requirements for compliance to the standards for use in a non-hazardous and hazardous environments.

The AADvance controller has been investigated and approved by UL for use as Industrial Control Equipment in hazardous locations, Class I, Division 2, Groups A, B, C and D in North America.

The AADvance controller has been assessed for ATEX compliance. The UL Certification No. is DEMKO 11 ATEX 1129711X. The ATEX marking is Ex nA IIC T4 Gc.

Additionally the AADvance controller is approved under the IECEx certification scheme. The certificate number is IECEx UL 12.0032X

Installation Requirements for Non-Hazardous Environment

Investigation File Number E341697

Products Covered

The products investigated and approved:

Programmable Logic Controller Models:

- T9110 Processor Module
- T9401 Digital Input Module
- T9402 Digital Input Module, 16 Channel
- T9431 Analogue Input Module
- T9432 Analogue Input Module, 16 Channel
- T9451 Digital Output Module
- T9481 Analog Output Module
- T9482 Analogue Output Module, 8 Channel.

Listed Accessories for use with PLCs:

- T9100 Processor Backplane
- T9300 I/O Backplane
- T9801 Digital Input Termination Assembly, Simplex
- T9802 Digital Input Termination Assembly, Dual
- T9803 Digital Input Termination Assembly, TMR
- T9831 Analogue input Termination Assembly, Simplex
- T9832, Analogue Input Termination Assembly, Dual
- T9833 Analogue Input Termination Assembly, TMR
- T9851 Digital Output Termination Assembly, Simplex and T9852 Digital Output Termination Assembly, Dual
- T9892 Digital Output Termination Assembly, Dual
- T9881 Analogue Output Termination Assembly, Simplex
- T9882 Analogue Output Termination Assembly, Dual.

Non-Hazardous Installation Requirements

Environmental

In a non-hazardous environment a system can be installed in an enclosure or on a support/wall; however, the enclosure or the area where it is installed must not be more than a Pollution Degree 2 or similar environment in accordance with IEC 60664-1:2007.

The surrounding air temperature ratings are:

- For the T9110 Processor module = 60 °C
- For all other I/O modules, base units and termination assemblies = 60 °C

Pollution Degree Definition

For the purpose of evaluating creepage distances and clearances, the following four degrees of pollution in the micro-environment are established:

- Pollution Degree 1: No pollution or only dry pollution occurs. The pollution has no influence.
- Pollution Degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.
- Pollution Degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
- Pollution Degree 4: Continuous conductivity occurs due to conductive dust, rain or other wet conditions.

Installation Requirements for Hazardous Environment

The AADvance controller has been investigated and approved by UL for use as Industrial Control Equipment in hazardous locations, Class I, Division 2, Groups A, B, C and D in North America.

The AADvance controller has been assessed for ATEX compliance. The UL Certification No. is DEMKO 11 ATEX 1129711X. The ATEX marking is Ex nA IIC T4 Gc.

Additionally the AADvance controller is approved under the IECEx certification scheme. The certificate number is IECEx UL 12.0032X.

Installation Requirements

To comply with the standards the following conditions must be applied to the installation:

WARNING: Special conditions for safe use:
- Model T9110: The ambient temperature range is -25 °C to +60 °C (-13 °F to +140 °F).
- All other Models: The ambient temperature range is -25 °C to +60 °C
- (-13 °F to +140 °F).
- Subject devices are to be installed in an ATEX/IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of EN 60079-0: 2012+A11:2013 and EN 60079-15:2010/IEC 60079-0 Ed 6 and IEC 60079-15 Ed 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments must be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm^2.
- Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.
- Subject devices are to use conductors with a minimum conductor temperature rating of 85 °C.
- Subject devices are to be installed in the vertical orientation only.

AADvance meets the essential requirements of EN 60079-0:2012 + A11:2013 & EN 60079-15:2010 and IEC 60079-0 Ed 6 and IEC 60079-15 Ed 4.

File Number E251761

The AADvance controller investigation and approval is contained in the following file certifications:

- NRAG.E251761: Programmable Controllers for Use in Hazardous Locations Class I, Division 2, Groups A, B, C and D.

The products have been investigated using requirements contained in the following standards:

- ANSI/ISA 12.12.01-2013, Nonincendive Electrical Equipment for use in Class I and II, Division 2 and Class III, Division 1 and 2 Hazardous Locations.
- UL508, Industrial Control Equipment, Seventeenth edition, with revisions through and including April 15, 2010.
- NRAG7.E251761: Programmable Controllers for Use in Hazardous Locations Certified for Canada; Class I, Division 2, Groups A, B, C and D.

The products have been investigated using requirements contained in the following standards:

- CSA C22.2 No 213-M1987, Nonincendive Control Equipment for Use in Class I, Division 2, Hazardous Locations.
- CSA C22.2 No 142-M1987, Process Control equipment, Edition 1 - Revision date 1990-09-01.

Products Covered

The products investigated and approved:

Programmable Logic Controllers Models:

- T9110 Processor Module
- T9401/2 Digital Input Module

- T9431/2 Analogue Input Module
- T9451 Digital output Module
- T9482 Analogue Output Module.

Listed Accessories for use with PLCs:

- T9100 Processor Backplane
- T9300 I/O Backplane
- T9801 Digital Input Termination Assembly, Simplex
- T9802 Digital Input Termination Assembly, Dual
- T9803 Digital Input Termination Assembly, TMR
- T9831 Analogue input Termination Assembly, Simplex
- T9832, Analogue Input Termination Assembly, Dual
- T9833 Analogue Input Termination Assembly, TMR
- T9851 Digital Output Termination Assembly, Simplex.

Certifications for Safety System Applications in Hazardous Environments

ATEX Certificate

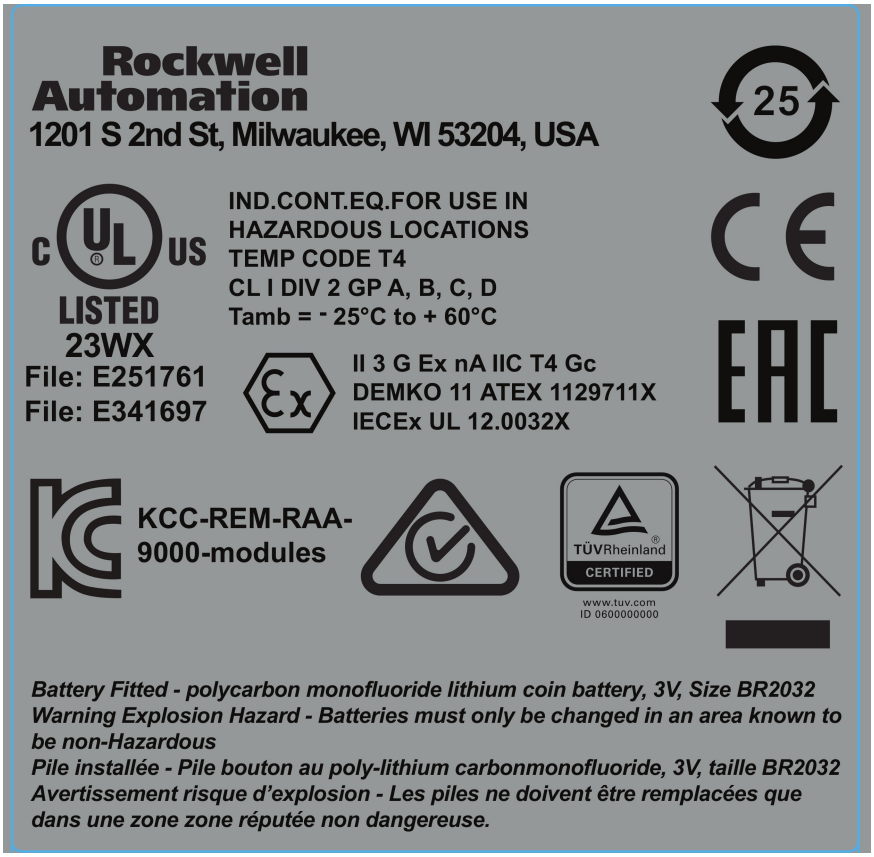
Refer to AADvance Series T9000 Programmable Control and Safety System - ATEX certificate, publication 9000-CT003.

IECEx UL Certificate

Refer to AADvance Series T9000 Programmable Control and Safety System - IECEx certificate, publication 9000-CT006.

Module Label

The following label information must be attached to each module.



KCC-EMC Registration

1. A급 기기 (업무용 방송통신기기): 이 기기는 업무용(A급)으로 전자파적합등록을 한 기기이오니 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
   - Translation: Class A device (Broadcasting Communication Device for Office Use): This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

The AADvance Software Development Environment

The AADvance Workbench software or AADvance-Trusted SIS Workstation software lets you design one complete control strategy, and then target parts of the strategy to individual controllers. Interaction between the resources is automatic, significantly reducing the complexity of configuration in a multi-resource system. Programs can be simulated and tested on the computer running the software before downloading to the controller.

The AADvance Workbench software and AADvance-Trusted SIS Workstation software are compliant with the IEC-61131 industrial standard and have several powerful features:

- the regulation of the flow of control decisions for an interacting distributed control system

- providing for the consistency of data
- providing a means for synchronous operation between devices
- eliminating the need to have separate synchronous schemes
- easing the development and maintenance of robust systems

The AADvance Workbench software and AADvance-Trusted SIS Workstation software are software development environments for a controller. Use the AADvance Workbench software or AADvance-Trusted SIS Workstation software to create local and distributed control applications using the languages of IEC 61131-3.

IMPORTANT AADvance Workbench software version 1.4 supports the Instruction List (IL) language.

AADvance Workbench software version 2.x and AADvance-Trusted SIS Workstation software do not support the IL language.

ATTENTION: The AADvance Workbench software and AADvance-Trusted SIS Workstation software do not support the Sequential Function Chart (SFC) language for safety-related applications.

Engineers can use one language or a combination that best suits their knowledge and programming style and the type of application.

The AADvance Workbench software or AADvance-Trusted SIS Workstation software is a secure development environment. There is also a Program Enable key that must be plugged into the processor base unit to allow the user to modify and download the application or access the AADvance Discover tool to set or change the controller IP address. The Program Enable Key when it is removed protects the application from unauthorized access.

The development environment includes:

- tools for program development
- program documentation
- function block library management
- application archiving
- import/export utilities
- on-line monitoring
- off-line simulation and controlled on-line changes
- Programs can be simulated and tested on the computer before downloading to the controller hardware.

Operating Systems

For information about supported operating systems and other software product version support, refer to product release notes from the Product Compatibility and Download Center (PCDC): rok.auto/pcdc.

Importing and Exporting Data

The AADvance Workbench software and AADvance-Trusted SIS Workstation software can import and export variables data in standard file formats such as Microsoft Excel spreadsheet and comma-separated values (CSV).

Software Licenses

Refer to the applicable publication for information on software licenses:

- AADvance Controller Configuration Guide Workbench 1.x, publication ICSTT-RM405
- AADvance Controller Configuration Guide Workbench 2.x, publication ICSTT-RM458
- AADvance-Trusted SIS Workstation Software User Guide, publication ICSTT-UM002

Corrective Maintenance and Module Replacement

Scheduled maintenance consists of checking the I/O Module calibrations and proof tests. Detailed scheduled and corrective maintenance information is given in the AADvance Troubleshooting and Maintenance Manual Doc No: ICSTT-RM406. Corrective maintenance is by module replacement and where required fuse replacement in Termination Assemblies. In dual and triple modular redundant configurations, you can remove a module and install a new one without interrupting the system operation. In simplex configurations removing a module will interrupt the system operation. However, certain restrictions apply on module replacement timing for Safety Related systems (see the AADvance Safety Manual - ICSTT-RM446 for guidance).

Field connection wiring is attached at the connectors on the termination assemblies. Ethernet and Serial data connections are made at the T9100 Processor Base Unit. There are no physical links needed to be set up on any modules or base units. Standard modules are used for all the different configurations.

IMPORTANT Processor modules must be replaced with a module containing the same firmware revision, you cannot use processor modules with different firmware revisions on the same controller.

TUV Approved Operating System

The AADvance system runs an IEC 61508 approved operating system and the overall system is certified to IEC 61508, Part 1-7: 1998 - 2000 SIL 3.

Main Components

An AADvance controller is built from durable processor and I/O modules and assemblies designed to IEC 61508 standards for safety systems and runs the AADvance Workbench software or AADvance-Trusted SIS Workstation

software. Field devices connect direct to a controller and external communication links over Ethernet and serial links use a secure protocol.

Physical Features

A new and innovative style characteristic of the AADvance controller is the design of the hardware. All the modules and assemblies connect together easily without the need for inter-module wiring.

CAUTION: The controller contains static sensitive components. When the controller is installed attach a label that is clearly visible to tell operators to follow anti-static precautions when they touch or move modules. Failure to follow these instructions can result in damage to the equipment.

Environmental Specification

An AADvance system can be installed in a non-hazardous or a hazardous environment. In a non-hazardous environment a system does not have to be installed in an enclosure; however, the area where it is installed must maintain a Pollution Degree 2 environment (IEC 60664-1).

The following environmental specification defines the minimum environmental conditions for an AADvance controller installation. Additional conditions apply to systems installed in a Hazardous environment.

Table 3 - Environmental Specification

Attributes	Value
Operating Temperature Range: For use in Hazardous Environments: Processor Modules I/O Modules and Termination Assemblies For use in Non-hazardous Environments: Processor Modules, I/O modules and Termination Assemblies	 –25 °C to +60 °C (–13 °F to +140 °F) –25 °C to +60 °C (–13 °F to +140 °F) –25 °C to +60 °C (–13 °F to +140 °F)
Storage and Transport Temperature Range	–40 °C to +70 °C (–40 °F to +158 °F)
Module Surface Temperature (during usual operation)	43° C (109 °F) ± 2 °C
Humidity	
Operating	10 % to 95 % RH, non-condensing
Storage and Transport	10 % to 95 % RH, non-condensing
Vibration	
Functional Stress	5 Hz to 9 Hz
Continuous	1.7 mm amplitude
Occasional	3.5 mm amplitude
Withstand	10 Hz to 150 Hz
Acceleration	0.1 g in 3 axes
Endurance	10 Hz to 150 Hz
Acceleration	0.5 g in 3 axes
Shock	15 g peak, 11 ms duration, ½ sine
Altitude	
Operating	0 to 2,000 m (0 to 6,600 ft.)

Table 3 - Environmental Specification

Attributes	Value
Storage and Transport	0 to 3,000 m (0 to 10,000 ft.) This equipment must not be transported in unpressurized aircraft flown above 10,000 ft.
Electromagnetic Interference	Tested to the following standards: EN 61326-1:2006, Class A; EN 61326-3-1:2008, EN 54-4: 1997, A1; EN 61131-2:2007; EN 62061:2005.
Hazardous Location Capability	Suitable for Class I Div 2 Groups A, B, C and D

There is no specific protection against liquids.

Product Dimensions

A typical controller arrangement is shown with processor modules installed on the processor base unit and an I/O base unit mated with the processor base unit. I/O modules are installed on the base unit and a termination assembly plugged into the I/O base unit.

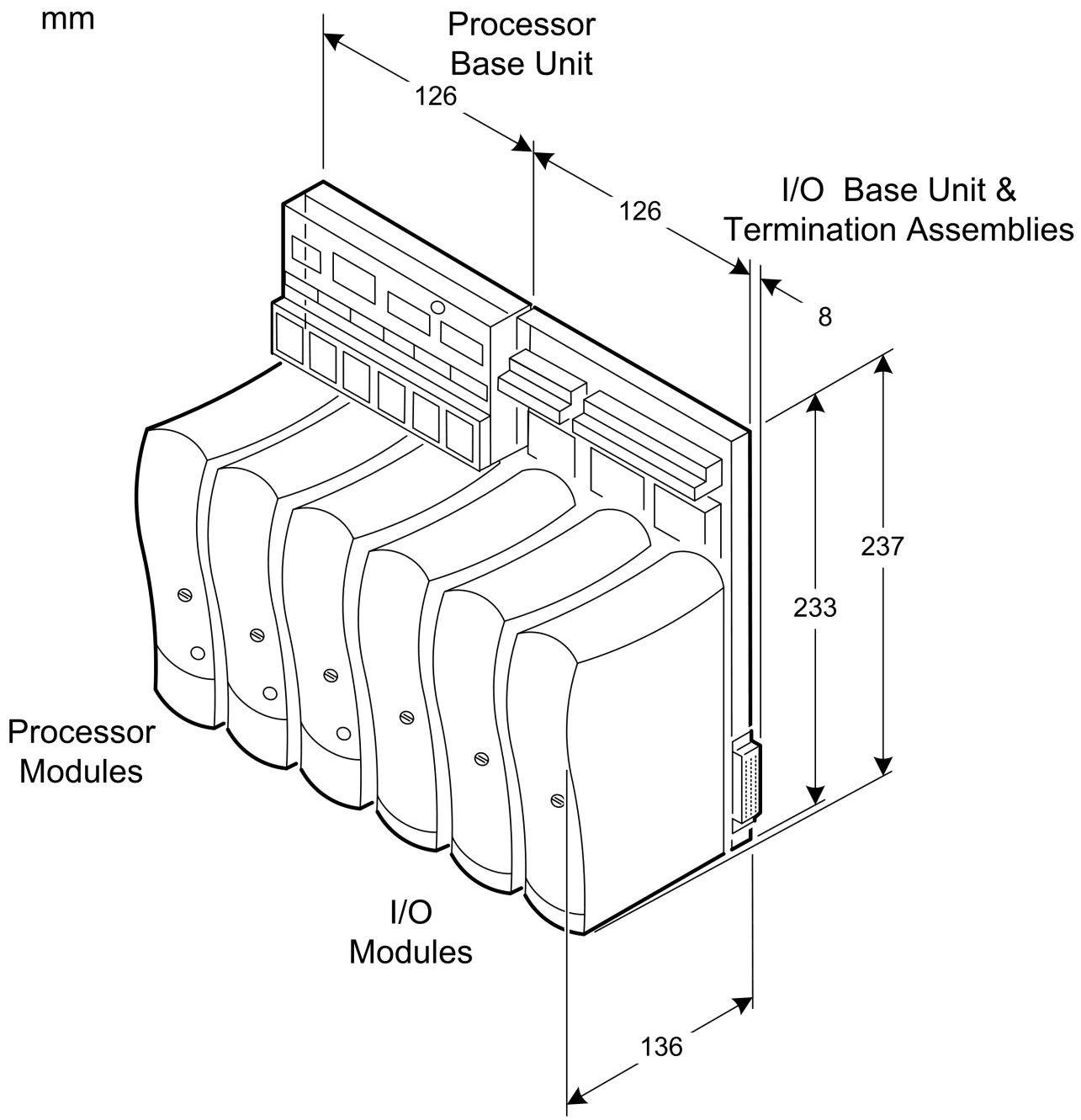


Table 4 - Summary of Dimensions

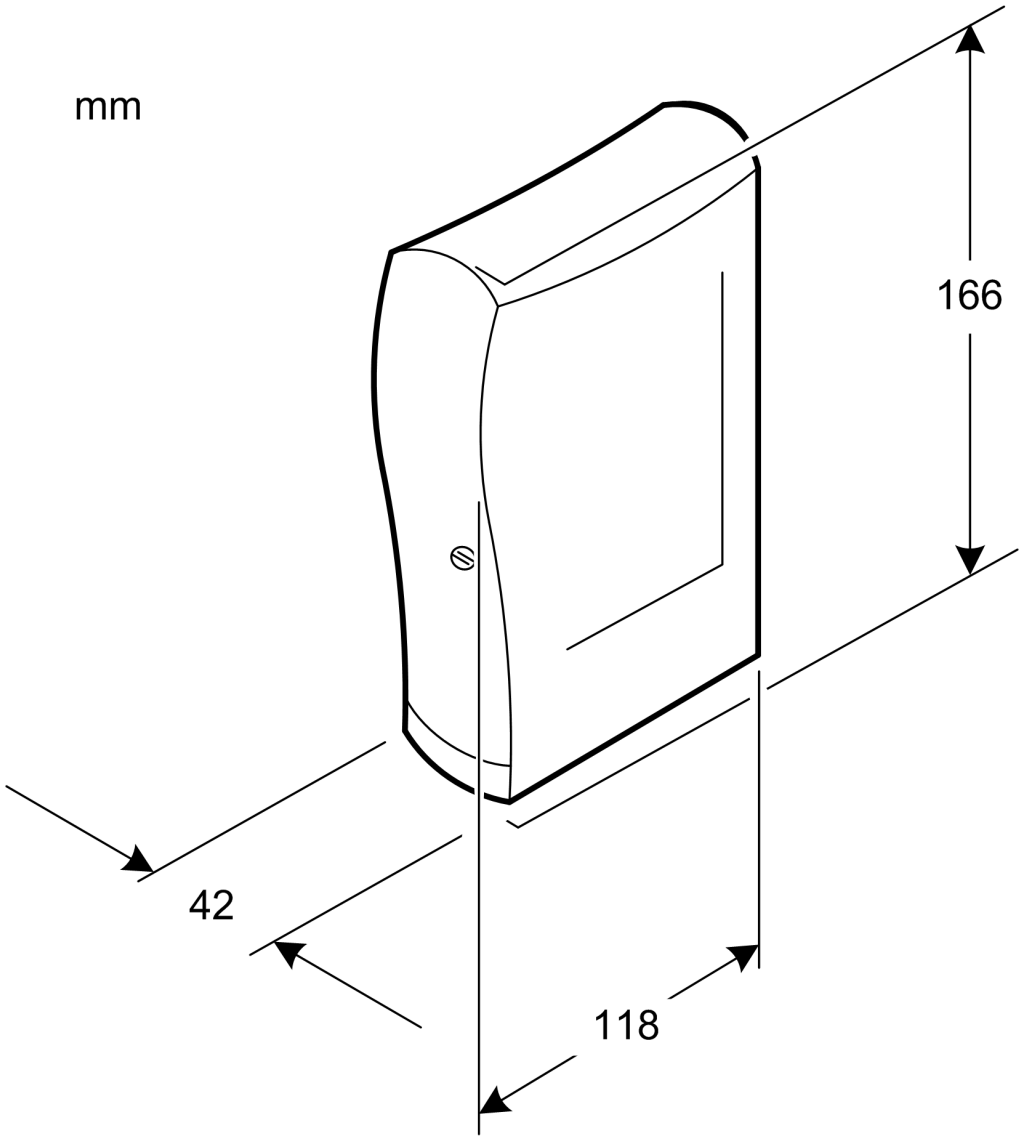
Attribute	Value
Base unit dimensions (H × W × D), approx.	233 mm × 126 mm × 18 mm (see text) (9-¼ in. × 5 in. × ¾ in.)
Module dimensions (H × W × D), approx.	166 mm × 42 mm × 118 mm (6-½ in. × 1-$^{5}/_{8}$ in. × 4-$^{5}/_{8}$ in.)

The depth of the base unit (18 mm) excludes the parts of the backplane connectors that mate inside the module connectors. Adding the depth of a module (118 mm) to the depth of the base unit gives the overall depth of the controller assembly at 136 mm.

Module Dimensions

All modules have the same dimensions.

Figure 1 - Module Dimensions



Compact Module Design

Each processor and I/O module has a flame-retardant and impact-resistant plastic cover. The cover is designed to help ventilation and heat dissipation occur naturally without the need for fan assisted cooling. Processor and I/O modules fit onto standardized base units. Base units plug together by side connectors and are securely held in position by specially designed plastic clips which cannot corrode or seize up. Modules are retained by a locking screw which is easy to access from the front.

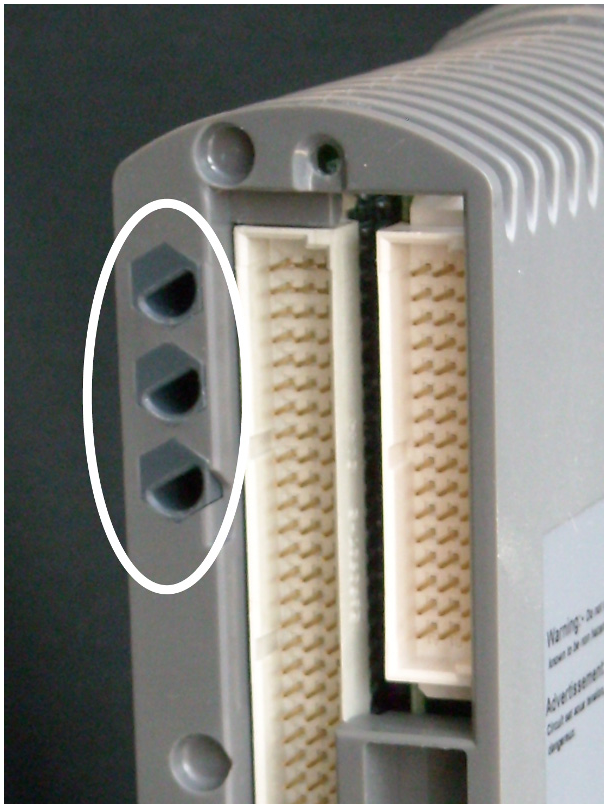
Figure 2 - An AADvance Module

NOTE Standard AADvance modules have a plastic casing and are rated IP20: Protected against solid objects over 12 mm (1/2 in.) for example "fingers". There is no specific protection against liquids.

Module Polarization Keying

For each I/O Module there is a matched termination assembly. The controller incorporates module polarization keying to make sure that they are correctly mated when installed. Sockets on the rear end plate align and mate with coding pins found on the termination assembly. The alignment of the sockets and pins make sure that only the matched I/O modules and termination assemblies can be mated.

Figure 3 - Coding Sockets



Module Locking Mechanism

Figure 4 - Locking Screw

Each module carries a locking mechanism, which secures the module onto its base unit. The locking mechanism is in the form of a clamp screw, which can be seen on the front panel of the module and engaged by a quarter turn of a flat blade screwdriver. The module senses the locking mechanism position and

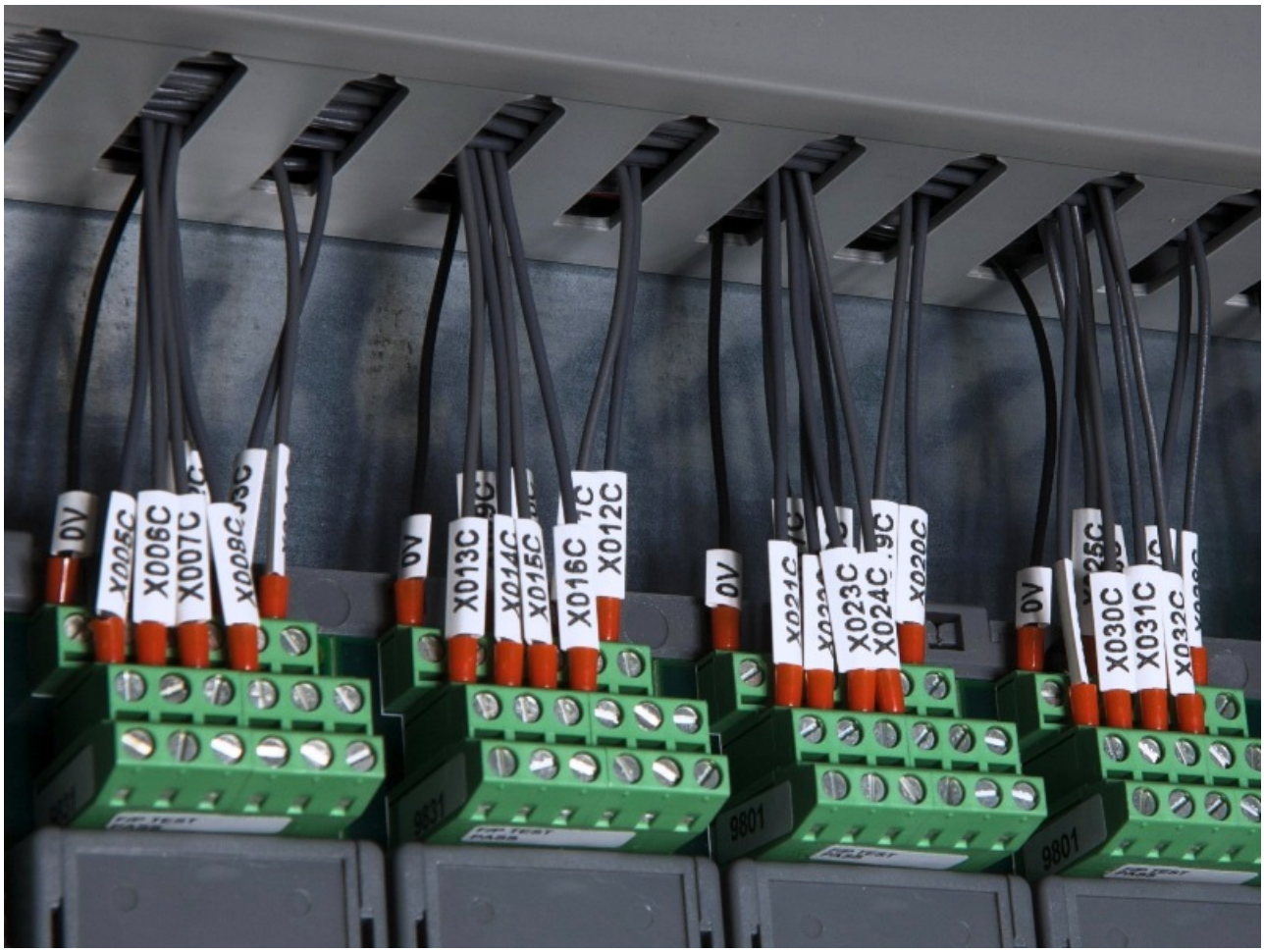
notifies the controller accordingly. This acts as an interlock device and helps prevent the module from going on-line when it is not in the locked position.

Field Wiring

Field device wiring connections are made to industry-standard screw terminal blocks on the termination assemblies. Terminals are easy to access without needing to dismantle assemblies. The specification for the field wiring sizes is given in the topic "Power and External Connector Wiring Requirements".

This illustration shows field wiring connections at the termination assemblies.

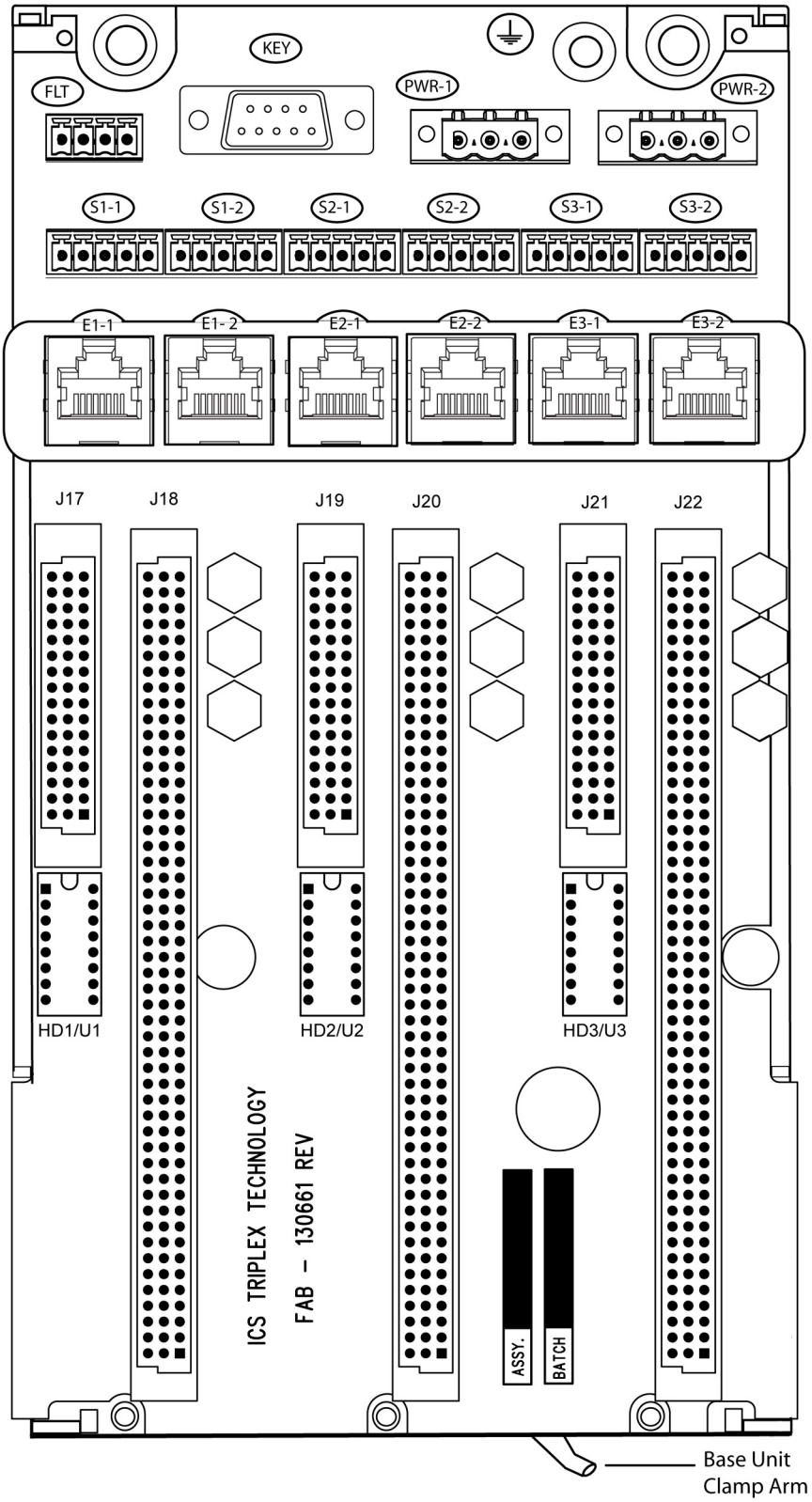
Figure 5 - Field Wiring Connections



NOTE The recommended torque for termination assembly screw connectors is 5 Nm.

Processor Base Unit

A processor base unit holds up to three processor modules:

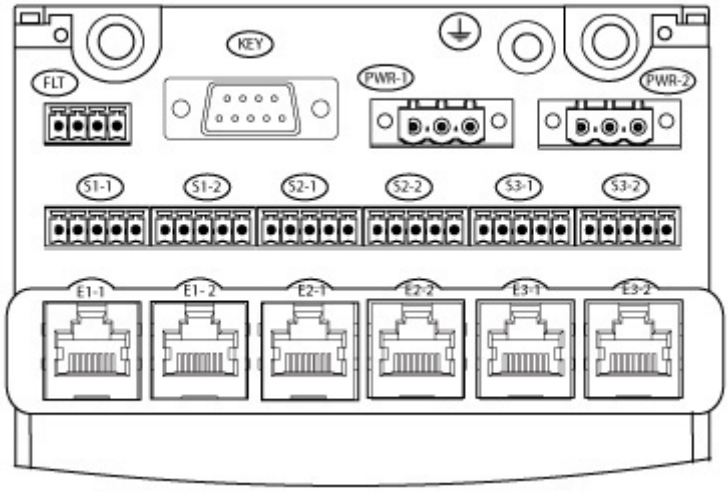


External Ethernet, Serial Data and Power Connections

The processor base unit external connections are:

- Earthing Stud
- Ethernet Ports (E1-1 to E3-2)
- Serial Ports (S1-1 to S3-2)
- Redundant +24 Vdc powers supply (PWR-1 and PWR-2)
- Program Enable security key (KEY)
- The FLT connector (currently not used).

Figure 6 - External Connectors on the Processor Base Unit



The power connections supply all three modules with redundant power, each processor module each have two Serial ports and two Ethernet port connectors. The KEY connector supports all three processor modules and helps prevent access to the application unless the Program Enable key is inserted.

Serial Communications Ports

The serial ports (S1-1 and S1-2; S2-1 and S2-2; S3-1 and S3-2) support the following signal modes depending on use:

- RS485fd: A four-wire full duplex connection that features different busses for transmit and receive. This selection must also be used when the controller is acting as a MODBUS Master using the optional four-wire definition specified in Section 3.3.3 of the MODBUS-over-serial standard.
- RS485fdmux: A four-wire full-duplex connection with tri-state outputs on the transmit connections. This must be used when the controller is acting as a MODBUS Slave on a four-wire bus.
- RS485hdmux: A two-wire half duplex connection applicable for master slave or slave use. This is shown in the MODBUS-over-serial standard.

Processor Back-up Battery

The T9110 processor module has a back-up battery that powers its internal Real Time Clock (RTC) and a part of the volatile memory (RAM). The battery only supplies power when the processor module is no longer powered from the

system power supplies. The specific functions that the battery maintains on complete loss of power are:

- Real Time Clock - The battery supplies power to the RTC chip itself.
- Retained Variables - Data for retained variables is stored at the end of each application scan in a portion of RAM, backed up by the battery. On restoration of power' the retained data is loaded back into the variables assigned as retained variables for use by the application.
- Diagnostic logs - The processor diagnostic logs are stored in the portion of RAM backed by the battery.

The battery has a design life of 10 years when the processor module is continually powered; for processor modules that are un-powered, the design life is up to 6 months. Battery design life is based on operating at a constant 25°C and low humidity. High humidity, temperature and frequent power cycles will shorten the operational life of the battery.

Low Battery Alarm

A variable in the AADvance Workbench software or AADvance-Trusted SIS Workstation software can be set up and report the battery status. It will give an alarm and set a warning light on the processor front panel when the battery voltage is low.

Disabling the Low Battery Alarm

For applications that do not require Real Time Clock functionality, or there are specific constraints, for example, the controller is in an inaccessible location, that make it necessary to remove the battery when the system is installed and set up, the battery failure alarm can be disabled from AADvance Workbench software or AADvance-Trusted SIS Workstation software.

Battery Location

The battery is supplied separately and inserted into a slot behind a removable cover on the front panel of the processor module. The battery position is shown in the illustration:

CAUTION: The battery may explode if mistreated. Do not recharge, disassemble or dispose of in a fire.

Battery Specification

A Polycarbon monofluoride Lithium Coin Battery with a nominal voltage of 3V; Nominal capacity (mAh) 190; Continuous standard load (mA) 0.03; Operating temperature range -30°C to +80°C, manufactured by Panasonic.

Processor Maintenance Socket

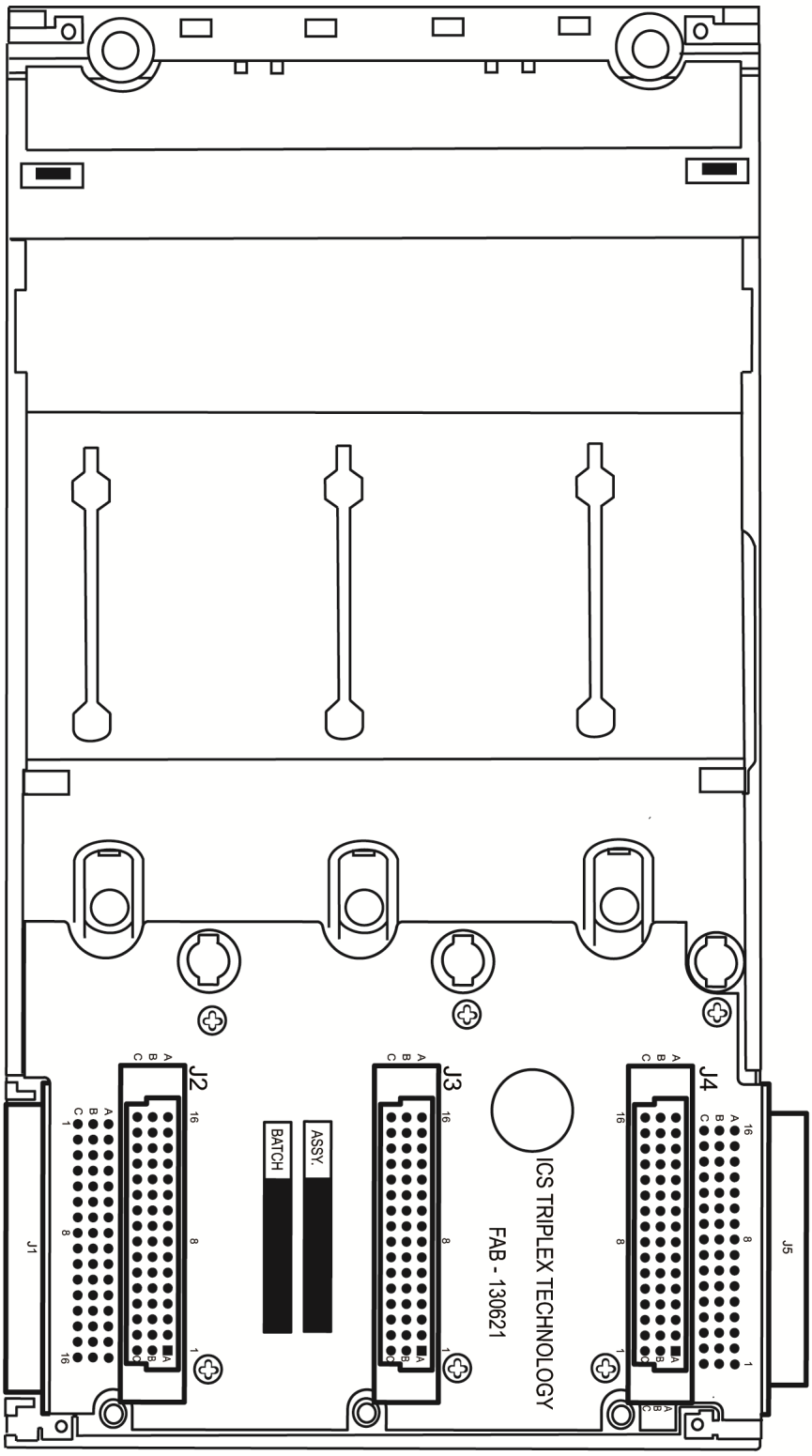
Behind the removal cover on the processor front panel is a maintenance socket SK1. This socket is for maintenance use only.

CAUTION: K1 is for maintenance only. When AADvance is installed in a hazardous location power must be disconnected or the area known to be free of ignitable concentrations of flammable gases or vapours when using this socket.

ATTENTION: Port SK1 pour les modules T9110 et T9111. « Pour la maintenance uniquement lorsqu'installé en environnement dangereux. L'alimentation doit être coupée ou la zone exempte de concentrations de gaz ou de vapeurs inflammables lorsqu'il est utilisé.

I/O Base Unit

An I/O base unit holds up to three I/O modules:


J1
J2
J3
J4
J5
BATCH
ASSY.
ICS TRIPLEX TECHNOLOGY
FAB - 130621

Termination Assemblies

The AADvance system provides a range of termination assemblies to connect field wiring to the I/O modules. A termination assembly is a printed circuit equipped with screw terminal blocks for the field wiring (and in some cases fuses) and connectors for the plug-in I/O modules. Termination assemblies give the system designer flexibility when configuring redundant and fault tolerant systems.

Termination assemblies come in three types: simplex, dual or triple to accommodate one two or three I/O modules. Each termination assembly provides connections for up to 16 channels but can accommodate 8 or 16 channel modules.

The version illustrated is a simplex termination assembly for a digital input module. The field wiring connectors are located to the left, the fuses have a cover (shown open) and the module sockets are to the right. Each fuse cover has a label that identifies the fuse numbers.

Figure 7 - Single Termination Assembly

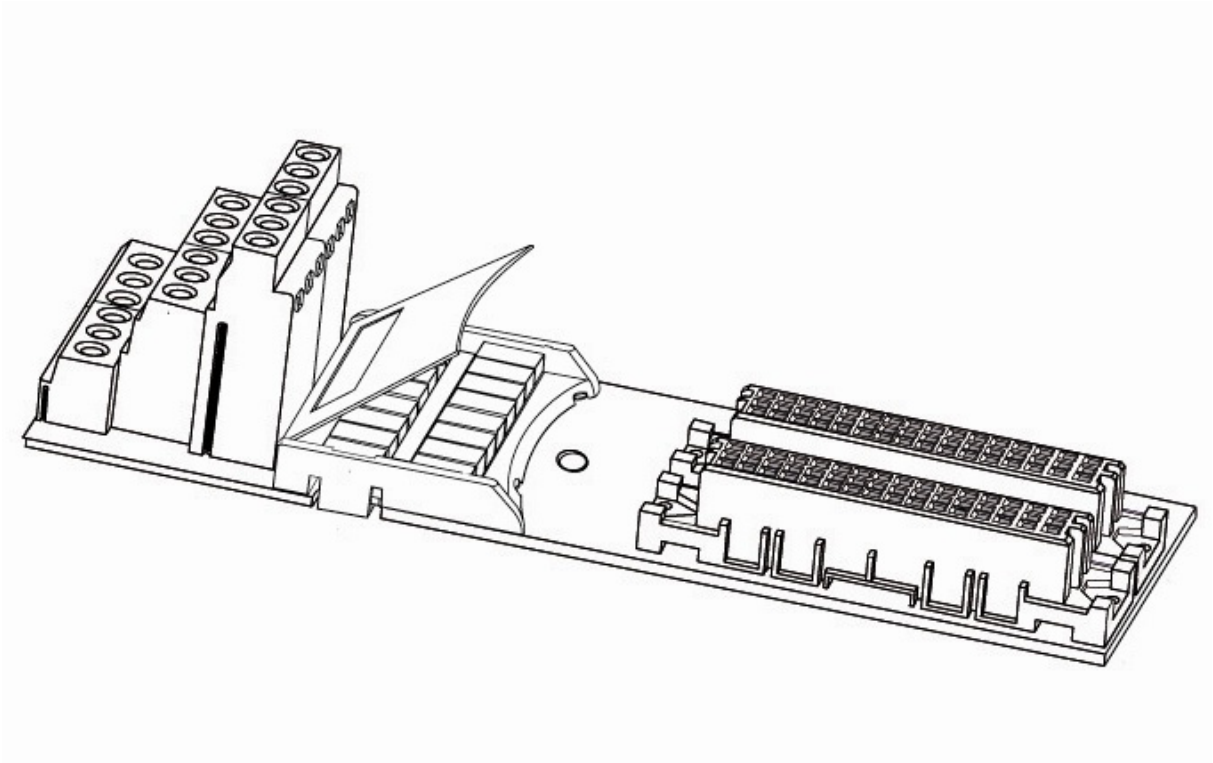
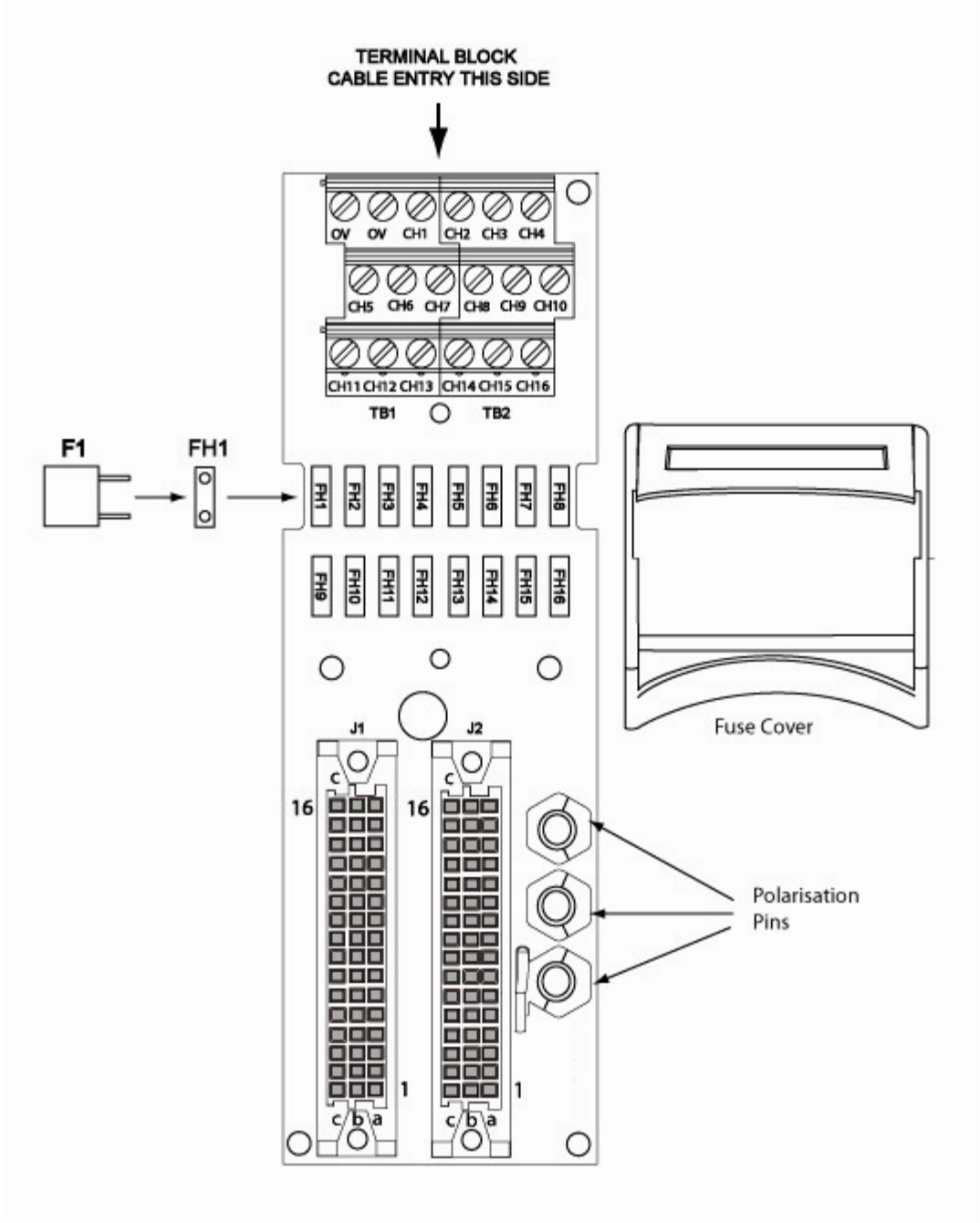


Figure 8 - Top View



T9892 Digital Output Termination Assembly

The T9892 Terminal Assembly module operates in conjunction with the T9451 Digital Output Module and provides 8 dual configuration output channels. It shares the same pin-out as the standard AADvance T9852 Digital Output Terminal Assembly and has the same coding peg configuration. The difference is that the T9892 has a separate connector for the field power input voltage connections (the left most terminal block shown below). It also has additional fusing to give extra protection against field faults.

Figure 9 - T9892 Dual Termination Assembly

Backplane Electrical Ratings

To comply with UL/CSA standards use the following voltage and current ratings for the Processor and I/O Backplanes when designing your power distribution:

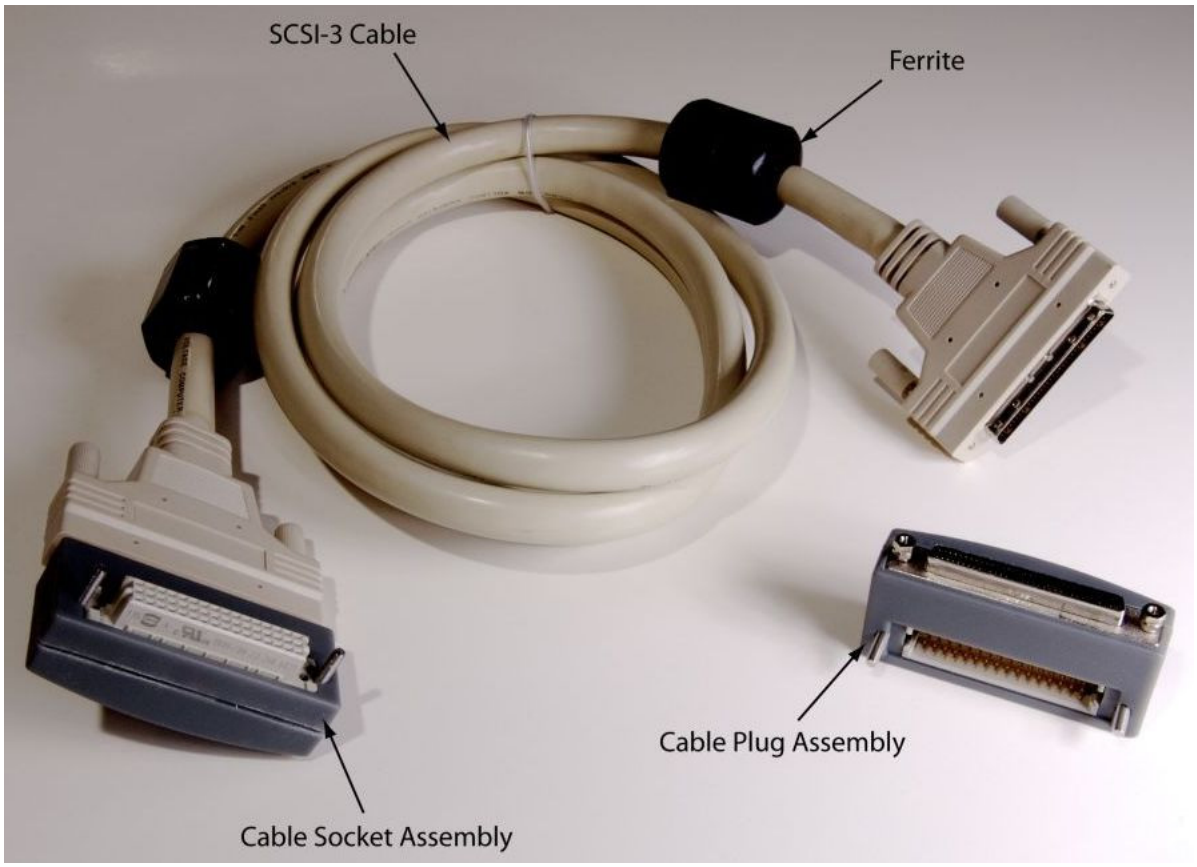
IMPORTANT	These are the maximum allowed electrical ratings given by UL for the backplane load installed with the relevant TAs and modules. They are not operating values so don't use them to calculate the controller power consumption or heat dissipation values. Refer to the separate topics on estimating Heat Dissipation and Power Consumption.

Table 5 - Maximum Electrical Rating Values

Module	Back-plane Electrical Ratings		Input/Output Electrical Ratings
	Voltage Range (Vdc)	Maximum Current (mA)	
T9100	18-32	10.4A (400 mA per slot)	-
T9300	18-32	9.6A (400 mA per slot)	-
T9110	18-32	380	-
T9401	18-32	260	Input: 18-32 Vdc @ 24 mA
T9402	18-32	260	Input: 0-32 Vdc @ 6.5 mA
T9431	18-32	260	Input: 0-32 Vdc @ 6.5 mA
T9432	18-32	260	Input: 18-32 Vdc @ 24 mA
T9481	18-32	260	Output: 18-32 Vdc/0-20 mA
T9482	18-32	260	Output: 18-32 Vdc/0-20 mA
T9451	18-32	165	Output: 18-32 Vdc @ 0.5 A, Pilot duty 16 VA, 1.5 A Inrush
T9801	18-32	6.5	-
T9802	18-32	6.5	-
T9803	18-32	6.5	-
T9831	18-32	0-24	-
T9832	18-32	0-24	-
T9833	18-32	0-24	-
T9851	18-32	500	-
T9852	18-32	500	-
T9892	18-32	500	-
T9881	18-32	0-24	-
T9882	18-32	0-24	-

Expansion Cable

This is used to add extra rows of I/O base units and modules.



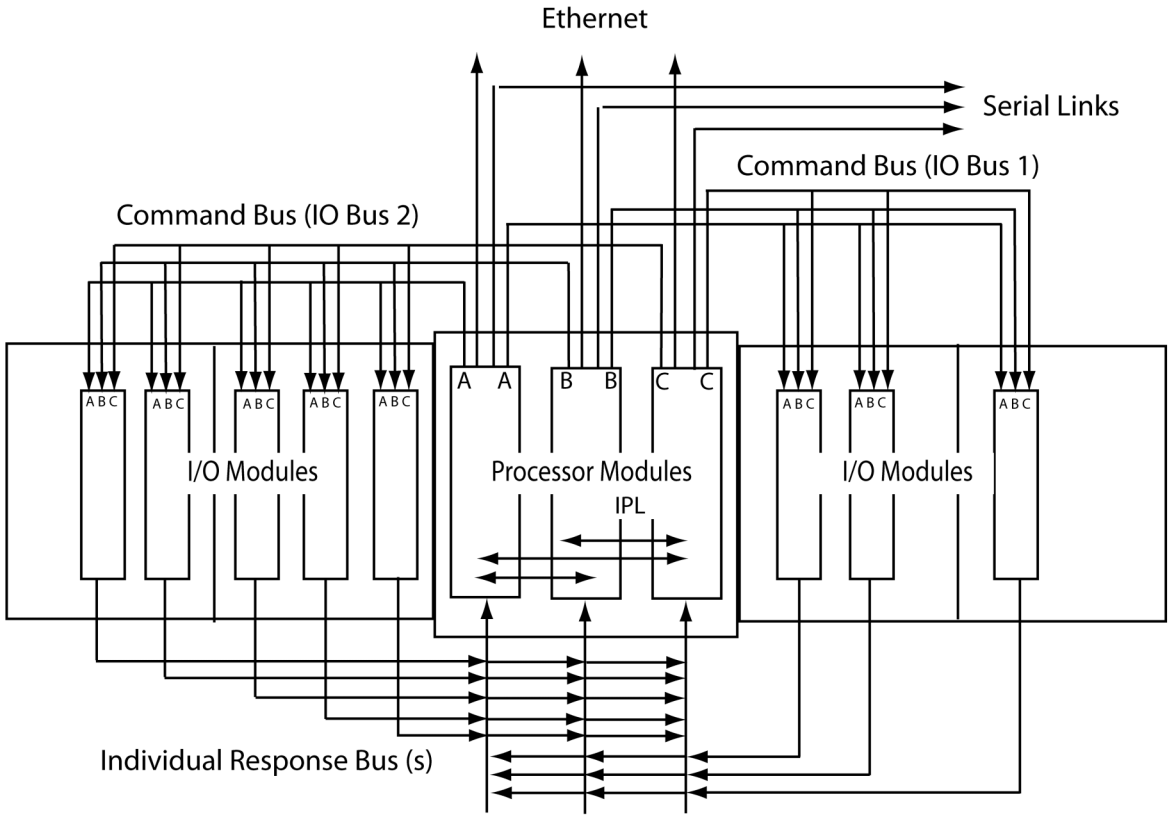
Technical Features

Controller Internal Bus Structure

Internal communication between the processor modules and I/O modules is supported by command and response busses that are routed across the processor and I/O base units.

The processor modules acts like a communications master, sending commands to its I/O modules and processing their returned responses. The two command busses I/O Bus 1 and I/O Bus 2 take the commands from the processor to the I/O modules on a multi-drop basis. An inter-processor link (IPL) supplies the communication links between dual or triple processor modules.

Each I/O module has a dedicated response line which returns to the processor. The unique response line for each I/O module supplies an unambiguous identification of the source of the I/O data and assists with fault containment.



Internal Diagnostics and Fault Reset

The AADvance controller contains comprehensive internal diagnostic systems to identify faults that occur during operation and trigger warnings and status indications. The diagnostic systems run automatically and test the system for faults related to the controller, and field faults related to field I/O circuits. Serious problems are reported immediately, but faults that are not on non-critical items are filtered to help prevent spurious alarms. The diagnostic systems monitor such items at regular times, and need a number of occurrences of a possible fault before reporting it as a problem.

The diagnostic systems use simple LED status indications to report a problem. The LED indications identify the module and can also identify the channel where the fault has occurred. There is also a summary system healthy indication for all of the controller. The application software uses its variable structures to report a fault problem; these variables give status reports and are configured using the AADvance Workbench software or AADvance-Trusted SIS Workstation software.

Faults in the processor modules are none latching. The controller will recover automatically and the fault indication will clear once the fault condition has been removed. Faults in the I/O modules are latched. To clear them a fault reset signal is sent from the processor module by pressing the Fault Reset button on

the processor module front panel. Field faults are not latched and will clear as soon as the field fault is repaired.

When the Fault Reset button on each processor module is pressed it attempts to clear a fault indication immediately, however, the diagnostic systems will report a serious problem again so quickly there will be no visible change in the fault status indications.

Remote Fault Reset

Using the AADvance Workbench software or AADvance-Trusted SIS Workstation software, you can set up a fault reset variable to mimic pressing the Fault Reset button on the front panel. This feature is provided for systems in inaccessible locations. Refer to these publications for instructions on how to set up the variable.

- AADvance Controller Configuration Guide Workbench version 1.x, publication ICSTT-RM405
- AADvance Controller Configuration Guide WorkBench version 2.x, publication ICSTT-RM458
- AADvance-Trusted SIS Workstation Software User Guide, publication ICSTT-UM002

On-line updates I/O Configuration Changes

The AADvance controller modular design makes it easy to create and change the I/O configuration. The on-line update facility enables you to make changes to the I/O configuration after the system is commissioned.

An on-line update can be used for the following changes.

- Expand a system and add new I/O modules, base units and termination assemblies.
- Change the module type in a simplex or group arrangement.
- Expand a simplex or group arrangement.
- Downgrade a group arrangement.
- Move a module to a different slot.
- Change an application variable.

You only have to plug an additional I/O base unit into the side socket on an installed I/O base unit. The command busses on the I/O base units do not need different terminations on the open ends of transmission lines, and the data response busses and power sources are supplied across all I/O base units. Termination assemblies are pushed into the I/O base unit for the additional I/O modules. To put the new modules on-line and make the changes to the system fully operational, the hardware configuration in the AADvance Workbench software or AADvance-Trusted SIS Workstation software must be updated by an on-line update.

IMPORTANT	An on-line update could affect the operation of the controller such that the application is stopped or the I/O data flow is interrupted. The AADvance Safety Manual outlines the precautions you need to follow when doing on-line updates on a Safety System.

When there is not sufficient space for extra I/O base units on a row you can use the Expansion Cable to connect a new row of I/O base units and modules to further expand the I/O system.

Hot Swap I/O for Business Critical Channels

You can add a "hot swap" capability for business critical data channels. By installing a single I/O module into a dual TA. When a dual TA is configured you are leaving an empty spare slot for a replacement I/O module when a fault occurs. You can insert a new I/O module into the spare slot and restore a failed channel without interrupting the operation of the other channels.

Configure this "hot swap" arrangement when you configure your system at installation and set up time.

Processor Firmware Upgrades

The firmware on the T9110 processor module can be updated with the following ControlFLASH™ files:

- T9110 ControlFLASH
- T9110 Recovery ControlFLASH

The files are available from th e Product Compatibility and Download Center website: rok.auto/pcdc.

If the Recovery Mode firmware in the modules is not the latest version, it should be updated first.

Before starting check that:

- RSLinx® Gateway has been installed and configured
- ControlFLASH program has been installed – minimum version 14
- The ControlFLASH files have been downloaded from the Rockwell Automation web site and installed in the ControlFLASH program using the DMK Extraction Tool
- IP addresses have been configured for the processor modules – use the AADvance Discover tool installed with the AADvance Workbench software or AADvance-Trusted SIS Workstation software
- The T9110 processor modules have been rebooted in Recovery Mode, if the modules are rebooted into Recovery Mode at the same time a single ControlFLASH update will be applied to all the modules

Update procedure:

- Run the ControlFLASH program
- Select the type of module from the list

- Browse to the T9110 Processor Module
- Select the version of the firmware to be installed (NOTE: it may be necessary to tick the "Show all versions" checkbox to see the version required)
- Update the module
- The firmware will be downloaded and stored on the module – this will take approximately 5 minutes
- The modules will be rebooted to confirm the firmware has been updated successfully

Refer to document 1756-UM105 ControlFLASH firmware Upgrade Kit User Manual in the Literature Library for detailed instructions for using ControlFLASH.

NOTE When updating the firmware, it is recommended that RSWho is not actively browsing the T9110 Processor module.

Ethernet Communication Protocols

AADvance Ethernet ports are used to support several transport layer services; these services are listed in the following table:

Protocol	Port Number	Availability	Purpose
TCP	502	When configured	MODBUS slave
TCP	1132	Always available	AADvance, application downloads, update, monitor, SoE, and so forth
TCP	10001- 10006	When configured (and the application is stopped)	Transparent Communications Interface (serial tunnelling)
TCP	44818	Always available	CIP™ Produce & Consume
TCP	55555	Always available	Telnet (diagnostic interface)
UDP	123	When configured	SNTP
UDP	1123,1124	Always available	SNCP bindings
UDP	2010	Always available	Discovery and configuration protocol (DCP, Rockwell Automation)
UDP	2222	When configured	CIP produce and consume I/Os
UDP	5000	When at least one P2P subnet is active on a controller	Peer-to-peer
UDP	44818	Always available	CIP produce and consume

Application Development

The AADvance® Workbench software or AADvance®-Trusted® SIS Workstation software environment helps you with the task of automation during the life-cycle of your system, from system design to commissioning and the day to day operation and maintenance. For application development, the AADvance Workbench software or AADvance-Trusted SIS Workstation software has powerful, intuitive features and functionality to enhance simplicity.

This chapter introduces the AADvance Workbench software and AADvance-Trusted SIS Workstation software, and describes basic software features.

Programming Language Support

The AADvance Workbench software and AADvance-Trusted SIS Workstation software are IEC 61131-3 compliant, offering up to five of the languages of the standard:

- Ladder diagram (graphical)
- Function block diagram (graphical)
- Structured text (textual)
- Instruction list (textual)
- Sequential function chart (graphical)

IMPORTANT	AADvance Workbench software version 1.4 supports the Instruction List (IL) language. AADvance Workbench software version 2.x and AADvance-Trusted SIS Workstation software do not support the IL language.

ATTENTION: The AADvance Workbench software and AADvance-Trusted SIS Workstation software do not support the Sequential Function Chart (SFC) language for safety-related applications.

Program Management Facilities

The development environment is designed for collaborative working. A group of engineers can work together, with shared ownership of a project. Each contributor can simply look at the part of the application on which they wish to work.

Program management features let you identify each functional module (program organization unit) and its operations, and the interactions between modules to form the complete application. This modular construction can help future use of code units. Engineers can debug their own modules independently from each other.

Programs can be tried and tested on the computer before downloading to the controller hardware.

Support for Variable Types

For each controller, you can declare variables using all types identified in IEC 61131-3, including Boolean, 16-bit integer (signed and unsigned) and 32-bit real. Controller-specific types include structures to hold multiple variables for each I/O channel type. Variables are easily imported from external databases if required.

Variables are found in a data dictionary. The development environment supplies a hierarchical tree of variables and a grid-like representation of their definitions.

I/O Connection (Addressing of Physical I/O)

To show the links between the hardware-independent logical variables of the AADvance application program and the physical I/O channel available on the controller, the AADvance Workbench software and AADvance-Trusted SIS Workstation software have a powerful I/O connection editor. I/O channel links are easily identified between the logical programming and the I/O wiring configuration. The I/O configuration can be tested separately from the application execution such that each module can be debugged separately.

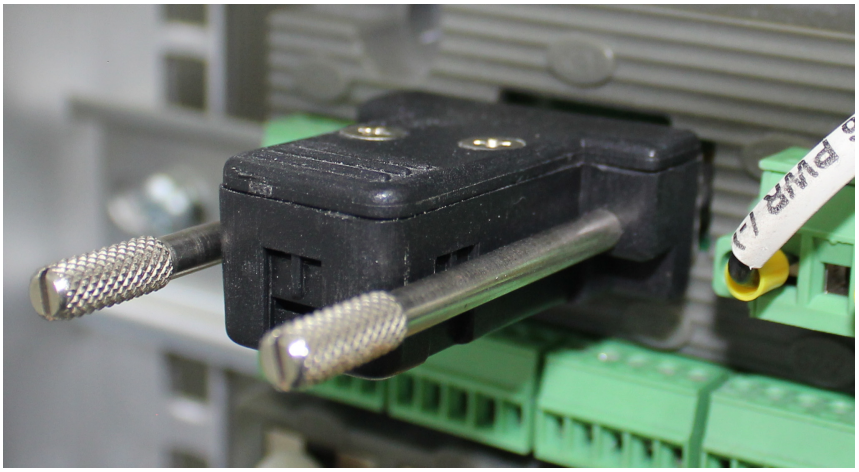
Any I/O device can be represented as a single module or a group of redundant modules. Different data types are accommodated. You can work directly on a pre-defined I/O configuration, expand and change the configuration, and the AADvance Workbench software or AADvance-Trusted SIS Workstation software fully supports directly represented I/O variables as described in the IEC 61131-3 standard.

Off-line Simulation and Testing

An engineer can validate a full application off-line, without the target hardware platform. The powerful simulator within the development environment can do structural and functional tests of each module and of the full application.

Application Program Security

The AADvance controller includes a Program Enable key that protects the application from access that has not been approved for change. The key must be fitted to the KEY connector on the T9100 processor base unit before you can download and make changes to an application. The program enable key is supplied with the processor base unit and is fitted as shown.



Use security features such as password-protection for AADvance Workbench software or AADvance-Trusted SIS Workstation software projects and firewall settings.

Aids to Software Development

The development environment automatically verifies the syntax of the source code entered in each of its supported languages. It performs checks at each stage of development, correcting or prompting the user with the correct use of the language. There is also extensive on-line help, which includes a cross-referenced explanation of the IEC 61131-3 standard.

Notes:

Before You Begin

This chapter lists important information that should be read before starting to build the system. It covers preparatory information that you should read tasks you should complete for a successful installation.

Required Tools Standard AADvance

The installation and maintenance of the AADvance® controller requires the following tools and test equipment:

Standard Tools

- Screwdriver, flat 0.8 mm x 9.0 mm (1/25 inch x 3/8 inch), for the module clamp screws and blanking covers
- Screwdriver, flat 0.6 mm x 3.0 mm (1/40 inch x 1/8 inch), or a similar that will open fuse covers on termination assemblies.
- Screwdriver, cross head number 0, for battery cover on T9110 processor module
- Screwdriver, flat 0.8 mm x 4.0 mm (1/25 inch x 5/32 inch), for screws on extension cables
- Torque screwdriver, flat 0.6 mm x 3.0 mm (1/40 inch x 1/8 inch), for dc power wiring terminals
- Torque screwdriver, flat 0.4 mm x 2.0 mm (1/64 inch x 5/64 inch), for field wiring terminals
- 2 x wrench, open end, 10 mm, for ground stud nuts
- Allen key (hex wrench), 2.5 mm, for plug and sockets assemblies used with extension cables

Special Tools

- Long nosed pliers to remove the fuses on termination assemblies.
- Digital voltmeter, for troubleshooting activities
- Resistor 1k8, for troubleshooting analogue input modules
- Resistor 1k 1W, for troubleshooting digital output modules
- Resistor 250R 1W, for troubleshooting analogue output modules

Specifying an Enclosure

When the system is installed in an enclosure it must meet the UL508 requirements for the installation environment; hold the modules securely, provide mechanical protection and should not interfere with other system components. The enclosure must also be able to handle the heat dissipated by the modules and other components/devices included in the same enclosure.

Maximum Enclosure Air Temperature

CAUTION: HEAT DISSIPATION AND ENCLOSURE POSITION
The maximum air temperature rating in an enclosure where standard AADvance processor and I/O modules are installed to support predictable reliability is +70 °C (+158 °F) for I/O Modules and +60 °C (+140 °F) for Processor modules. System and field power consumption by modules and termination assemblies is dissipated as heat. You should consider this heat dissipation during the design and positioning of your enclosure; e.g. enclosures exposed to continuous sunlight will have a higher internal temperature that could affect the operating temperature of the modules. Modules operating at the extremes of the temperature band for a continuous period can have a reduced reliability.

ATTENTION: DISSIPATION THERMIQUE ET EMPLACEMENT DE L'ENCEINTE
La température ambiante nominale maximum dans une enceinte où un processeur AADvance et des modules d'E/S standard sont installés pour assurer une fiabilité prévisible, est de +70 ºC (+158 °F) pour modules d'E/S et de +60 °C (+140 °F) pour un processeur modules. La consommation électrique du système et du terrain par les modules et les ensembles de raccordement est dissipée sous forme de chaleur. Vous devez tenir compte de l'effet de la dissipation thermique lors de conception et de disposition de votre enceinte, par exemple, des enceintes continuellement exposées à la lumière solaire auront une température interne plus élévée qui pourrait accroître la température de fonctionnement des modules. La fiabilité des modules fonctionnant aux limites extrêmes de la plage de température pendant une période prolongée peut être réduite.

Enclosure Requirements for a Non-hazardous Environment

ATTENTION: An AADvance system must be installed in an IP54 enclosure for use in a Pollution Degree 2 environment or similar in accordance with IEC 60664-1: 2007

ATTENTION: Un système AADvance doit être installé dans une enceinte normalisée IP 54 si l'environnement est classé en degré de pollution 2 conformément à la norme CEI 60664-1: 2007

Pollution Degree Definition

For the purpose of evaluating creepage distances and clearances, the following four degrees of pollution in the micro-environment are established:

- Pollution Degree 1: No pollution or only dry pollution occurs. The pollution has no influence.
- Pollution Degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.
- Pollution Degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.

- Pollution Degree 4: Continuous conductivity occurs due to conductive dust, rain or other wet conditions.

Enclosure Requirements for a Hazardous Environment - Class I, Division 2, Groups A, B, C and D

The enclosure must comply with the following UL requirements.

WARNING: Special Conditions for Safe Use

- Models T9110: The ambient temperature range is -25 °C to +60 °C (-13 °F to +140 °F).
- All other Models: the ambient temperature range is -25 °C to +70 °C (-13 °F to +158 °F).
- Subject devices are to be installed in an ATEX/IECEx Certified, IP54, tool accessible enclosure that has been evaluated to the requirements of EN 60079-0: 2012 + A11:2013, EN 60079-15: 2010/ IEC 60079 -0 Ed 6 and IEC 60079-15 Ed 4. Enclosure is to be marked with the following: "Warning - Do not open when energized". After installation of subject devices into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected. Grounding conductor should have a minimum cross sectional area of 3.31 mm^2
- Subject devices are for use in an area of not more than pollution degree 2 in accordance with IEC 60664-1.
- Subject devices are to use conductors with a minimum conductor temperature rating of 85 °C.
- Subject devices are to be installed in the vertical orientation only.

AVERTISSEMENT: Conditions spéciales pour une utilisation sûre

- Modèles T9110: la plage de température ambiante est de -25 °C à +60 °C;
- Pour tous les autres modèles: la plage de température est de -25 °C à +70 °C;
- Les dispositifs concernés doivent être installés dans une enceinte certifiée ATEX/CEIEx, IP54, accessible à l'aide d'un outil et qui a été évaluée conforme aux exigences des normes EN 60079-0: 2012 + A11:2013, EN 60079-15: 2010/IEC 60079-0 Ed 6 and IEC 60079-15 ed 4. Le marquage suivant doit être apposé sur l'enceinte : « Avertissement – Ne pas ouvrir sous tension ». Après l'installation des dispositifs concernés dans l'enceinte, l'accès aux compartiments de raccordement sera dimensionné de façon à faciliter le raccordement des conducteurs. Le conducteur de mise à la terre devra avoir une section minimale de 3,31 mm^2.
- Les dispositifs concernés sont utilisables dans un environnement présentant un degré de pollution 2 au maximum conformément à la norme CEI 60664-1 ;
- Les dipositifs concernés doivent utiliser des conducteurs avec une température nominale minimum de +85 °C ;
- Les dispositifs concernés doivent être installés verticalement uniquement.

WARNING: EXPLOSION HAZARD
Do not connect or disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent.

AVERTISSEMENT: RISQUE D'EXPLOSION
Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente

WARNING: Substitution of any component may impair suitability for Class I, Division 2 or equivalent.

AVERTISSEMENT: La substitution de composants peut rendre impropre à l'utilisation en Classe I, Division 2 ou équivalente.

CAUTION: For AADvance modules T9110, T9801,- T9803, T9831- T9833, T9851, T9852, T9892, T9881 and T9882 a disconnect suitable for the location where they are installed shall be provided to allow for removal of power from the fuses before replacement.

ATTENTION: Pour les modules AADvance T9110, T9801,- T9803, T9831- T9833, T9851, T9852, T9892, T9881 et T9882, un sectionneur adapté à l'environnement où ils sont installés devra être fourni pour couper l'alimentation en amont des fusibles avant leur remplacement.

Controller Mounting

An AADvance controller and I/O bases can be mounted using one of two methods:

- A pair of parallel TS35 DIN rails.
- Panel mounted using three holes on each base.

Free Space around the Controller

Whichever mounting method is used the minimum depth from the rear mounting panel to the front panel and space around the base units are shown in the illustration, if you wish to mount the controller on DIN rails, increase this allowance by the increased depth of the DIN rails. The DIN rails must be TS35 rail, which is a 35mm × 7.5mm standard symmetric rail.

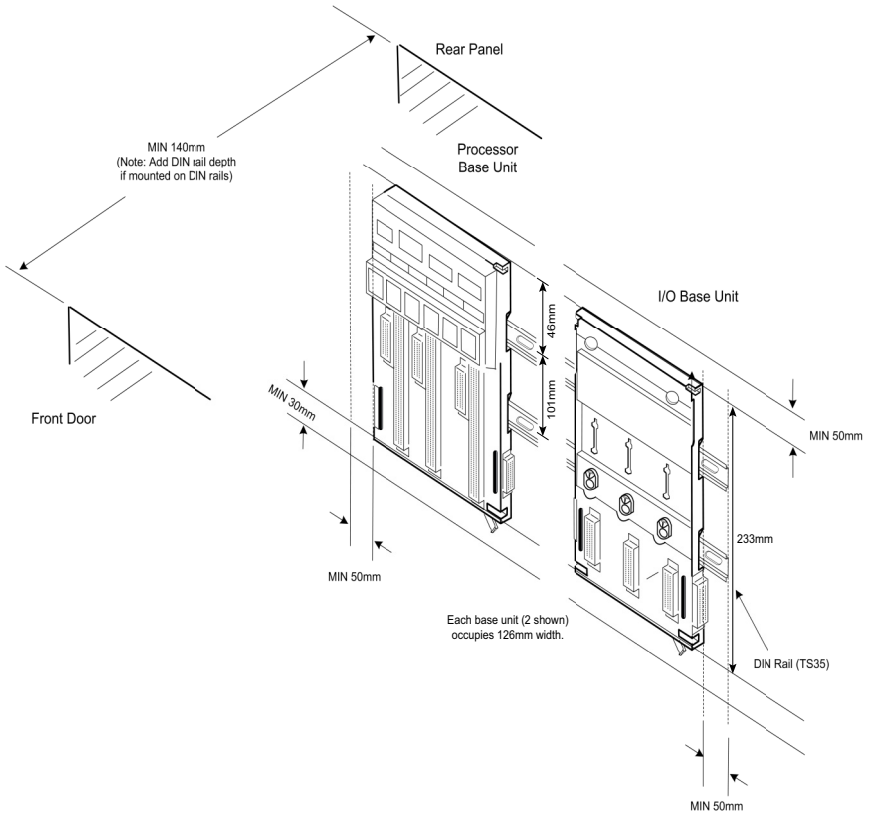
You must have sufficient free space around the base units to allow for the following:

- Space above, to adjust and install field wiring.
- Space below, to let modules fit and to be able to hold a module during removal.
- Space to the right of the last base unit in the row, to move an I/O base unit during assembly or if you are installing a new base unit.

If an expansion cable is to connect to the left-most base unit, the controller also needs space to the left, to fit the expansion cable adapter.

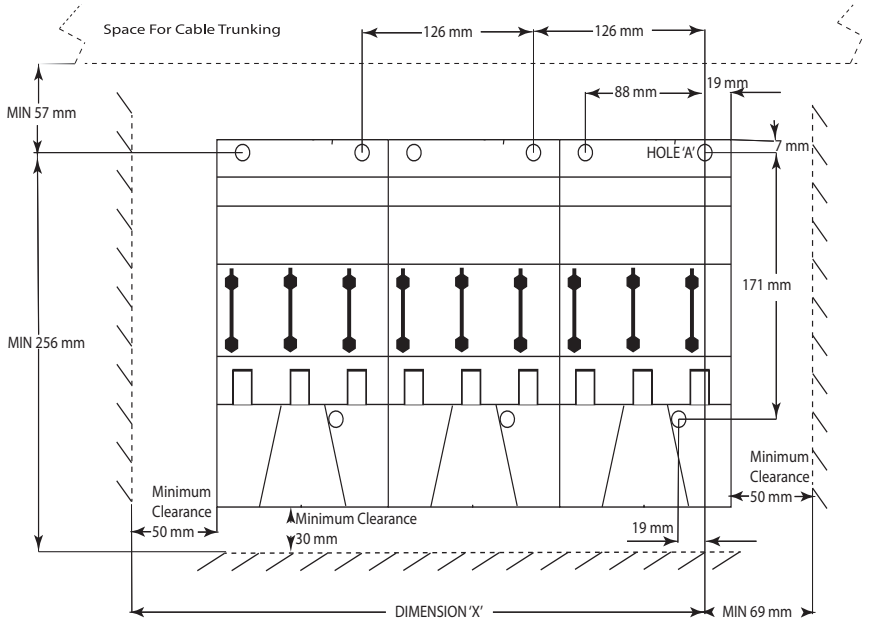
This illustration (Figure 10) shows the minimum recommended clearances and rail positions for DIN rail mounting. The clearances also apply to flat panel mounting.

Figure 10 - Free Space for Din Rails Fitting



The flat panel drilling holes are shown in the illustration (Figure 11) below:

Figure 11 - Flat Panel Mounting



With reference to Figure 11 - Flat Panel Mounting, three mounting units are illustrated above.

Drill three holes per base unit to suit M5 screws.

The screws are positioned with reference to the datum Hole A, which is shown on Figure 11 above.

- Set Dimension 'X' to suit number of base units:
- Min 157 mm for 1 base unit
- Min 283 mm for 2 base units
- Min 409 mm for 3 base units
- Add 126 mm for each additional base unit

CAUTION: HEAT DISSIPATION AND ENCLOSURE POSITION

The maximum air temperature rating in an enclosure where standard AADvance processor and I/O modules are installed to support predictable reliability is 70 ºC (158 °F) for I/O modules and 60 °C (140 °F) for processor modules. System and field power consumption by modules and termination assemblies is dissipated as heat. You should consider the effect of heat dissipation on the design and positioning of your enclosure; e.g. enclosures exposed to continuous sunlight will have a higher internal temperature that could increase the operating temperature of the modules. Modules operating at the extremes of the temperature band for a continuous period can have a reduced reliability.

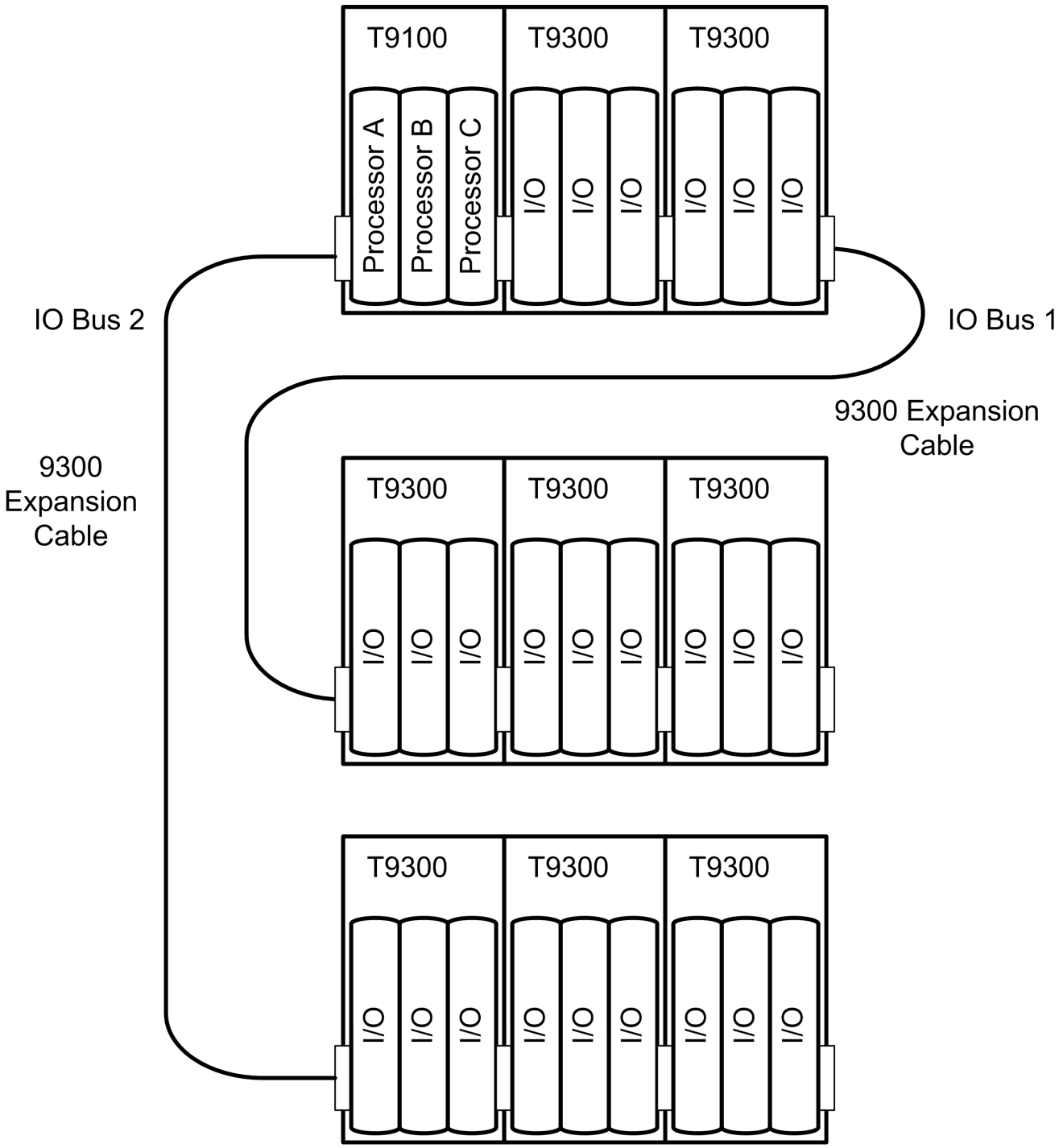
ATTENTION: DISSIPATION THERMIQUE ET EMPLACEMENT DE L'ENCEINTE

La température ambiante nominale maximum dans une enceinte où un processeur AADvance et des modules d'E/S standard sont installés pour assurer une fiabilité prévisible, est de 70 ºC (158 °F) pour modules d'E/S et de 60 °C (140 °F) pour processeur. La consommation électrique du système et du terrain par les modules et les ensembles de raccordement est dissipée sous forme de chaleur. Vous devez tenir compte de l'effet de la dissipation thermique lors de conception et de disposition de votre enceinte, par exemple, des enceintes continuellement exposées à la lumière solaire auront une température interne plus élévée qui pourrait accroître la température de fonctionnement des modules. La fiabilité des modules fonctionnant aux limites extrêmes de la plage de température pendant une période prolongée peut être réduite.

Base Units Rows and Expansion Cables

AADvance T9300 I/O base units connect to the right hand side of the T9100 processor base unit (I/O Bus 1) and to the right hand side of other T9300 I/O base units by a direct plug and socket connection. The I/O base units connect to the left hand side of the processor base unit by using the T9310 expansion cable (I/O Bus 2). The expansion cable also connects the right hand side of I/O base units to the left hand side of other I/O base units to install extra rows of I/O base units. Base units are secured in place by top and bottom clips that are inserted into the slots on each base unit.

Figure 12 - Connecting Base Units with Expansion Cables



The expansion bus accessed from the right hand edge of the T9100 processor base unit is designated I/O Bus 1, while the bus accessed from the left hand edge is designated I/O Bus 2. The module positions (slots) in the I/O base units are numbered from 01 to 24, the left most position being slot 01. Any individual module position within the controller can thus be uniquely identified by the combination of its bus and slot numbers, for example 1-01.

The electrical characteristics of the I/O bus interface limit the maximum possible length of either of the two I/O buses (the combination of I/O base units and expansion cables) to 8 meters (26.24 ft.).

NOTE The T9310 Expansion Cable is 2 m (6.56 ft.).

Adding Field Cable Management

The field, power and other system wiring will be connected to terminals along the top of the base units. It is recommended a length of cable trunking or the equivalent be put above each set of base units, for cable management.

Figure 13 - Field Wiring Connections

System Power Requirements

A controller's system power should be supplied from two different 24 Vdc (Nominal) power supplies with a common return path; that is, the 0 V return will be the same between the power feeds. Each controller also requires an external field power source for the field loops.

WARNING: A controller system must be installed with a power network that is designed to meet over voltage Category II

This means that a controller must be supplied with system power from a power source that complies with SELV and PELV standards.

- SELV (safety extra-low voltage) is a voltage which is no larger than 30 Vrms, 42.4 Vpeak and 60 Vdc between conductors, or between each conductor and earth in a circuit which is isolated from the line voltage by a safety transformer.
- PELV (protected extra-low voltage) is an extra low voltage circuit with a protective partition from other circuits which has a protective earth connection.

To satisfy SELV and PELV requirements the power source must have a safety transformer with a protective partition between the primary and secondary windings so that the windings are galvanic and electrically isolated.

Power Supply and Power Distribution Requirements

The power supplies and power distribution, if incorrectly designed, are a possible electrical or fire safety hazard and can contribute to common cause failure. It is therefore necessary to:

- Establish the power philosophy, specific earthing philosophy, power requirements, and the separation requirements where items of equipment are separately supplied, for example system internal supplies and field loop supplies.
- Make sure that the chosen Power Supply Units (PSUs) are compatible with the power feeds supplied. Alternatively, measures must be put in place to make sure that the power feeds stay within the specifications of the PSUs.
- Define the power distribution requirements, together with the protective philosophy for each distribution; for example, current limited at source or protective devices. Where protective devices are used, it is important to find out that sufficient current will be available to make sure their protective action and the protective device can break the maximum prospective fault current.
- Make sure that the power supplies are sufficient to meet the system load and for any foreseeable load requirements and load transients.
- Make sure that the power supplies have a minimum hold up time of 10 ms.
- Make sure that the power distribution cabling is sized to allow the maximum prospective fault currents and tolerable voltage losses. This is specifically important where floating supplies are employed and other power sources can cause high prospective fault currents if multiple earth faults occur.

Controller Power Supply Requirements

A controller requires the following power supply sources:

- A dual redundant power supply of + 24 Vdc with an operating range of 18 Vdc to 32 Vdc. The AADvance controller is designed to accept supply transient and interference according to IEC 61131 part 2.

An over current fault in the controller must not cause the system to lose power. Consequently, the power sources must be able to supply the peak current to open any over current protection devices (such as fuses) without failing.

The power supply protection of the controller is in the modules, the power distribution arrangement must have a circuit breaker on the input side of each power source. The controller is designed to be resistant to a reverse polarity connection without permanent damage.

The power sources must come from a commercially available industrial un-interruptible power supply (UPS) system. An applicable UPS must have the capacity sufficient to satisfy the entire system load (including field devices and the controller) and an applicable contingency allowance for projected future expansion.

WARNING: The power supplies must satisfy the electrical requirements and tests specified in IEC 61131 EN 61010-1 and EN 60950 and must be big enough for the system requirements.

Power Arrangements for Field Devices

Output modules use an external source of power for field devices. This may be the power source used for the controller or a separate power source.

- For digital and analogue outputs a field power supply of +24 Vdc within a range of 18-32 Vdc is required.

Recommended field circuits are given for each type of I/O module later in the section "Connecting Field Wiring".

IMPORTANT It is highly recommended that the negative side of the field supply be connected to earth (ground). This will avoid possible fail danger conditions that can be caused by some earth fault monitors used with floating power supplies.

Power Distribution Protection

The power distribution circuit for each field input and for each output module must be protected, externally to the controller. Rockwell Automation recommend that power distribution must meet national and local panel wiring protection standards.

Digital Output Field Power

Special fusing arrangements are required for Digital Output field supplies for UL, ATEX and IECEx approved installations, (see topic on field loops for Digital Output Modules).

Estimating Power Consumption

To estimate the power supply requirements (power supply sizing) you need to know the power consumption of all the modules. Use the following table to estimate the system power consumption.

Table 6 - Module Supply Power Consumption

Item	Number of Modules	Power Consumption	Subtotal
T9110 Processor Module		× 8.0 W	=
T9401 Digital Input Module 24 Vdc, 8 channel		× 3.3 W	=
T9402 Digital Input Module 24 Vdc, 16 channel		× 4.0 W	=
T9431 Analogue Input Module, 8 channel		× 3.3 W	=
T9432 Analogue Input Module, 16 channel		× 4.0 W	=
T9451 Digital Output Module, 24 Vdc, 8 channel		× 3.0 W	=
T9482 Analogue Output Module, 8 channel, isolated		× 3.6 W	=
		Total:	

IMPORTANT The above figures are worst case values calculated from the range of operating voltages and currents. If your system is required to meet UL/CSA standards the power consumption and the corresponding electrical ratings must not exceed the maximum electrical ratings given in the table included in the topic "Backplane Electrical Ratings".

Field Power Consumption

To estimate overall controller power dissipation it is necessary to include the field power component dissipated within the controller. Refer to the table "Field Loop Power Heat Dissipation". The field power requirements should be calculated separately and is dependent on the number and type of field elements. Refer to the specifications for the Digital and Analogue output modules for details of the channel output electrical specifications.

System Design Considerations for Heat Dissipation and Cooling

The controller is designed to operate in its specified environment without forced air cooling. However, forced air cooling may be needed in individual circumstances when the controller shares its enclosure with other heat producing equipment and the internal temperature could exceed the recommended operating temperature range.

Module Orientation

Rockwell only recommend that modules are oriented vertically, if modules are mounted in any other orientation then specific temperature tests must be done to achieve reliable and predictable operation.

Maximum Air Temperature

The maximum air temperature rating in an enclosure where AADvance modules are installed to support predictable operation is 70 °C (158 ° F).

Estimate Heat Dissipation

The heat in the enclosure is generated from several sources such as the power supplies, the AADvance modules and some of the field loop power. Use the following calculation and the data given in the tables to estimate the overall heat dissipation:

- Power supply consumption (Watts x (100-efficiency) (%) + the sum of the system power consumed by the modules + part of the field power that is in the enclosure.

The following module power dissipation values are worst case values over the range of operating voltages and currents.

Table 7 - Module Supply Power Heat Dissipation

Item	Number of Modules	Module Power Heat Dissipation	Subtotal (W/BTU/hr)
T9110 Processor Module		× 8.0 W (27.3 BTU/hr.)	=
T9401 Digital Input Module 24 Vdc, 8 channel		× 3.3 W (11.3 BTU/hr.)	=
T9402 Digital Input Module 24 Vdc, 16 channel		× 4.0 W (13.6 BTU/hr.)	=
T9431 Analogue Input Module, 8 channel		× 3.3 W (11.3 BTU/hr.)	=
T9432 Analogue Input Module, 16 channel		× 4.0 W (13.6 BTU/hr.)	=
T9451 Digital Output Module, 24 Vdc, 8 channel		× 3.0 W (10.2 BTU/hr.)	=
T9482 Analogue Output Module, 8 channel, isolated		× 3.6 W (12.3 BTU/hr.)	=

Total:	

The field loop power heat dissipation is generated from the input voltages and currents + the output currents:

Table 8 - Field Loop Power Heat Dissipation

Item	Number of Field Loops	Field Loop Power Heat Dissipation	Subtotal (W x 3.412 BTU/hr)
Digital Inputs		× Input Voltage (V)/5125	=
Analogue Inputs		× Input current (A) x 135	=
Digital Outputs		x Output current (A) x 0.57	=
Analogue outputs		x (Field voltage(V) x Output Current (A) - load Resistance (Ω) x Output current (A) [1]	=

Total:	

[1] The maximum field loop power heat dissipation for analogue outputs should be calculated at an output current corresponding to the smaller of the Maximum Channel Output Current OR Field Voltage/(2 x Load Resistance)

Estimate AADvance Controller Weight

Use the following table to make an estimate of the weight of your controller.

Table 9 - AADvance Controller Module Weight

Item	Number Used	Weight Allowance g (oz.)	Subtotal
T9100 Processor Base Unit		× 460 g (16 oz.)	
T9110 Processor Module		× 430 g (15 oz.)	
T9401 Digital input module, 24 Vdc, 8 channel		× 280 g (10 oz.)	
T9402 Digital input module, 24 Vdc, 16 channel		× 340 g (12 oz.)	
T9431 Analogue input module, 8 channel		× 280 g (10 oz.)	
T9432 Analogue input module, 16 channel		× 340 g (12 oz.)	
T9451 Digital output module, 24 Vdc, 8 channel		× 340 g (12 oz.)	
T9482 Analogue output module, 8 channel		× 290 g (10.5 oz.)	
T9300 I/O base unit (3 way)		× 133 g (5 oz.)	
T98x1 Simplex Termination assembly		× 133 g (5 oz.)	
T98x2 Dual Termination Assembly		× 260 g (10 oz.)	
T98x3 Triple Termination Assembly		× 360 g (13 oz.)	
T9310 Expansion cable assembly and 2 m cable		× 670 g (24 oz.)	
T9841 Termination Assemblies (average weight)		× 175 g (6 oz.)	

Total estimated controller weight	

Estimating Center of Gravity Information

If it is necessary to calculate the location of the center of gravity of an AADvance controller destined for a maritime or other shock-mounted application, it is reasonable to assume the center of gravity of each assembly of modules and their base unit is at the geometric center of the assembly.

Design Considerations for Electrical Grounding

All applications of the controller will require at least two separate ground (earth) systems:

- An AC safety ground (sometimes called the 'dirty ground') to protect people in the event of a fault. The ground stud on the T9100 processor base unit, and all exposed metalwork such as DIN rails, will be bonded to the AC safety ground.
- An instrument ground (sometimes called the 'clean ground' or the '0 Vdc ground') to provide a good stable 0 V reference for the system. Every signal return will be referenced to the instrument ground. The instrument ground will be isolated from the AC safety ground.

The AC safety ground and the instrument ground will usually be made available through bus-bars. Bus-bars must be of copper; they may be nickel plated. For a small application, you may use ground studs instead of bus-bars.

Some field wiring, such as communications cables, will need shielded (screened) cable. There may be a shield ground, in addition to the AC safety and instrument grounds, to provide a common point to terminate shields of such cables. The shield ground will usually be connected to the AC safety ground; or, more rarely, to the instrument ground. In practice, the continuity of the shield connections will be more important than the goodness of the ground connection provided.

The controller input and output modules incorporate galvanic isolation. Nevertheless, it is possible that a particular application will require the provision of barrier strips with galvanic isolation, for example to provide consistency with an existing installation. In these cases, there may be a separate intrinsic safety ground as well.

Specify software requirements

For information about supported operating systems and other software product version support, refer to product release notes from the Product Compatibility and Download Center (PCDC): rok.auto/pcdc.

Design Considerations for Maintenance Activities

Maintenance Activities

The design of the installation must allow preventive and corrective maintenance activities to take place. Corrective maintenance tasks will embrace the identification and renewal of defective modules and other assemblies and, when exhausted, renewal of the back-up battery within the T9110 processor module.

Fuses on the termination assemblies can be replaced so access to the fuses is required. There are no user-serviceable parts inside modules therefore repair is by replacement; defective modules should be returned to Rockwell Automation for investigation and repair.

WARNING: EXPLOSION HAZARD
Do not connect or disconnect equipment, while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent.

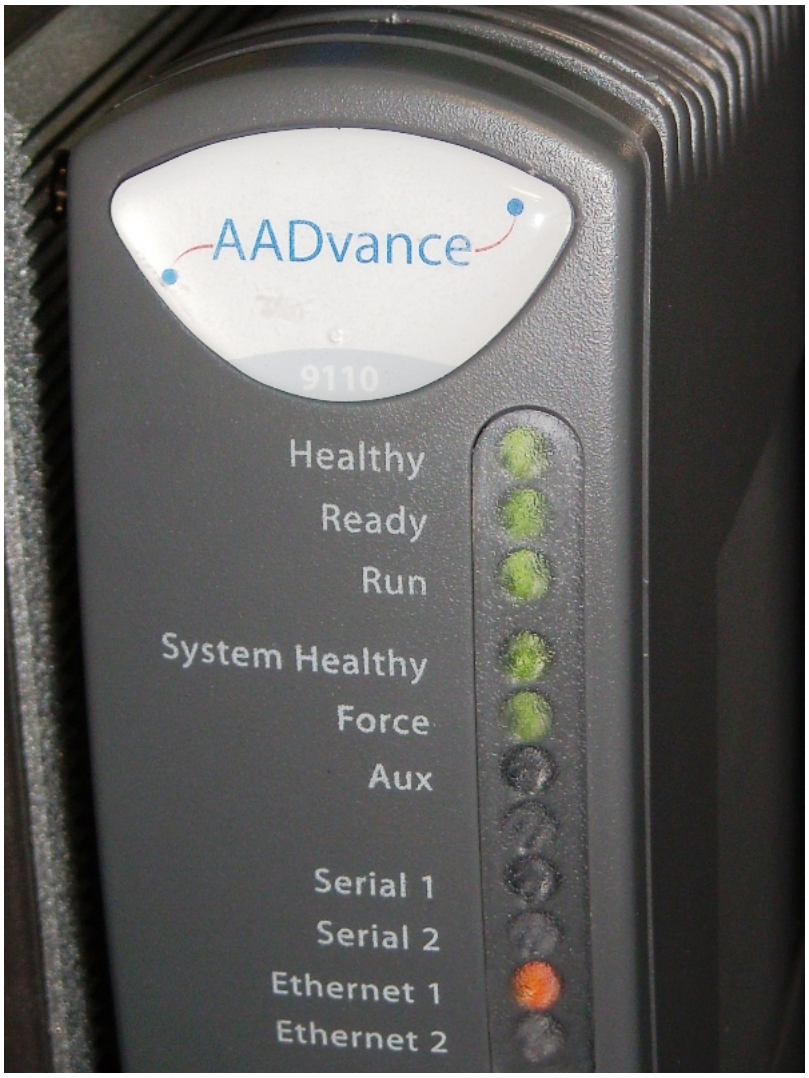
AVERTISSEMENT: RISQUE D'EXPLOSION
Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente.

Design Provisions

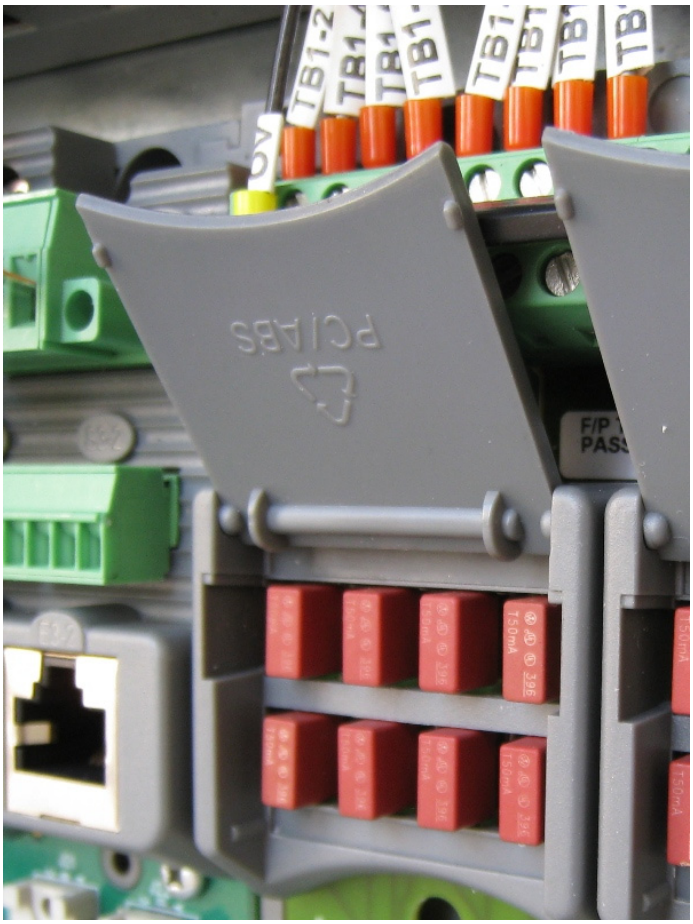
The design of the controller installation should make the following provisions:

- Clear access to remove and install modules, termination assemblies, base units and security dongle (Program Enable key). Repair of controller modules will be by module replacement.

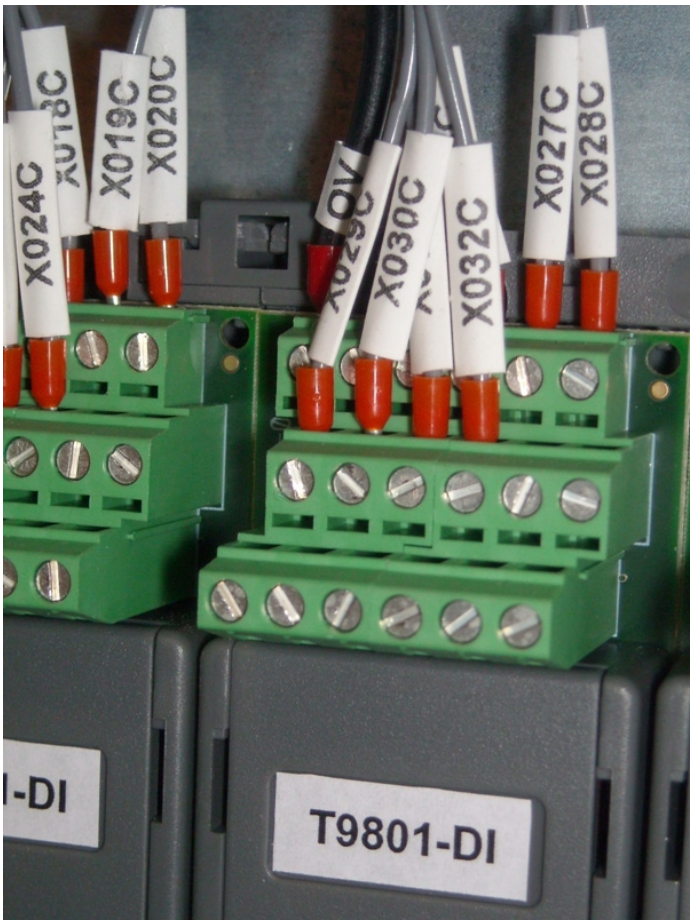
A way for plant operations personnel to inspect the status LEDs on each module. The status LEDs report faults.



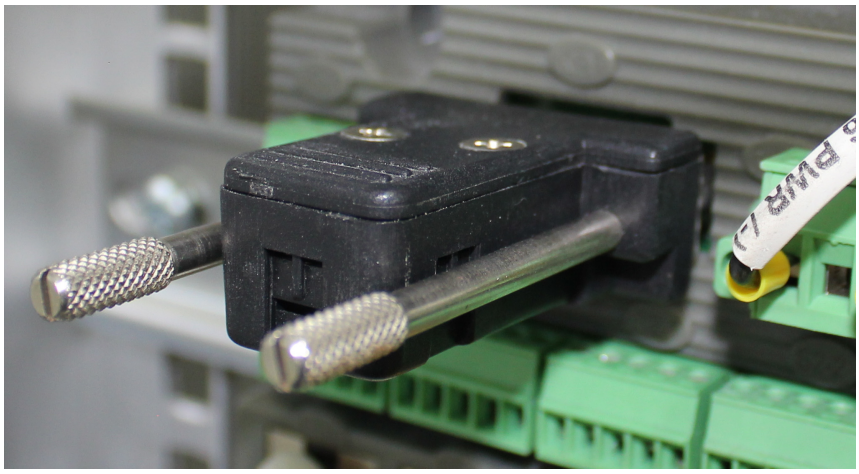
Clear access to examine, remove and install fuses located on the termination assemblies.



Clear access to terminals and connectors for field, power and network wiring, and access to the wiring itself.



Clear access to the Security Dongle (Program Enable Key)



In addition, it may be appropriate to make the following provisions:

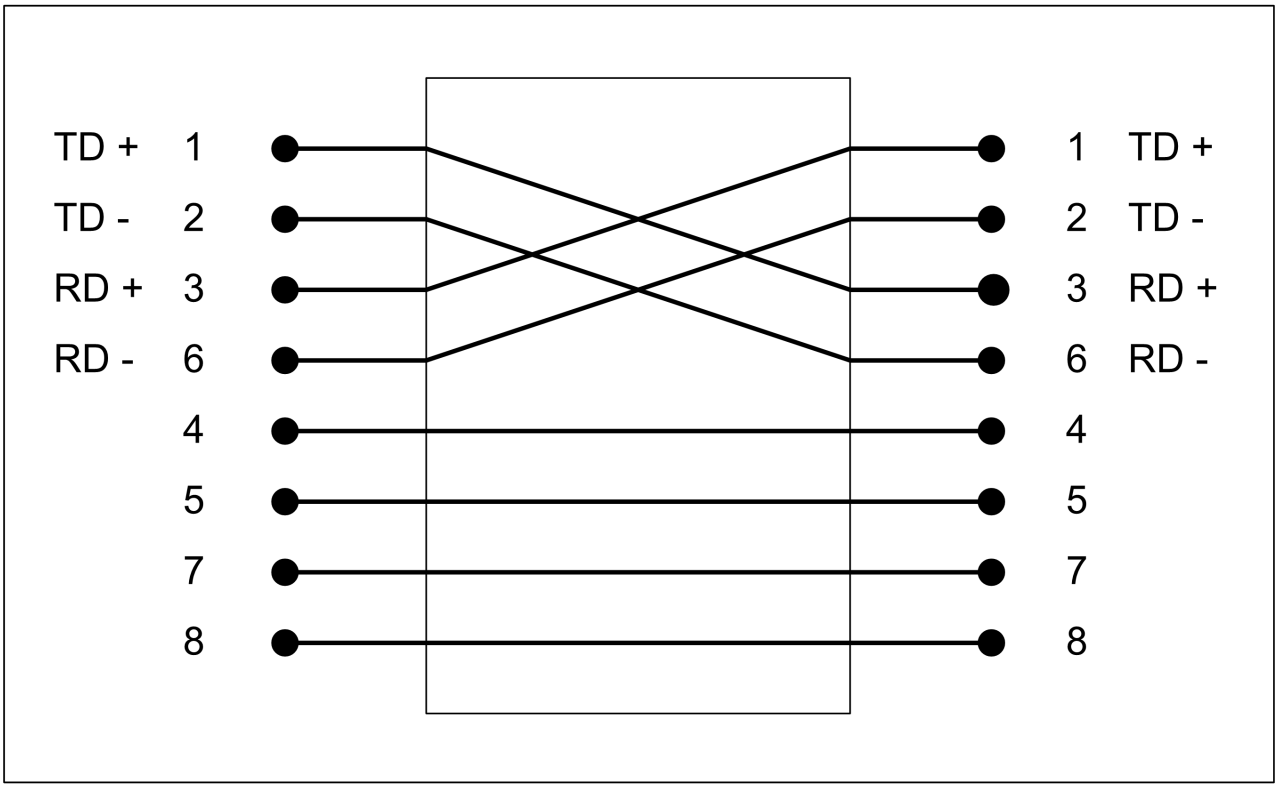
- A lock on the door of the enclosure, to deter unauthorized access and possible unofficial modifications.
- Lighting.
- Utility sockets.

Connecting the AADvance Controller to the Network

The T9100 processor base unit has six auto-sensing 10/100BASE-TX Ethernet ports which allow it to connect to a local area network through standard Rj45 Ethernet cable. These are two ports for each processor module.

If a direct connection is required from the controller to the computer (for example, during setting up) use a crossover cable. This will depend on the characteristics of the network interface in the PC.

Figure 14 - Wiring for 100BASE-TX Ethernet Crossover Cable

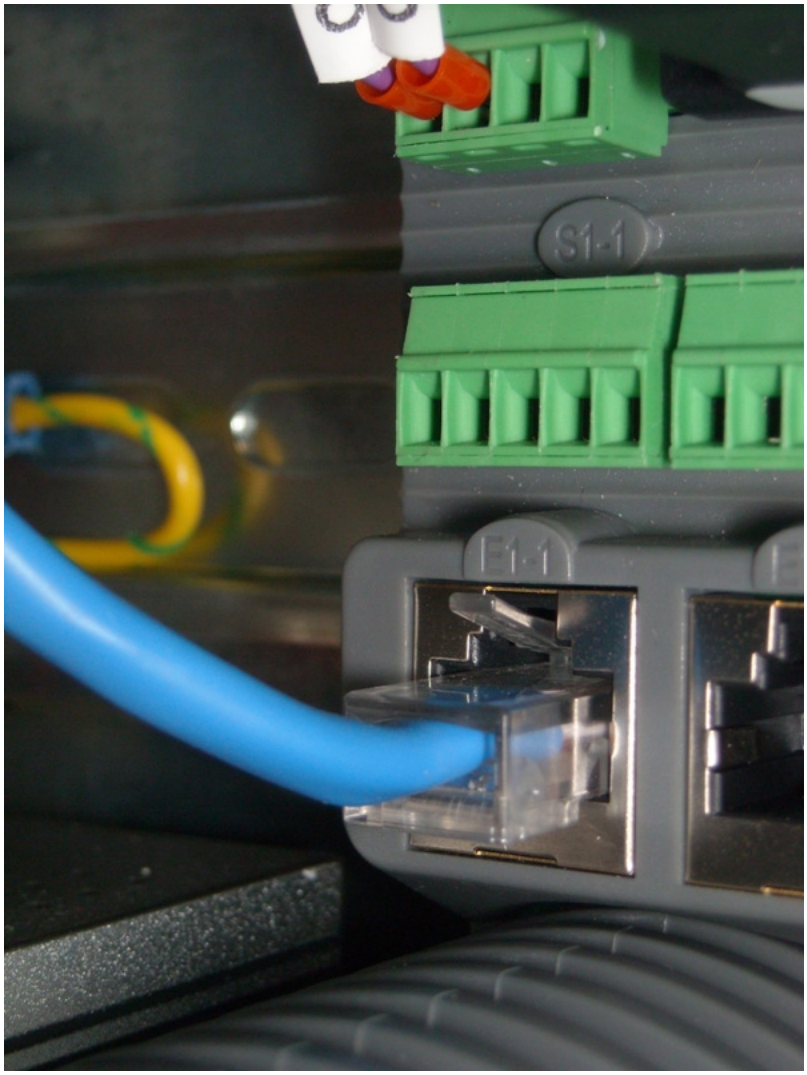


The fixed connectors on the controller are RJ45 sockets. Use Cat5e (enhanced) cables with RJ45 modular plugs for the network cabling.

Connect the network cables to the sockets on the T9100 processor base unit.

- For each network connection, insert the RJ45 modular plug on the cable into the appropriate socket.
- Make sure the length of the cable does not exceed 100m (328 ft).

Refer to the illustration for an example.


S1-1
F1-1

Notes:

Install the AADvance System

The system installation defines the steps that will verify that the system is correctly installed and ready for the on-site factory tests before the system is brought on-line. This chapter describes how to install the AADvance® system hardware into the chosen enclosure.

WARNING: In addition to the installation guidelines given in this chapter you must also use installation and commissioning procedures that obey the rules and standards of the country of installation. These standards can include for example, IEC 61511, NFPA72 and ISA 84.00.01 depending on the location.

Unpacking and Preassembly Checks

The components are packed to make sure they arrive undamaged and ready for assembly. Nevertheless, you should inspect all modules before beginning the assembly work.

On receipt, carefully inspect all the shipping cartons for damage.

- If any cartons are damaged, note the damage on the carrier's shipping document before signing it. Save any damaged cartons for inspection by the carrier.
- If any part of the delivered components has been damaged during shipping, notify the carrier and Rockwell Automation immediately.

Damaged goods must be returned Rockwell Automation for repair or replacement (see Warranty and Returns instructions with delivery documentation).

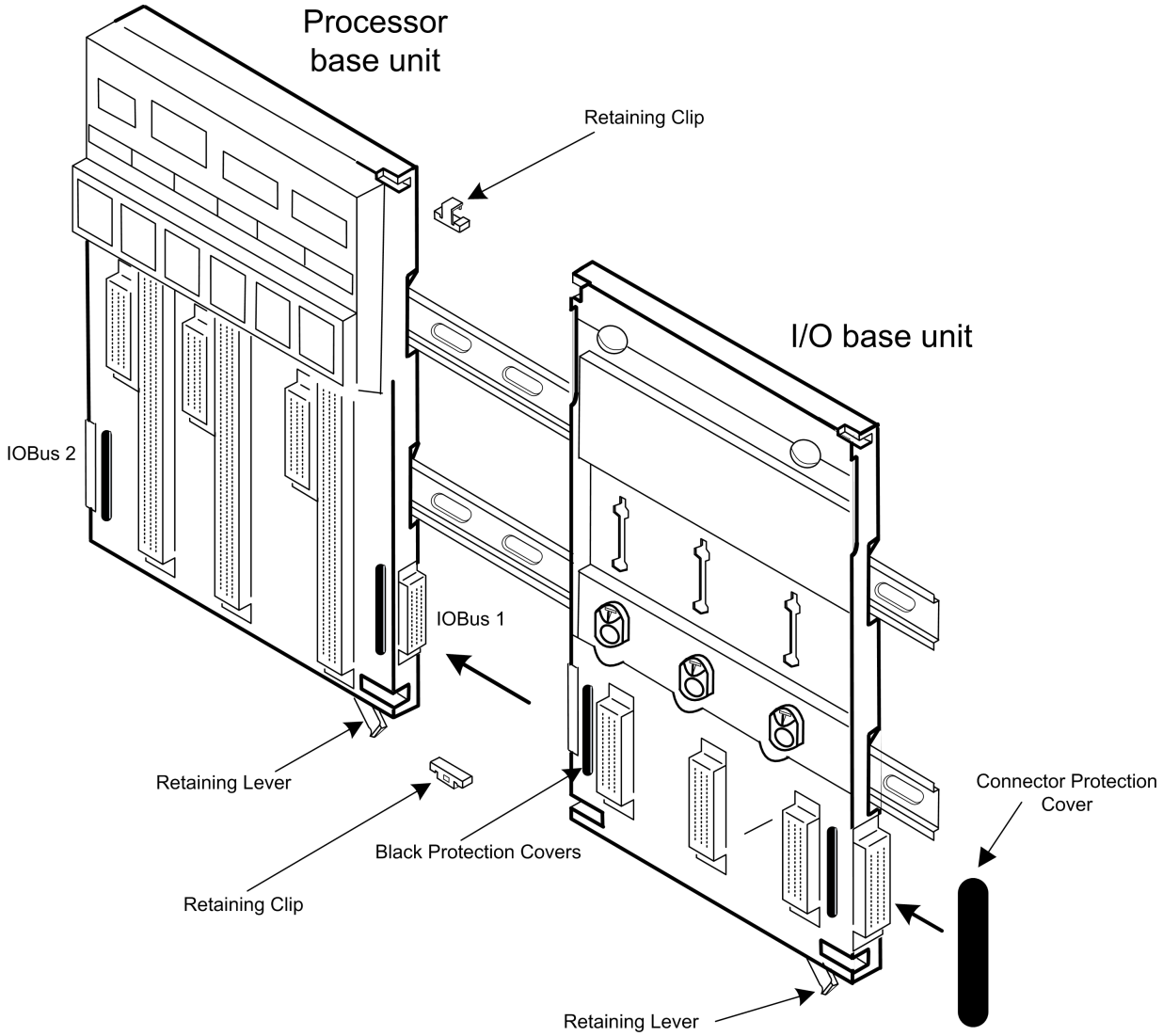
CAUTION: Handling Modules Stored at Extreme Temperatures:
It is recommended that modules removed from storage should be allowed to normalize their temperature before installation. This is particularly important when modules have been stored at very low temperatures where condensation can occur. Remove the modules and place them in an upright position and wipe away any condensation that might appear on the modules.

Failure to follow these recommendations could lead to damage to modules or incorrect operation when installed into a running system.

Install Base Units and Termination Assemblies: Enclosure DIN Rail Assembly Method

The following illustration shows how to it the backplanes on to Din rails and use the retaining clips and lever to hold them in position.

Figure 15 - Fit I/O Base Unit onto DIN Rails



IMPORTANT Fit the rubber connector protection cover to exposed connectors that are not joined to another base unit.

For a system build that uses DIN rails do the following:

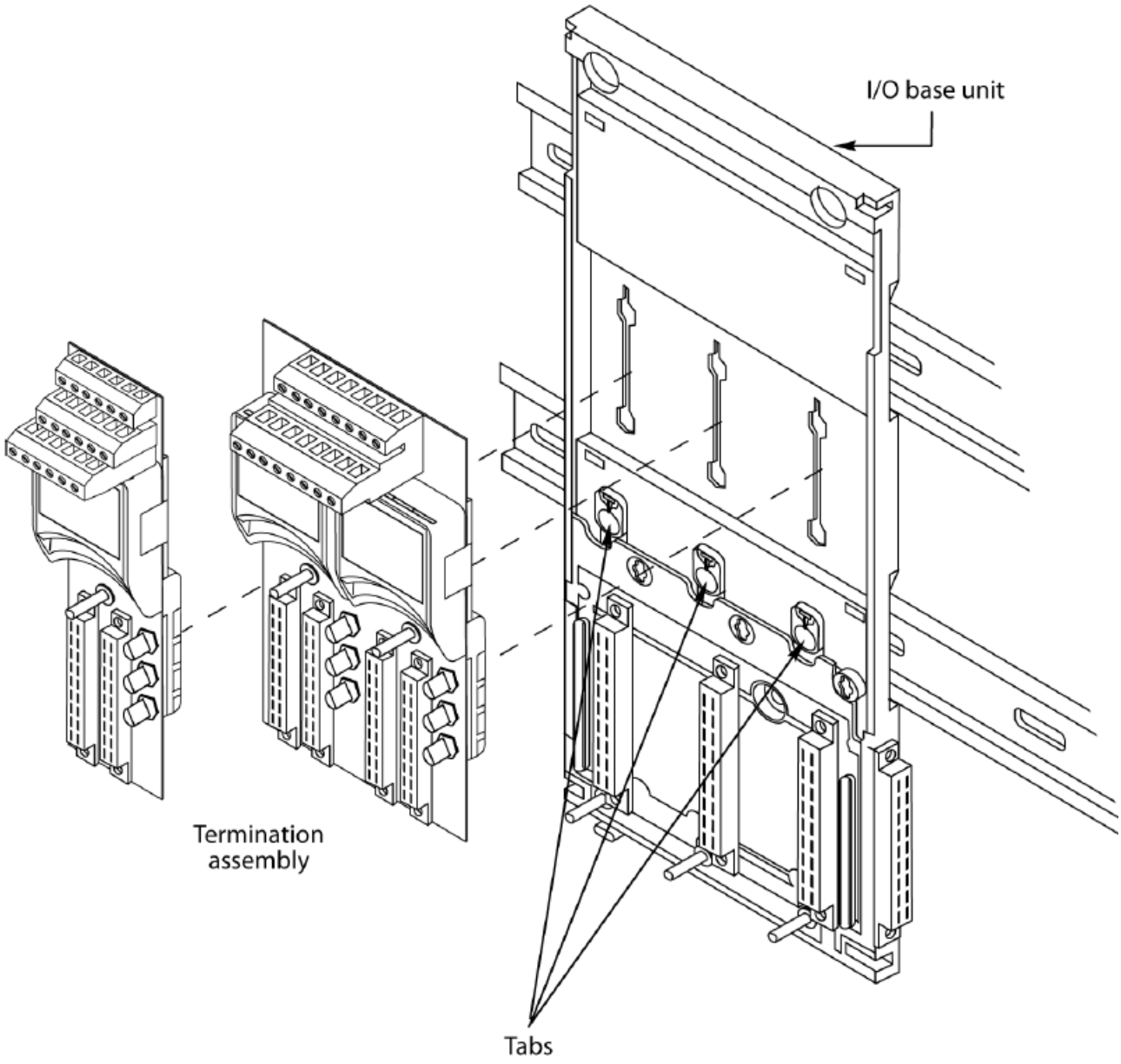
1. Install the **DIN rails**.
   - The AADvance controller will be mounted onto one or more pairs of parallel DIN rails. For each pair of rails, mount the lower rail with its center line 101.0mm below the center line of the upper rail. M5 thread rolling screws are suitable.
2. Mount the **T9100 processor base unit**
   - Place the **T9100 processor base unit** onto the **DIN rails** and position it towards the left, leaving space for the T9300 I/O base units to the right.
   - Secure the **processor base unit** onto the **DIN rails** by sliding the retaining lever (below the base unit) to the left.
3. Mount each **T9300 I/O base unit**
   - Place a **T9300 I/O base unit** onto the **DIN rails** to the right of the T9100 processor base unit.

- Slide the **I/O base unit** to the left until the joining connectors are fully mated.
- Insert the **retaining clips** at the top and bottom of the **base units**.
- Secure the **I/O base unit** onto the **DIN rails** by sliding the retaining lever (below the base unit) to the left. Then insert the **backplane clips** into the top and the bottom slots.

4. Mount **end stops** onto **DIN rails**.
   - Install two **end stops** onto the **upper DIN rail**, one at each end of the assembly.

Fitting Termination Assemblies

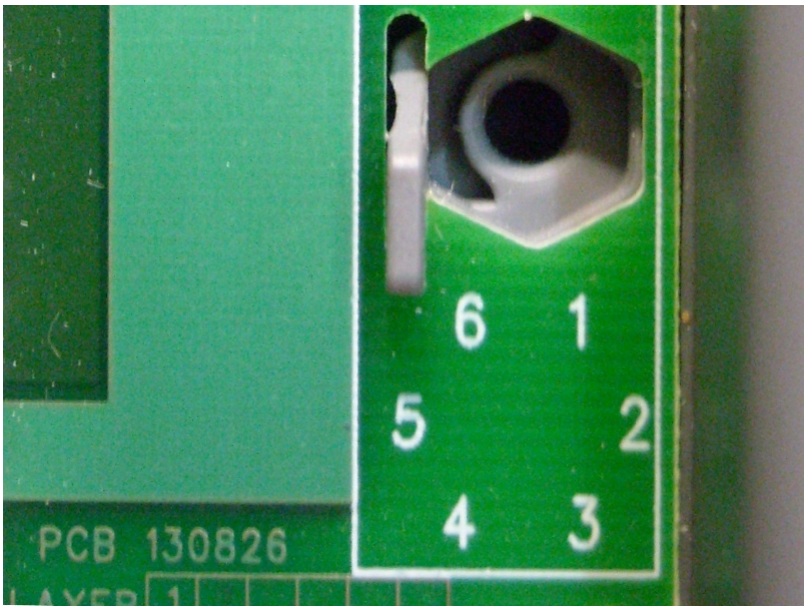
Figure 16 - How to Fit Termination Assemblies



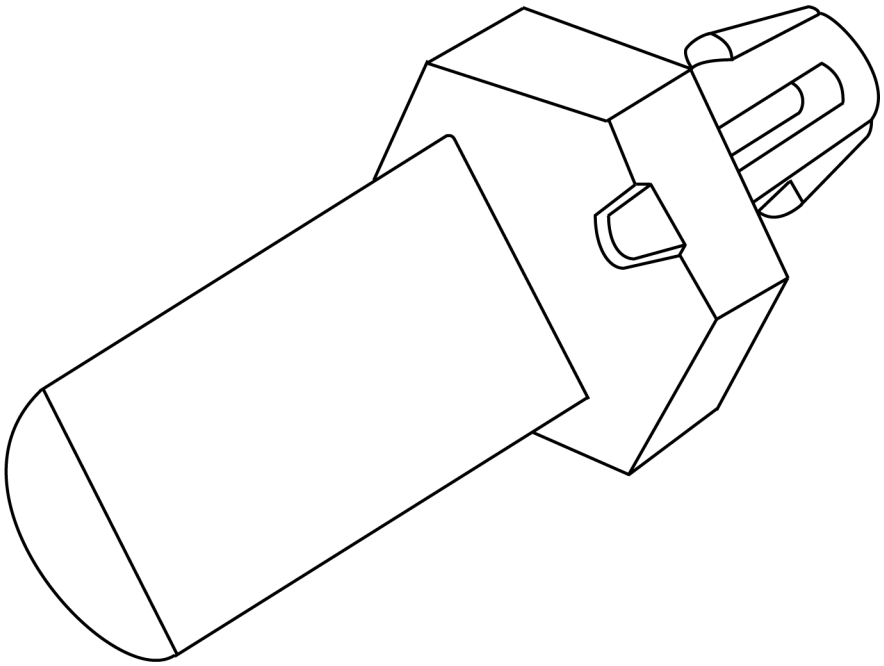
1. To fit termination assemblies do the following:

- Insert the **retaining clip** on the back of the termination assembly into the **slot** on the I/O base unit. Press the **termination assembly** onto the **base unit** and then slide the **assembly** upwards as far as it will go.
- Make sure the **retaining tab** clips over the **printed circuit board** to secure the termination assembly in position.

2. Check **coding pegs**.
   - Observe the **legend** on the T9100 processor base unit (and repeated on some termination assemblies) which defines the six possible positions for a coding peg. The positions are numbered from 1 to 6.



   - Examine a **coding peg** (fitted) and identify the index recess on the hexagonal flange.



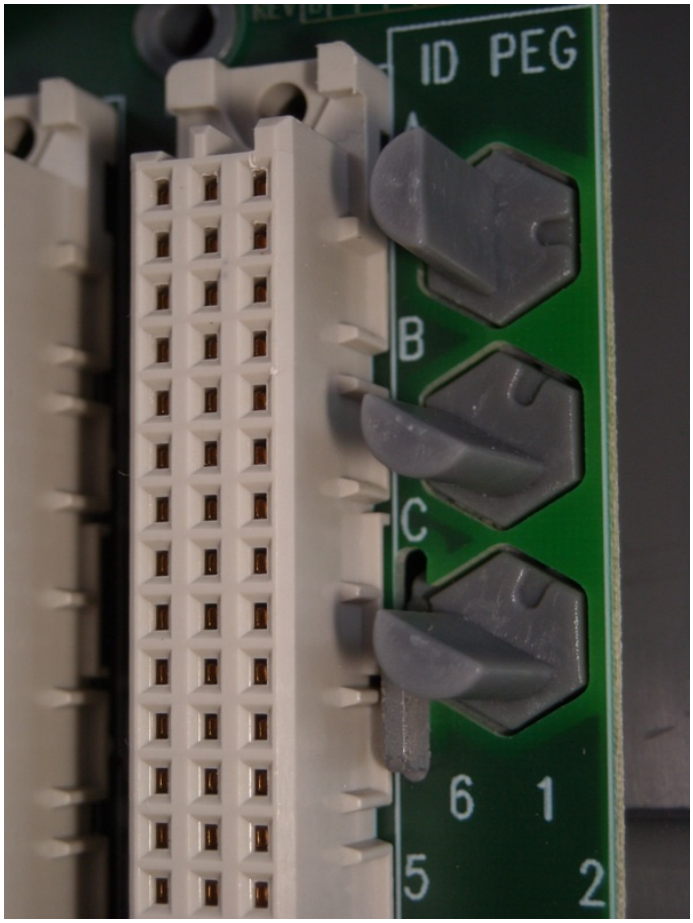
   - Refer to the **following table** and verify each **coding peg** is fitted so its index recess is adjacent to the relevant numbered position.

Allocations of Coding Pegs

Coding pegs are assigned to each module type as shown in the following table:

Application	Key A	Key B	Key C
T9100 processor base unit (for T9110 processor module)	1	1	1
T9801/2/3 digital input termination assemblies (for digital input modules)	2	1	1
T9831/2/3 analogue input termination assemblies (for analogue input modules)	2	1	3
T9851/2 digital output termination assemblies (for digital output modules)	3	1	1
T9842/1 analogue output module	3	1	2

This example shows pins set to positions 2, 1, 1 for a T9401 digital input module.



Connect the AC Safety Ground Connection

The T9100 processor base unit has a ground stud which must be connected to the AC safety ground. Connect the **ground stud** to the **AC safety ground bus-bar** of the system or panel.

- Conductor wire must be a minimum of 12 AWG (3.31 mm2) with a temperature rating of 85 °C.
- Use a **M6 lug** on the end of the ground wire.
- Place the **lug** below the second nut on the ground stud, between two washers, and use **two 10mm wrenches** to tighten the nuts to a torque of 1.2 Nm to 2 Nm (0.88 lb./ft. to 1.48 lb./ft.).