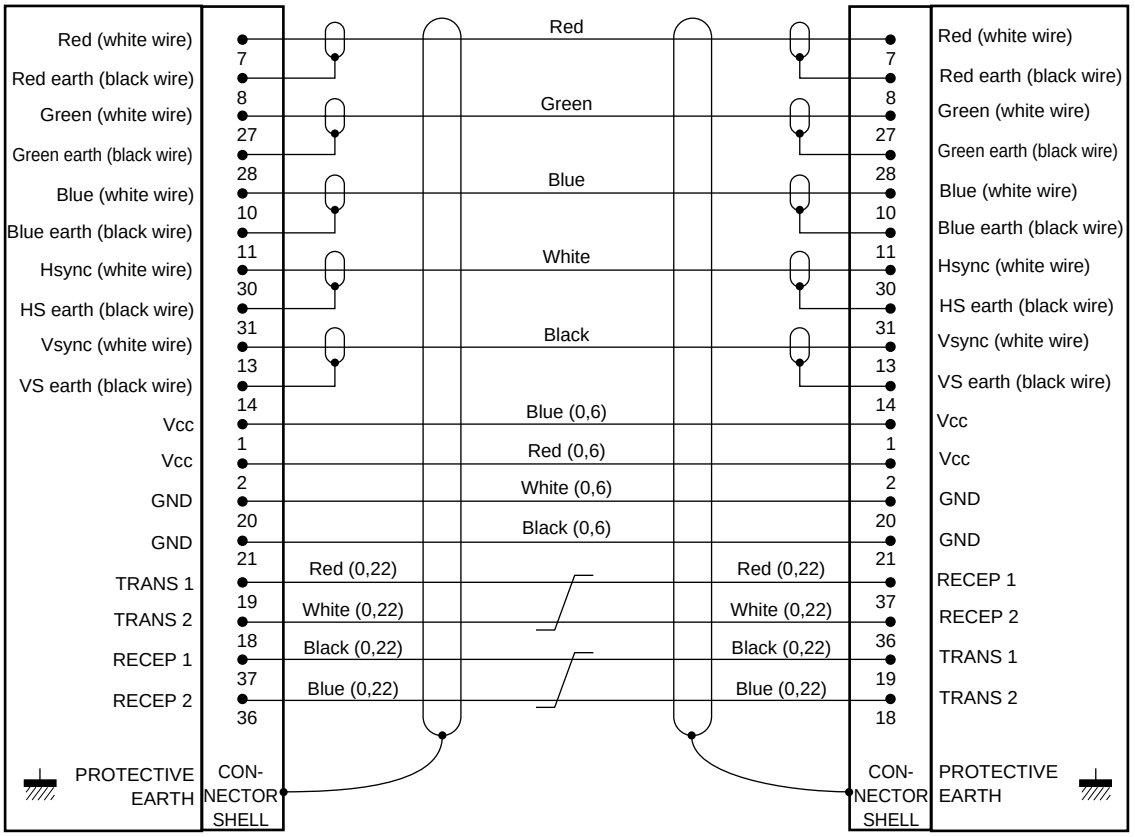
Wiring instructions:
- solder a wire to each of the conductors of jack (A),
- fold back the tabs onto the cable (B),
- insert the insulator up to the connector collar (C).

REMARK *The drive must not be supplied via the jack when the remote serial line provides the power supply.*

6.6 Video/Panel Cable



1 - 37-contact male Sub.D connector
2 - Video cable
3 - 37-contact female Sub.D connector



Wiring instructions:

- Clamp the cable to a half-cover
- Solder the wires to the contacts opposite the half-cover
- Clamp the other side of the cable to the other half-cover
- Solder the wires to the contacts on the side opposite the half-cover.

CAUTION

For correct interference suppression in the system, the cable shielding must be earthed (over 360 degrees) in accordance with the instructions of Section 1.4.3.2.

The two clamps must be used to clamp the cable to the cover.

Part Two

COMMISSIONING

7 Initial Operation

Initial Conditions

- Power components turned off.
- CPU supplied with 24 VDC.
- Mains voltage 230 VAC.

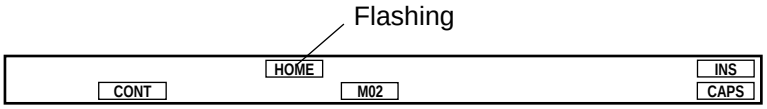
Actions

Turn on the general power supply.

Turn on the CNC (a reset is automatically executed).

The "PWR" (power on) LED is lit.

The current point page and the following status window are displayed on the main display page:



The "Def" and "Fail" LEDs on the CPU are unlit ("Def" is lit to indicate a system fault and "Fail" is lit to indicate a software failure).

All the display pages must be accessible from the operator panel.

Problems

In the event of a malfunction:

Reset the system (press the "Reset" button on the CPU).

8 Load and Check of the PLC Programme

8.1 Load Procedures

The Ladder language is used to programme the automatic control function (see Automatic Control Function Programming Manual in Ladder Language).

Programming and programme loading are carried out with PLCTOOL running on a PC or compatible.

The programme coherence and consistency with the system configuration is checked using CNC utility 7 (UT7).

8.2 Checking the PLC Programme: Test of the Safety Systems

The safety systems and PLC programme are checked off load before turning on the power components.

8.3 PLC Programming Supplements

The information below supplements the Automatic Control Function Programming Manual in Ladder language. It describes the specific features of the NUM 1020/1040 and compact panel.

8.3.1 Specific Features of the NUM 1020/1040

8.3.1.1 Numbering of %I and %Q I/O Variables

In Ladder language, the PLC input and output variables are denoted %Irc_ and %Qrc_ respectively, where «r» is the rack number and «c» is the card number.

On the NUM 1020/1040 CNCs, the rack number «r» is always equal to 0 and can therefore be omitted.

The card number «c» has a value of 5 for the CPU inputs and outputs and a value of 1 to 4 for machine panel inputs and outputs (value encoded on the machine panels).

Examples

The CPU inputs are denoted %I5_.

The outputs of the machine panel with code 3 are denoted %Q3_.

8.3.1.2 Writing the Analogue Output

Function **anao** addresses the analogue outputs on one byte, «cv» (card, channel).

On the NUM 1020/1040 CNCs, the «cv» address of the only analogue output has the value 0x10.

8.3.1.3 Reading the Analogue Inputs

Function anai addresses the analogue inputs on one byte, «cv» (card, channel).

On the NUM 1020/1040 CNCs, the «cv» addresses of the two analogue inputs have the values 0x10 and 0x11.

8.3.1.4 Interrupt Input

The interrupt functions address the interrupts on one byte, «n_iti».

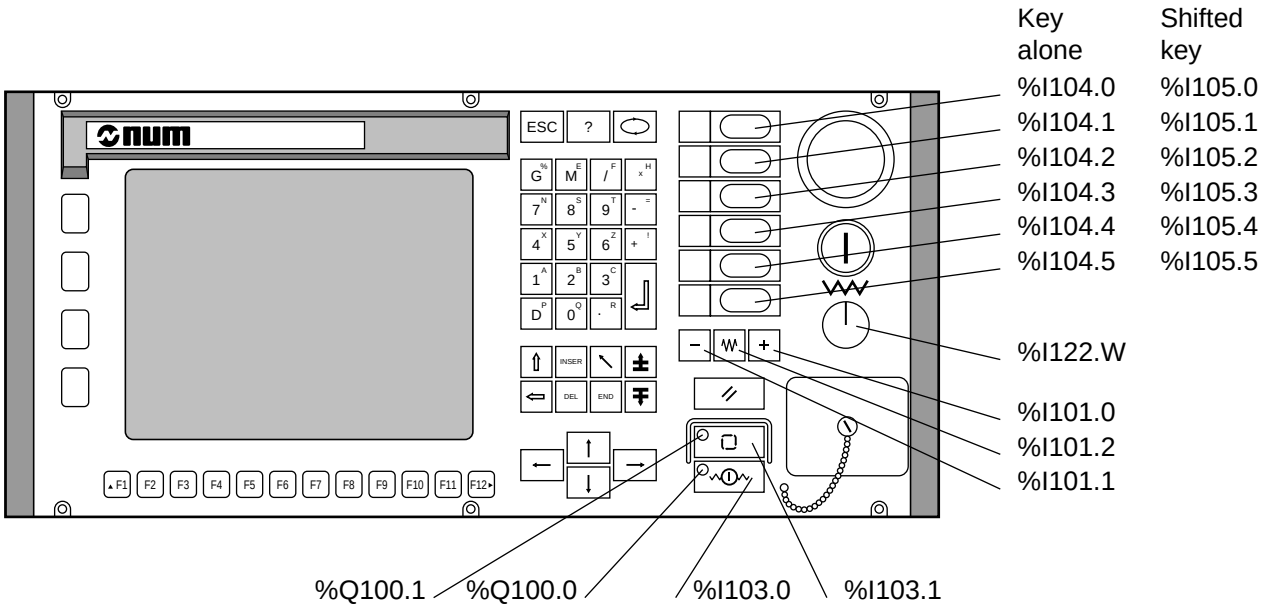
On the NUM 1020/1040 CNCs, the «n_iti» address of the only interrupt has the value 0x0.

8.3.2 Specific Features of the Compact Panel

8.3.2.1 Image of the Compact Panel in the Exchange Area

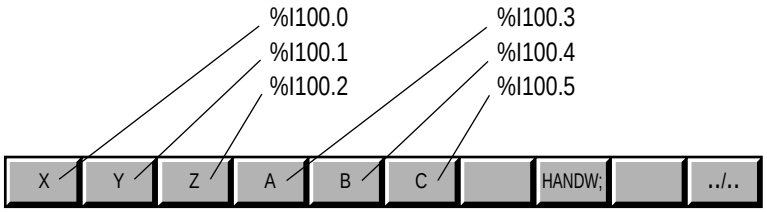
Variable type	Input or output type	Variables
%I100.B	Axis selection by jog softkeys	%I100.0 to %I100.5
%I101.B	+, - and fast axis jogs	%I101.0 to %I101.2
%I103.B	Cycle stop and Cycle start keys	%I103.0 (Cycle stop) and %I103.1 (Cycle start)
%I104.B	Programmable keys 1 to 6	%I104.0 (key 1) to %I104.5 (key 6)
%I105.B	Shifted programmable keys 1 to 6	%I105.0 (key 1) to %I105.5 (key 6)
%I122.W	Analogue potentiometer input	
%Q100.B	Cycle stop and Cycle start LEDs	%Q100.0 (Cycle stop) and %Q100.1 (Cycle start)
%Q102.B	LEDs for programmable keys 1 to 6	%Q102.0 (LED 1) to %Q102.5 (LED 6)
%Q102.B	LEDs for shifted programmable keys 1 to 6	%Q103.0 (LED 1) to %Q103.5 (LED 6)

8.3.2.2 View of the Compact Panel



8.3.2.3 View of the Jog Softkeys

The compact panel has special softkeys including the new jog softkeys used to select the axis controlled by the axis jogs:

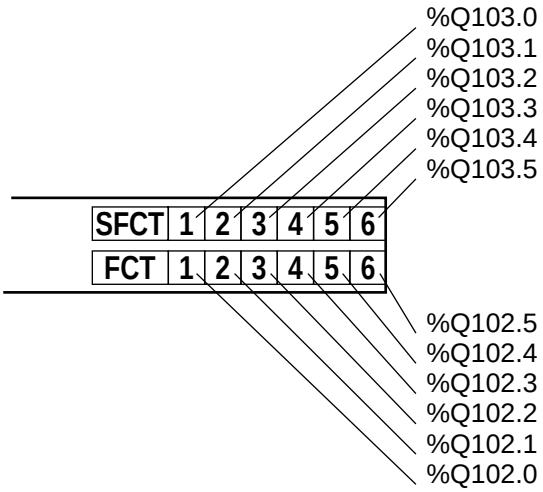


These softkeys are accessed by keys:  and JOG (F7).

The axes whose names appear on the softkeys are those defined in machine parameter P9 (see Parameter Manual). They appear in the order in which they were defined.

8.3.2.4 View of the LEDs of the Programmable Key

The functions activated by the programmable keys are indicated by an LED in the Status window:



The bottom row of LEDs corresponds to the programmable keys alone and the top row to the shifted programmable keys.

9 Integration of the Machine Parameters (by UT5)

Integration of the machine parameters is defined in the Parameter Manual. Only the specific features of the NUM 1020/1040 CNCs are detailed below.

9.1 Maximum Time Allocated to the PLC Application: P99

Category	Miscellaneous
Type 5	Unsigned decimal
No. of words	1

Description

Defines the maximum CPU time allocated to the customer PLC application.

Principle

With the NUM 1020/1040 CNCs, the CPU time is shared between the customer PLC application, the CNC function and panel management. The time allocated to the customer PLC application must be adjusted as accurately as possible.

The maximum time allocated to the PLC application is expressed in ms. The basic value is 10 ms.

The value is a multiple of 2 ms between 4 ms and 18 ms. If the value set for P99 is outside these limits, the system selects the corresponding limit value.

Adjusting the Time Allocated to the PLC Application

There is a minimum value for execution of the sequential tasks below which the PLC goes into fault status.

If the PLC application is running without background tasks, this value can be kept.

If the PLC application is running with background tasks, this value can be slightly increased to improve the time allocated to the background tasks. This value must be adjusted as closely as possible to optimise the CNC performance (graphic display and block preparation time).

9.2 Sampling Period: P50

The sampling period is set in microseconds.

Specific Features of the NUM 1020/1040 CPUs

Default value

The default value is 6 ms.

Possible values of the sampling period

The sampling period must be a multiple of 2 ms.

If the sampling period set is not a multiple of 2 ms, the following message appears when the system is initialised:

```
WARNING : SAMPLING PERIOD
IS NOT A MULTIPLE OF 2 ms
```

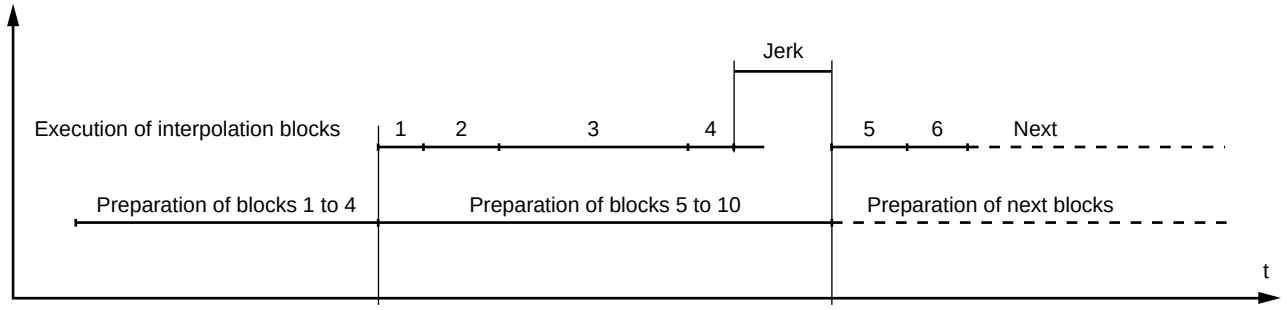
The system operates normally, but the sampling period is rounded down to the next lower multiple of 2 ms.

9.3 Minimum Block Execution Time: P51

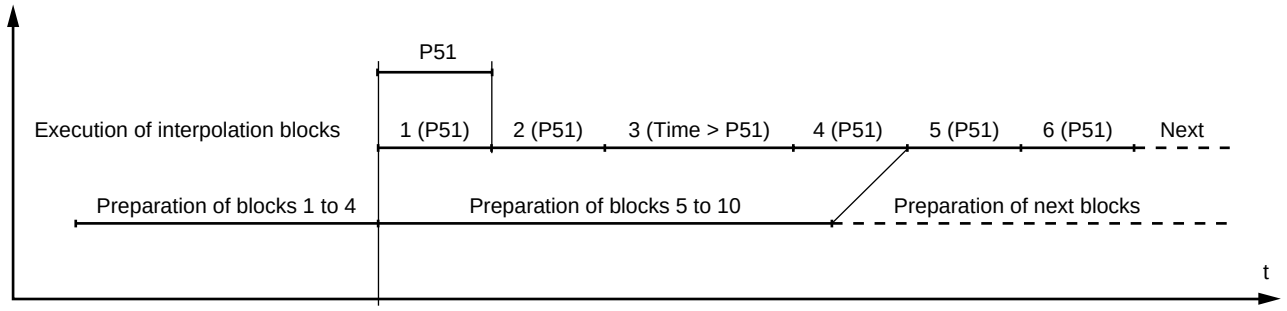
The block execution time is set in milliseconds.

Before execution, the system prepares a variable number of blocks.

During execution of short interpolation blocks, the movements may be completed before the system has time to prepare the next blocks (see diagram below) which causes jerks.



The jerks can be avoided by setting a minimum interpolation block execution time by parameter P51 to give the system time to prepare the next blocks (see diagram below).



The larger the number of axis groups and axes, the longer the block preparation time. The minimum block execution time must be set according to the system configuration. It is generally between 6 and 12 ms.

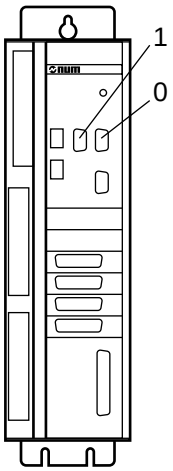
It should be noted that too long a block execution time can be penalising to system performance when executing short blocks.

REMARK *External parameter E32000 is used to modify the minimum block execution time within a part programme (see programming manuals), and in particular to set different times for each axis group.*

9.4 Assignment of Serial Lines: N0 of P110, P111 and P112

Byte N0 of machine parameters P110, P111 and P112 defines the serial line assigned to:
- A master UNI-TELWAY link (P110),
- A slave UNI-TELWAY link (P111),
- A PLCTOOL link (P112).

Special features of NUM 1020/1040 CPUs



The only difference for the NUM 1020/1040 CPUs concerns location of the serial lines.

The possible values of byte N0 are:
- $0 for the Com 1 line,
- $1 for the Serial line.

The default value is $FF: no line assigned.

9.5 Axis Assignment to a Group: P9

The format of parameter P9 is unchanged, but it affects display of the jog softkeys specific to the compact panel.

The first six axes defined in P9 are displayed in that order in the jog softkeys of the compact panel, e.g.:

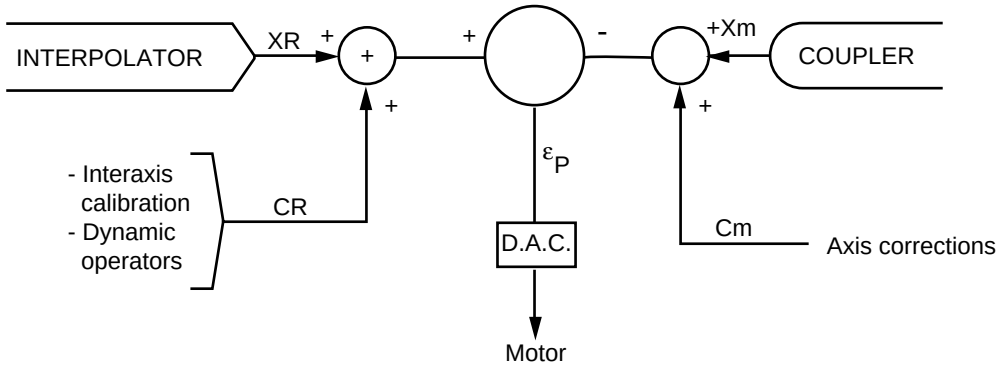
These softkeys are displayed by keys:  then JOG (F7).

9

10 Axis Calibration (by UT2)

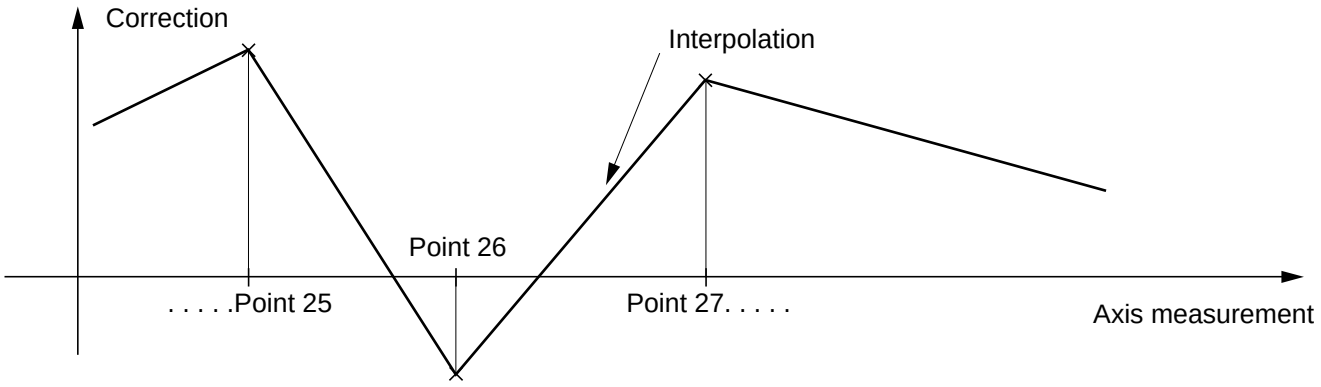
10.1 General

Axis calibration allows the system to add a correction depending on the real axis position to the measurement made by the coupler.



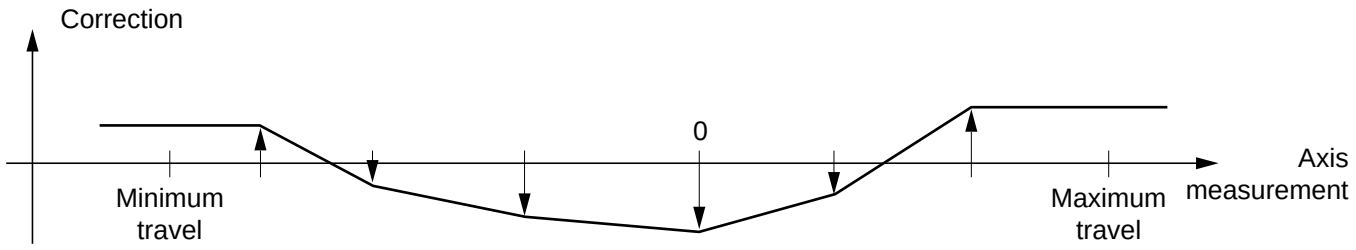
Axis calibration is carried out on both linear and rotary axes.

The corrections are entered for a limited number of points per axis. The system computes the corrections between two points by linear interpolation.

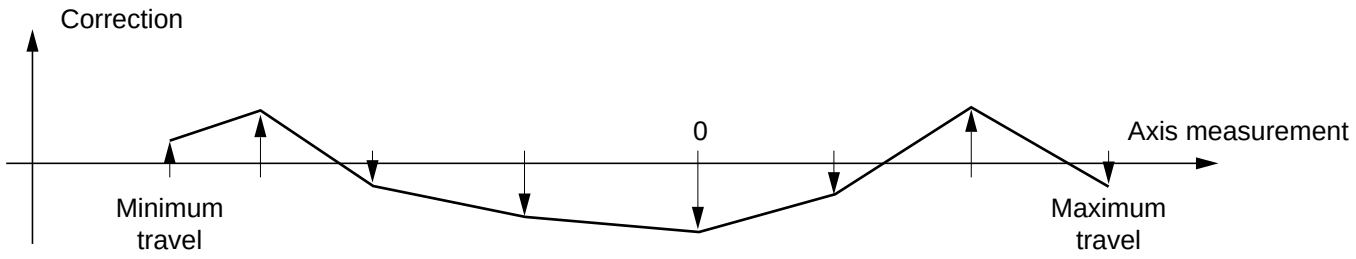


It is recommended to correct the measurements of the minimum and maximum travel points (defined by machine parameter P17). Otherwise, the value of the last correction is applied to these points:

Minimum and maximum travel points not corrected



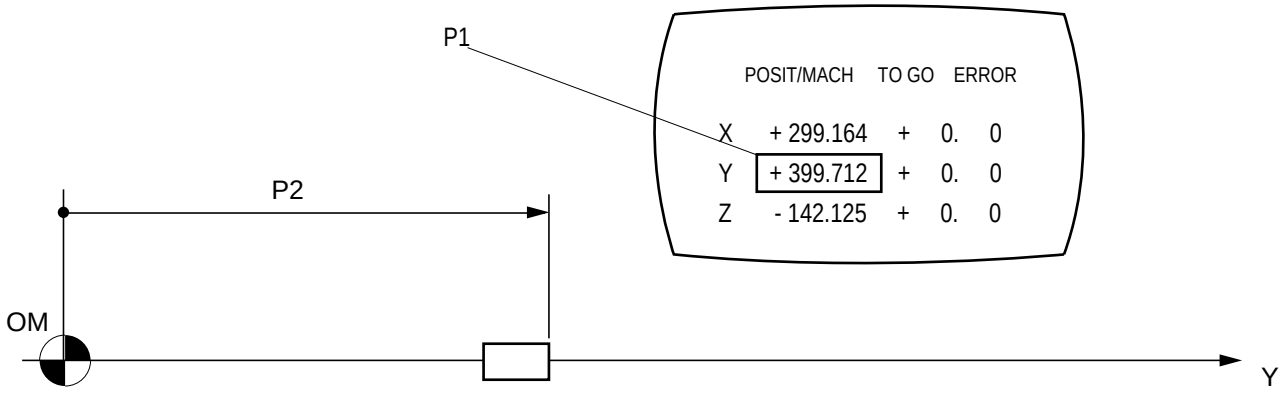
Minimum and maximum travel points corrected



A maximum number of approximately 2600 points can be corrected for all the axes combined. There are no restrictions on how the points are distributed on the axes.

10.2 Record of Corrections to Be Made

The real axis position is taken for a series of points to determine the corrections required:



The corrections are in the internal system unit or ten-thousandths of a degree

Axis number: Unit:

Measured position (P1)							
Real position (P2)							
Correction (P2 - P1)							

The measured values and corresponding corrections are recorded in the correction tables (see 10.3.1).

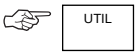
REMARKS *A correction table must have at least three points.*

The correction range is between -32768 and +32768 units.

For a rotary axis, the corrections must be identical for the 0 and 360 degree points.

10.3 Operations on Axis Measurement Correction Tables

Select the CN UTILITY menu.



Display of the «CN UTILITY» menu.

Select the «UTILITIES PRESENT» menu.

Display of the «UTILITIES PRESENT» menu.

Select the axis calibration utility.

Display of the menu:

```
      AXIS CABLIBRATION VALUES

>0 DISPLAY - CHANGE
 1 LOAD
 2 UNLOAD
 3 VERIFY
```

Select the operation to be performed:

- enter a measurement correction table (see 10.3.1),
- load a measurement correction table (see 10.3.4),
- save a measurement correction table (see 10.3.2),
- check the measurement correction table (see 10.3.3),
- exit from the utility, confirming the data modified (see 10.3.5).

10.3.1 Entering the Measurement Correction Table

Initial Conditions

Record made of required corrections (see 10.2).

«AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «DISPLAY - CHANGE» ☞ [ ) 0] [⟵]

Display of the question:

```
AXIS ?
```

Enter the number of the axis to be corrected (corresponds to the axis position in machine parameter P9). ☞ [⟵]

Display of the measurement correction table for the axis considered, e.g.:

```
   AXIS CALIBRATION  AXIS: 2

>M-   10000   C-       3
 M-    9000   C+       6
 M-    8000   C-       9
 ...
```

Interpretation of the measurement correction table:
- the header gives the axis number selected,
- the next number, «M», is the measurement of the point (in microns or ten-thousandths of a degree),
- the following number, «C», is the correction to be made (in microns or ten-thousandths of a degree).

The table is in increasing order of measurements.

When the table is empty, only the header is displayed.

Modifying or Adding a Correction

The corrections can be entered in any order.

Enter the correction: «M±[measurement] C±[correction]». ☞ [⟵]

Modification of the correction line concerned or display of the new line.

Deleting a Correction

Select the correction to be deleted. ☞ [↓]

Delete the correction. ☞ [_ -] [⟵]

Return to the «AXIS CALIBRATION VALUES» menu (to enter the corrections for another axis)

Exit from the measurement correction table. ☞ [EXIT]

Return to the «AXIS CALIBRATION VALUES» menu.

10.3.2 Saving the Measurement Correction Table

Initial conditions

Peripheral device (PC + communication tool, diskette drive or tape reader/punch) connected and ready to receive data.

«AXIS CALIBRATION VALUES» menu displayed.

Actions

Select «UNLOAD». 

Display of the question:

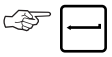
```
READY  (Y/N)?
```

Initiate the save. 

Display of :

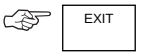
```
%[CNC job reference]
```

Keep the job reference	Change the job reference
Possibly add a comment	Enter another job reference (possibly with comment)

Reinitiate the save. 

The correction tables are saved then the following message is displayed:

```
UPLOADING COMPLETE!
```

Acknowledge the message. 

Structure of the data transmitted

The data saved are in the following format:

```
%00084001 ;0A
AXIS:  0;08
M-   10000   C-       3;17
M-    9000   C-      10;17
...
AXIS:  1;08
M-   10000   C+      25;17
M-    9000   C-       5;17
...
!!
```

Interpretation of the data transmitted:

- the first line gives the CNC job reference (which may be followed by a comment, e.g.:.« %00084001 28 June 1995»),
- each of the axes (AXIS: [No.]= is followed by the corrections assigned to it,
- the number after «M» is the measurement of the point (in microns or ten-thousandths of a degree),
- the number after «C» is the correction of the point (in microns or ten-thousandths of a degree),
- the two digits after «;» on each line are the hexadecimal number of characters in the line.

10.3.3 Checking the Measurement Correction Table

The measurement correction table can be checked to make sure that it was saved or loaded correctly.

Initial Conditions

Peripheral (PC + communication tool, diskette drive or tape reader/punch) connected and ready to transmit the table to be checked.

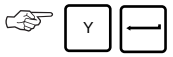
«AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «VERIFY». 

Display of the question:

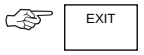
```
READY  (Y/N)?
```

Initiate the check. 

Initiate transmission by the peripheral.

The measurement correction table is checked followed by display of the message:

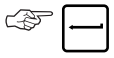
```
OK!
```

Acknowledge the message. 

Possible Problems

The job reference is different from the CNC job reference

Loading stops and the incorrect job reference is displayed.

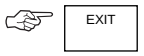
Enter the correct job reference. 

The check is then resumed and continues normally.

The data saved do not correspond to the correction table

Display of the message:

```
ERROR
```

Acknowledge the message. 

Resume save (see 10.3.2) or load (see 10.3.4).

The changes made to the measurement correction table were not confirmed before the check

Display of the message:

```
WARNING - CHANGES MAY BE LOST
(EXIT TO SAVE)
```

Acknowledge the message.	☞ EXIT
Confirm the modifications (see 10.3.5).	
Resume the check.	

10.3.4 Loading a Measurement Correction Table

The measurement correction tables to be loaded can have two possible origins:
- table saved earlier,
- table entered on a peripheral device (complying with the structure shown in 10.3.2; the spaces before the numerical data can be omitted and the two digits after the «;» on each line are the number of characters in the line).

Initial Conditions

Peripheral device (PC + communication tool, diskette drive or tape reader/punch) connected and ready to transmit data.

«AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «LOAD».	☞ ! 1 ⟵

Display of the question:

```
READY  (Y/N)?
```

Initiate the load.	☞ Y ⟵
Initiate transmission by the peripheral.	

Load of the correction table.

Possible Problems

The job reference is different from the CNC job reference

Loading stops and the incorrect job reference is displayed.

Enter the correct job reference.	☞ ⟵

Loading is then resumed and continues normally.

10.3.5 Exit from the Utility Confirming the Changes Made

Exit from the utility.

Changes were made

Display of the message:

```
WRITING IN PROGRESS
```

After confirmation, display of the message:

```
WARNING ! LOADING REQUIRES TO STOP
          MACHINE CONTROL OK?  (Y/N) :
```

It is necessary to reset the system to take the changes made into account.

Reset the system.

No changes

Return to the menu «UTILITIES PRESENT».

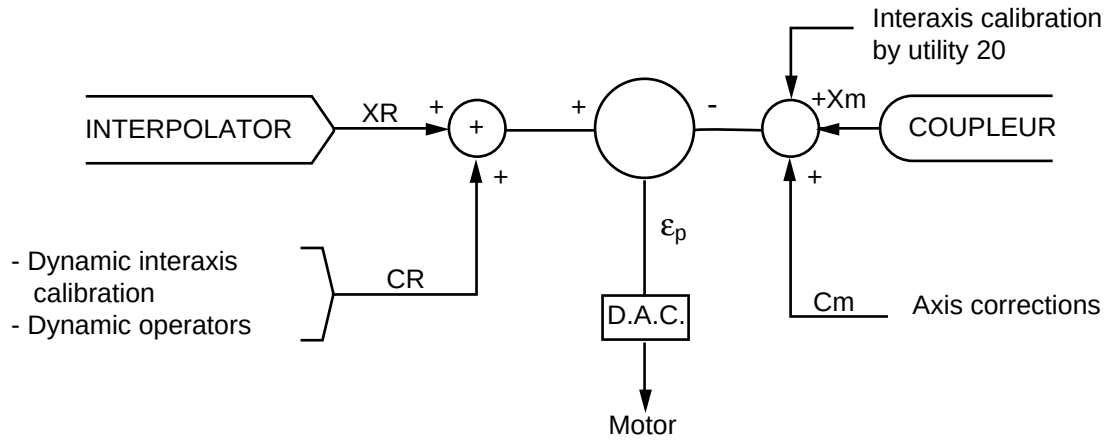
11 Interaxis Calibration

11.1 General Description of Interaxis Calibration

11.1.1 General

Interaxis calibration allows the system to add an offset to the normal reference of an interpolator depending on the position of another axis.

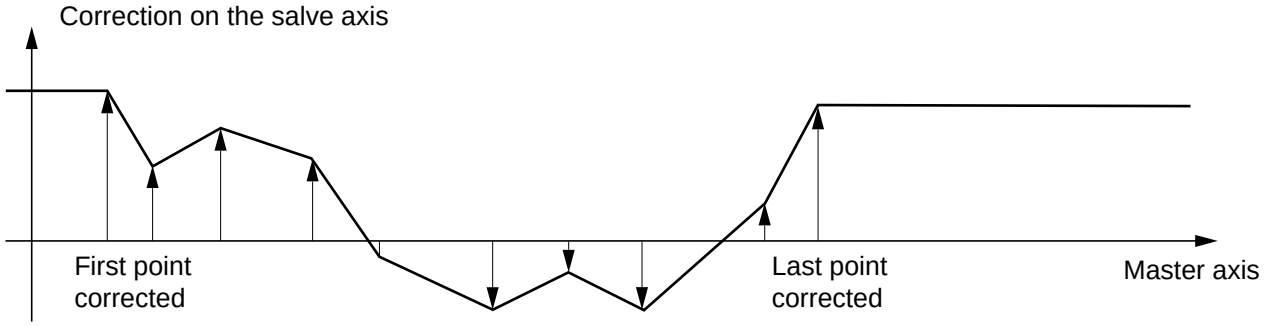
The control axis is called the master axis and the corrected axis is the slave axis.



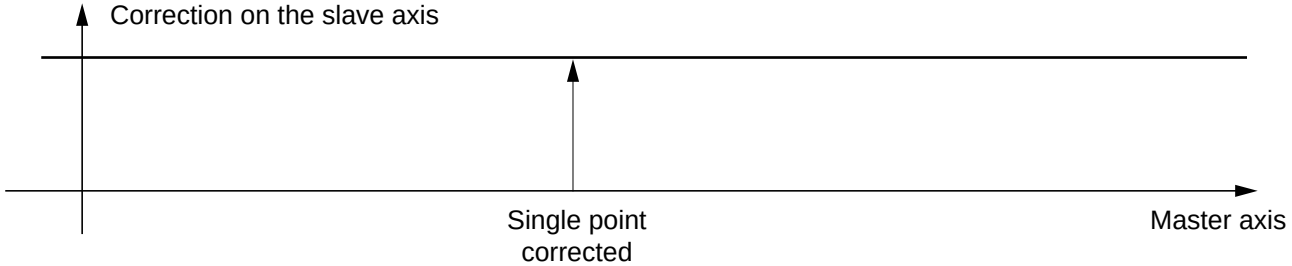
The corrections concern both linear and rotary axes.

They are entered for a limited number of points per axis. The system computes the corrections between two points by linear interpolation.

Beyond the end points, the corrections are constant.



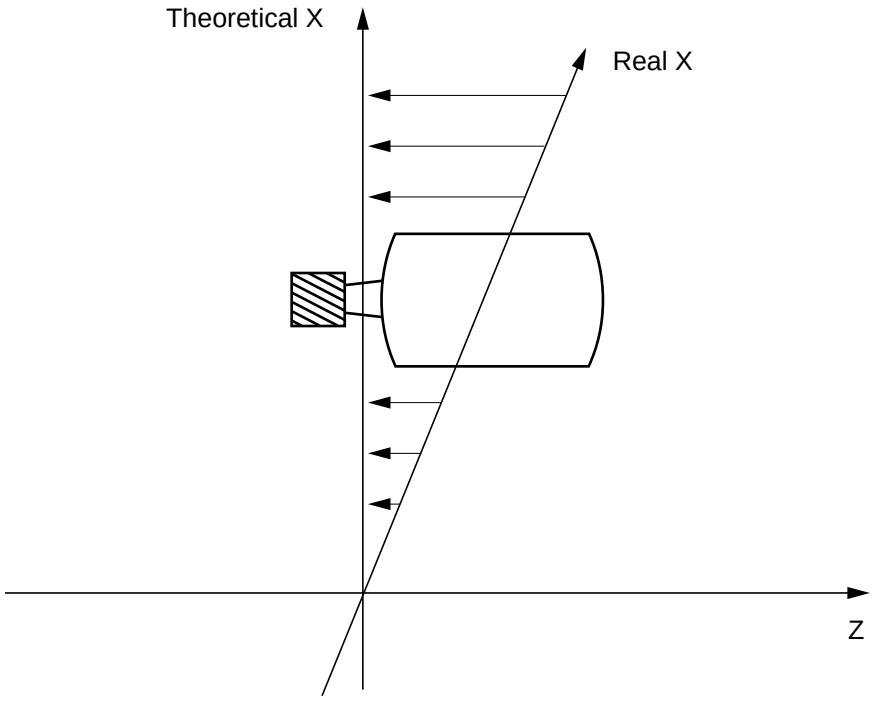
Special case: Correction in a single point



11.1.2 Examples of Interaxis Calibration

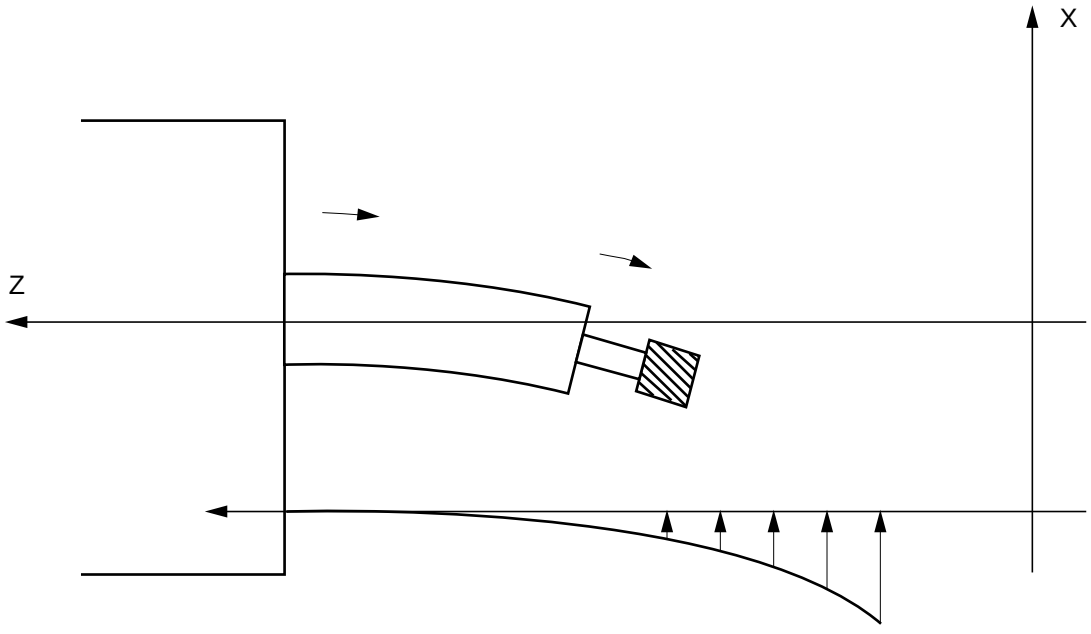
REMARK The deformations are exaggerated for clarity in the examples below.

Correction of a perpendicular alignment fault



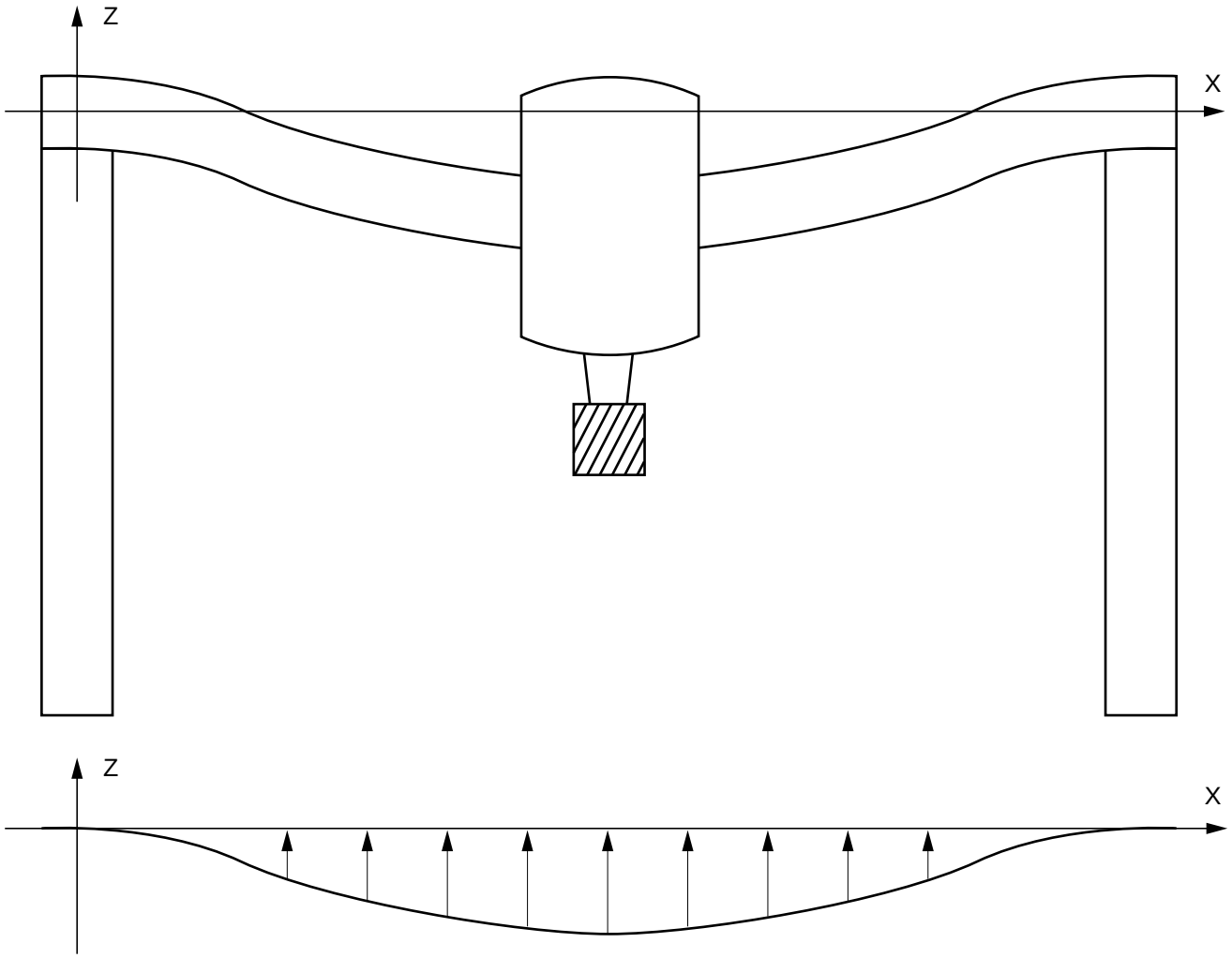
Z corrected according to the position on the X axis.

Correction of bending of a boring bar



X corrected according to extension of the boring bar

Correction of sag of the cross member of a gantry machine



Sag in Z corrected according to the position on the X axis.

Expansion take-up on an axis

An axis can be self-corrected (only with dynamic calibration, master axis aligned with slave axis) to cater for thermal expansion.

The correction tables can be written by the PLC programme according to the measured temperatures then used by the system.

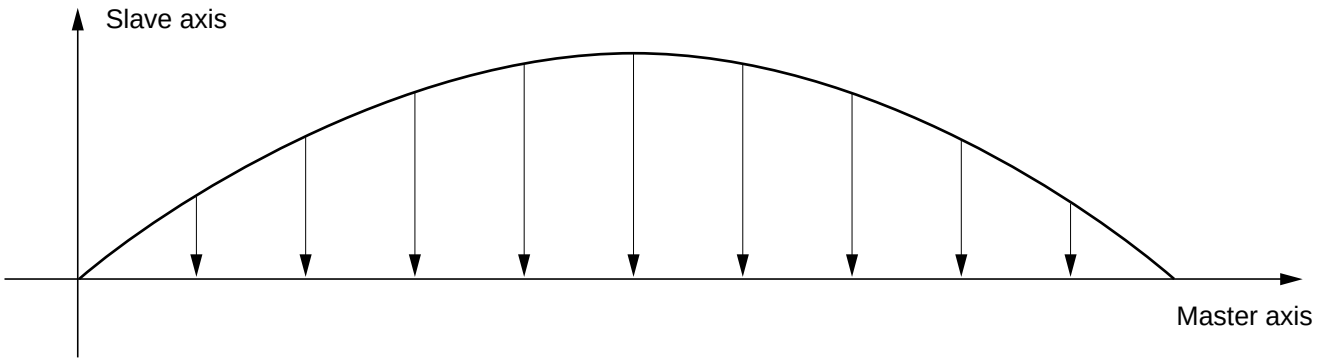
The use of these corrections may prove difficult because of the thermal inertia of the machines.

11.1.3 Tools Used for Interaxis Calibration

Two tools can be used for interaxis calibration:
- calibration by utility 20 (see 11.2) to make unvariable corrections to take into account deformations of the machine,
- dynamic calibration by parameters E81xxx and E82xxx (see 11.3) that can be modified at any time (by the PLC programme or the part programme). These corrections are suited to variables that change over time such as thermal expansion.

11.1.4 Measurement of the Corrections on the Axes

The corrections to be made to the slave axis are measured for a series of reference positions on the master axis.



The corrections are made in the internal system unit or one-thousandths of a degree.

Master axis No.: Slave axis No.:

Master axis position Unit:							
Slave axis correction Unit:							

The values measured are recorded in the correction tables (see 11.2.1 and 11.3.3).

REMARKS: For interaxis calibration by utility 20, the maximum corrections are ± 9999 units.

For dynamic interaxis calibration, the maximum difference between two consecutive corrections is ± 65,000 units.

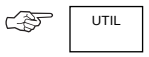
11.2 Interaxis Calibration by Utility 20

A slave axis can have only one master axis.

A master axis can have several slave axes.

An axis cannot be its own slave (contrary to dynamic calibration).

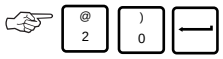
Actions

Select the "CN UTILITY" menu. 

Display of the "CN UTILITY" menu.

Select the "UTILITIES PRESENT" menu. 

Display of the "UTILITIES PRESENT" menu.

Select the interaxis calibration utility. 

Display of the menu:

```
      INTER-AXIS CALIBRATION VALUES

>0 DISPLAY- CHANGE
 1 LOAD
 2 UNLOAD
 3 VERIFY
```

Select the operation to be performed:

- enter a measurement correction table (see 11.2.1),
- load a measurement correction table (see 11.2.4),
- save a measurement correction table (see 11.2.2),
- check the measurement correction table (see 11.2.3),
- exit from the utility, confirming the data modified (see 11.2.5).

11.2.1 Entering the Measurement Correction Table for an Axis

Initial Conditions

Record made of required corrections (see 11.1.4).

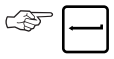
«INTER-AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «DISPLAY - CHANGE»	

Display of the question:

```
AXIS ?
```

Enter «[slave axis No.], [master axis No.]» (the numbers correspond to the axis positions in machine parameter P9).	

Display of the measurement correction table for the axis considered, e.g.:

```
   SLAVE AXIS: 0, MASTER AXIS: 2

>M-   10000   C-       1
 M-    9000   C+       1
 M-    8000   C+       4
 ...
```

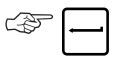
Interpretation of the measurement correction table:
- the header gives the slave axis number followed by the master axis number,
- the next number, «M», is the measurement of a point on the master axis (en micromètre ou dix millième de degré),
- the following number, «C», is the correction made to the slave axis (en micromètre ou dix millième de degré).

The table is in increasing order of measurements.

When the table is empty, only the header is displayed.

Modifying or Adding a Correction

The corrections can be entered in any order.

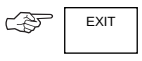
Enter the correction: «M±[measurement] C±[correction]».	

Modification of the correction line concerned or display of the new line.

Deleting a Correction

Select the correction to be deleted.	
Delete the correction.	

Return to the «INTER-AXIS CALIBRATION VALUES» menu (to enter the corrections for another axis)

Exit from the measurement correction table for axis pair.	

Return to the «INTER-AXIS CALIBRATION VALUES» menu.

11.2.2 Saving the Measurement Correction Table

Initial conditions

Peripheral device (PC + communication tool, diskette drive or tape reader/punch) connected and ready to receive data.

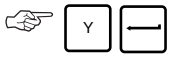
«INTER-AXIS CALIBRATION VALUES» menu displayed.

Actions

Select «UNLOAD». 

Display of the question:

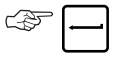
```
READY  (Y/N)?
```

Initiate the save. 

Display of :

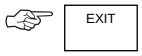
```
%[CNC job reference]
```

Keep the job reference	Change the job reference
Possibly add a comment	Enter another job reference (possibly with comment)

Reinitiate the save. 

The correction tables are saved then the following message is displayed:

```
UPLOADING COMPLETE!
```

Acknowledge the message. 

Structure of the data transmitted

The data saved are in the following format:

```
%00084001 ;0A
AXIS:  0, 1;0B
M-   10000   C-       2;17
M-    9000   C+       1;17
...
AXIS:  2, 1;0B
M-   10000   C+       8;17
M-    9000   C+       5;17
...
!!
```

Interpretation of the data transmitted:

- the first line gives the CNC job reference (which may be followed by a comment, e.g.:.« %00084001 6 June 1995»),
- each of the axis pairs (AXIS: [slave], [master]) is followed by the corrections assigned to it,
- the next number, «M», is the dimension of a point on the master axis (in microns or ten-thousandths of a degree),
- the following number, «C», is the correction made to the slave axis (in microns or ten-thousandths of a degree),
- the two digits after «;» on each line are the hexadecimal number of characters in the line.

11.2.3 Checking the Measurement Correction Table

The measurement correction table can be checked to make sure that it was saved or loaded correctly.

Initial Conditions

Peripheral (PC + communication tool, diskette drive or tape reader/punch) connected and ready to transmit the table to be checked.

«INTER-AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «CHECK». 

Display of the question:

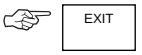
```
READY  (Y/N)?
```

Initiate the check. 

Initiate transmission by the peripheral.

The measurement correction table is checked followed by display of the message:

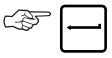
```
OK
```

Acknowledge the message. 

Possible Problems

The job reference is different from the CNC job reference

Loading stops and the incorrect job reference is displayed.

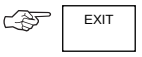
Enter the correct job reference. 

The check is then resumed and continues normally.

The data saved do not correspond to the correction table

Display of the message:

```
INCORRECT TAPE
```

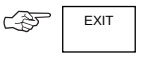
Acknowledge the message. 

Resume save (see 11.2.2) or load (see 11.2.4).

The changes made to the measurement correction table were not confirmed before the check

Display of the message:

```
WARNING - CHANGES MAY BE LOST
          (EXIT TO SAVE)
```

Acknowledge the message. 

Confirm the modifications (see 11.2.5).

Resume the check.

11.2.4 Loading a Measurement Correction Table

The measurement correction tables to be loaded can have two possible origins:
- table saved earlier,
- table entered on a peripheral device (complying with the structure shown in 11.2.2; the spaces before the numerical data can be omitted and the two digits after the «;» on each line are the number of characters in the line).

Initial Conditions

Peripheral device (PC + communication tool, diskette drive or tape reader/punch) connected and ready to transmit data.

«AXIS CALIBRATION VALUES» menu displayed.

Actions

Choose «LOAD». 

Display of the question:

```
READY  (Y/N)?
```

Initiate the load. 

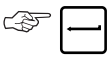
Initiate transmission by the peripheral.

Read of the correction table.

Possible Problems

The job reference is different from the CNC job reference

Loading stops and the incorrect job reference is displayed.

Enter the correct job reference. 

Loading is then resumed and continues normally.

11.2.5 Exit from the Utility Confirming the Changes Made

Exit from the utility. 

Changes were made

Display of the message:

```
WRITING IN PROGRESS
```

After confirmation, display of the message:

```
WARNING ! LOADING REQUIRES TO STOP
          MACHINE CONTROL OK?  (Y/N) :
```

It is necessary to reset the system to take the changes made into account. 

Reset the system.

No changes

Return to the menu "UTILITIES PRESENT".

11.3 Dynamic Interaxis Calibration

11.3.1 Addresses of the Correction Parameters

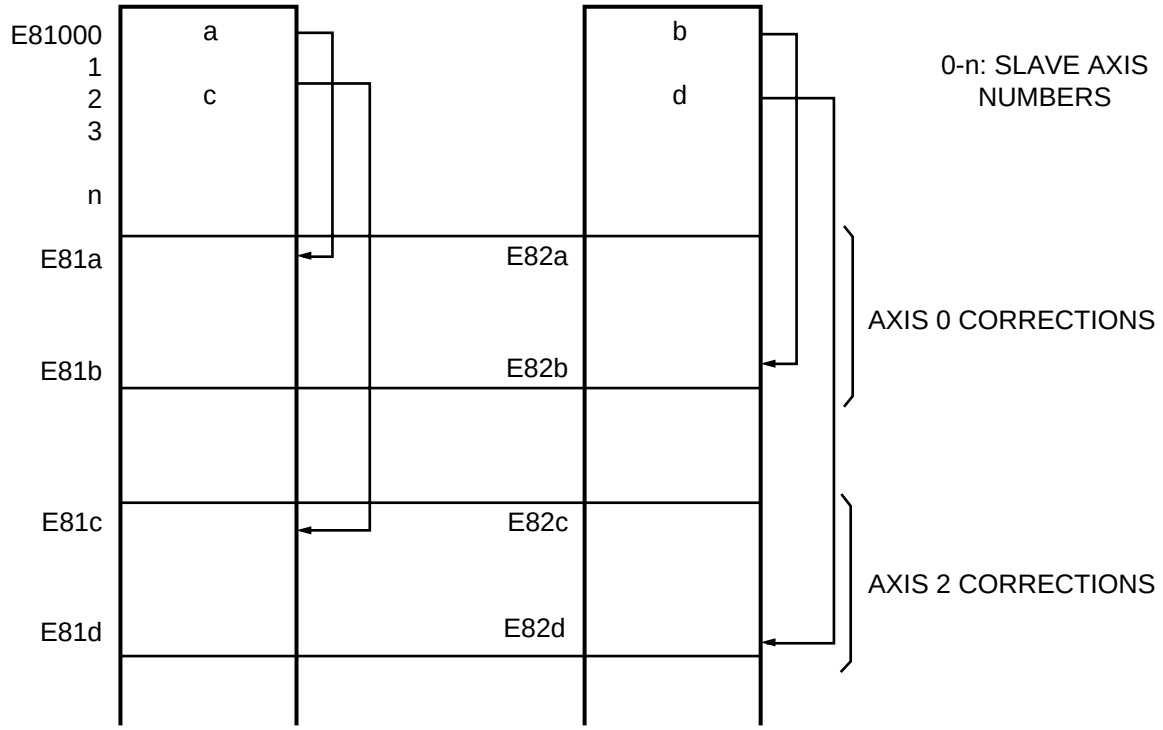
The corrections are made using parameters E81xxx, E82xxx and E94xxx:
- parameters E81xxx address the master axis reference positions,
- parameters E82xxx address the corresponding corrections on the slave axes,
- parameters E94xxx assign a master axis to a slave axis.

The current slave axis correction is accessible in read-only parameters E950xx.

11.3.2 Correction Tables

The size of the correction tables (number of parameters E81xxx and parameters E82xxx) is defined by machine parameter P58 (See Parameters Manual). The maximum size of the correction tables is 1000 parameters E81xxx and 1000 parameters E82xxx.

The correction tables can be schematically represented as follows:



The first 32 parameters E81xxx and E82xxx are each assigned to the axis with the same number: E81003 and E82003 are assigned to axis 3. They define the limits of the correction table assigned to the axis.

The following parameters included in the table of corrections assigned to an axis define:
- the reference position on the master axis (parameters E81xxx)
- the corresponding correction applied to the slave axis (parameters E82xxx).

The reference positions and slave axis corrections are signed values in internal system units.

A master axis is assigned to a slave axis by E940xx = yy where:
- xx is the slave axis number,
- yy is the corresponding master axis number.

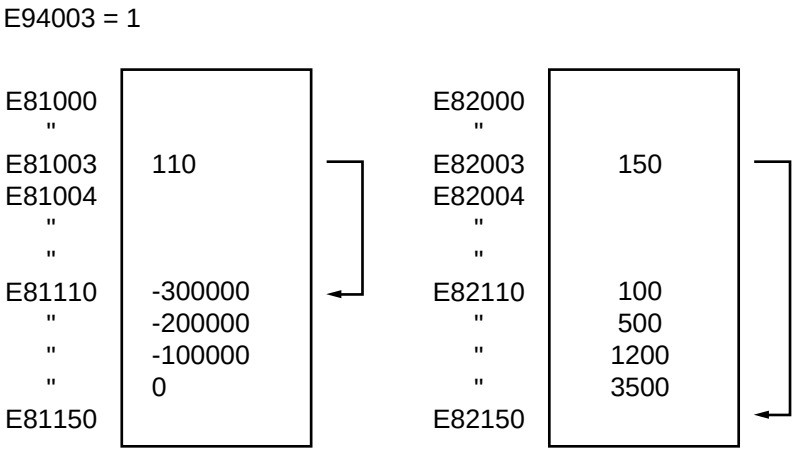
E940xx = -1 means that no master axis is assigned to slave axis xx.

Specifically

For a corrected axis, the reference positions on the master axis must be defined in increasing order.

Any unused location in the correction table can be used as extra E80xxx parameters (local data written and read by the CNC).

Example



E94003 = 1 means that master axis 1 is assigned to slave axis 3.

E81003 = 110 and E82003 = 150 mean that the parameters defining the corrections of axis 3 are between E81110 and E81150 for the reference positions on master axis 1 and between E82110 and E82150 for the corresponding corrections made to slave axis 3.

E81110 = -300000 and E82110 = 100 means that the first reference position on master axis 1 is located at -300000 µm, i.e. -300 mm and that the corresponding correction on slave axis 3 is 100 µm (if the internal system unit is micrometres).

11.3.3 Writing and Enabling the Correction Tables

Parameters E81xxx, E82xxx and E940xx can be written by the PLC programme or a part programme.

11.3.3.1 Conditions for Writing Parameters E81xxx and E82xxx

At least one E940xx parameter is different from -1

This means that there is at least one master axis.

The parameters defining the limits of the correction tables cannot be modified.

The parameters defining the reference points cannot be modified.

The corrections can be modified providing the difference between the two values is less than 100 mm.

All E940xx parameters are equal to -1

This means that no correction table is enabled.

All E81xxx and E82xxx parameters can be modified without restriction.

11.3.3.2 Conditions for Writing Parameters E940xx

To change the master axis, it is first necessary to disable the correction linkage (parameter = -1). For instance, the following steps are necessary to change from master axis 3 to master axis 1 for slave axis 2:
- E94002 = -1
- E94002 = 1.

An axis can be slaved to its own reference, e.g. E94002 = 2.

Checks are made on the correction table when writing parameter E940xx: table limits, master axis reference points in increasing order, maximum difference between two consecutive corrections. The parameter is not enabled if the checks are not satisfied.

11.3.3.3 Procedure for Writing and Enabling the Correction Tables

The conditions for writing parameters E81xxx, E82xxx and E940xx determine the logical order for writing the correction tables:
- cancel enabling of all the correction tables: E940xx = -1,
- modify parameters E81xxx and E82xxx,
- assign master axes to the slave axes: E940xx = yy.

Writing of the Correction Tables by a Processor

The parameters can be written:
- during the timeout on a reset (data S_RAZ = 1),
- during execution of a program, while a character string is being transmitted to the processor (logical address $0430).

In a multiple axis group system, the enabled axis groups other than the one making the transfer must be on wait (G78 Pxx).

Writing of the Correction Tables by a Part Programme

The possibility of writing of the correction tables by a part programme is conditioned by machine parameter P7 (see Parameters Manual):
- bit 5 of word 0 of P7 = 0: write by part programme enabled
- bit 5 of word 0 of P7 = 1: write by part programme inhibited.

12 Final Inspection

A final inspection is made by machining a reference part (e.g. NASA part) to check that the CNC has been correctly configured for the machine (in particular by making the corrections on the axes).