ARGUS TITAN 2 SYSTEM DESCRIPTION

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INTRODUCTION

The Argus Titan Control system is a user-programmable, distributable, real-time control system with dedicated hardware and software. It has been specifically designed for automated equipment control, monitoring, and data acquisition in commercial and institutional protected horticulture production settings. It also has many applications in general climate control, irrigation management, and nutrient control situations.

The system gathers input information from sensor devices such as temperature, wind speed, tank levels, pH, vent position, humidity, light, CO_2 etc. It then uses this information, in conjunction with sophisticated internal algorithms and user-defined parameters to control target processes such as air temperatures, CO_2 concentrations, humidity, soil moisture, and nutrient levels supplied by irrigation.

The system is highly modular and expandable, so you only purchase the components you need when you need them. Since the hardware components can be located nearly anywhere in your operation, you can substantially reduce the total length and cost of low and line-voltage wiring runs (when compared to more centralized control systems) for your sensors and controlled equipment.

The Argus Titan Control system is designed to provide the highest degree of durability, reliability, and flexibility in both hardware and software for achieving powerful control objectives. Wherever possible, critical control functions are designed to be failsafe. In cases where the physical design of the controlled equipment does not allow failsafe or fail-soft design, we provide appropriate user configurable alarms combined with a fallback to manual override control for additional safety.

Titan systems are custom configured by Argus to your exact requirements, with a custom set of software navigation screens that match the names and layout of your controlled equipment and locations. One of the strengths of the Titan system is the modular building block approach that we use to configure our control applications. With it, we can construct increasingly sophisticated applications by combining simpler generic control modules. The end result is shaped into the custom applications that you use for day-to-day control.

If at any time your requirements change, we can usually adapt the control logic by simply reconfiguring the underlying control programs to suit your new requirements. In most cases there is no need to revise or recompile the underlying program code to accomplish this. This ability to rapidly and economically adapt our software to your changing requirements helps set the Argus Titan system apart from our competition.

The Argus Advantage

The Argus Titan system is designed to provide you with these benefits:

- The most powerful and flexible control capabilities in its class.
- Maximum system reliability and stability.
- Full-featured control programs complete with safety limits and overrides tailored to your applications and the capabilities of your equipment.
- Distributed processing hardware for improved on-line redundancy.
- Modular 'plug and run' hardware design.
- Easy 'no wire' module replacement courtesy of the included backplane design.
- Self-diagnostics and simplified trouble shooting.
- Fully integrated monitoring and alarms.
- Flexible, high-end data filtering and data logging capabilities.
- Full-featured graphical trend analysis tools.
- Minimal on-site wiring costs.
- Superior electrical isolation and lightning protection.
- A variety of integrated panel and line voltage interfacing options.
- High-resolution sensor measurement and accuracy.
- Simplified, economical sensor interfacing.
- Full remote operation capabilities and support via on-line system access.
- Minimal requirement for on-site service.
- Fully customizable user interface.
- Extensive password protection and configurable user permissions.
- Argus' legendary service and support.

Three Complete Systems in One

The Argus Titan system provides the capabilities of three full featured management systems in a single platform:

❶ A Real-Time Equipment Control System

The system gathers continuous input information from sensor devices (temperature, wind speed, tank levels, pH, vent position, humidity, light, CO_2, soil moisture etc.). It then uses this information, in conjunction with sophisticated internal programs and user-defined control parameters to automatically operate the equipment under its control.

Integrated control enables the coordination of multiple equipment systems, and the possibility of a variety of control strategies for each device. Systems are engineered to meet the specific requirements of each application while providing automatic compensation for the effects of weather and other dynamic environmental variables. This reduces the need for constant human monitoring and adjustment.

❷ A Data Recorder

Whether you need data recording for general management purposes or as an integral component for research, the Argus Titan system provides extensive data collection capabilities. Each system functions as a complete user-configurable recorder that can be used for collecting, displaying, and analyzing real-time and historical data in graphical, tabular, and summary formats. All collected data can be viewed online, from any location as well as exported to other applications for further analysis. The Titan system's unique data filtering and compression methods make it possible to record thousands of items at selectable sampling frequencies, including all sensor readings and equipment positions.

❸ An Early Warning Alarm System

The word Argus is synonymous with watchfulness. It comes from the many-eyed creature of Greek mythology who, even as he slept, could always keep at least one eye opened. Accordingly, we have always included monitoring and alarm features as an integral part of our systems. You can monitor virtually any measured and controlled condition and configure the appropriate alarm logic, thresholds, and annunciation methods. Not only can you use the system to watch over its own controlled processes, but any measurable conditions within your operation.

Your system will arrive with many preconfigured alarms. You can also configure as many additional alarms as you need. Selectable alarm priorities and annunciation methods enable you to set some alarms to warn you immediately of critical conditions such as low or high temperatures, and other non-critical alarms for management purposes, such as tracking the operational hours of controlled equipment for preventative maintenance purposes. You can even configure 'smart' alarms that warn you only when a combination of events occurs. For example, if you lose heating *and* there are low temperatures outside you can set a critical alarm to alert someone immediately. On the other hand, if there is a heating system problem while the temperatures are warm outside, you might want to set this as a non-critical alarm (no need to get you out of bed!).

Benefits of Integrated Control

Argus Titan systems are specifically designed to provide facility-wide equipment control and monitoring. This offers the convenience of managing all your major climates and equipment systems from a single, unified program interface. It enables you to provide the most uniform and precise control for your situation. Central management is not only much more convenient, but it can be more accurate and safer due to the many built-in self-diagnostic and alarm monitoring features of the system.

With integrated control, you can coordinate the operation of all equipment and zones. You can even use single equipment systems for more than one purpose. For example, ventilation systems can be used to control both humidity and climate temperature. Integrated systems are engineered to meet the specific requirements of each zone while providing full compensation for external events such as outdoor weather conditions. This substantially reduces the need for constant human monitoring and adjustment.

Integrated control also ensures that all your greenhouse equipment operates effectively, efficiently, and in harmony with other control processes. By using advanced control strategies such as energy balance and "feed-forward" control intelligence, Argus Titan systems anticipate and respond to rapidly changing climate conditions *before* negative deviations occur. When all of the major equipment systems are controlled from the same platform, equipment conflicts are prevented and you can easily combine the effects of multiple systems to accomplish common control objectives. You can specify the exact operational parameters that will ensure all your equipment systems operate in a coordinated manner, and you can observe the results with our built-in data recording and analysis tools.

The major advantages of integrated control include:

- Increased precision in monitoring and equipment control
- Smoother, more uniform growing conditions
- Better crop quality and uniformity
- Maximum energy and irrigation efficiency
- Reduced equipment operation and wear

Argus Customers

Our major customer groups include:

- Professional greenhouse and nursery growers
- Researchers
- Facilities managers

Our systems are ideally suited to:

- Commercial greenhouses and nurseries
- Biotechnology research facilities
- Aquaculture facilities
- Aquaponics Facilities
- Conservatories
- Teaching institutions
- Any situation where precision climate and water management are required

All Argus systems feature quick and easy configuration to match your requirements. They are designed to maximize the performance of all types of properly engineered and installed equipment, regardless of make. Our unmatched design flexibility enables you to select the equipment that is best for your existing situation and your future needs.

Whatever your control needs, our flexible programs can be adapted to your situation. In addition to standard greenhouse equipment applications, the Argus Titan system has been used for many special situations at research, educational, and commercial installations including:

- Building HVAC equipment operation
- Butterfly conservatories and insectaries
- Tanks, reservoirs, and recirculation ponds
- Bulb curing rooms
- Amphibian enclosures
- Mushroom barns
- Vegetable storage
- Cogeneration systems
- Geothermal heat recovery
- Temperature controlled rail cars
- Cold rooms and freezers
- Bulb and seed curing rooms

FULL SYSTEM CONFIGURATION

Argus systems are fully configured by Argus for your applications. We typically provide systems for commercial and institutional applications where a specific set of control requirements has been specified. We engineer each systems to provide an exact fit for your needs. We supply everything required to automate your operation. This includes all:

- Control hardware, power supplies and communications equipment.
- Sensors
- Line Voltage interfacing panels and equipment (optional)
- Nutrient injection equipment (optional)

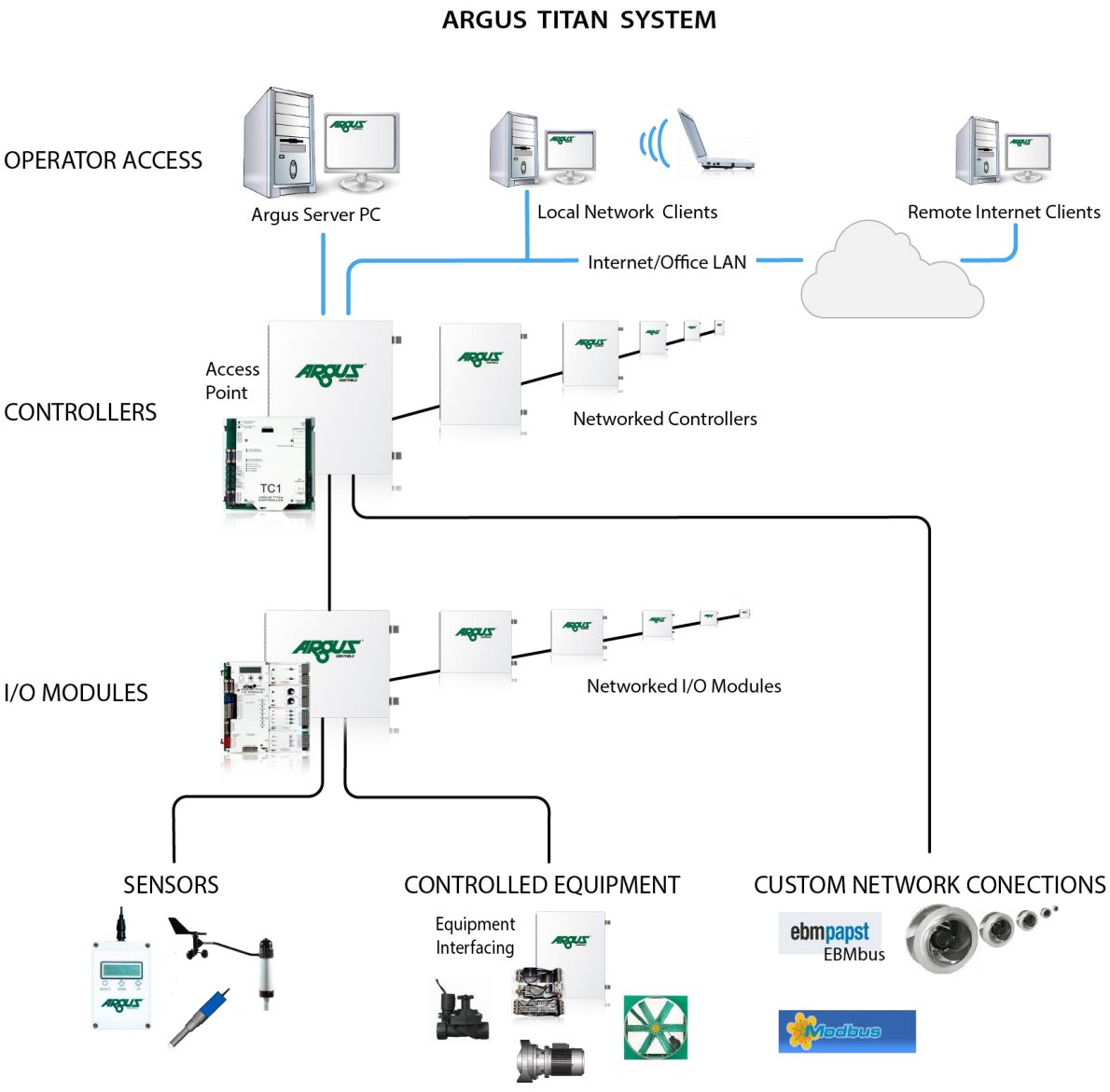
Line voltage interfacing is also available in separate or integrated panels. Typically, the only items you need to supply are a PC for operator access, and the interconnecting wiring between the control panels, equipment, and sensors.

Once your system is configured and operational we back it up with our legendary on-line service and support. We provide complete instructions and detailed wiring diagrams for easy installation. Since your system is custom configured to match your operation, you can begin using it immediately after commissioning. All control information and settings are presented in plain language and there is no programming required and no computer languages to learn.

Although, your system may arrive fully configured, that doesn't mean that it's frozen in time. As your requirements change, your system can be modified or expanded as needed. Our highly flexible modular design makes it easy to add new capabilities in small economical increments.

ARGUS TITAN SYSTEM HARDWARE

This section describes the main components of your control system. Although each control system is configured to your specific needs, certain components are common to most Argus Titan systems.



Typical hardware components include:

- Argus Server PC (often sourced locally)
- Argus Titan controller(s)
- Titan I/O modules
- Sensors
- Output Control Relays
- Line voltage interfacing equipment (can be provided by Argus or locally sourced)
- Power supplies

Note: With the exception of Argus Multi-Feed nutrient injection systems, we generally do not provide controlled equipment such as vent motors, pumps, irrigation valves, etc.

Controllers and I/O modules are designed to be distributed to where the action is. They can be located very close to the equipment they monitor and control, and are designed for a wide range of environmental conditions. In many cases this can substantially reduce low and line voltage installation costs when compared to centralized control systems where all wiring must be run to a single location. System network wiring consists of inexpensive, easy to install twisted pair communications wire, and system installation is simple and straightforward.

This distributed network of controllers is treated as a single system. The activities of individual controllers can be coordinated to accomplish cross-module control objectives such as irrigation and the efficient distribution of heat from a central supply.

Argus Server PC

Titan systems require a PC to be used as the **Argus Server PC** at the **Access Point** controller location. Other remote PCs can also connect to the control system *through* the Argus Server PC via modem, LAN or Internet. Argus provides the software for these operator access options. This PC should be left running continuously for the best operating performance, uninterrupted remote system access, and to facilitate the automatic transfer of recorded data from the controllers. It should also be used primarily for accessing and managing your Argus system.

A PC is connected to the Titan Access Point Controller and designated as the **Argus Server PC**. Argus provides proprietary software for using this PC to:

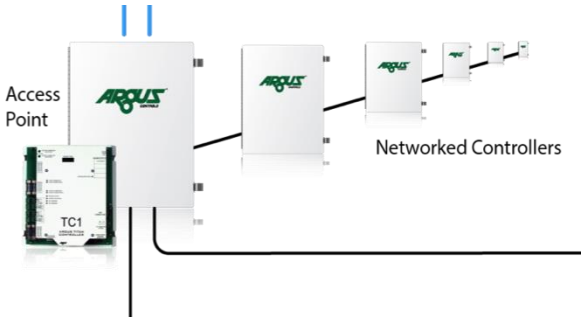
- Provide Operator Access to the connected control system
- Save archival data and back up control system settings to the PC hard drive
- Serve Argus data to other PCs connected as Argus clients via modem, across a local network, or the Ethernet

Argus Server PC specifications (for 2014):

Ram	• 8GB (4GB is sufficient for systems with less than 10 controllers)
Processor	• Quad Core
Hard Drive	• 1 TB 7200 RPM (500 GB is sufficient for systems with less than 10 controllers)
OS	• Windows Professional 7 or 8 or Windows Server 2008 or 2012
Additional Features	• Ethernet, keyboard, mouse, video, sound, modem (for dial-up connections)
Monitor	• 24" HD (1920 x 1080)

PCs that are connected as remote clients can generally provide satisfactory performance with lesser performance specifications than the Argus Server PC. Performance may suffer on machines with slower processors and less than 2 GB of RAM. In general, the Argus Server PC specifications listed above for an Argus system with less than 10 controllers will provide good performance as a Client PC. Note that while the Argus Client/Server software is generally very efficient in terms of bandwidth, it may be affected by very slow Internet connections. **Note:** Windows RT is not supported.

Access Point Controller



Each Titan system starts with an Access Point module, usually located near and connected to the Argus Server PC used for operator access. The Access Point is equipped with a Titan controller and components to facilitate Ethernet connection to the Operator PC, external alarm output relays, an included automatic alarm dialer, a battery for emergency backup power, and power supply circuitry for operating the controller and the first segment of the connected I/O Communications Network.

The Access Point features all the control capabilities of a standard Titan controller, and on smaller installations, may be the only controller required. Additional controllers are added via Argus System Network communications cabling or Ethernet connection.

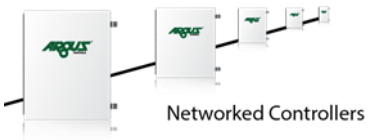
Access Point Features

- **Easy Connection to the PC** – the Access Point controller includes a fast Ethernet connection to the Argus Server PC.
- **Battery Backup and Smart Charging circuitry** – a 12-volt battery provides emergency power for alarm annunciation and external communications with the access point during power outages.
- **Alarm Outputs** – the controller back plane is equipped with four alarm outputs used to provide alarm signals to external annunciation devices such as sirens, lights, or alarm dialers.
- **Industrial Ethernet** - a Phoenix Contact switch is mounted inside the enclosure to connect to the Argus Server PC
- An APC **Ethernet surge protection** device is included to protect the Access Point. There is also space provided for additional surge protection devices if required.

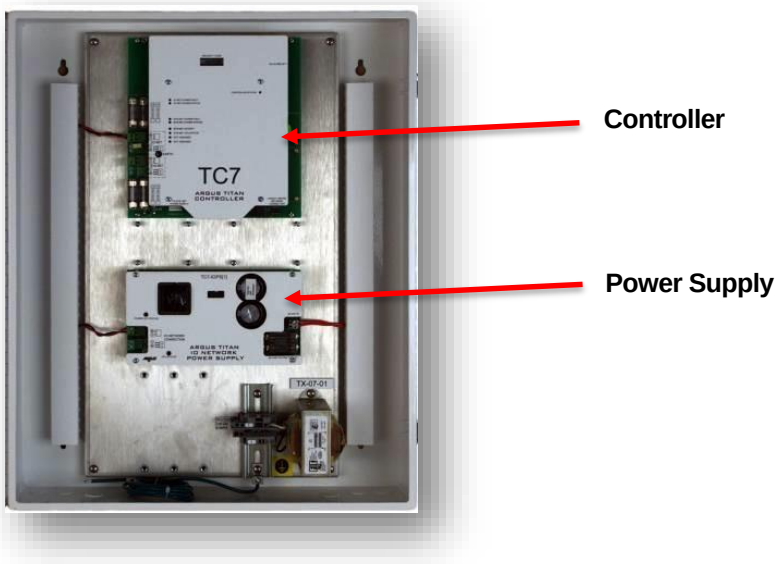
Access Point Specifications

Enclosure	Argus part: **SUB-CL100/NBP** UL type 12, white powder coated aluminum
Enclosure Dimensions	22" x 18" x 4" (H x W x D)
Titan Controller	Argus part: **TTN-CONT-2.0** (includes Ethernet adapter daughter board) See Controller Specifications below.
Controller Back Plane	Argus part: **TTN-CMBP-1.8**
Power Supply	Argus part: **TC-IOPS-1.4** (Titan I/O Network Power supply)
Battery	Argus part: **TTN-CONT/BBU** 12 Volt, 7.2 Amp-Hour sealed lead-acid.
Line Voltage Transformer and Fused Terminal Block	Argus part: **RCC-TX75/TITAN** Input voltage: 120 VAC (line voltage wiring must be supplied to the panel) Output Voltage: 24 VAC, 75 VA
Alarm Auto-dialer	Argus part: **TTN-AD2001** automatic voice pager/dialer
Controller System Network and I/O Network Cable	Argus part number **CAB- 2C18G/TITAN** (West Penn Wire - AQ224): a 2-conductor 18AWG UV and moisture resistant cable suitable for indoor/outdoor use and is direct burial and wire tray-rated. **NO SUBSTITUTIONS – USE OF THIS EXACT WIRE IS CRITICAL FOR PROPER NETWORK COMMUNICATION** **Note:** Controllers can also be connected via **CAT5 Ethernet** pathways. The **I/O Device Network** must use the Aquaseal AQ224 Cable.

Titan 2 Controllers



Additional controllers on the Titan system use a **Basic Controller** configuration. This consists of a Titan Controller on a standard Back Plane with a plate to facilitate mounting into Argus panels A complete controller assembly mounted in a separate enclosure is also available. Basic Controllers do not have alarm contacts, or battery charging circuitry.



Each Titan controller consists of a powerful 32-bit RISC processor with a nonvolatile memory area for program storage. The extensive program features provide the most advanced flexibility and control capability in its class.

The job of each controller is to:

1. Process information from the sensor inputs located on various connected I/O Modules.
2. Execute the on-board control programs according to your current settings.
3. Make equipment control decisions for operating the physical outputs located on various connected I/O modules.

There are no on-board sensor inputs or equipment control outputs on the Titan controllers. All connections to the physical world are performed on one or more slaved I/O modules that perform the input sensing and output signal operations for each controller. This provides the highest degree of control safety, isolation, flexibility, and economy.

Almost any type of equipment can be controlled, including hot water mixing valves and pumps, gas-fired unit heaters, exhaust fans, air circulation fans, modulating vents, thermal and photo period shading systems, HID lighting, CO2 enrichment, crop irrigation, nutrient mixing systems, HVAC equipment, etc.

Titan controllers are typically housed in powder-coated, white, heat reflecting aluminum enclosures, with a hinged, gasketed door that provides a dust and drip-proof seal. They may be mounted alone, or in combination panels along with input/output hardware such as Titan I/O modules, line voltage interfacing, and power distribution. The enclosures are suitable for mounting in almost any location, but should be protected from extreme heat and weather. In areas subject to frequent dripping, we recommend the installation of a protective drip shield above the enclosures.

Titan controllers perform all of the control processing functions for the system. Depending on your needs, your Argus system will use at least one, and perhaps dozens of Titan controllers. These dedicated, interconnected, supervisory control computers can be distributed about your operation as the need requires. The system network is self-configuring and self-monitoring.

All control programs are stored in and executed from the controllers. When you use the Argus operator program to access your system, you are communicating with the controllers. When you are not on line, the Titan controllers automatically operate your controlled equipment in accordance with your settings.

For maximum safety and redundancy, Titan controllers can operate independently from one another, and independent from the Argus Server PC. Each controller is equipped with power failure protected memory for settings and data storage, memory data integrity checks, program execution integrity checks (hardware watchdog), hardware memory protection, an onboard alarm beeper, and protocols to prevent inadvertent corruption of critical settings and data. All programs execute from resident non-volatile program memory.

In addition, each controller contains protection against transient electrical noise and ground potential variations. Power supply fusing and transient clamping devices (varistors) provide further protection. The system constantly monitors the state of all controllers and peripheral Input/Output modules and automatically warns you should any component become erratic or fail. Should this occur, you can quickly restore normal operation without any rewiring using our plug-and-run replacement components. All systems are designed with temporary manual operation overrides in the event of an emergency.

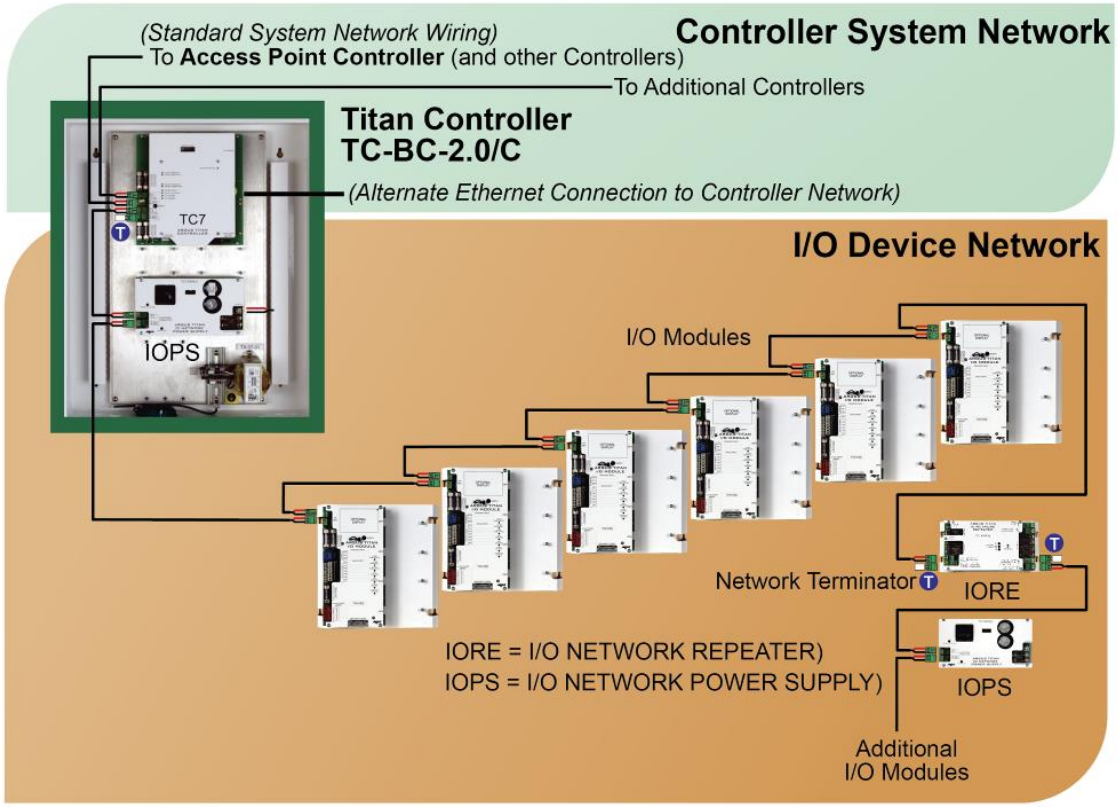
Titan 2 Controller Features

High Capacity	Each controller can manage dozens of independent control processes and a large number of connected I/O devices.
Ethernet Port	Controllers can be connected using standard Argus network wiring or CAT5 Ethernet. Mixed Argus System Network/Ethernet environments are supported to accommodate more flexible wiring topologies. Wired and wireless Domain Bridging can be configured for connecting controllers and groups of controllers in situations where physical or logistical impediments prevent the use standard Argus network wiring. In such cases, new or existing Ethernet pathways can be substituted. The Ethernet port also provides a high-speed connection from the Access Point controller to the Argus Server PC.
SD Card Slot	A removable high capacity SD card slot (4-32 GB) with an included 4 GB SD card is provided for additional on-board buffering of recorded data. This helps prevent loss of recorded data during network interruptions and whenever the Argus Server PC is off-line. Plug-in memory also enables easy firmware updates and board replacements.
Flash Memory	Controllers can receive firmware revisions or updates from any local or remote operator workstation.
Fully Programmable	An extensive depth of control settings and options is provided.
Distributable	Controllers can be distributed throughout the operation for ease of peripheral wiring.
Diagnostics	Continuous self-diagnostics, communication diagnosis, and monitoring of all slaved components for maximum safety and reliability.
Easy Installation	No-wire 'Plug & Run' module replacement courtesy of the included backplane that accommodates all external connections.
Independent operation	Peer-to-peer communications between controllers ensures independent operation.
Backwards compatible	Earlier Argus control system hardware is supported via a legacy communications port.
LED Status Indicators	Used to indicate proper wiring and network operation

Titan 2 Controller Specifications

Panel Dimensions	22" x 18" x 4" (height x width x depth)
Power Consumption	3.75 Watts @ 24VDC (via Titan I/O Power Supply)
Data Storage Memory Backup Power	Lithium battery will hold up memory for approximately 2 years without power (settings are automatically reloaded on power-up)
Program Execution	All programs are executed once each second
Maximum linked controllers per system	64 (more if domain bridging is used)
Program Capacity	Up to 255
Program Storage Memory	4 MB (Flash) + 1 MB (Fast RAM)
Data Storage Memory	1 MB (RAM)
Removable Memory	SD Card Slot (a 4 GB SD card is included)
Power and Data Connections	All connections except Ethernet are provided via the included backplane.
Controller System Network and I/O Device Network Wiring	Argus part number CAB- 2C18G/TITAN (West Penn Wire - AQ224): a 2-conductor 18AWG UV and moisture resistant cable suitable for indoor/outdoor use and is direct burial and wire tray-rated. NO SUBSTITUTIONS – USE OF THIS EXACT WIRE IS CRITICAL FOR PROPER NETWORK COMMUNICATION Note: Controllers can also be connected via CAT5 Ethernet pathways. The I/O Device Network must use the Aquaseal AQ224 Cable.

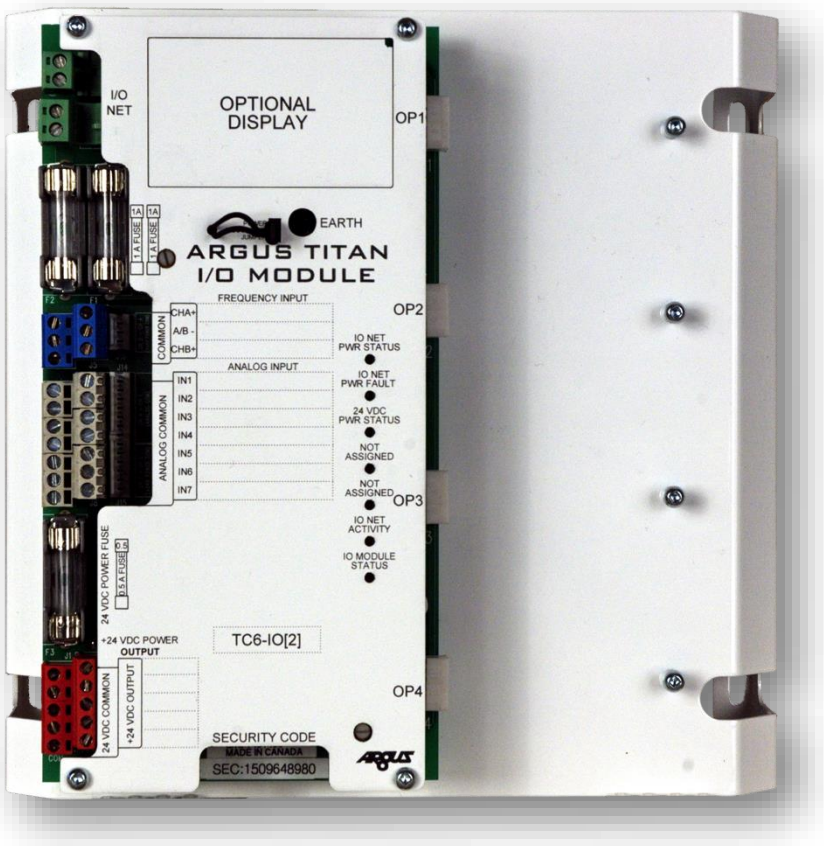
Titan 2 Connection Details



Controller Backplanes

Each Titan controller fits onto a specially designed Backplane. There are different Backplane receptacles for different applications. For example, the controller that is connected to the Local Argus Server PC is provided with a backplane containing dedicated alarm outputs. All of the wires for connecting the controller to the power supply, and various communications pathways are connected to the Backplane. Should a controller ever need replacing, it can be removed without undoing any wires other than unplugging the power connector.

Titan I/O Modules



Titan I/O modules are used to gather sensor information and to provide the physical outputs for equipment control. They can be located remotely, close to the connected sensors and controlled equipment. They are connected to Titan controllers and powered via a 2-wire I/O Communications Network. With more than a million parts of resolution over a 0-5 volt span, Titan I/O modules can be directly interfaced to many sensors that produce signals of only a few millivolts. Nearly any industrial sensor can be connected, although a few special types may require external signal conditioning. This helps reduce instrumentation costs and wiring complexity.

Each output channel is addressable, and can be extensively configured for most types of output signals including digital (including on/off, pulse width modulation, pulse period modulation, frequency), analog, and tri-state floating control. Any combination of Titan Output Relay Boards can be connected to the supplied backplane to provide the appropriate output signals. An optional on-board display unit with operator entry keys is available to monitor readings and change setting values at the control locations.

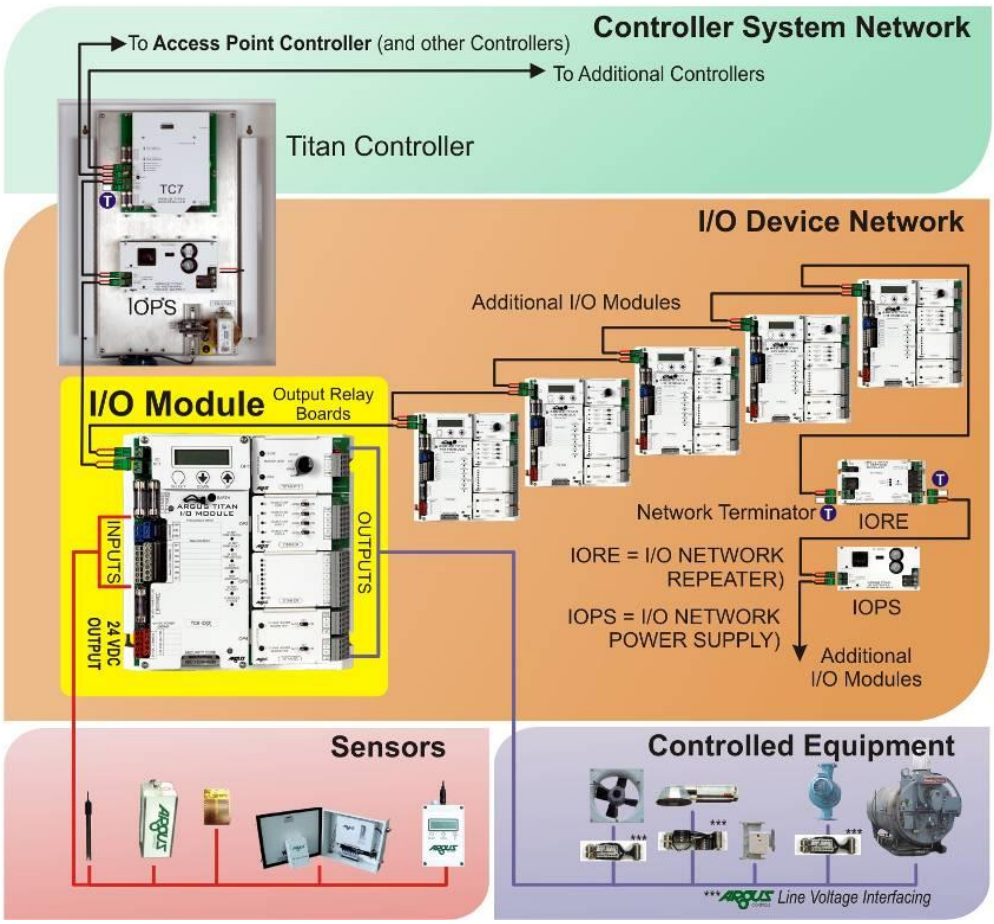
I/O Module Features

'Plug and Run'	No-wire module replacement courtesy of the included backplane that accommodates all external connections
Input Switching	Analog sensor channels can be switched in the software between AC Voltage, DC Voltage, or DC Resistance
High Resolution	Digital frequency measurements up to 50,000 Hz
LED Status Indicators	Indicate proper wiring and network operation
Expansion Capacity	Up to 32 I/O Modules can be operated from a single Titan Controller
Flash Memory	Firmware updates can be performed from any operator workstation
Isolation	Built-in cross-channel interference protection
Consistent Performance	Scan rate does not degrade as a function of system size or load
Low installation and wiring costs	Modules can be located hundreds of meters apart, close to the connected sensors and the equipment they control
Error Detection	Extensive self-diagnostics, error detection, and fault diagnosis for wiring and connected equipment
EMI Choke	Reduces interference generated by devices emitting high frequency 'noise'

I/O Specifications

Dimensions	9" x 9" x 3" (length x width x depth)
Power Consumption	1.5 Watts @ 24VDC (via Titan IO Power Supply module)
Sample Conversion	24-bit A/D, 12 bit D/A
Analog Input Raw Resolution	One million parts over 0-5 volts in 5 microvolt steps.
Output Channels	4 Output Relay Board connectors (OP1-OP4) provide: • up to 8 - 32 discreet digital outputs (depending on the choice of output relay boards to suit each application) • *or* up to 4 tri-state floating (open/close/stop) for reversing motor control • *or* up to 4 analog signal (voltage, frequency or current modes) • *or* combinations of the above
Analog Input Channels	7 universal analog channels, each 0-5 volts. Software-configurable for direct connection of DC resistance, DC voltage, or AC signal devices.
Digital Frequency Inputs	2 channels at up to 50,000 Hz.
I/O Device Network Cable	Argus part number CAB- 2C18G/TITAN: West Penn Wire - Aquaseal AQ224, 2-conductor, 18 gauge cable, suitable for outdoor use (direct burial), indoor trays, moisture & UV resistant. NO SUBSTITUTIONS – USE OF THIS EXACT WIRE IS CRITICAL FOR PROPER NETWORK COMMUNICATION

I/O Module Connection Details



Sensors

Each Titan I/O module has seven high-resolution analog inputs and two high-speed frequency inputs for connection of sensors and other input signals. Virtually any industrial sensor can be connected, although a few special types may require external signal conditioning.

With more than a million parts of resolution over a 0-5 volt span, the Titan I/O module can even accommodate direct connection of sensors that produce signals of only a few millivolts. This can help you save money on expensive signal conditioning circuitry as well as reduced wiring complexity. The Argus Titan system provides on-board gain, offset, temperature compensation, linearization, display scaling, and other sensor specific calibrations to simplify sensor connections and allow the use of lower cost sensors. Many standard sensors used for control applications are available directly from Argus for measuring:

- Air, soil, water, and pipe temperature
- Relative humidity and vapor-pressure deficit (VPD) - wet bulb and solid state
- CO2 – multiplexers and stand alone
- pH
- Electrical conductivity (EC)
- Wind speed and direction
- Rain/snow detection and measurement
- Equipment position (potentiometer)
- Flow meters (liquid & gas)
- Light sensors (including photometric, radiometric, PAR, infra-red, UV)
- Soil moisture
- Weight scales, strain gauges

Sensor input features Include:

- On-board 125 mA, 24-volt DC power supply can be used to drive 4-20 ma loop-powered sensors such as pressure transducers, soil moisture tensiometers, CO_2 Sensors, and remote infrared temperature sensors.
- Direct connection of isolated voltage source sensors in the 0 - 5 volts range without external signal conditioning. This includes sensors such as PAR and Pyranometers that produce full-scale output signals in the 10 – 20 millivolt range.
- The control software supports configuration of a wide range of custom sensor types and brands through generic linearization routines, slope, temperature, and other offset compensation routines.
- Thermocouple suppor**t** - direct connection and configuration of thermocouple types: B, E, J, K, N, R, S, & P, resolvable to 0.1 degree C and +/- 0.1 degree ‘noise’ with short term filtering. Thermocouples can be referenced to an onboard temperature sensor or an optional high precision cold junction temperature reference installed on one input channel. Measurement accuracies are constrained by thermocouple limits and cold junction compensation temperature errors.
- Dedicated digital frequency inputs – two per module. These can be used for on/off pulse counting applications.

Omni Sensors

Omni-Sensors were developed to resolve many issues relating to the measurement of the most common climate parameters used in horticultural production. In particular, the Omni-Sensor applies our very successful strategy of heating the RH sensor in high humidity environments to protect it from condensation induced errors and damage. Compared to unheated solid-state RH sensors, this technique offers extraordinary accuracy and sensor life over the range of humidities common in horticultural environments. Omni Sensors are available in a range of models and features:

Model:	Temperature	Relative Humidity	Light	On-Board Display
SEN-OSM/C	✓	✓	✓	✓
SEN-OSM/RHT	✓	✓		
SEN-OSM/T	✓			

SEN-OSM/C

SEN-OSM/RHT & SEN-OSM/T

Omni Sensors are compact and easily interchangeable measuring stations for indoor applications including greenhouses and growth chambers. A simple 2-wire cable is used to connect them to any available Titan I/O module, and since the communications cable also supplies the power, there is no need for an additional power source.

The Omni-Sensor uses a single digital channel on a Titan I/O module *leaving all the analog inputs available for other uses.*

Dimensions (all models)	4.9" x 3.3" x 2.1" (HxWxD)
Power Requirements (all models)	Power is provided by the connected **I/O Module** via the 2-wire connection.
Cabling (all models)	Factory cable is provided with an easy-to-use Micro-Con-X connector When ordering, specify the length required. Cable can be extended using 2-conductor 18-24 AWG approved sun/UV-resistant cable. A blue **Omni-Sensor Input Protection Board** (part #: **TTN-IPB/OMNI**) is provided with each sensor and must be installed on the I/O Module input as shown. Wiring details are provided with each unit.
Display (SEN-OSM/C only)	2 line, 16 characters reflective. 0 – 50 ºC operating range
Temperature Sensors	Solid-state digital sensors. Factory calibration accuracy of better than 0.2 ºC over the working range of 0 to +50 ºC.
Humidity Sensor (all models except SEN-OSM/T)	Range: 10-100% non-condensing Accuracy: 10-20 %RH: +/- 4% ; 20-180 %RH = +/- 1.8%; >90 %RH: +/- 4%
Light Sensor SEN-OSM/C only	**Note:** This is an uncalibrated light sensor intended as a general sensor for light/dark differentiation (lights on/off, shade pulled, etc.) For accurate light measurement and quantification Argus can provide separate PAR and Pyranometer sensors.
Operating Temperature	0-50 ºC (Tested and calibrated to work from -20 to +40 ºC) *Not suitable for use in extremely cold environments.*

Control Outputs

The Argus Titan system provides specialized output signals tailored to the equipment being controlled. Output relay boards are selected and configured according to the application

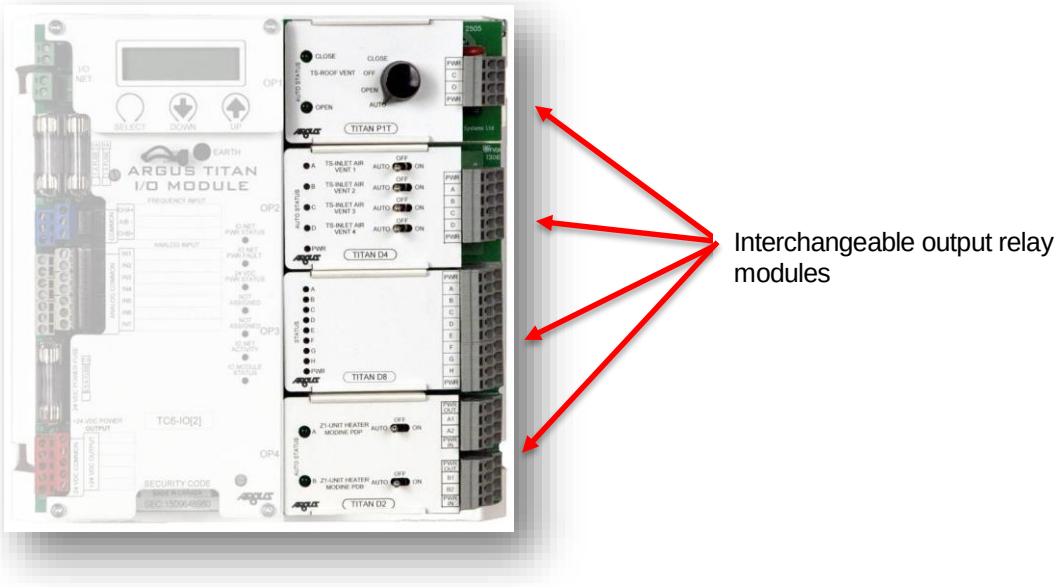
Output Relay boards connect directly to the Titan I/O Module. Each I/O module can accommodate up to 4 interchangeable relay boards providing for simple and efficient configuration of the output signals required by different types of equipment. These boards include the appropriate field wire terminations, status indicators lights, and most include manual overrides for testing and emergency operation.

All output control on the Titan system is designed to operate as Class-2 low-voltage equipment. This maximizes safety, reduces wiring costs, and is compatible with most greenhouse control equipment. Separate line voltage interfacing equipment is also available to convert low voltage control signals into line voltage power (for more information please see the Argus Line Voltage Interface Equipment Data Sheet).

Each I/O module contains 4 output connectors. Each of these connectors is addressable, and can be extensively configured for any type of output signal. Special output relay modules are connected to the outputs to provide the appropriate signal for the type of equipment being controlled. Depending on the application, each I/O module can operate between 4 and 32 discreet outputs. The I/O module software provides for precision calibration of each output. Once connected to the I/O Network, each I/O Module is operated by a corresponding I/O Module Program running on the Controller to which it is connected.

Output Relay Modules

The Argus Titan system uses specialized output signals tailored to the equipment being controlled. Output relay types are selected and configured according to your particular equipment configuration. All output control is designed to operate as Class-2 low-voltage equipment. This reduces wiring costs (and you can do it yourself) and is compatible with most greenhouse control equipment. Low-voltage wiring (24V, AC) is also safe, allowing you to safely open the enclosure and use the manual overrides in an emergency. Connectors on the I/O Module Backplane provide for simple configuration of output signals by using different types of plug-in Output Signal Boards. These boards include the appropriate field wire terminations, status indicators lights, and manual overrides.



Output Signal Types:

Digital Control - This includes standard ON/OFF control and equipment that is operated by low frequency digital pulsing strategies such as pulse width modulation and pulse period modulation. Form 'A' and Form 'C' contact configurations are available. For simple digital applications such as irrigation valves, special relay boards are available to increase the number of addressable On/Off outputs to up to 32 per I/O module.

2-speed – A special output relay board is available to provide mechanically interlocked low and high-speed control signals for 2-speed fans and motors.

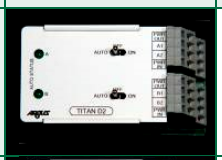
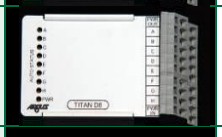
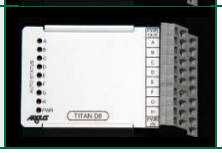
Tri-State Floating Control - These relays provide safe, proportional, reversing motor control for equipment such as motorized roof vents, louvers, and shade curtains.

Analog Control - Argus provides an extremely versatile high resolution analog output module for equipment that requires variable current, voltage, or frequency signals to control proportional equipment such as analog valves, speed controllers (VFD), etc.

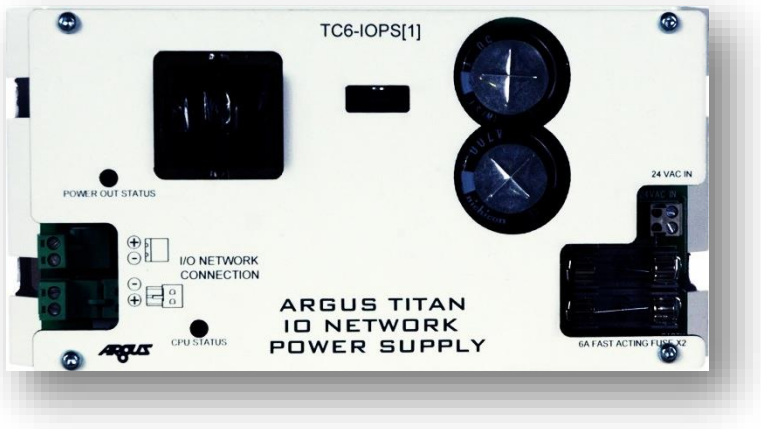
Special Applications – Other output boards are available for specialized control applications such as sensor multiplexing.

Note: Titan controllers also support serial communications including Modbus.

Titan Output Relay Selection Table

Part Number	Dimensions for all Modules: 4" x 2" x 1 ½" (LxWxH)	Description	Control Signal Type	Manual Override Positions	Contact Ratings	Shared Common Buss	Field Isolation	Typical Applications
TTN-D2-1.0/C		Digital (2 x Form A) Dry or Wet contacts	ON/OFF; PWM+/-; PPM+/- (1 second Pulse Resolution)	ON OFF AUTO	3.2 A @24V AC/DC 5 A @12V AC/DC	×	5000 V	Independent control of up to 2 ON/OFF devices. Control of equipment that can be digitally modulated using Pulse Width Modulation, Pulse Period Modulation, or Soft Start Pulsing
TTN-D2C-1.0/C		Digital (2 x Form C) Dry or Wet contacts	ON/OFF (Open/Close)	ON OFF AUTO	3.2 A @24V AC/DC 5 A @12V AC/DC	×	5000 V	NC or NO signals for control of up to 2 ON/OFF Devices. Interlocked signals for up to 2 Power Open/Power Close valves or drive motors.
TTN-D4-1.0/C		Digital (4 x Form A) Wet contacts	ON/OFF	ON OFF AUTO	3A Max @ 24V AC/DC (max 4.2 amps per board)	✓	5000 V	Independent control of up to 4 ON/OFF devices i.e. lights, Irrigation valves. (From one common power source)
TTN-D8-1.0/C		Digital (8 x Form A) Wet contacts	ON/OFF	×	3A Max @ 24V AC/DC (max 4.2 amps per board)	✓	5000 V	Independent control of up to 8 ON/OFF devices i.e. lights, Irrigation valves (no ob-board manual overrides). (From 1 power source)
TTN-D1S-1.0/C		Digital 2 Speed Electrically Interlocked	ON/OFF	HIGH LOW OFF AUTO	3.2 amps @ 24V 5 amps @ 12V AC/DC	✓	5000 V	Control of one 2-speed fan or motor
TTN-P1T/IC		Digital 2x Form A Isolated Common	Tri-State Floating	CLOSE OFF OPEN AUTO	3.2 amps @ 24V 5 amps @ 12V AC/DC	✓	5000 V	Control of one Tri-State Floating (OPEN/CLOSE/STOP) reversing motor (i.e. vents, shade curtains, mixing valves)
TTN-P1T-1.0/C		Digital 2x Form A Electrically Interlocked	Tri-State Floating	CLOSE OFF OPEN AUTO	3.2 amps @ 24V 5 amps @ 12V AC/DC	×	5000 V	Control of one Tri-State Floating (OPEN/CLOSE/STOP) reversing motor (i.e. vents, shade curtains, mixing valves)
TTN-P1A-1.2/C		Analog 1x	0-20 ma current 0-10V 0-5V Frequency PWM (0.001 second Pulse Resolution)	Manual (0-100%) AUTO	Sinking: External 24 VDC (isolated) Sourcing: On-board 24 VDC (isolated)	✓	1500 V	Modulating Analog control of proportional output equipment
TTN-D8/MUX-8X1		Digital Input Multiplexer 8 x 1 Dry contacts	ON/OFF	×	10 microamps to 3A Max @ 24V AC/DC	✓	5000 V	Multiplexed sensor applications: 8 dry contact relay inputs sequentially multiplexed into a single output.
TTN-D8/MUX-4X2		Digital Input Multiplexer 4 x 2 Dry contacts	ON/OFF	×	10 microamps to 3A Max @ 24V AC/DC	✓	5000 V	Multiplexed sensor applications: 4 independent groups of 2 dry contact inputs sequentially multiplexed into 2 outputs.
TTN-D8/MUX-3.0V		Digital Input Multiplexer 8 x1 3V Power Dry contacts	ON/OFF	×	10 microamps to 3A Max @ 24V AC/DC	✓	5000 V	Multiplexed sensor applications: 8 relay inputs provide 3V VDC on-board excitation for sequential switching of up 8 soil moisture probes (or similar sensors) into a single multiplexed output.

Power Supply Modules



Specially designed Titan power supply modules are used to provide combined module power and I/O network communications over a two-conductor twisted pair wire. These regulated power supplies feature intelligent fault detection and automatic reset capabilities. They automatically protect the controllers and I/O modules from short-circuits, faulty wiring, lightning, utility power surges, and brown-outs. This significantly enhances the overall robustness and reliability of your control system.

Each power supply module can power up to eight control modules (up to eight I/O Modules, or one Titan Controller and 7 I/O Modules). Since they also provide the power to slaved I/O modules over the same communications wire, it is possible to locate I/O modules at a significant distance from line power sources. This can greatly simplify and reduce the installation costs for managing outdoor irrigation valves and locating remote sensor arrays such as weather stations.

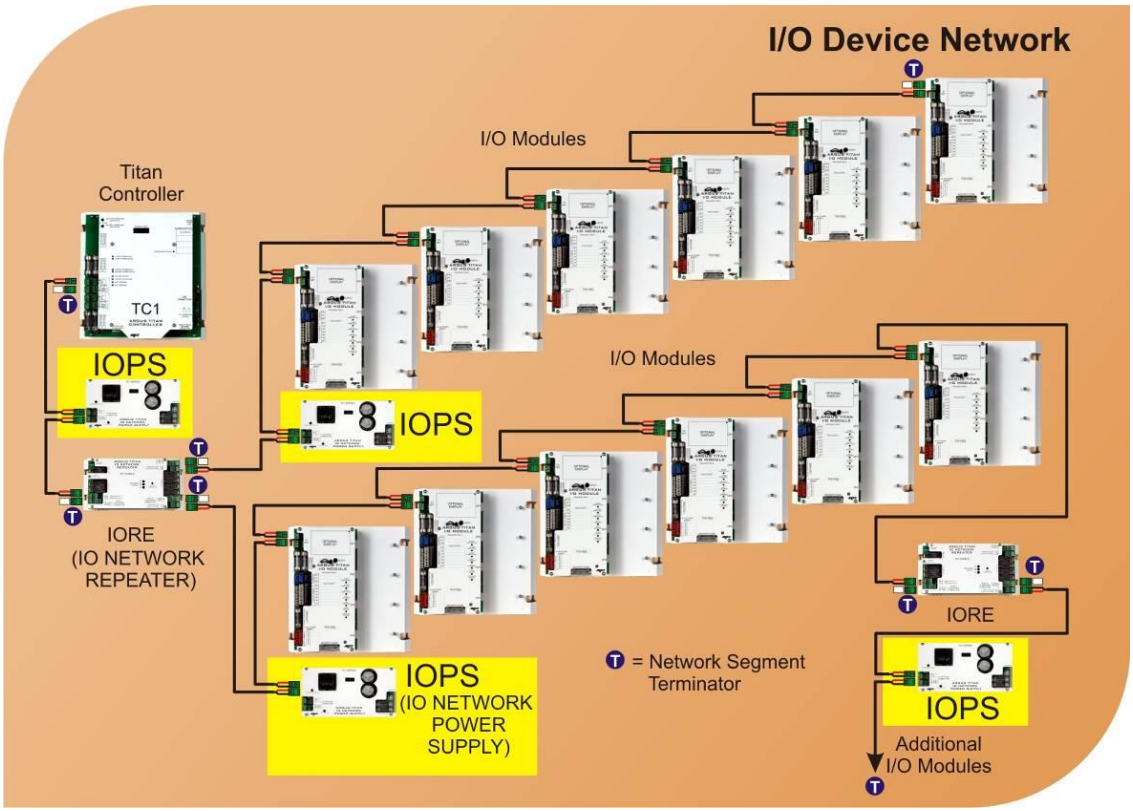
Features:

Over Voltage Protection	Power supply will switch off and visibly indicate when input voltage is greater than 32VAC.
Zero-voltage turn-on	Reduces inrush current that may cause interference to the environment and the microprocessor.
Short-Circuit Protection	The IOPS will switch off when the output is shorted to prevent the fuse from blowing.
Over-current Protection	Intelligent programming detects an accumulated over-current condition and will switch off supply to protect components from overheating.
Zero-current turn-off	Reduces inrush current that may cause interference to the environment and the microprocessor.
Automatic recovery	The IOPS will attempt to resume power delivery after a error condition is detected and continue to repeatedly test for removal of the error before switching on.

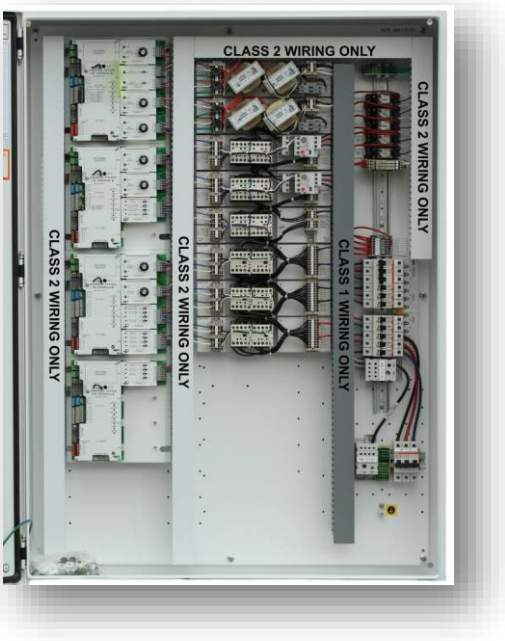
Specifications:

Dimensions	8" x 4 1/2" x 1 1/2" (length x width x height)
Power Requirements	24VAC 75VA transformer (Class II) - i.e. Argus Part # RM-2TX75
Max. Operating Power Output	50W (29VDC @ 1.7A)
Max. Peak Power Output	60W (27VDC @ 2.2A)
Min. Input Voltage	24VAC
Max. Input Voltage	32VAC
Max. Current Load	2.2A (@ 27VDC)
Power Output Type	Current-limited switching power supply
Temperature Range	0 – 50°C

Connection Details:



Line Voltage Interfacing



Argus can provide custom engineered combination panels containing the Argus Titan control hardware along with prewired power distribution and line voltage relays matched to the controlled loads. Combination panels are well suited to new construction and major retrofits. They can be situated in centralized power rooms or distributed throughout your facility in close proximity to the controlled equipment. A selection of standard relay interfacing modules is available to suit most applications. For special applications, custom relays and motor starters can also be provided.

Features

- Space saving 'all-in-one' design.
- White, powder-coated Nema 4 enclosures are heat reflective, and water resistant. Nema 4x panels are also available where enhanced corrosion resistance is required.
- Panels are engineered to maintain proper separation between Class 1 and Class 2 low voltage equipment and wiring:
    - Class I and Class 2 components and wire-ways are clearly marked, color coded, and segregated within the panels for maximum safety and isolation of sensor and communications cabling from potential sources of electrical interference.
    - A segregated Class 2 ↔ Class 1 Translation Area facilitates the field installation of power transformers, isolating relays, contactors, and motor overloads where required.
    - A Class 1 power distribution section accommodates the fuses and breakers required to distribute power and protect all wiring.
- Meets NEC, CEC & UL standards
- Line voltage relay modules are factory matched to each load.
- Panels are carefully engineered to ensure proper grounding and protection of all internal components when connected to a good earth ground.

SOFTWARE FEATURES

Our design goal is to provide control systems that are as powerful and flexible as possible that can be successfully used by operators without any advanced skills in computing or industrial control. For the most part, system users are shielded from the complexity of equipment automation, and daily activities are abstracted to the setting of control targets and reviewing control performance. Extensive monitoring, self-diagnostics and redundant alarms enable true 'management by exception' where the control system watches over all processes including its own, and only alerts operators when a problem occurs.

Titan systems are configured using a proprietary suite of pre-built control applications that have been designed for specific equipment types such as mixing valves, shade curtains, and ventilation systems. These applications contain a large number of options for tuning the control responsiveness to the capabilities of your equipment. They also contain many safety limits and overrides to protect your facilities from improper operation. In addition, we provide an array of highly configurable generic program modules for developing custom applications. Whenever you have special control requirements beyond the scope of our standard modules, we create custom applications from these generic programs.

One advantage to using the Argus Titan system for custom control applications is that all program setup and configuration is performed at run-time using our pre-built, pre-tested logic modules. There is no need for off-line compilation and debugging.

In keeping with the flexibility of the Titan control system, the Argus operator software offers substantial user customization capabilities. You can design and customize your own overview screens and create a navigation system that best suits your needs. Each user of the system can develop a personal screen system for managing the entire control system or their own sections of the controlled operation. In addition, a factory built screen system is always available to display all programs and parameters that are currently in use.

Firmware (controller programming)

Titan firmware is software responsible for real-time control residing in the Titan controllers. It includes standard, comprehensive modules for managing environments, irrigation systems, and nutrient control applications, as well as a powerful suite of generic programs for configuring custom equipment control. All Titan systems feature quick and easy configuration to match your requirements. The system is self-monitoring with an extensive array of fail-safe and fail-soft features for maximum safety and reliability.

Most equipment control applications feature alarms and conditional safety limits and overrides to suit your situation. All programs are managed and continuously monitored by their respective controllers for the highest reliability and safety. Program execution does not degrade as a function of system load. This ensures that all time-critical sensor readings and output responses are performed instantly.

In most cases your system will arrive with the control programs already fully configured for your applications. Your system ships with a full set of control programs, including many that you may not currently need. Should your needs change, we can usually adjust your program configuration on-line using the program set already provided with your controller.

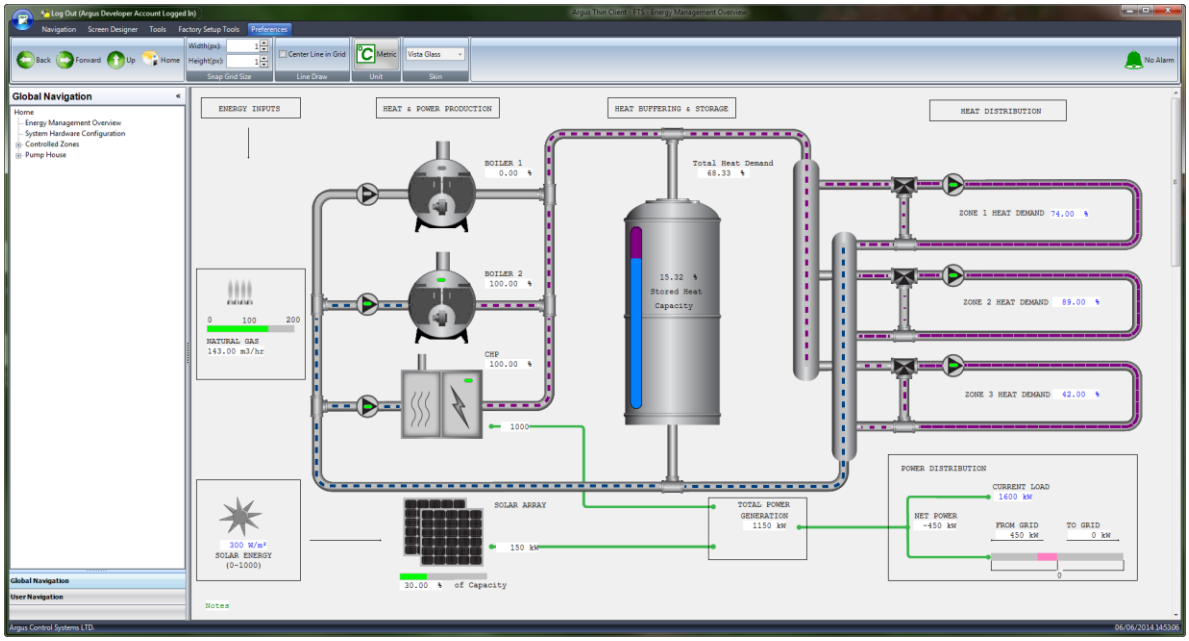
Open-Ended Applications

The unique architecture of the Argus Titan hardware and software provides unparalleled flexibility in configuring custom control applications. Aside from the standard equipment control capabilities available in many competing systems, the Argus Titan system contains a suite of generic control modules that make it easy to provide custom control logic and custom sequences of operations. Unlike other systems this can usually be accomplished on-line and at runtime without the need to recompile any code or understand arcane programming languages and no possibility of syntax errors and other program coding problems. With this 'second tier' programming architecture, real-time configuration and testing is possible, greatly speeding up applications development all in a plain language format.

Updates and Revisions

Minor revisions and bug fixes are always provided for free. Occasionally, Argus will release a major revision to our control program set. These upgrades are reasonably priced, and are always optional. We will update your entire control system using our on-line flash update procedures. This completely eliminates the need for changing out EPROMs and other hardware memory components.

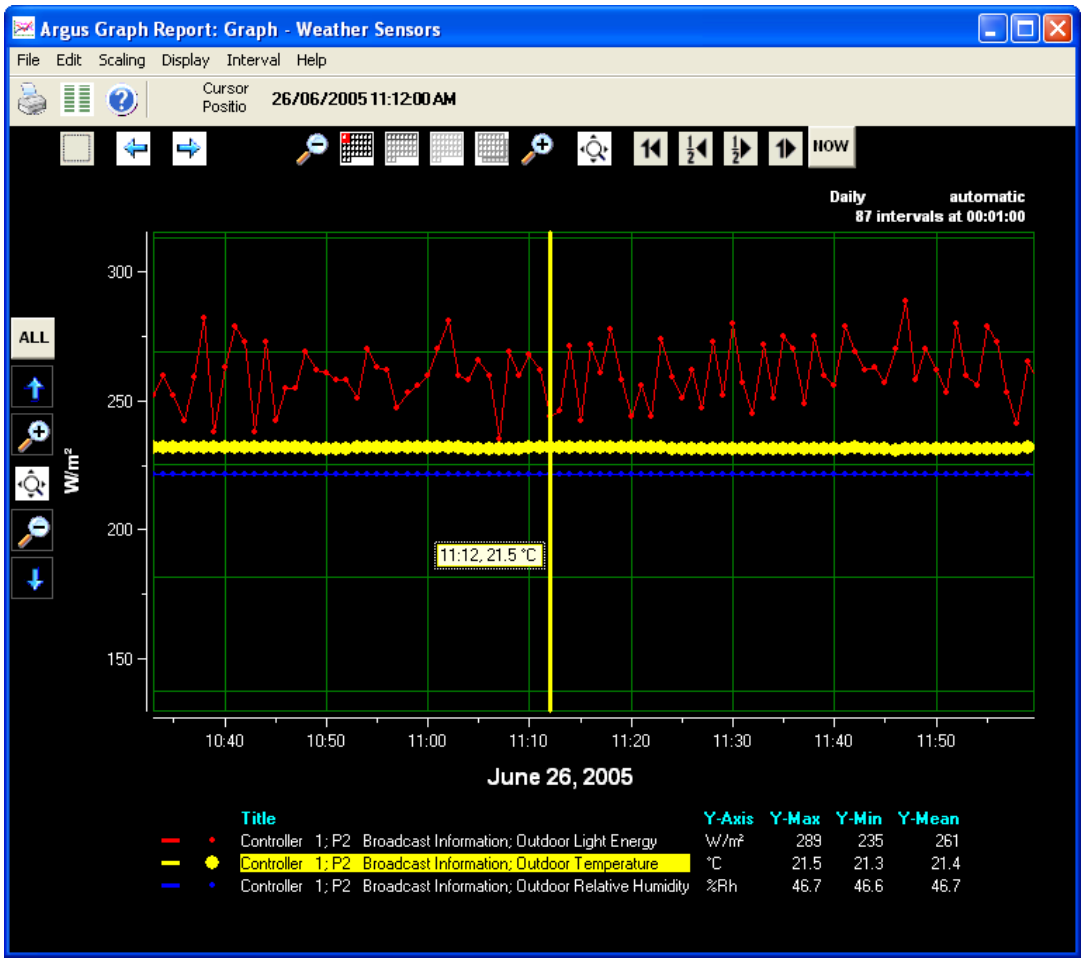
Argus Operator Program



The Argus operator program is used to access the control system from a local or remote PC. The program contains a wealth of features for managing and monitoring equipment, controlled processes and environmental conditions. Each site is custom configured to match the physical layout of your facility, your equipment systems, and your control and monitoring applications.

Argus Graph

The Argus graph is a full featured graphing utility for viewing and comparing recorded data from your control system.

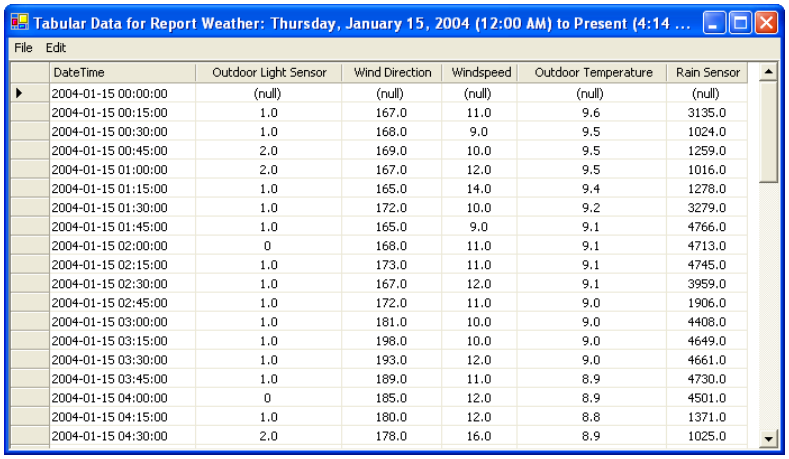


The Argus Graph enables you to get the most from your recorded data. Featuring graphical and tabular views, not only can you visualize the effects of present readings and settings on your system, but you can see how these values are changing over time. You can track the cause and effect relationships between such environmental parameters as light, heat, and humidity, and the effects of the equipment control actions that your system is taking to achieve your targets.

Features of the Argus Graph

- You can view any recorded data anytime, by simply starting the graph and selecting recorded parameters directly from your screens.
- Jump to any date by using the **Time Buttons** and the **Data Cursor**. The **Daily**, **Weekly**, **Monthly**, and **Yearly** preset time scales have been retained.
- Arrow 'history' buttons take you back to previous views and forward again.
- You can zoom and pan the timescale directly.
- You can make and save any number of custom **Data Recording Reports.** These are fully preconfigured graphs that you can recall at any time.
- Create **Shortcuts** to individual Data Recording Reports and place them anywhere on your system screens.
- Up to 64 parameters can be viewed and saved in each **Report**. The display of individual parameters in graph reports can be toggled 'on' or 'off'.
- There are numerous controls for manipulating graph data channels singly or in groups.
- Manual scaling values can be saved with reports.
- Auto-fit to data and zoom to fit data display options.
- Line and background colors can be configured and saved.
- The graph window is resizable. When a graph is opened it can float independent from the main Argus window.
- Graph values are updated automatically, based on the present zoom level.
- Interactive **Data Cursor** displays value and time for selected parameters.
- Optional **Data Legend** can be toggled on and off.
- Off-scale data icons help you to find data channels that are not visible in the current **Y-axis** view

Graphed information can also be displayed in tabular form:



DateTime	Outdoor Light Sensor	Wind Direction	Windspeed	Outdoor Temperature	Rain Sensor
2004-01-15 00:00:00	(null)	(null)	(null)	(null)	(null)
2004-01-15 00:15:00	1.0	167.0	11.0	9.6	3135.0
2004-01-15 00:30:00	1.0	168.0	9.0	9.5	1024.0
2004-01-15 00:45:00	2.0	169.0	10.0	9.5	1259.0
2004-01-15 01:00:00	2.0	167.0	12.0	9.5	1016.0
2004-01-15 01:15:00	1.0	165.0	14.0	9.4	1278.0
2004-01-15 01:30:00	1.0	172.0	10.0	9.2	3279.0
2004-01-15 01:45:00	1.0	165.0	9.0	9.1	4766.0
2004-01-15 02:00:00	0	168.0	11.0	9.1	4713.0
2004-01-15 02:15:00	1.0	173.0	11.0	9.1	4745.0
2004-01-15 02:30:00	1.0	167.0	12.0	9.1	3959.0
2004-01-15 02:45:00	1.0	172.0	11.0	9.0	1906.0
2004-01-15 03:00:00	1.0	181.0	10.0	9.0	4408.0
2004-01-15 03:15:00	1.0	198.0	10.0	9.0	4649.0
2004-01-15 03:30:00	1.0	193.0	12.0	9.0	4661.0
2004-01-15 03:45:00	1.0	189.0	11.0	8.9	4730.0
2004-01-15 04:00:00	0	185.0	12.0	8.9	4501.0
2004-01-15 04:15:00	1.0	180.0	12.0	8.8	1371.0
2004-01-15 04:30:00	2.0	178.0	16.0	8.9	1025.0

For more Information on the Argus Graph, please refer to the Argus Graph Operator Manual.

SYSTEM CAPABILITIES

What can an Argus Titan system do for you?

An Argus Titan system can manage and monitor every aspect of environmental control. It can co-ordinate and integrate the activities of all controlled equipment ensuring that they operate efficiently and in harmony with your current control objectives. It accommodates changes in the crop and weather while monitoring, recording, and reporting on current conditions, and raising alarms if things go wrong. When matched with the right structures and equipment, an Argus Titan system can create and maintain a precision growing environment despite constantly changing external conditions such as temperatures, humidity, and light.

The Argus Titan system can also meet the needs of the crop by controlling CO_2 levels, irrigation, chemical treatments, and nutrient concentrations. It continuously monitors all growing environments and equipment operations and reports on the consumption and supply of resources such as water, electricity, heat, and equipment operation hours. The system maintains a detailed history of your operation so you can get accurate reports whenever you need them. In all cases, the controlled equipment must be properly installed and serviced. In particular, there must be a good match between the capacity and response of the equipment and the tasks they are expected to perform.

The following sections explain some of the control capabilities for protected cropping in greenhouses, conservatories, growth chambers, growth rooms, aquaculture, Aquaponics and any other facilities with similar control requirements. They also illustrate the direct connection between the grower's objectives, the physical equipment design, and the computer control strategies that are required. These examples are by no means complete but should provide some insight into the approaches Argus uses to solve problems in equipment control.

Climate Control

Argus configures each control system to your specifications and needs. Each controller is capable of managing several climates. However, the actual number of managed zones per controller depends on:

- the complexity of each climate
- the physical layout of the operation
- the number of controlled equipment systems
- the level of control separation and redundancy required

Climate control is one of the most common applications, and one of the most complex. The Argus Titan system provides extensive climate control capabilities and features including:

Scheduling

Argus provides several ways to schedule climate targets in advance. Diurnal (24 hour repeating) and multi-day strategies can be used individually or in combination to program your growing environment for the changing needs of the crop over time. Any climate targets can be scheduled including heating, ventilation, and humidity levels. The targets can be fixed settings or they can be dynamically adjusted by other conditional control logic. For example, heating targets can be automatically adjusted in relation to current or recent light levels. To control energy costs, you can also define resource rationing limits for activities such as dehumidification.

Energy Balance Calculations

The Argus Titan control system constantly evaluates greenhouse and outdoor conditions and grower established targets to develop the best possible strategy for control. It accurately predicts the energy balance for a given heating zone and manipulates the heating and/or cooling equipment to maintain this balance. The computer system 'looks ahead' and reacts to changes in conditions that will result in errors and target deviations if not corrected. This is far superior to waiting until a deviation has occurred before making changes.

Temperature Management

Climate air and media temperatures must be controlled to produce the correct growing environment. Extensive heating and ventilation equipment control programs are available to manage all types of systems including:

- Central or distributed heating management
- Water or steam from central heating plants
- Forced air
- Infra-red
- Electric
- CO_2 Flue Gas Recovery & Heat exchangers
- Waste heat and geothermal sources
- Solar storage and recovery systems
- Heated/Chilled ground beds
- Compartmentalized heating zones and beds
- HVAC systems

During the configuration process, we work with you and your heating system supplier to make sure that your equipment is operated in the safest, most efficient manner, according to the manufacturer's recommendations. Even if your heating plant comes with packaged controls, we can provide improved heating system management by efficiently interfacing these stand-alone systems with the heat distribution system.

Our flexible programs can be used for:

- Intelligent staging of boiler firing as a function of return water temperature relative to the design "Delta T"
- Boiler or unit heater rotation for equipment 'wear leveling'
- Pipe temperature management (mixing valve control)
- Modulating burner systems
- Return temperature limiting to protect against boiler shock
- CO2 extraction
- Heat storage and recovery
- Cogeneration (combined heat & power applications)
- High temperature cutoff in conjunction with boiler safety limits
- Control of cycle times to prevent excessive wear on equipment

Argus SmartHeat

You can also use this program when you want to automatically modify the value of a Target parameter (such as a Heating or Cooling target) based on an accumulated multi-day average.

A SmartHeat multi-day integration strategy enables you to manage your climates in a manner that can compensate for prior conditions. For example, a SmartHeat strategy allows you to offset the gains made by crops on warm, sunny days by automatically lowering target temperatures on subsequent days. This approach is based on the assumption that there is a strong correlation between average daily temperatures (ADT) and net plant growth.

For example, the maximum growth rate (rate of photosynthesis) for many greenhouse plants is often attained at temperatures that are quite a bit warmer than it is economic to maintain with purchased energy. With a SmartHeat strategy you can take advantage of good weather by allowing the sun to boost temperatures well above your heating setpoints to their optimum level. This will create a heat 'surplus' as measured against your setpoints and average daily temperature targets. As a surplus accumulates, the program will automatically reduce the heating target by a specified amount in relation to the surplus amount. Whether or not the climate temperature is actually reduced depends on the weather. For example, on warm sunny days, the climate may continue to accumulate a heat surplus despite a reduced heating target. However, on cooler, duller days the climate temperature will be reduced until the surplus has been exhausted.

There are two potential benefits to this type of strategy:

1. It can help to maintain your target ADT. This in turn will help keep the crop on schedule.
2. It can help maximize the benefits of solar heating while minimizing the use of purchased heat energy.

Although we call it 'SmartHeat' this program can be used with both heating and cooling operations. Other non-heating applications are also possible. Each Equation is designed to average and accumulate a specific value. It maintains running totals and daily averages for each of the last 7 days, as well as multi-day combined averages and totals. These averages can then be recorded and used as the basis for triggering alarms and other control events.

Air Exchange

Greenhouse ventilation must be controlled to remove solar heat, to reduce relative humidity, and to provide additional moisture absorbing capacity for evapo-transpiration and evaporative cooling systems. Ventilation also supplies carbon dioxide for plant growth during daylight hours. All types of ventilation equipment are supported including:

Passive roof and sidewall vents – fully modulating, wind direction compensated control with safety limits and overrides for high wind speeds, and rainfall. To protect your vents, your structure, and your crop from the effects of strong winds, the control system constantly monitors the current outdoor conditions and will close or limit the vent openings in extreme conditions. To maximize air exchange and cooling precision, the system can compensate for the effects of wind speed and wind direction by managing windward and leeward vents separately. Features include:

- Full span modulating control (0 -100% opening)
- Reaction tables to accelerate or decelerate vent opening with respect to ventilation required
- Rain position opening limits
- Separate cooling and dehumidification settings
- Evaporative cooling position
- Wind speed lockout
- Wind lockout release rates
- Windward/leeward control
- Low temperature opening overrides for "winter freeze up" protection
- Time and position based vent movement
- Vent compensation settings to compensate for reduced air exchange when energy curtains are deployed
- Spray program overrides
- Minimum crack settings
- Additional overrides, limits, and operating logic as required

Open Roof Structures – These structures are operated differently from conventional roof vents. In general, they take longer to open and close, and tend to be operated less aggressively. The Argus Titan system can provide safe, optimum operation for these types of structures while respecting the limitations of the equipment.

Exhaust Fans – including sophisticated staging and fan rotation programs for multiple fan applications. With the Argus Titan system, you can use a variety of control strategies to operate ventilation fans. In climate control situations, the operation of the ventilation fans is coordinated with your heating system to maximize energy efficiency. For multi-fan applications, the Argus Titan system regulates the operation of fans based on the current calculated ventilating requirement. Fans can be operated individually or in groups to achieve varied ventilation rates. Each fan can be controlled using a simple ON/OFF strategy, or with pulse width modulation (PWM). With PWM control, the control system regulates the on/off times as well as the number of fans operating to precisely match the current cooling or dehumidification requirements. This results in exceptional temperature control precision. Fan operation can also be coordinated with evaporative cooling pad(s) systems. Typical features include:

- Fully user customizable multi fan output grouping and staging
- On/Off control
- Multiple speed control
- Variable speed control
- Evaporative cooling settings
- Pulse width modulation (PWM) control
- Minimum on/off time fan cycling protection
- Spray program interlock settings
- Additional overrides, limits, and operating logic as required

HVAC systems - Argus Titan systems are capable of managing all types of heating ventilation and air conditioning systems typically found in commercial buildings, and research facilities. In situations where other control systems are in place (for example, providing central heating and cooling water resources), our systems are capable of signal interlinking for coordinated operation.

Humidity Management

Almost every activity in a greenhouse has an effect on humidity. Some examples are:

- ventilation rates
- indoor/outdoor temperature differences
- transpiration
- evaporation
- short term temperature changes
- carbon dioxide burners
- curtain systems

Control of relative humidity is extremely important in the production of most crops. Greenhouse humidity may need to be controlled by use of heating and ventilation (to reduce humidity) and humidification systems to supplement the evapotranspiration from soil and plants to help meet the climate temperature, vapor-pressure, and relative humidity targets.

The Argus Titan system can operate your heating and ventilating equipment to simultaneously mange temperature and humidity. At the same time, it can manage evaporative pad and fan systems, as well as misting and fogging equipment to achieve your humidification and cooling objectives. The operation of these systems is integrated with your other climate management equipment to ensure fully coordinated operation of all devices.

Typical dehumidification options include:

- Selection of heating, ventilation, or a combination of strategies
- Heating and ventilation energy resource allocation to limit dehumidification costs

Typical humidification and cooling control options include:

- Time windowing
- Operator configurable diurnal humidity and fixed VPD (vapor pressure deficit) setpoints
- Intelligent integration of evaporative cooling with standard ventilation techniques
- Minimum on and off time matched to your equipment operation specifications
- Evaporative cooling opening limits on roof vents
- Integration with other climate control equipment systems

Equipment Operation

Each equipment system has operating requirements imposed on it by its design and the way it must interact with other equipment. Although these requirements often limit the ability of the control system to instantly execute corrective measures they must be recognized and dealt with to protect the equipment. The Argus Titan system not only addresses direct safety issues with proper equipment installation and wiring, but also includes additional settings to further protect and improve operation. These include:

- **Minimum "on" and "off" times** to prevent short-cycling and premature wear of equipment.
- **Power-up delay times** to delay and stage electrical loading upon return from power failures or drop outs. This feature is much appreciated by either your generator or the electrical company, as the case may be.
- **Event records** and **data recording** provide summaries of equipment operating frequency and duration as well as a continuous operating audit. This information is very important when evaluating performance or maintenance and service requirements.
- **Multiple operating limits**, and **safety overrides** can be configured to ensure the safest operation, and extend the operating life of your equipment.
- **Modulating control** - the Argus Titan control system contains programs to manage modulating equipment such as hot water heating systems and ventilation systems. These systems are capable of delivering a wide range of output levels. The computer can calculate and then directly deliver the correct output, after evaluating a range of operator set limits.
- **Pulse-width modulation** - most on/off equipment is sized so that it is either too effective when on or not effective enough when off. Most of the time, the correct equipment response needed is somewhere between these two extremes. Staging of multi-unit systems like cooling fans can provide some intermediate steps, but these are not always sufficient for full, evenly distributed control. The Argus Titan system can cycle an equipment device on and off in proportion to the required response to accurately match the current requirements. When properly configured, the inertia of the greenhouse environment will absorb the operating pulses quite effectively resulting in a smooth control response. For example, the computer can turn a unit heater "off" after the calculated heat requirement has been delivered, regardless of the current air temperature reading. The longer term air temperature average will be monitored, and future heat pulses are adjusted to give a greater or lesser response as required. This control strategy greatly reduces temperature overshoot, resulting in lower energy costs and a better growing environment without increasing the total number of equipment operations (cycling). Pulse-width modulation is particularly effective for managing fog and mist systems.

Curtain Systems

Thermal curtains can reduce energy loses by up to forty percent while simultaneously providing features that often improve crop quality and production. In addition to energy savings, curtains can be used to control light intensities, humidity, and plant surface temperatures. Curtains made from black cloth may also be used for photoperiod control. Greenhouses may require controlled shade (seasonal or light level dependent) to regulate solar energy levels for optimum plant growth, and to provide substantial reductions in the solar heat load.

The Argus Titan system provides several flexible modes of operation for curtain systems including:

- **Thermal Operation**: used to reduce energy requirements by closing during specified times and conditions
- **Photoperiod Control**: used with blackout systems to regulate the day night periods
- **Shade Control**: used to reduce the amount of heat gain and light exposure during periods of high solar radiation

Features include:

- Time of day and/or light based operation
- Up to 8 time/temperature/position based opening steps to reduce cold spillage
- Temperature overrides can be tied to current climate and outdoor temperatures
- Snow load overrides
- Override positions for spraying
- User definable light based shading steps
- Independent delay time setpoints for opening and closing to control excessive curtain moves and protect sensitive crops
- Timed and position based movements
- Minimum crack setting
- Separate dehumidify settings for night and day can be tied to ventilation required
- Additional overrides, limits, and conditional operating logic as required

Air circulation

Adequate air circulation must be provided to ensure thorough mixing of the air inside the greenhouse. This avoids thermal stratification, and increases the temperature uniformity throughout the compartment. Even small changes in temperature for a given air moisture content can result in large differences in relative humidity, or VPD readings.

Dehumidification and humidification strategies also require good mixing of the air mass since even small variations in temperature can result in large differences in relative humidity and vapor pressure deficit. By maintaining consistent conditions throughout the greenhouse with good air circulation, many plant diseases can be prevented and more uniform crops can be produced.

The Argus Titan system controls the operation of horizontal and vertical airflow (HAF) fans and poly tube air distribution systems to optimize air circulation within the growing environment. To save on energy costs, internal air circulation fans can be linked to the ventilation rate. In this way, whenever the roof vents or ventilation fans are providing sufficient air movement, the internal air circulation fan system will be deactivated. Fan operation can also be influenced by the time of day, the climate temperature, and many other user selectable parameters and conditions.

Multi-Fan Operation

This program provides the control logic for staging the operation up to eight separate fans or fan groups, based on the current ventilating requirement as calculated by a **Climate Energy Balance** program or another control program configured to determine the amount of ventilation that is required.

Up to eight ventilating **Stages** can be configured. Each Stage supports up to eight logical fan outputs and up to eight rotation **Steps**. Alternating fan operation within each ventilating stage can improve the distribution of the air in the compartment as well as balance fan wear. Each fan can be controlled using a simple on/off strategy, or with Pulse Width Modulation (PWM) to provide more precise control.

Lighting

Controlled high-intensity-discharge (HID), LED and fluorescent lighting is beneficial as a supplement for low natural light levels. Lighting can also be used to extend the natural day length to control the photoperiod response of plants. All of the electrical energy used to provide lighting becomes part of the heat gain of the structure. This is usually beneficial, as lighting is customarily used during low light periods in the winter months when additional heat is required.

The Argus Titan system provides specialized control programs for operating a lighting system in photoperiod or supplementary regimes. Photoperiod lighting control is used for day length management. Supplementary lighting control is typically used to turn lighting systems whenever the ambient light levels are insufficient for the desired plant response.

Features include:

- DLI (Daily Light Integral) based operation
- Photoperiod start/end time settings can be absolute (time of day) or relative (tied to dawn or dusk)
- Cyclical lighting settings for energy efficient photoperiod control
- Time windowed supplementary light control
- Automatic reset of user initiated overrides
- Light sensor based operation
- Light level and light duration proving times
- Light accumulation override features to reduce energy costs and extend lamp life
- Minimum cycle on times to prevent short cycling of lighting equipment
- Additional overrides, limits, and operating logic as required

Spray Override Programs

The Argus Titan system enables integrated management of pesticides and other types of spray systems typically used in greenhouse compartments. Whether or not you use automated spray systems, you can still use the power of the control system to automatically manage your other equipment systems while you are spraying. For example you can automatically manage your vents, irrigation equipment, HAF fans, etc. while you are spraying, and immediately afterwards by simply setting up the proper spray cycle times and triggering a spray cycle before you begin spraying.

Features include:

- Separate override settings for before, during and post spraying events
- Individual spray override states can be configured for each controlled output
- Automated management of other equipment systems such as CO_2, lighting, vents, mixing valves, shade, fan, and multi-output programs while spray operations are occurring.
- Programmed start or manual initiation

Several output control programs have built-in override settings for spray program phases. This helps provide zone wide management of other equipment system such as CO_2, lighting, vents, mixing valves, shade, fan, and multi-output programs while spray operations are occurring. These settings allow the normal functions of these programs to be automatically overridden during the spray operations, and resumed once they are completed.

Carbon Dioxide Enrichment

The Argus Titan CO_2 enrichment control program is used to manage the operation of CO_2 burners and liquid CO_2 valves. For applications where carbon dioxide gas is generated from combustion, the Argus Titan system can also be used in conjunction with heat storage and recovery equipment. A control strategy of maintaining a CO_2 enrichment rate during daylight hours can be very successful when used with crops that derive a significant benefit from CO_2 such as tomatoes, cucumbers, and roses. To save on CO_2 costs, the system can automatically reduce or suspend CO_2 enrichment when the compartment is at higher ventilation rates.

For CO_2 monitoring and control applications, Argus can provide timed or sensor based dosing and a range of CO_2 sensors to match your applications

Features include:

- Enrichment control based on user definable time or light levels
- Settings for using CO_2 burners as an emergency heat source
- Ventilation based dosing overrides
- Dosing overrides for spraying operations
- Separate dosing targets for closed and venting modes
- Minimum on/off interval settings for time-based dosing
- Emergency shutdown source
- Additional overrides, limits, and operating logic as required

Irrigation Management

An irrigation system is defined as an integrated system that includes one or more sources of water or fertilizer solution, pressurization pump(s), distribution piping around the nursery, irrigation valves, and final irrigation water delivery systems.

Along with complete climate control, Argus Titan systems have fully integrated irrigation and nutrient management capabilities. Our irrigation and nutrient management programs are the most complete and sophisticated in the industry. Flexibility and an "open" system approach are two of the key factors that set Argus apart. Argus can control virtually any type of pump, valve, or other equipment. We can assist in the design of virtually any irrigation and nutrient system, including all types of "site-built" systems. The Argus Titan system has also been used to provide all measurement and control functions for many different commercially available nutrient injection and mixing systems.

Features Include:

- System wide capacity management
- Management of multiple irrigation feed sources
- Coordination with nutrient control equipment
- Feed/Water rotation cycles
- Control of base watering times at the individual valve level
- Recirculation, water level, and volume management in tanks, ponds, and ebb and flood systems
- Dynamic control of irrigation event duration and/or frequency
- Output source and irrigation valve coordination
- Manual and automatic operation
- Sensor-based watering decisions including soil tensiometers, weight scales, start-trays, tipping buckets, as well as heat and frost protection sensors

The Argus Titan system can accommodate:

Irrigation Decision Making

There are many different reasons for delivering water or feed to a crop. These include:

- Meeting the water demand
- Delivering fertilizers to the crop
- Flushing salt build-up from the soil
- Cooling the soil surface to prevent high temperature damage to tender crops (seedlings)
- Humidifying the air and reduce crop wilting and stress
- Providing some frost protection on outdoor crops in spring and fall
- Bringing the crop to a uniform moisture level before packing and shipping

Transpiration and evapotranspiration computer models, soil-moisture probes (tensiometers and conductivity sensors), and other systems that measure or predict crop water-usage are of no use for most of these other tasks. For this reason, Argus has many different water management approaches that can be used separately or together to meet the specific requirements of your crop. Each of the following decision programs can also select its own specific fertilizer source:

- Manual operation
- Time schedules
  - Time of day
  - Two-week calendar
- Sensor accumulation values
- Light sensor input
- Other sensor input
- Combination time-sensor values
- Water starts based on an accumulation of sensor measurements or time-interval values. Watering response can vary with time of day and can automatically track a user-defined schedule as the crop grows from seedling to market.
- Control equations using measurements from:
  - Soil tensiometers
  - Weight scales
  - Start-tray irrigation sensors
  - Thermometers (typically for frost and heat protection)
  - Others
- Specific crop models - For example, evapotranspiration models that use temperature, light, relative humidity, vapor-pressure deficit (VPD), and other sensor and sensor-derived measurements as inputs. Once a model is developed for a particular crop and greenhouse, control settings are automatically adjusted to match the changing water requirements over the lifetime of a crop.

Water Scheduling and Capacity Management

Argus separates water decision making (when to water) from the actual delivery of water to the crop (irrigation system capacity management). This frees the grower from having to worry about capacity and feed management limitations of the irrigation system when making watering decisions. The Argus Titan Control system will automatically manage the irrigation-system resources to best meet the requirements of any irrigation zones that need water. The control system maximizes efficient use of the irrigation system while protecting against overloading. If too many zones request water at the same time, the system will schedule them and service them as soon as water supply is available.

Separating the water delivery from the decision-making has another advantage. The grower is only concerned with meeting the needs of the crop. How the water is delivered can vary greatly, depending on the type of irrigation equipment used. Argus allows the mixing of very different irrigation system components on one system, for example, irrigation booms, sprinklers, and drip systems. These systems are transparent to the grower once they are set up on the control system. A single crop can then be managed from one decision-making program, even if it is physically located across several different types of irrigation systems. The control system will automatically manage each irrigation valve in the correct way to meet the crop's requirements.

Irrigation Pulsing

Many watering systems deliver water at a rate that is faster than the growing media is capable of absorbing. This can be more of a problem when the growing media is dry. Normal watering will result in excessive waste and run-off. Pulse watering can be used to divide the required watering into a number of shorter pulses with a delay time between each pulse to allow water absorption to occur.

- Recirculating systems
  - Ebb & flood systems
    - Table & bench systems
    - Floor systems
    - Separate and variable fill, drain, and hold times for each zone
  - Trough & nutrient-film-technique (NFT) systems
  - Hydroponic media (rock wool, clay pellets, cocoa peat, etc.)
- Non-recirculating systems
  - Sprinklers
  - Drip tubes
  - Misting
  - Hydroponic media (rock wool, clay pellets, cocoa peat, etc.)
  - Container crops
  - Field Crops

Evapotranspiration Modeling

For outdoor nurseries, silviculture, and other outdoor irrigation applications, the Argus Titan system contains built-in evapotranspiration modeling software for calculating water loss. This advanced program can be used alone or in conjunction with other irrigation decisions for scheduling irrigation events. This program is based on the Penman-Monteith equations, the FAO (UN Food and Agriculture Organization) standard for evapotranspiration calculations. It combines solar, wind, temperature, and other outdoor atmospheric effects to calculate probable water loss.

Note: This model is suited to predicting evapotranspiration water loss from outdoor crops. For indoor crops, where wind is not a factor and the evapotranspiration losses are different due to a protected environment, it is generally easier to simply use accumulated light as a means of predicting irrigation demand.

Feed Selection

The irrigation system can also provide feed delivery management. The feeds can come from almost any source - injectors, pump sets, tanks, etc. - and do not have to be controlled by Argus. The capacity management system selects the feed source that the irrigation zone requires and delivers it to the zone valve. This is done using a selector valve or pump. Multiple feed sources plus clear water are supported on each irrigation system. Feeds and clear water can be alternated to provide a range of nutrient levels for a variety of crops while using only one fertilizer source - a great way to keep fertilizer systems simple.

Nutrient Monitoring and Control

Argus Titan nutrient injection programs and injection equipment offer sophisticated nutrient for a variety of applications. Nutrient control is fully integrated with irrigation management. You can manage anything from the simple injection of pre-blended fertilizer concentrates to full single element dosing where the target recipes are blended on-the-fly from available stock tanks. You can create and save multiple recipes by simply entering the desired parts per million for the required elements. The system automatically creates a blending solution from the available stock tanks (or reports back if a recipe cannot be created). When a recipe is called by the irrigation system, the nutrient injection program automatically produces it for the current flow rate. Nutrient injection systems can be used to produce a single feed or many different feeds in multiplexing applications where a single injection system services several crops. Feed chemistry and overall concentration can also be varied dynamically in relation to light levels or the need for substrate salts management.

Nutrient Injection Features

- Management of up to 14 stock concentrate tanks plus 1 Acid/Base tank
- Full fertilizer analysis entry for each stock tank
- Concentration factor settings
- Compensation for preexisting fertilizer elements in the water supply
- Output styles to accommodate a wide variety of injector types
- Complete integration with Argus **Irrigation** programs
- This program can be used with **Argus Multi-Feed** injector systems or other injection equipment
- Full support for single-tank, A/B. and single element dosing systems
- Can be used for in-line injection or dilute stock tank management
- Can produce up to 64 distinct user specified **Feed Recipes**

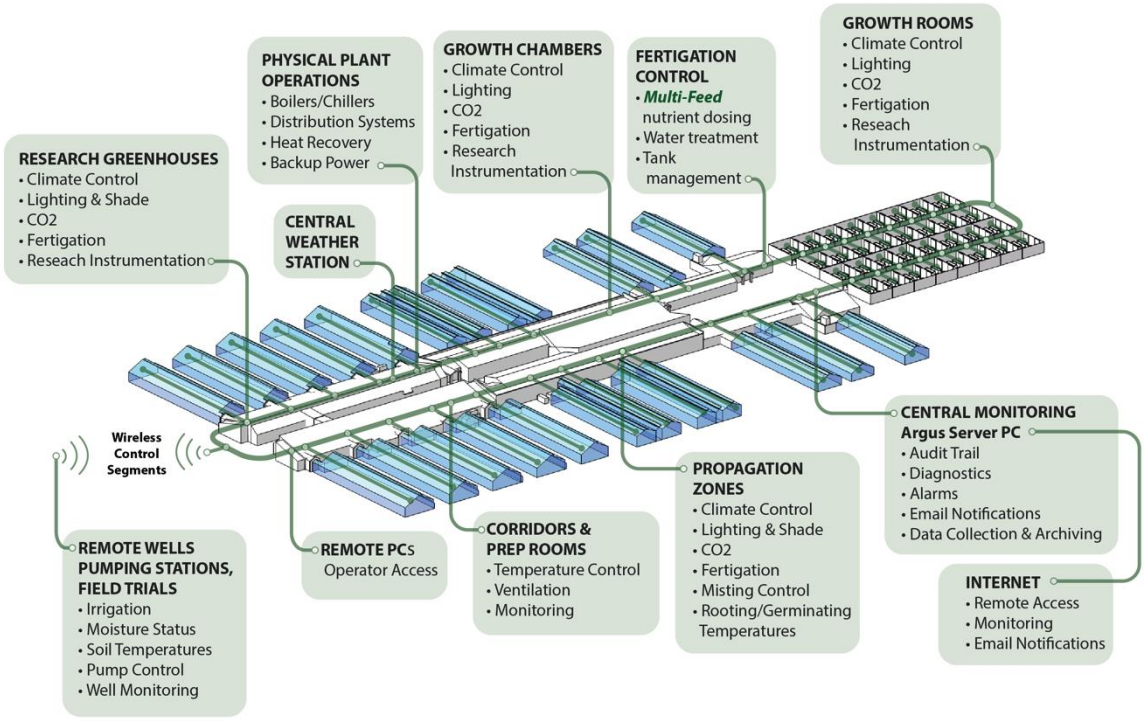
Feed Recipes Program Features

- Enter recipe element targets in parts per million – the program automatically determines how to create the recipe from the available stock concentrates.
- Up to 8 distinct feed recipes per program
- Automatic, semi-automatic, or manual feed recipe creation
- Rules-based feed recipe creation
- Automatic parts per million tabulation for each element
- Full integration with the **Nutrient Injection** program and **Irrigation** programs

Additional Features

- Full set-point control for EC and pH
- Feedback based recipe compensation for recirculating systems
- Alarming and safety shutdown
- Recirculation management
- Light-level or accumulated-light compensation of EC

Facility and Physical Plant Management



Argus Titan systems are designed for central monitoring and management of engineered climate zones throughout a facility. There are control features and options throughout the system to manage each equipment item as efficiently as possible while respecting the limitations and safe operating parameters of each controlled device.

Integrated Control of Multiple Heat Source Systems

The Argus Titan system can be used to manage, stage, and integrate the use of alternative and supplementary heat sources. Natural gas is a clean, economical, reliable, and easily managed energy source, but there are other energy sources that can be used to improve the performance and economics of the greenhouse operation. Some sources such as solar energy are “free” to the extent that greenhouses naturally trap and use it. Others such as waste cooling water or alternate fuels (sawdust, waste oil, etc.) may be relatively inexpensive but not continuously available or in sufficient supply for all conditions. Control strategies can be optimized for energy conservation by using less expensive energy when it is available.

Boiler limiting

The Argus Titan control system arbitrates between the heat requirements of the greenhouse and the ability of a boiler system to reliably and safely deliver this heat. The program eliminates thermal shock and condensation problems when used with properly designed equipment. A direct benefit of this type of program is the need to only size the boiler system for average heating requirements rather than short term peak requirements.

Co-generation (Combined Heat and Power)

Co-generation is potentially very useful to greenhouse growers, assuming that adequate use can be made of all components of energy output. The Argus Titan system coupled with properly designed physical systems, can handle the arbitration required to make the highest and best use of each energy component. The computer system can select the best use for the recovered heat and schedule operating periods for maximum benefit.

Thermal Storage and Heat Buffering

Argus has sophisticated control programs for operations that need to recover stored heat energy produced by activities such as CO_2 generation from natural gas. Surplus heat energy can be automatically stored and recovered seamlessly, in harmony with the primary heating source.

Heat storage systems are used in situations where the heat energy produced by a heating plant is in excess of the current heating demand. For greenhouse operations, heat storage is often used for daytime CO2 generation from natural gas or propane, and in other situations such as combined heat and power generation (Cogen) where the heat energy created to produce electricity occurs at a time when it is not needed. The reservoir of hot water that accumulates is typically used at night when the greenhouse requires heat.

Without a managed storage system in place, the heat generated by these processes would otherwise be wasted since it is not immediately required. Therefore, a properly engineered heat storage system has the potential to generate considerable energy savings.

The Argus Titan system can manage the somewhat complex equipment required to store and recover surplus heat efficiently. This includes precision management of zone heating, heat storage, & heat recovery as well as intelligent transitioning between these operational phases.

Argus can configure a control design to match your specifications including:

- CO2 extraction and optional condenser heat recovery
- Cogeneration heat extraction
- Boiler operation (storage & heating modes)
- Heating system supply and return valves
- Hot water storage mixing control
- Hot water storage pump control
- Hot water recovery mixing valve control
- Monitoring and data recording of all storage system sensors and relays
- Hot water storage tank status & stratification monitoring.

Custom Equipment Control

In situations where specialized equipment systems require additional or non-standard features, Argus has a powerful suite of generic control programs that can be configured to meet the control objectives of the most demanding applications.

These powerful and flexible programs are adaptable to almost any situation and unlike many alternative systems, they are user-configurable without the need to learn a complex computer programming language.

In situations where other stand-alone equipment controllers are in place, such as boiler control packages, PLCs, and nutrient controllers, the Argus Titan system can often provide an interface to coordinate and integrate the operation of these devices with the rest of your facility. This not only helps you to better manage these systems, it also ensures maximum operating efficiency and effectiveness while avoiding potential equipment conflicts.

Whenever you are selecting new equipment that is available with custom control options, you should check with Argus first. We can often manage your new equipment directly, providing convenient and coordinated central control and monitoring, while saving you money on redundant control hardware.

Supervisory Control

The Titan system is designed for custom interoperability with external decision support products such as plant growth models and other expert systems. The **Supervisory Control Guardian** program acts as a safe portal for accepting the results of these external applications as control inputs and targets.

The **Supervisory Control Guardian** program provides a safe means of receiving information and control instructions from outside sources into the Argus Titan system. For example, if you wish to use an external crop modeling program to set targets for climate temperatures and other parameters, the Supervisory Control Guardian will safely import the results of your model into the Titan system. It enables an external program to automatically 'direct' or influence the activities of the Titan system. The program is called the Supervisory Control Guardian because it watches over the incoming data to make sure that it is safely within the tolerances and limits that you define. It also requires the incoming data to be refreshed at regular intervals to make sure that the communications link is sound. If problems occur, there are configurable failure mode contingencies and alarms to alert you.

The Supervisory Control Guardian program is intended primarily for researchers involved in the development of predictive and feedback supported growth modeling systems. It enables them to use the features of the Titan control system to safely accept the results of the modeling programs as control targets. The advantage of this strategy is that it allows researchers to focus their efforts on plant growth modeling without needing to worry about the complexities of equipment control. Two-way communications are also possible with the use of a **UDP RealTime** window that acts as a host for inter system communications. In this way the Titan system can also provide feedback information to the model such as sensor readings and equipment states.

Modbus, BACnet and ebmBUS support

There are a number of situations where it is useful to pass data into and out of the Titan system. In some instances there may be a need to coordinate the activities of the Titan system with standalone or 'package' equipment systems that are supplied with their own control processors. There may also be other control systems in place such as a building control system that regulates the availability of hot water from a central heating plant. To coordinate control activities, the Argus Titan system often needs to know the status of these systems and they may also need to receive and process data from the Argus Titan system. Depending on the type of equipment and the specific application, this can often be accomplished through physical signal wiring between the systems. Titan system also support Modbus and BACnet protocols that can be used to exchange information between control systems.

Argus also provides a Modbus interface for monitoring arrays of load cells used for plant moisture/plant weight studies and for general monitoring and control of equipment systems that are Modbus capable. In addition, Titan systems have direct support for the embBUS protocol used for operating arrays of ebsPabst fans.

TITAN 2 SYSTEM DESCRIPTION

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