AADvance Controller

Catalog Numbers T9110, T9300, T9310, T9401/2, T9431/2, T9451, T9481/2

AB
QUALITY

Allen-Bradley
by **ROCKWELL AUTOMATION**

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

⚠	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

⚠	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

⚡	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

🔥	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

💥	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

About This Publication

This technical manual describes how to assemble a system, switch on and validate the operation of your system.

In no event will Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment. The examples given in this manual are included solely for illustrative purposes. Because of the many variables and requirements related to any particular installation, Rockwell Automation does not assume responsibility or reliability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, with respect to use of information, circuits, equipment, or software described in this manual.

All trademarks are acknowledged.

Disclaimer

It is not intended that the information in this publication covers every possible detail about the construction, operation, or maintenance of a control system installation. You should also refer to your own local (or supplied) system safety manual, installation and operator/maintenance manuals.

Revision And Updating Policy

This document is based on information available at the time of its publication. The document contents are subject to change from time to time. The latest versions of the manuals are available at the Rockwell Automation Literature Library under "Product Information" information "Critical Process Control & Safety Systems".

Downloads

The product compatibility and download center is rok.auto/pcdc.

Select the Find Downloads option under Download

In the Product Search field enter "AADvance" and the AADvance® option is displayed.

Double click on the AADvance option and the latest version is shown.

Select the latest version and download the latest version.

AADvance Release

This technical manual applies to AADvance system release 2.011 and these software:
- AADvance® Workbench software version 1.4
- AADvance Workbench software version 2.1

- AADvance®-Trusted® SIS Workstation software version 2.00

> **NOTE** AADvance system release 2.011 identifies the product family release. Each hardware, firmware and software component has its own version within this family release and the details of those versions can be found in the **AADvance System Requirements for version 2.011** in the PCDC Release Notes, which can be accessed from the Product Compatibility and Download Center at rok.auto/pcdc.

Latest Product Information

For the latest information about this product review the Product Notifications and Technical Notes issued by technical support. Product Notifications and product support are available at the Rockwell Automation Support Center at rok.auto/knowledgebase.

At the Search Knowledgebase tab select the option "By Product" then scroll down and select the ICS Triplex® product AADvance.

Some of the Answer IDs in the Knowledge Base require a TechConnect℠ Support Contract. For more information about TechConnect Support Contract Access Level and Features, click this link: Knowledgebase Document ID: IP622 - TechConnect Support Contract - Access Level & Features.

This will get you to the login page where you must enter your login details.

> **IMPORTANT** A login is required to access the link. If you do not have an account then you can create one using the "Sign Up" link at the top right of the web page.

Environmental Compliance

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Global Changes

This table identifies changes that apply to all information about a subject in the manual and the reason for the change. For example, the addition of new supported hardware, a software design change, or additional reference material would result in changes to all of the topics that deal with that subject.

Subject	Reason
Added French translations to Warning and Attention information.	Compliance improvement.
Applied latest publication template	Marketing product change.

New or Enhanced Features

This table contains a list of topics changed in this version, the reason for the change, and a link to the topic that contains the changed information.

Subject	Reason
AADvance Release on page 3 and 4	Updated AADvance system release and software information.
Added the information about SSH on page 15	Added information about the use of SSH protocol.
Environment Standards on page 20	Updated information about the modules' standards.
Installation Requirements on page 22	Updated Environmental Installation Requirements
Installation Requirements for Hazardous Environment on page 23 on page 24	Changed the standards to EN IEC 60079-0, EN IEC 60079-7
Standards on page 23 and 24	Updated with the appropriate standards' names.
Product Labels on pages 25 and 26	Changed module labels.
TUV Approved Operating System on page 29	Updated the certificate's name.
Electromagnetic Interference on page 32	Updated information about standards.
Enclosure Requirements for Non-Hazardous Environment on page 59	Updated the standard's number.
Ethernet Communication Protocols on page 54	Added information about TCP protocols.
Controller Power Supply Requirements on page 68	Updated standard's number.
Status Indicators on the T9110 Processor Module on page 119	Updated information for firmware 2.011
SSH definition on page 145	Added definition of SSH.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
AADvance Controller Safety Manual, ICSTT-RM446	This technical manual defines how to safely apply AADvance controllers for a Safety Instrumented Function. It sets out standards (which are mandatory) and makes recommendations to make sure that installations satisfy and maintain their required safety integrity level.
AADvance Controller Configuration Guide Workbench 1.x, ICSTT-RM405	This software technical manual defines how to configure an AADvance controller using the AADvance Workbench software version 1.x to satisfy your system operation and application requirements.
AADvance Controller Configuration Guide Workbench 2.x, ICSTT-RM458	This software technical manual defines how to configure an AADvance controller using the AADvance Workbench software version 2.x to satisfy your system operation and application requirements.
AADvance-Trusted SIS Workstation Software User Guide, ICSTT-UM002	This publication provides how-to instructions for AADvance-Trusted SIS Workstation software configuration and use.
AADvance Controller OPC Portal Server User Manual, ICSTT-RM407	This manual describes how to install, configure and use the OPC Server for an AADvance Controller.
AADvance Controller PFH and PFDavg Data, ICSTT-RM449	This document contains the PFH and PFD_{avg} Data for the AADvance Controller. It includes examples on how to calculate the final figures for different controller configurations.
AADvance Controller Solutions Handbook, ICSTT-RM447	This technical manual describes the features, performance and functionality of the AADvance controller and systems. It gives guidance on how to design a system to satisfy your application requirements.
AADvance Controller Troubleshooting and Maintenance Manual, ICSTT-RM406	This technical manual describes how to maintain, troubleshoot and repair an AADvance Controller.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Chapter 3

Application Development

Chapter 4

Before You Begin

Chapter 7

Functional Acceptance Testing

Chapter 8

Dismantling the AADvance System

Chapter 9

Parts List

Appendix A

History of Changes

The AADvance System

Introduction

An AADvance® system consists of an AADvance controller, an external operator's computer, field connections, power sources and external network connections. The flexibility of the design means that a system can meet a wide variety of business needs. An AADvance system is assembled to a scale and configuration that is applicable to your initial requirements and can be easily changed to meet your changing business requirements in the future. A system is built from an approved range of modules and assemblies.

Notes:

The AADvance Safety Controller

The AADvance® controller is specifically designed for functional safety and critical control applications; it gives a flexible solution for smaller scale requirements. The system can also be used for safety implemented functions as well as applications that are not related to safety but are nevertheless critical to a business process. This AADvance controller offers the ability to make a cost-effective system to a customer's specification for any of the following applications:

- Emergency shutdown system
- Fire and gas installation protection system
- Critical process control
- Burner management
- Boiler and furnace control
- Distributed process monitoring and control

An AADvance controller is particularly useful for emergency shut down and fire and gas detection protection applications as it offers a system solution with integrated and distributed fault tolerance. It is designed and validated to international standards and is certified by independent certifying bodies for functional safety control installations and UL for use in hazardous environments.

This chapter introduces the primary components that can be used to assemble an AADvance controller.

A controller is built from a range of compact plug-in modules (see illustration) that are straightforward to assemble into a system. A system can have just one or more controllers, a combination of I/O modules, power sources, communications networks and computers. It can operate as a stand-alone system or as a distributed node of a larger control system.

Processor Base Unit

Termination Assembly

I/O Base Unit

Blanking Panel

Field Wiring Connectors

Processor module
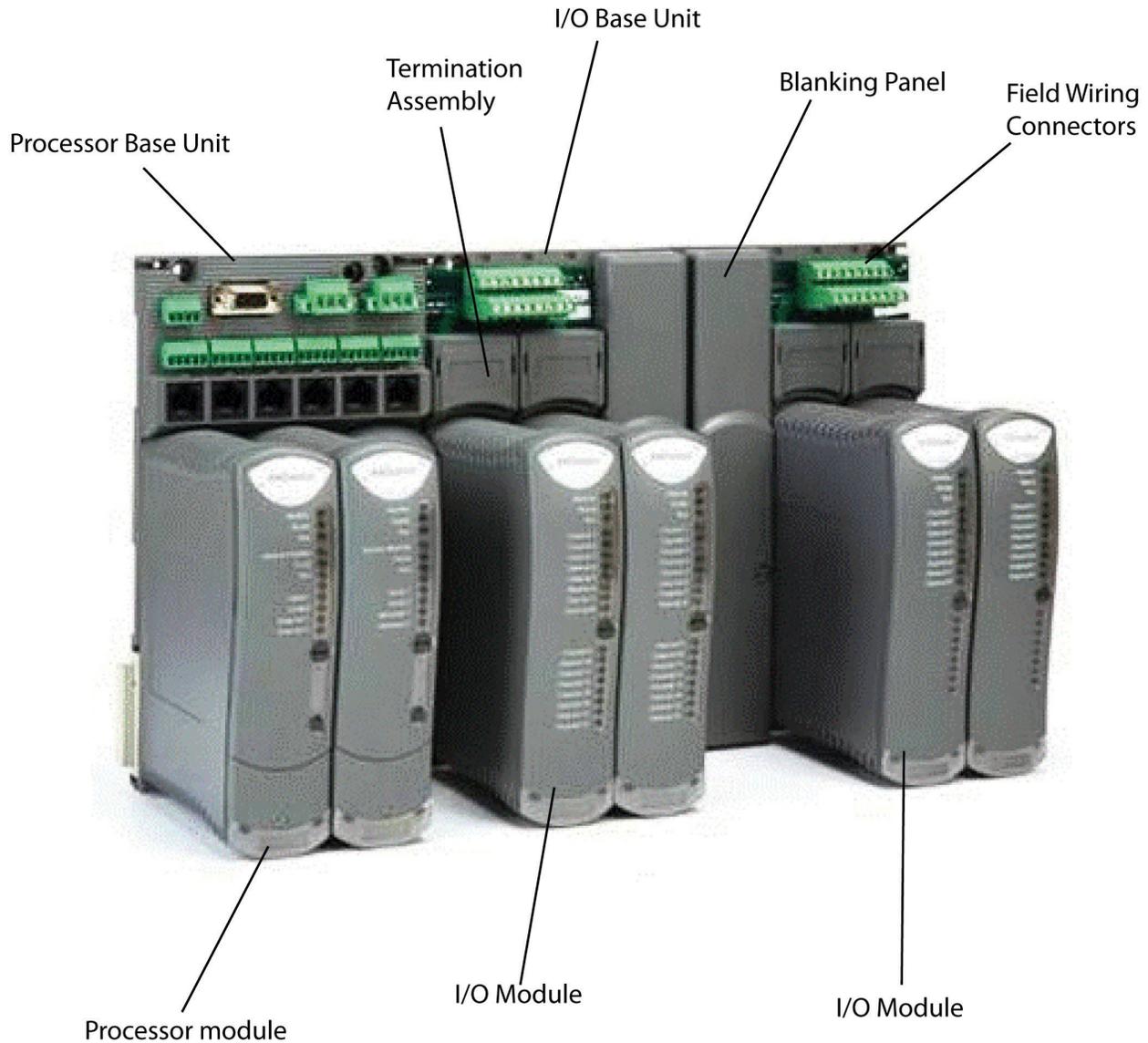
I/O Module

I/O Module

NOTE The printed circuit boards of all AADvance modules, termination assemblies and backplanes are coated during manufacture. The coating meets defense and aerospace requirements, is approved to US MIL-1-46058C standard and meets IPC-CC-830. The coating is also UL approved.

A Key benefit of the AADvance system is its flexibility. All of the configurations are readily achieved by combining modules and assemblies without using special cables or interface units. System architectures are user configurable and can be changed without major system modifications. Processor and I/O redundancy is configurable so you can make a decision between fail safe and fault tolerant solutions. There is no change to the complexity of operations or programming that the controller can handle if you add redundant capacity to create a fault tolerant solution.

They can be mounted onto DIN rails in a cabinet or directly mounted onto a wall in a control room. Forced air cooling or special environmental control

equipment is not necessary. However, important consideration must be given to the choice of cabinet or when the controller is installed in a hazardous environment.

Specific guidelines are given in this user documentation to help you choose an enclosure that will make sure that the system operates to its full capability and reliability and that it also complies with the ATEX and UL certification requirements for use in hazardous environments.

The Ethernet and serial ports are configurable for a number of protocols in both simplex and redundant configurations for connection to other AADvance controllers or external third party equipment. Communications internally between the processors and I/O modules uses a proprietary communications protocol over a custom wired harness. The AADvance system supports transport layer communication protocols such as TCP and UDP for MODBUS, CIP, SNCP, SSH and SNTP services.

A secure network communications protocol (SNCP), developed by Rockwell Automation for the AADvance system, permits distributed control and safety using new or existing network infrastructure while ensuring the security and integrity of the data. Individual sensors and actuators can connect to a local controller, minimizing the lengths of dedicated field cabling. There is no need for a large central equipment room; rather, the complete distributed system can be administered from one or more computers placed at convenient locations.

The AADvance controller is developed and built for IEC 61131 compliance and includes support for all five programming languages.

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.

IMPORTANT	La version 1.4 du logiciel AADvance Workbench est compatible avec le langage Instruction List (IL).
	La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstationest ne sont pas compatibles avec le langage Instruction List (IL).

⚠	**ATTENTION:** La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstation ne sont pas compatibles avec le langage Sequential Function Chart (SFC) pour les applications reliées à la sécurité fonctionnelle.

Program access is secured by a "Program Enable" key that you can remove. Simulation software lets you prove a new application before reprogramming and downloading, again maximizing system uptime. Additional security functions are also included to help prevent unauthorized access.

Safety Features

The AADvance controller meets non-safety business requirements and SIL 2 and SIL 3 safety related system requirements. The system has comprehensive built-in redundant capabilities that improve system availability.

The AADvance safety system features are:

- Easily transformed from a simplex non-safety system to a fault tolerant safety related system.

- An AADvance system provides a set of components that can be configured to meet a range of safety and fault tolerance user requirements within a single system such as - fault tolerant topologies 1oo1, 1oo2D and 2oo3.
- IEC 61508 certified, reviewed and approved for safety systems up to SIL 3 by independent certifying bodies.
- The scalable characteristics of the system enables independent safety functions within the same system to be configured with different architectures to meet a user specific safety and availability requirements.
- The main components that provide the safety architecture are the processor and I/O modules; the remaining components provide secure external interfaces and connectivity between the field elements and the main components and add to the safety functionality.
- AADvance processor modules are designed to meet the requirements for SIL 3 in a dual or triplicated configuration.
- Individual input modules are designed to meet the requirements for SIL 3 in simplex, dual or triple configurations.
- Individual output modules have been designed to meet the requirements for SIL 3 in a simplex or dual configurations.
- Safe SIL 3 rated 'Black Channel' external communication over Ethernet.

Safety Configurations

An AADvance system supports the following safety configurations:

Fail-safe

I/O modules fail-safe in the most basic simplex system.

SIL 2

SIL 2 architectures for fail-safe low demand applications. All SIL 2 architectures can be used for energize or de-energize to trip applications.

- SIL 2 low demand architectures
- SIL 2 fail safe architectures
- SIL 2 fault tolerant input architectures
- SIL 2 triplicated input architectures
- SIL 2 fault tolerant output architectures
- SIL 2 fault tolerant input/output architectures

SIL 3

SIL 3 architectures:

- SIL 3 de-energize to trip applications.
- SIL 3 energize to action applications when fitted with dual digital output modules.

- SIL 3 simplex or dual output module architectures
- SIL 3 fail safe I/O fault tolerant processor architecture
- SIL 3 fault tolerant architecture
- SIL 3 fault tolerant simplex, dual and triple input architectures
- SIL 3 dual or triple processor architectures
- SIL 3 high demand applications where the required safe state is greater than 4 mA, when fitted with dual analogue output modules (A 'safe state' is an output configured to go to a specific value, or configured to hold last state).

Safety System Certification

The AADvance Controller is certified by independent certifying bodies. Refer to the certificate for details of the standards included in the certification.

Performance and Electrical Specifications

Table 1 - Controller Performance and Electrical Specifications

Attribute	Value
Performance Characteristics	
Safety Integrity Level	IEC 61508 SIL 2 IEC 61508 SIL 3 (depending on processor and I/O module configuration)
Safety level Degradation	1oo1D, 1oo2D, 2oo3D
Processor Modules supported	Three
I/O Modules supported	48 (8 or 16 channels modules)

Safety Accuracy Limit:
  Digital inputs
  Analogue inputs
	
	1.0 Vdc
	200 µA

Sequence of Event Resolution
Processor Module (for internal Variables):
    Event Resolution
    Time Stamp Accuracy
Digital Input Module:
    Event Resolution
    Time Stamp Accuracy
	
	1 ms
	Application Scan
	
	1 ms
	10 ms

Electrical Characteristics	
Supply voltage	Redundant 24 Vdc nominal, 18 Vdc to 32 Vdc range
Channel isolation (channel to channel and channel to chassis Maximum withstanding	 ± 1.5 kVdc withstand for 1 minute.

> **IMPORTANT** Overall system power consumption, heat dissipation and weight can be estimated using the values given in the heat dissipation and weight data tables shown in this manual.

Scan Times

The controller processing scan times listed in the table are taken from a test system which used only production modules. The tests which were used to measure the scan times did not measure the effects of logic complexity and communications loading.

Table 2 - Typical Module Scan Times

Module		Scan
T9402	Digital input module, 24 Vdc, 16 channel Simplex Dual Triple	0.924 ms 1.676 ms 2.453 ms
T9432	Analogue input module 24 Vdc, 16 channel Simplex Dual Triple	1.170 ms 1.965 ms 2.656 ms
T9451	Digital output module, 24 Vdc, 8 channel Simplex Dual	1.174 ms 2.202 ms
T9482	Analogue output module, 24 Vdc, 8 channel Simplex Dual	0.981 ms 1.761 ms
	Minimum cycle time overhead	39.3 ms
	Scan overhead for each module	0.04 ms

The scan time is:

Scan time = 39.3 ms (minimum cycle time overhead)

    + Sync time

    + Total number of modules * 0.04 ms

    + Σ (Number of module groups x scan time shown above)

Where:

Sync time is a function of the total number of modules defined according to the following table:

0..10 modules	20 ms
11..20 modules	22 ms
21..30 modules	24 ms
31..40 modules	27 ms
41..48 modules	32 ms.

Though the average scan time will be within 1 ms of the scan time calculated above the calculation does not take into account the effects of application logic and network communication, and individual scans can vary by up to +/- 4 ms around the average scan time.

Throughput time is the time from input change to output action. For asynchronous inputs the throughput times can be derived from the Scan time calculated above according to the following formula:
- Minimum throughput time = Scan period + 7 ms
- Maximum throughput time = 2 x Scan time + 13 ms

EXAMPLE: An example configuration scan time:

System configuration includes T9432 Analogue input simplex modules x 30 and T9451 Digital output simplex modules x 18.

Total I/O modules = 48

Sync time = 32 ms

Scan time = 39.3 ms + 32 ms + (48 x 0.04) ms + (30 x 1.170) ms + (18 x 1.174) ms => 129.5 ms

Minimum throughput time = 129.5 ms + 7 ms => 136.5 ms

Maximum throughput time = (2 x 129.5) ms + 13 ms = 272.0 ms.

System Installation Environment

The installation environment can be a source of common cause failure so it is necessary that the installation assessment covers the environmental specification for the AADvance system and includes the following:

- the prevailing climatic conditions
- type of area, e.g. is it a hazardous or non-hazardous area
- location of power sources
- earthing and EMC conditions

In some customer installations parts of the system can be installed in differing locations; in these cases the assessment must include each location.

Power Sources and Heat Dissipation Calculations

It is highly recommended that module supply power and field loop power consumption calculations are done to find out the heat dissipation before designing a suitable enclosure and making a decision about the installation environment (see topic "System Design for Heat Dissipation").

Safety Related System Installation Process

For a Safety Related System the installation process must also be in line with the following:

WARNING: You must use the installation guidelines given in this manual and any installation and commissioning procedures that comply with applicable international or local codes and standards.

AVERTISSEMENT: Vous devez suivre les directives d'installation décrites dans ce manuel ainsi que toutes les procédures d'installation et de mise en service conformément aux normes internationales ou aux codes et règles.locales.

CAUTION: AADvance modules are suitable for use in Class I, Division 2, Groups A, B, C and D Hazardous locations or Non-hazardous locations only or equivalent.

ATTENTION: Les modules AADvance sont utilisables dans Class I, Division 2, A, B, C et D pour un environnement dangereux ou pour un environnement non dangereux ou équivalente.

Environment Standards

The AADvance system has been investigated to United States National Standard (s) UL 61010-2-201, and Canadian National Standard (s) C22.2 No 61010-2-201. The investigation covers the following modules and provides 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 ec IIC T4 Gc.

Additionally the AADvance controller is certified 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.

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 ec 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 IEC 60079-0 and EN IEC 60079-7. 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 mm².
- 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 +60 °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 IEC 60079-0 e EN IEC 60079-7. 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 mm².
- 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.

AADvance meets the essential requirements of EN IEC 60079-0 and EN IEC 60079-7.

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/UL 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.
- UL 61010-2-201, Industrial Control Equipment.

- 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. 61010-2-201, Process Control equipment, Edition 1.

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

One of the following labels must be attached to each module.

Rockwell Automation

IND.CONT.EQ.FOR USE IN HAZARDOUS LOCATIONS
TEMP CODE T4
CL I DIV 2 GP A, B, C, D
Tamb = ⁻ 25°C to + 60°C

c(UL)us LISTED
23WX
File: E251761
File: E341697

UKCA
ULxxUKxxxxX

II 3 G Ex ec IIC T4 Gc
DEMKO 11 ATEX 1129711X
IECEx UL 12.0032X

KCC-REM-RAA-9000-modules

TÜVRheinland CERTIFIED
www.tuv.com
ID 0600000000

GB/T 3836.1
GB/T 3836.3

Battery Fitted - polycarbon monofluoride lithium coin battery, 3V, Size BR2032
Warning Explosion Hazard - Batteries must only be changed in an area known to be non-Hazardous
Pile installée - Pile bouton au poly-lithium carbonmonofluoride, 3V, taille BR2032
Avertissement risque d'explosion - Les piles ne doivent être remplacées que dans une zone zone réputée non dangereuse.
Refer to Installation Instructions for Overcurrent Protection
XXXX   COUNTRY OF ORIGIN   YYYYMMDD
Rockwell Automation, 1201 South 2nd Street, Milwaukee, WI 53204 USA

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.

IMPORTANT	La version 1.4 du logiciel AADvance Workbench est compatible avec le langage Instruction List (IL).
	La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstation ne sont pas compatibles avec le langage Instruction List (IL).

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

ATTENTION: La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstation ne sont pas compatible avec le langage Sequential Function Chart (SFC) pour les applications reliées à la sécurité fonctionnelle.

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: 2010.

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.

> ⚠️ **ATTENTION:** Le contrôleur contient des composants sensibles à l'électricité statique. Lorsque le contrôleur est installé, collez une étiquette qui indique clairement aux opérateurs de suivre les précautions anti-statique lorsqu'ils manipulent ou déplacent les modules. Tout manquement au suivi de cette procédure peut causer des dommages à l'équipement.

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, Class A; EN 61326-3-1, EN 54-4, A1; EN 61131-2; EN 62061.
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.

mm

Processor
Base Unit

126

126

I/O Base Unit &
Termination Assemblies

8

237

233

Processor
Modules

I/O
Modules

136
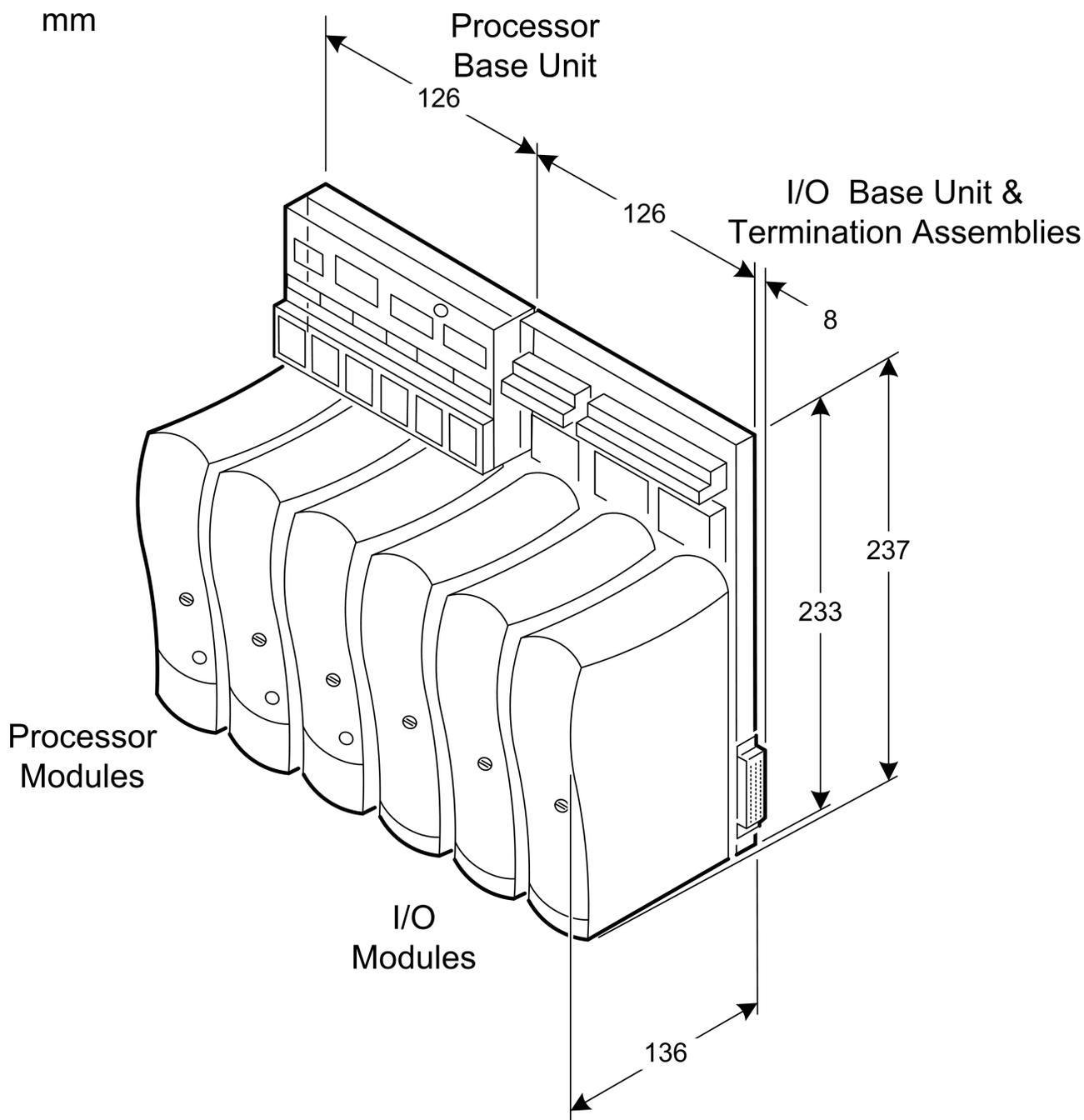
Table 4 - Summary of Dimensions

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

mm

166

42

118
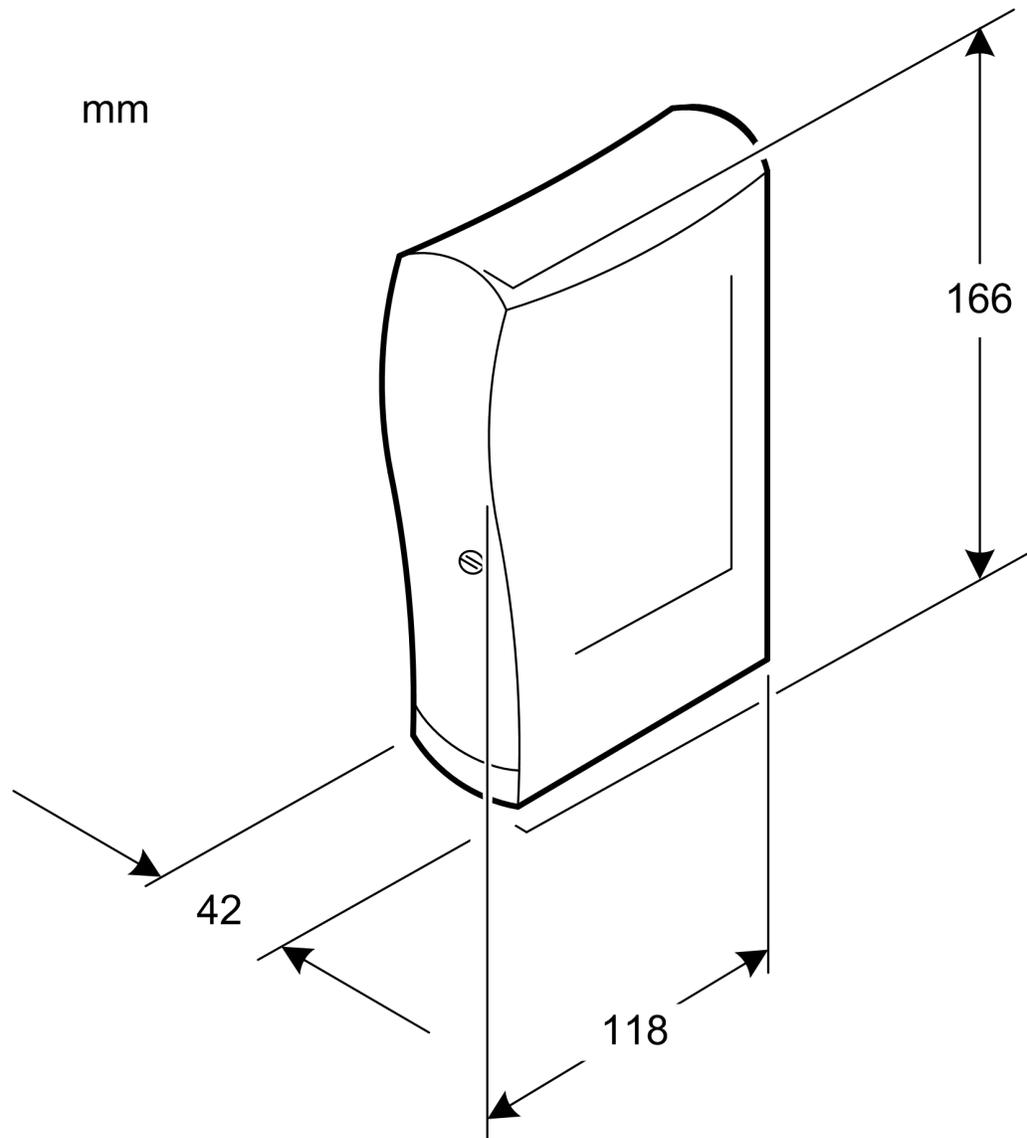
Compact Module Design

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
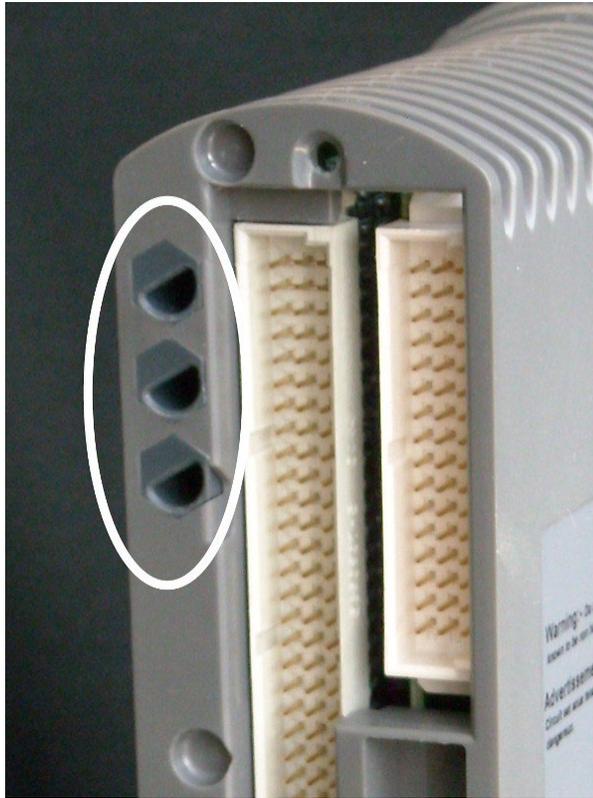
Module Locking Mechanism

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:
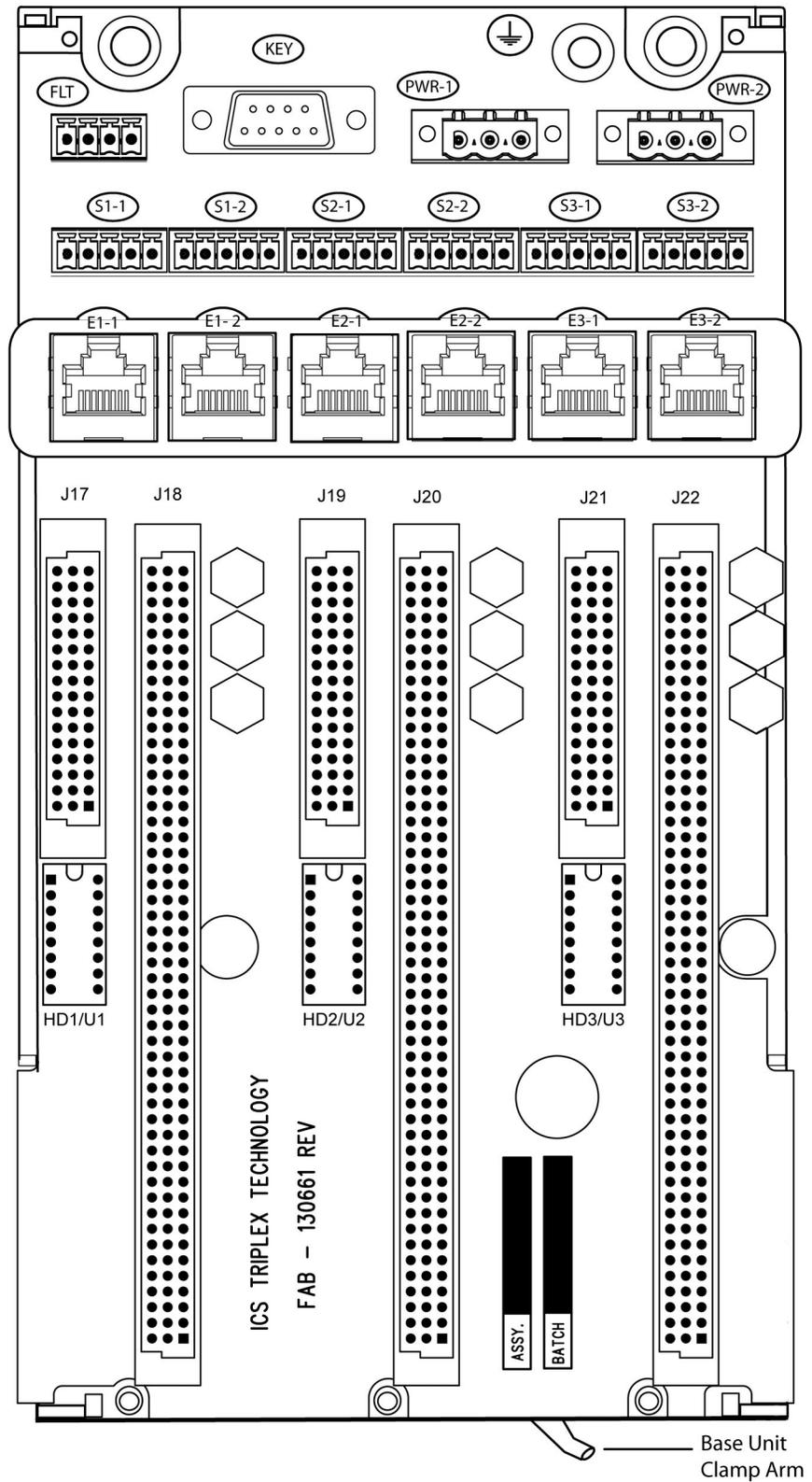
Base Unit
Clamp Arm

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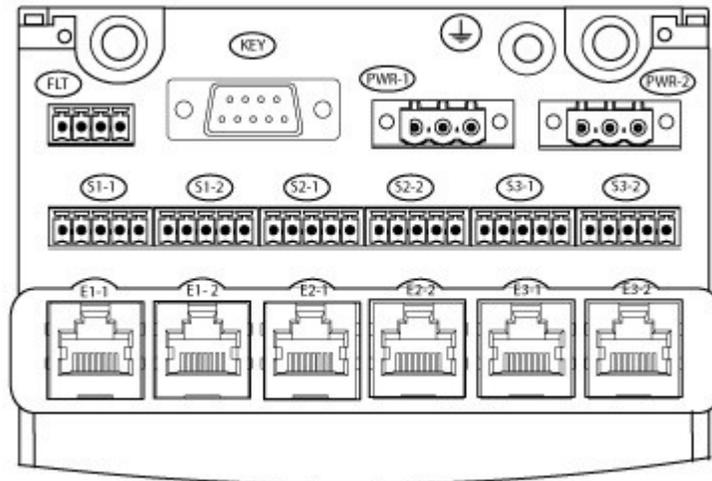
The power connections supply all three modules with redundant power, each processor module each have two Serial ports and two Ethernet port connectors. The KEY connector supports all three processor modules and helps prevent access to the application unless the Program Enable key is inserted.

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.

> ⚠️ **ATTENTION: La batterie peut exploser si elle est mal traitée. Ne pas recharger, démonter ou jeter au feu.**

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 -30ºC to +80ºC, manufactured by Panasonic.

Processor Maintenance Socket

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

> ⚠️ **CAUTION: SK1** 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:
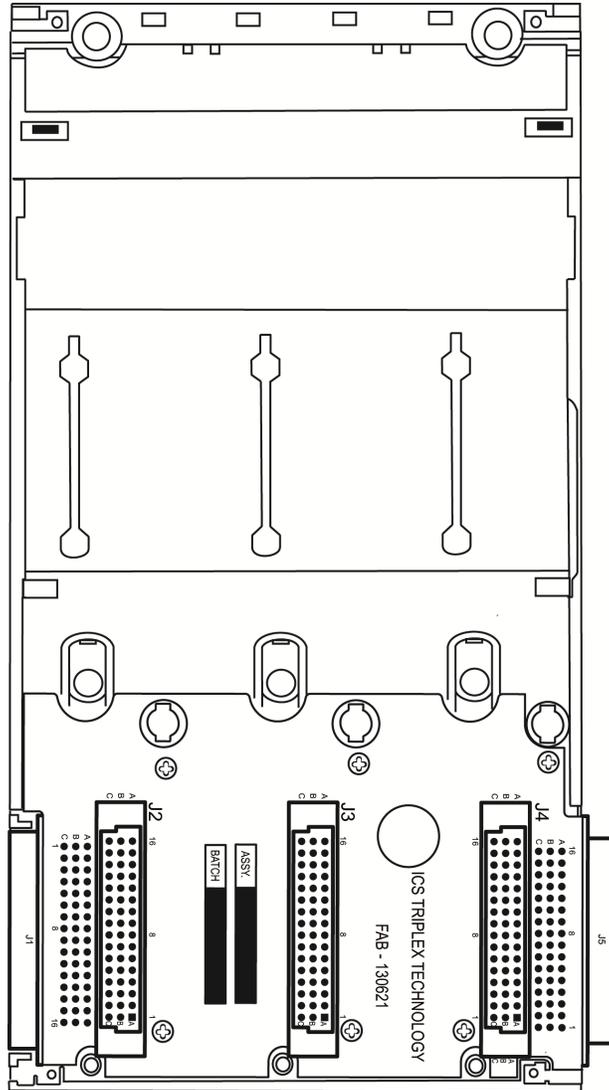
Termination Assemblies

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
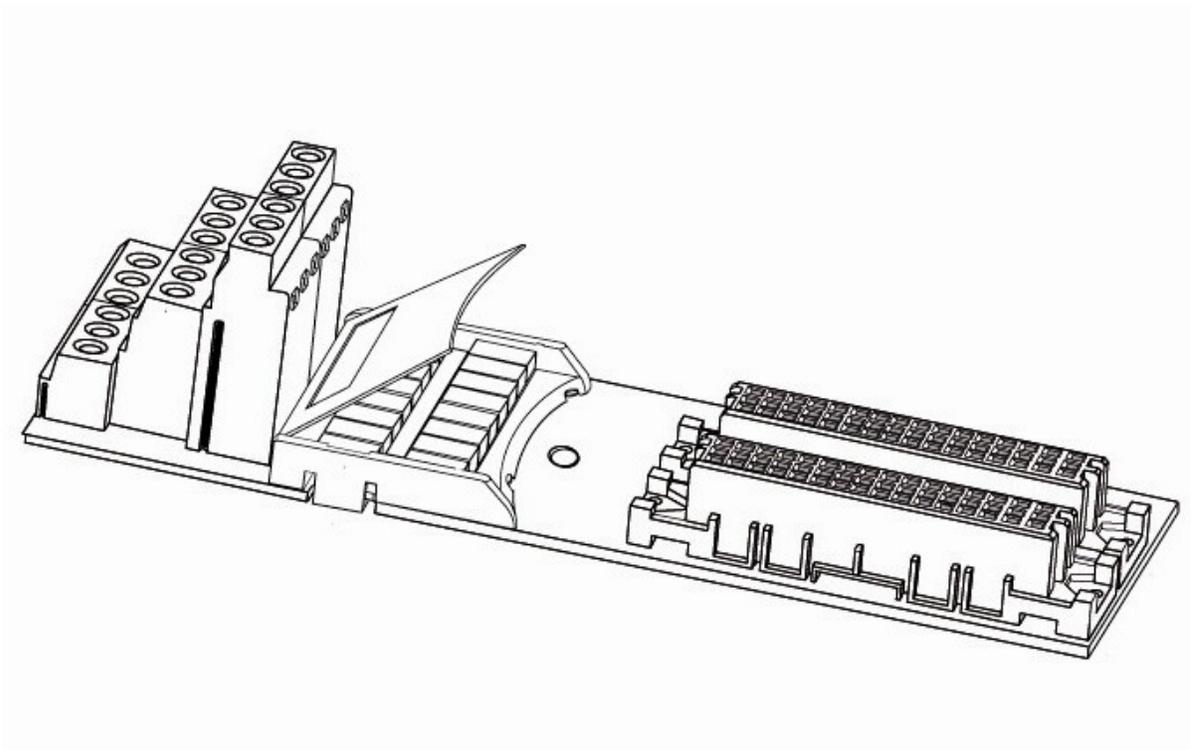
Figure 8 - Top View
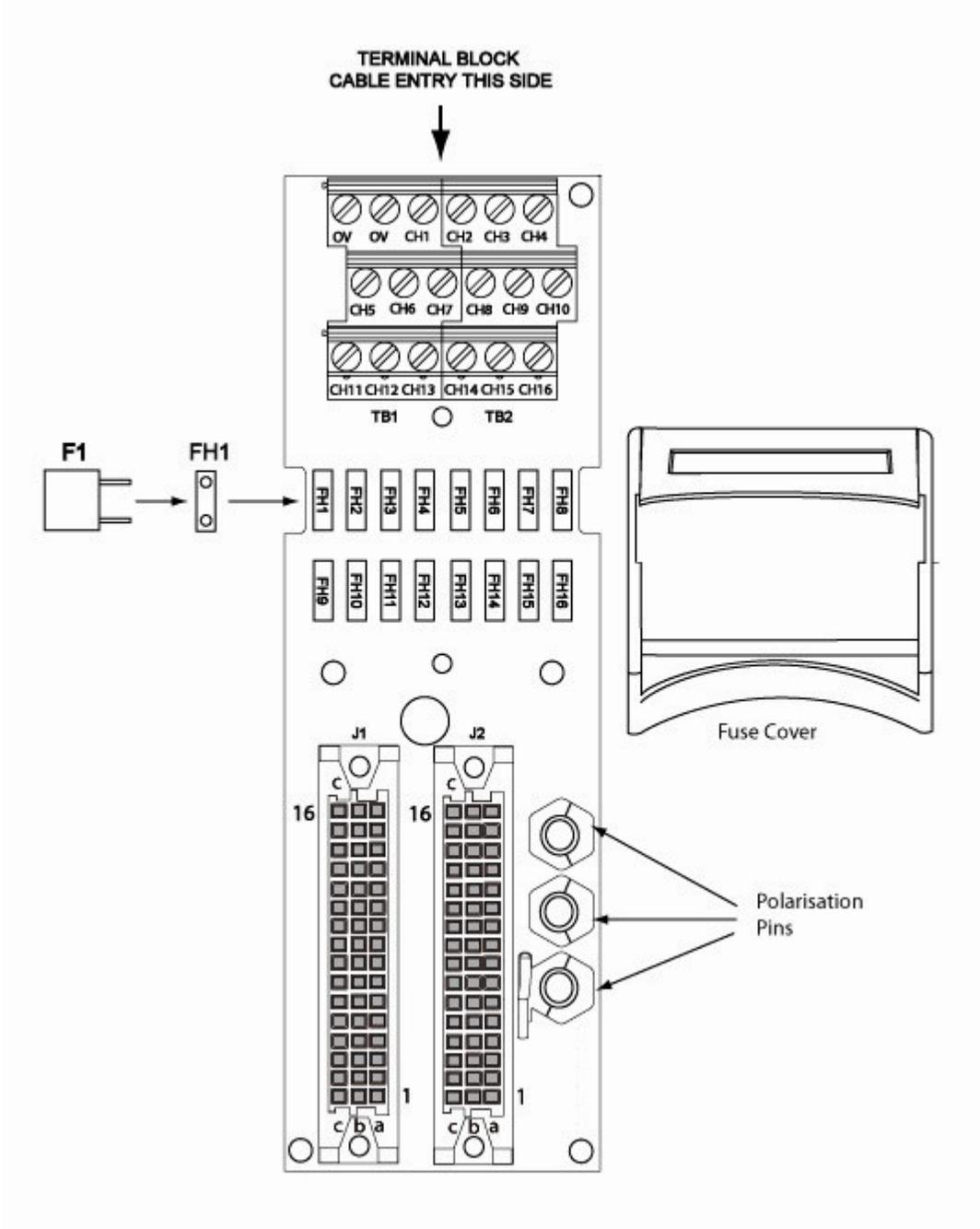
T9892 Digital Output Termination Assembly

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.
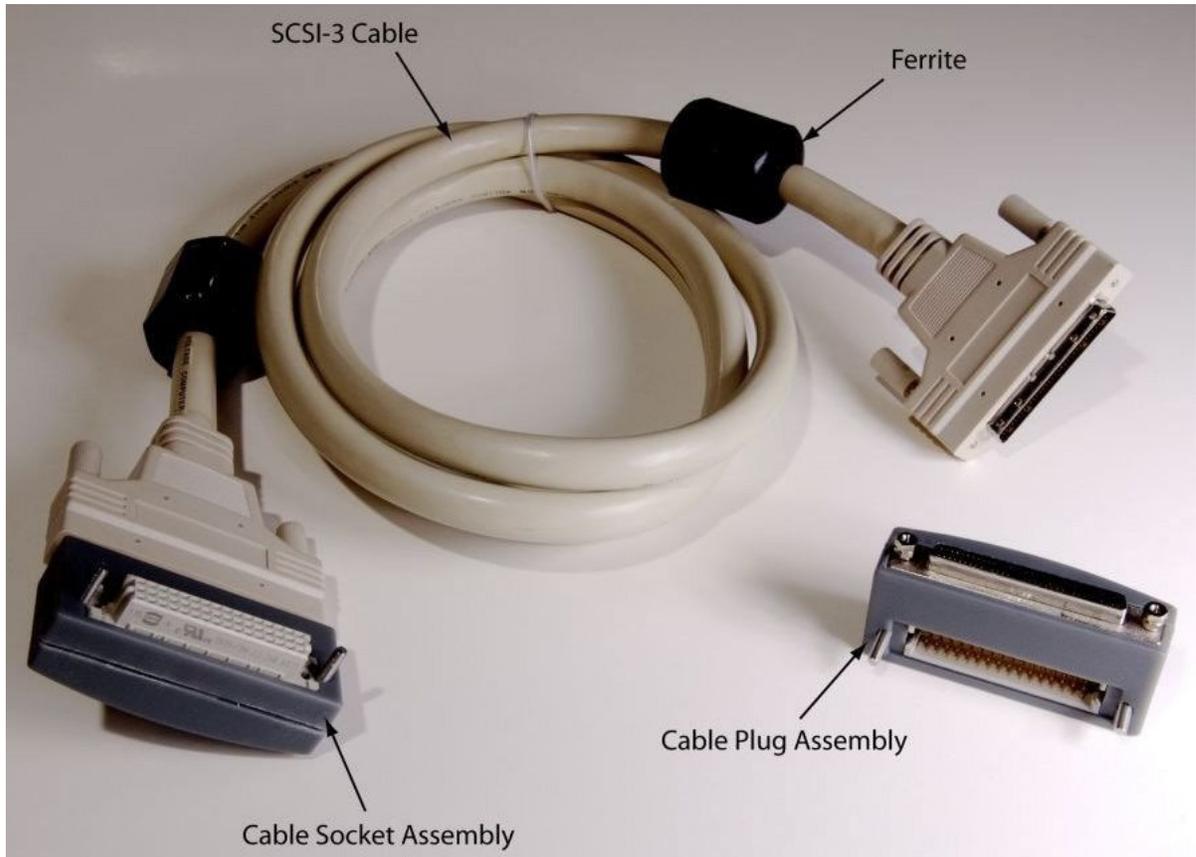
Technical Features

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.

Ethernet

Serial Links

Command Bus (IO Bus 1)

Command Bus (IO Bus 2)

A   A   B   B   C   C

A B C   A B C   A B C   A B C   A B C   A B C   A B C   A B C

I/O Modules   Processor Modules   I/O Modules

IPL

Individual Response Bus (s)
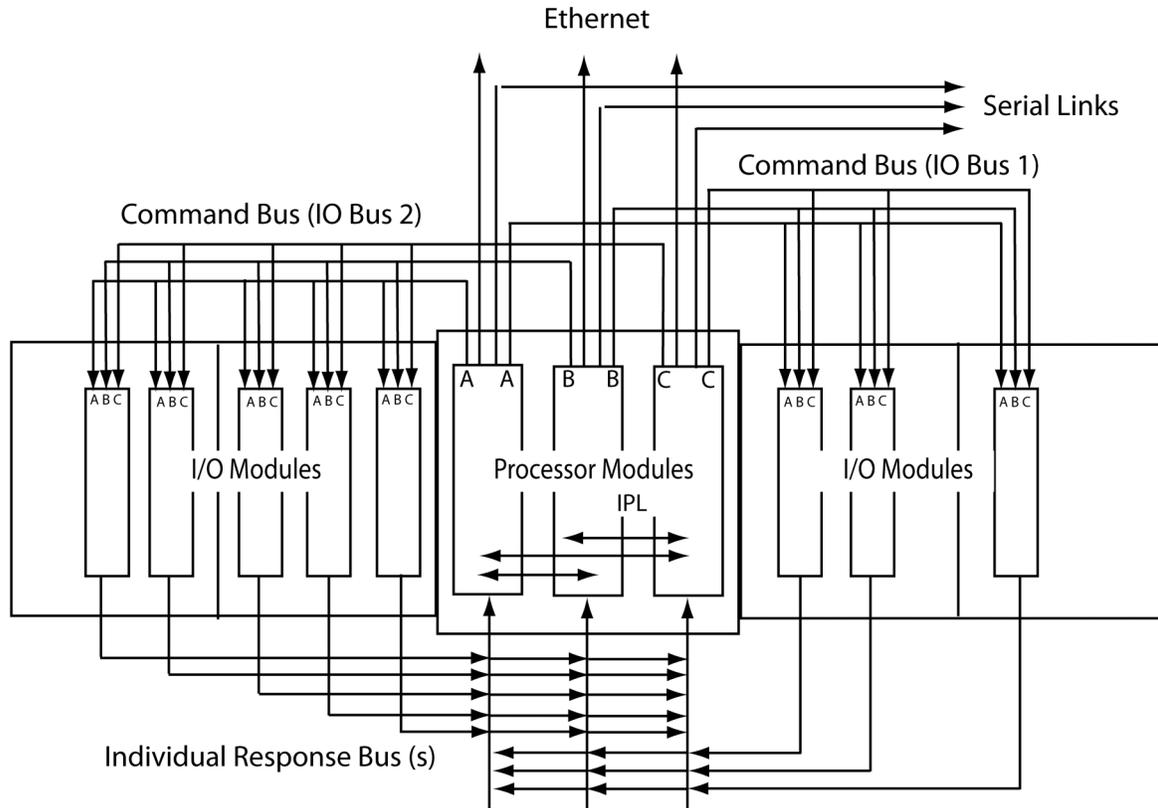
Internal Diagnostics and Fault Reset

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	Secure Shell (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.

IMPORTANT	La version 1.4 du logiciel AADvance Workbench est compatible avec le langage Instruction List (IL). La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstationest ne sont pas compatibles avec le langage Instruction List (IL).

⚠	**ATTENTION:** La version 2.x du logiciel AADvance Workbench et le logiciel AADvance-Trusted SIS Workstation ne sont pas compatibles avec le langage Sequential Function Chart (SFC) pour les applications reliées à la sécurité fonctionnelle.

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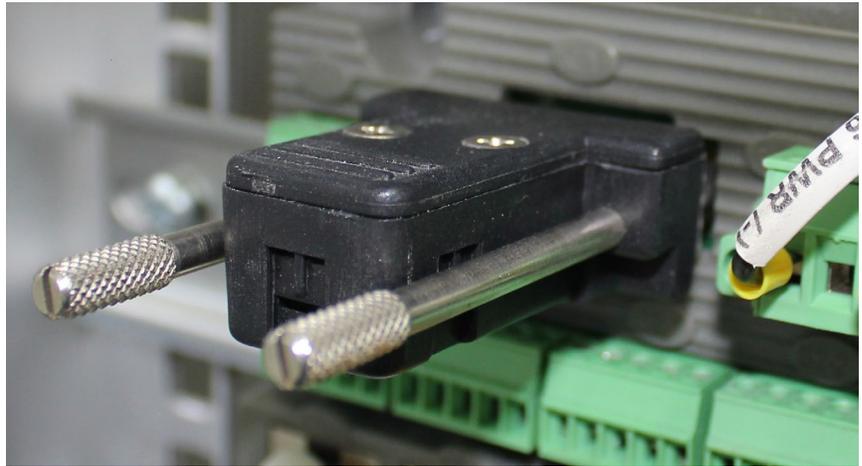
Use security features such as password-protection for AADvance Workbench software or AADvance-Trusted SIS Workstation software projects and firewall settings.

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:

Chapter 4

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 °C (+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

⚠️ **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

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 mm²
> - 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 mm².
> - 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 °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 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 °C (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 élevée 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
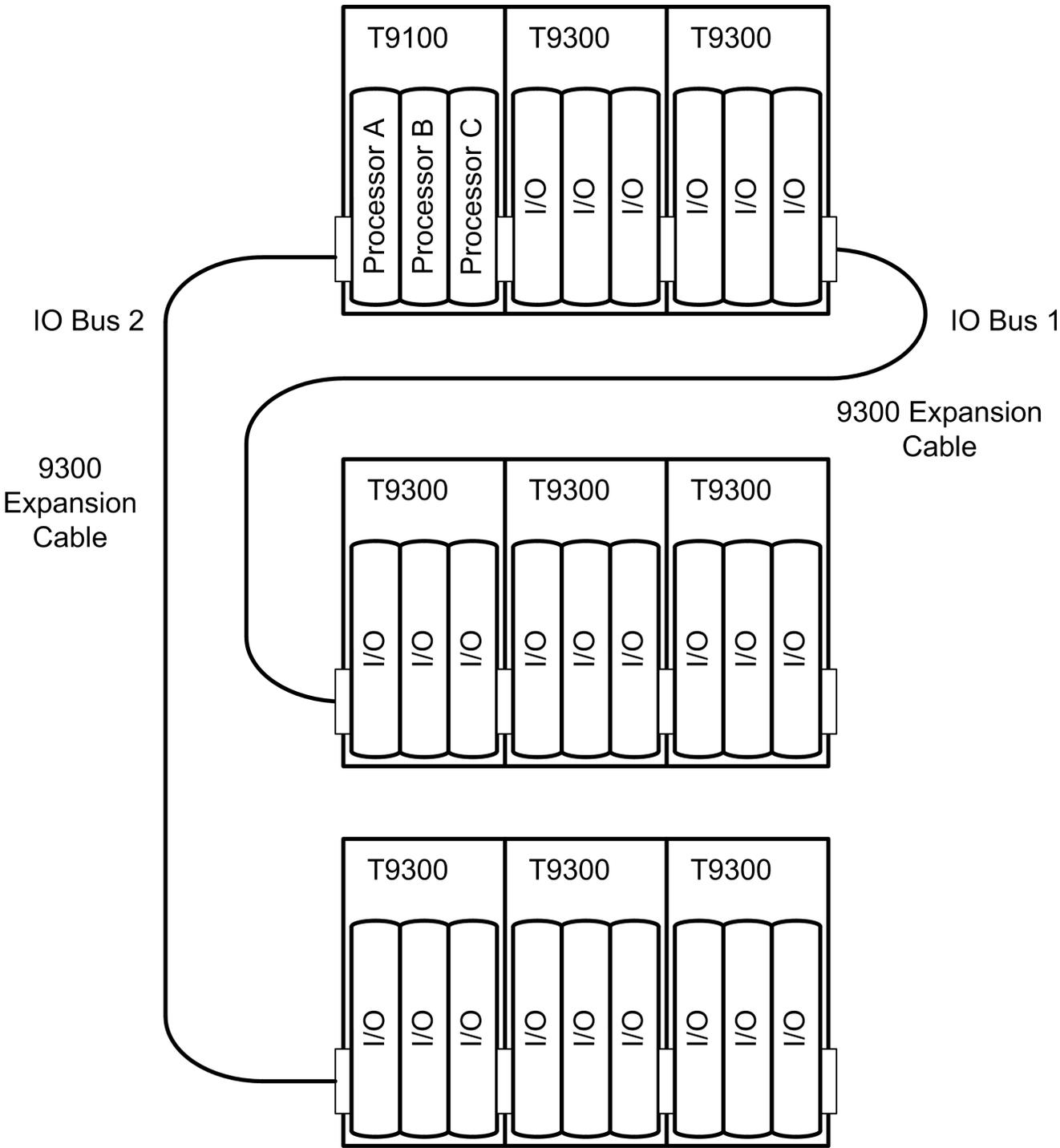
The expansion bus accessed from the right hand edge of the T9100 processor base unit is designated I/O Bus 1, while the bus accessed from the left hand edge is designated I/O Bus 2. The module positions (slots) in the I/O base units are numbered from 01 to 24, the left most position being slot 01. Any 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

⚠ **AVERTISSEMENT:** Un système contrôleur doit être installé avec un réseau d'alimentation qui doit rencontrer les surtensions de 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 EN IEC 60079-0, EN IEC 60079-7, and EN 62368-1 and must be big enough for the system requirements.

> **AVERTISSEMENT:** L'alimentation doit être conforme aux exigences électriques et aux essais spécifiés par EN CEI 60079-0, EN CEI 60079-7 et EN 62368-1 et doit rencontrer les exigences du système.

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.

> **IMPORTANT**   Il est fortement recommandé que la borne négative de l'alimentation des terminaux soit connectée à la mise à terre (masse). Cela permettra d'éviter d'éventuelles conditions défaillantes pouvant être causées par certains détecteurs de défauts à la terre utilisés avec des alimentations flottantes.

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".
IMPORTANT	Les figures précédentes sont des valeurs des pires cas calculées pour la plage des tensions et courants opérationnelles. Si votre système doit rencontrer les normes UL/CSA la consommation en puissance et la caractéristique nominale électrique correspondantes ne doit pas dépasser la caractéristique nominale électrique rapportée par la table de la section "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.
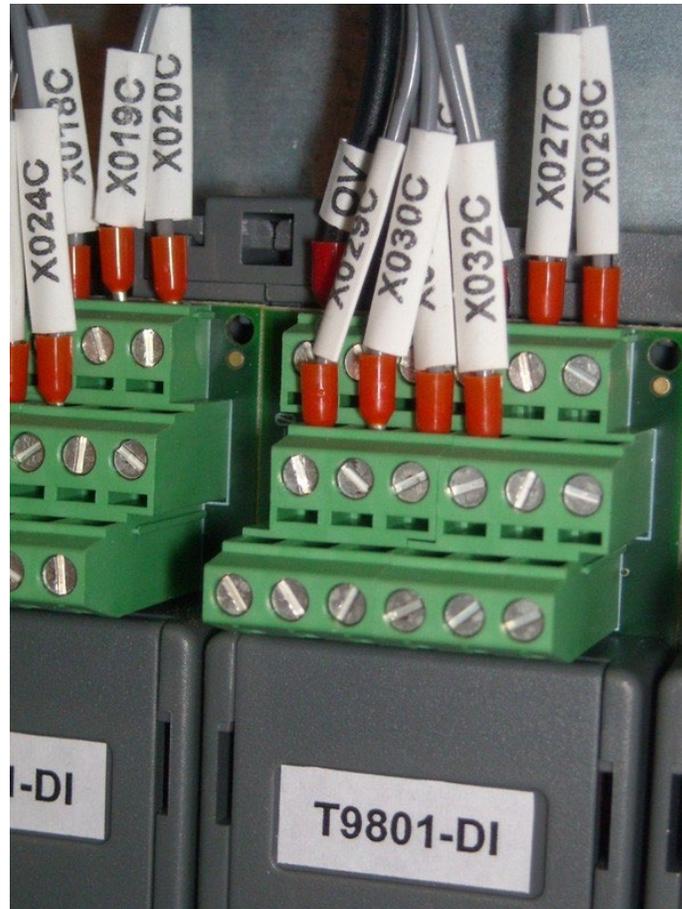
A way for plant operations personnel to inspect the status LEDs on each module. The status LEDs report faults.
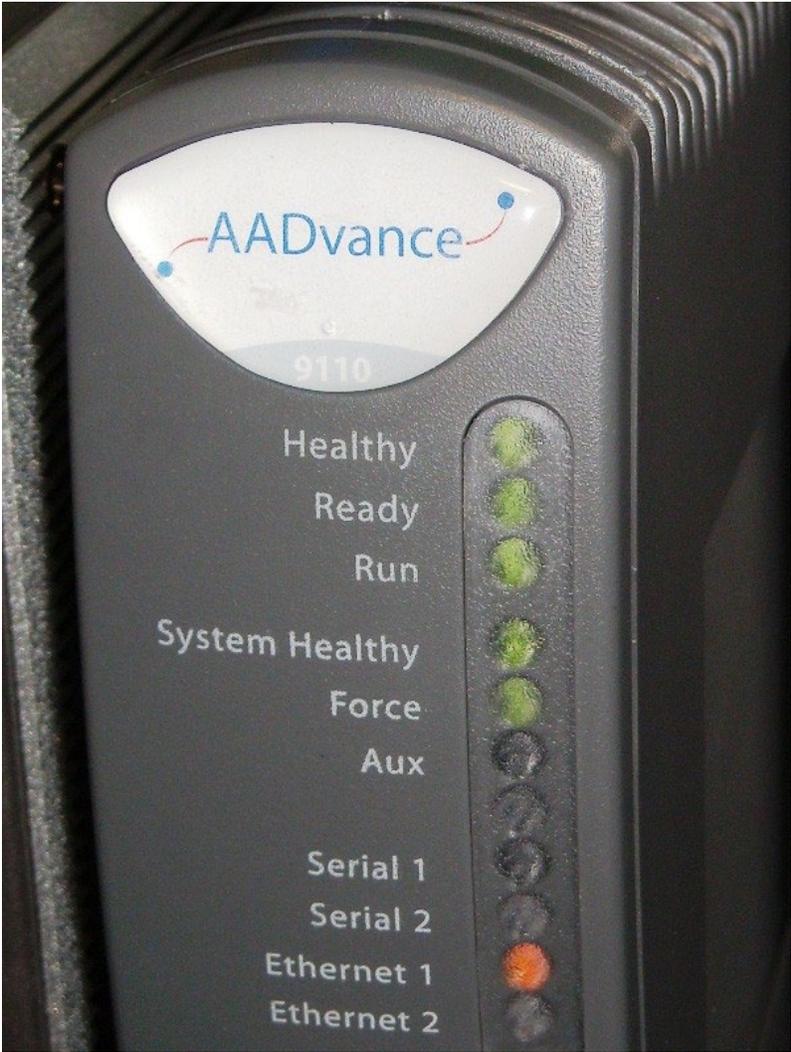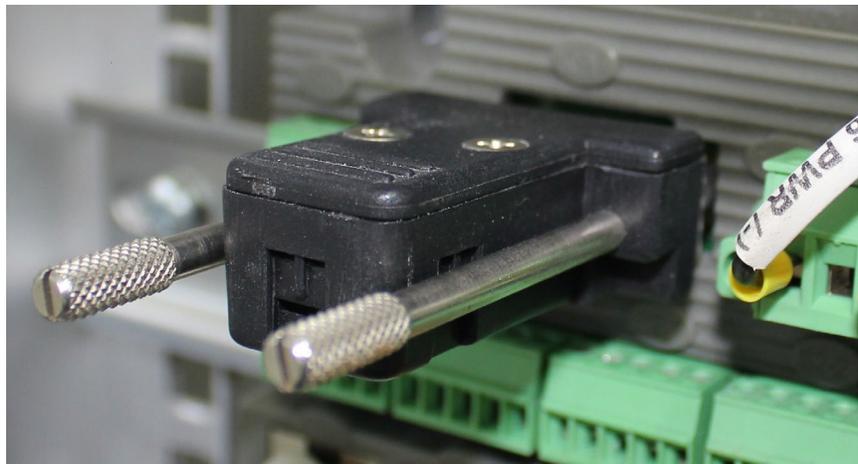
Clear access to examine, remove and install fuses - located on the termination assemblies.
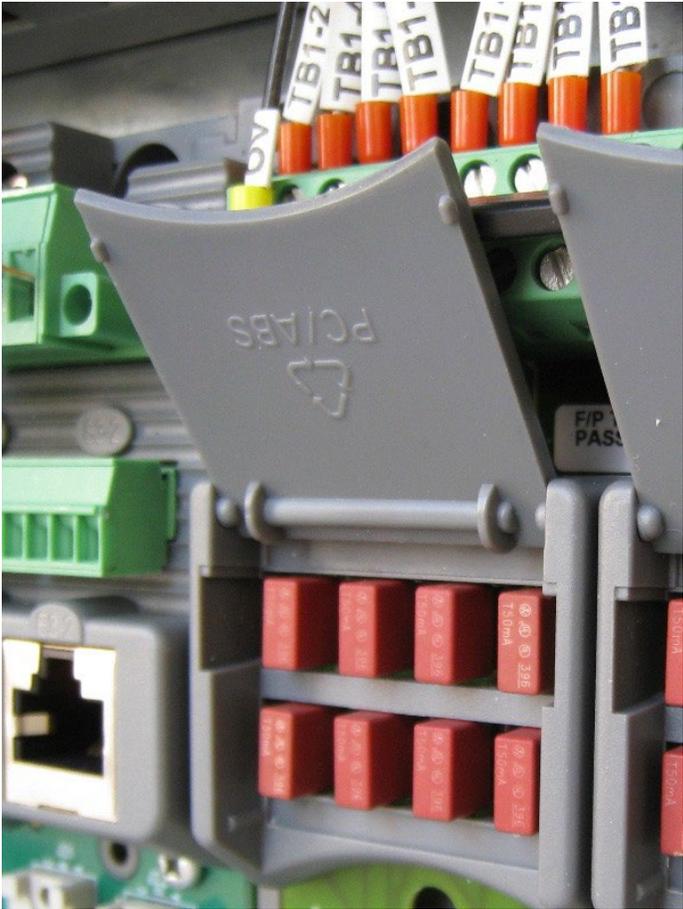
Clear access to terminals and connectors for field, power and network wiring, and access to the wiring itself.

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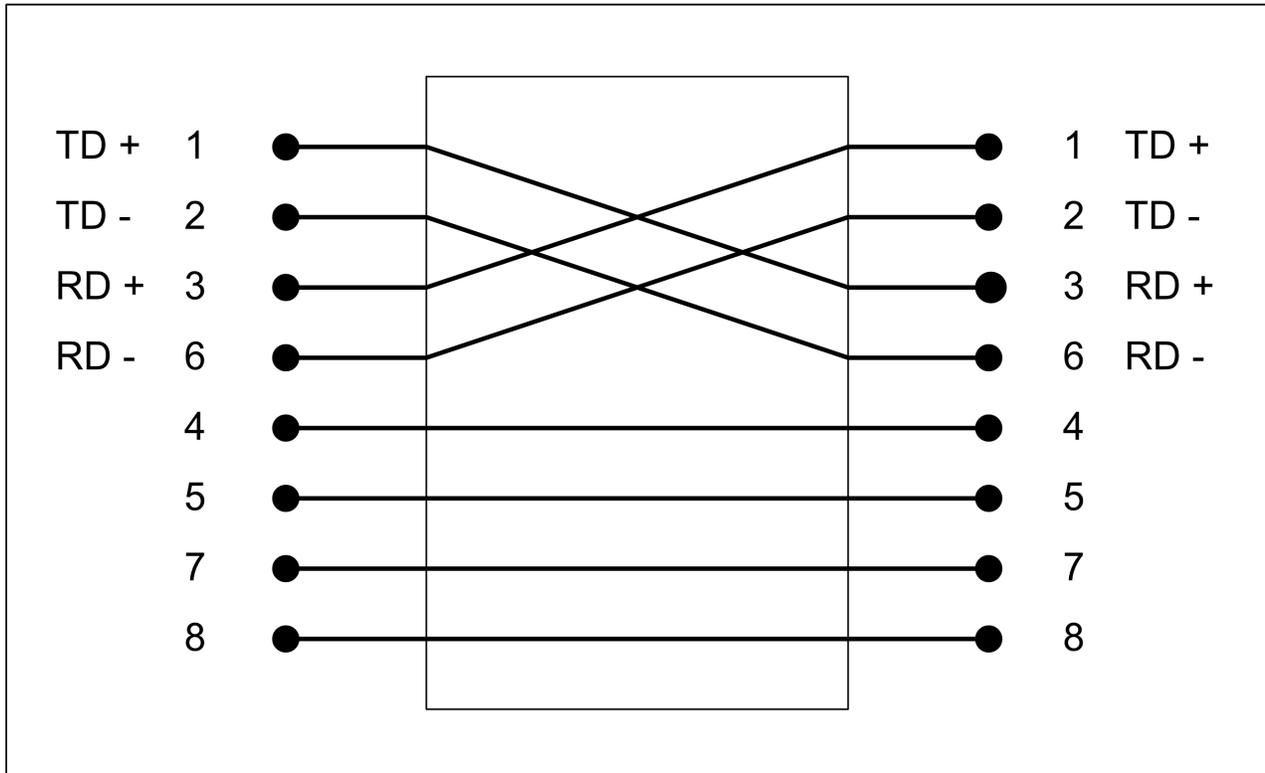
The fixed connectors on the controller are RJ45 sockets. Use Cat5e (enhanced) cables with RJ45 modular plugs for the network cabling.

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.
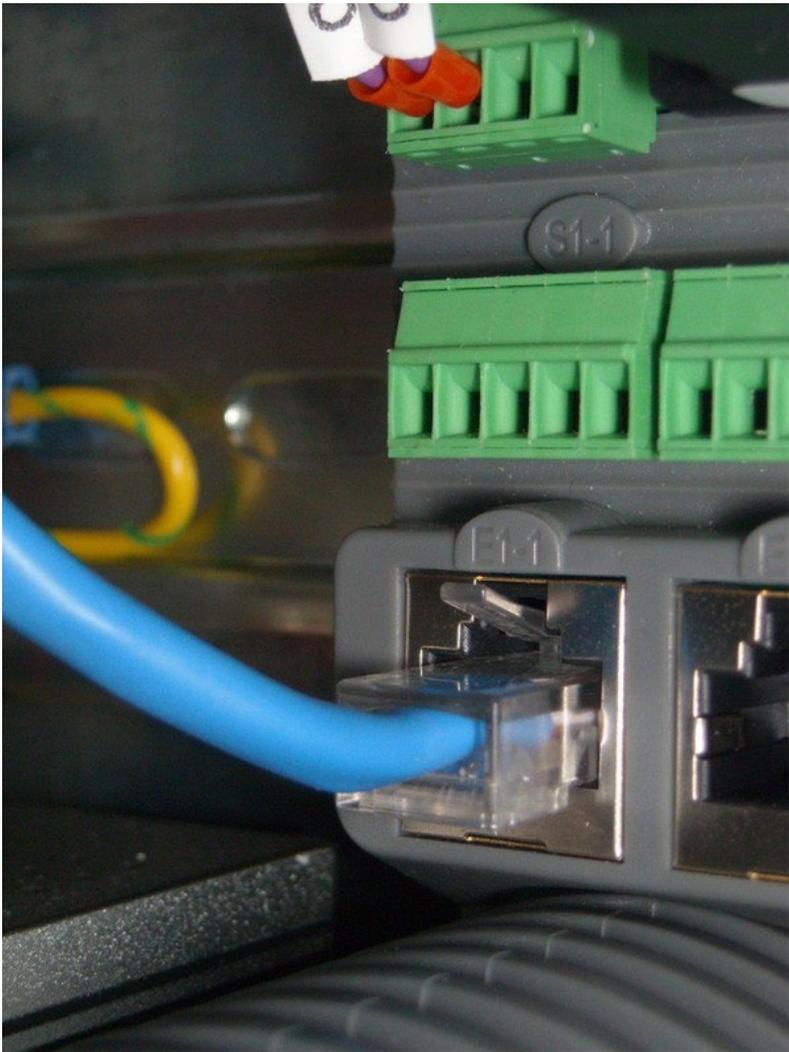
Notes:

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.

> ⚠ **AVERTISSEMENT**: En plus du guide d'installation inclus dans ce chapitre vous devez aussi suivre les procédures d'installation et de mise en service conformément aux règles et aux normes du pays d'installation. Ces normes peuvent inclurent aussi par exemple, IEC 61511, NFPA72 et ISA 84.00.01 dépendant de l'emplacement.

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.
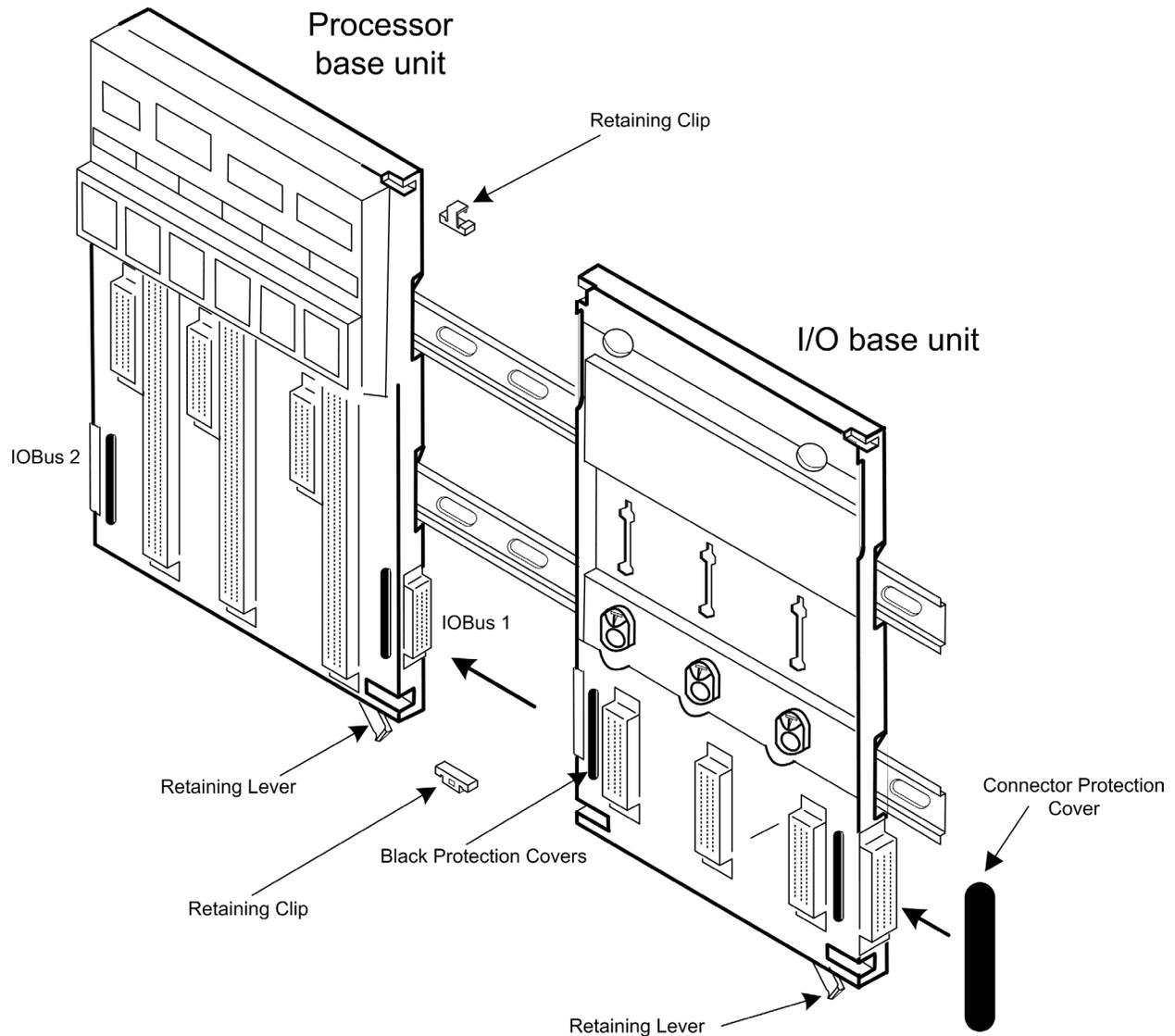
⚠️ **ATTENTION:** Manipulation des Modules Entreposés à des Températures Extrêmes : Il est recommandé de permettre aux modules retirés de l'entrepôt de normaliser leur température avant l'utilisation. Ceci est particulièrement important lorsque les modules ont été entreposés à des températures très basses où une condensation peut se produire. Retirez les modules et placez-les en position verticale et essuyez toute condensation qui pourrait apparaître sur les modules. Le non-respect de ces recommandations peut endommager les modules ou effectuer un fonctionnement incorrect lors de l'installation sur un système en cours d'exécution.

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

Processor base unit

Retaining Clip

I/O base unit

IOBus 2

IOBus 1

Connector Protection Cover

Retaining Lever

Black Protection Covers

Retaining Clip

Retaining Lever

| **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**
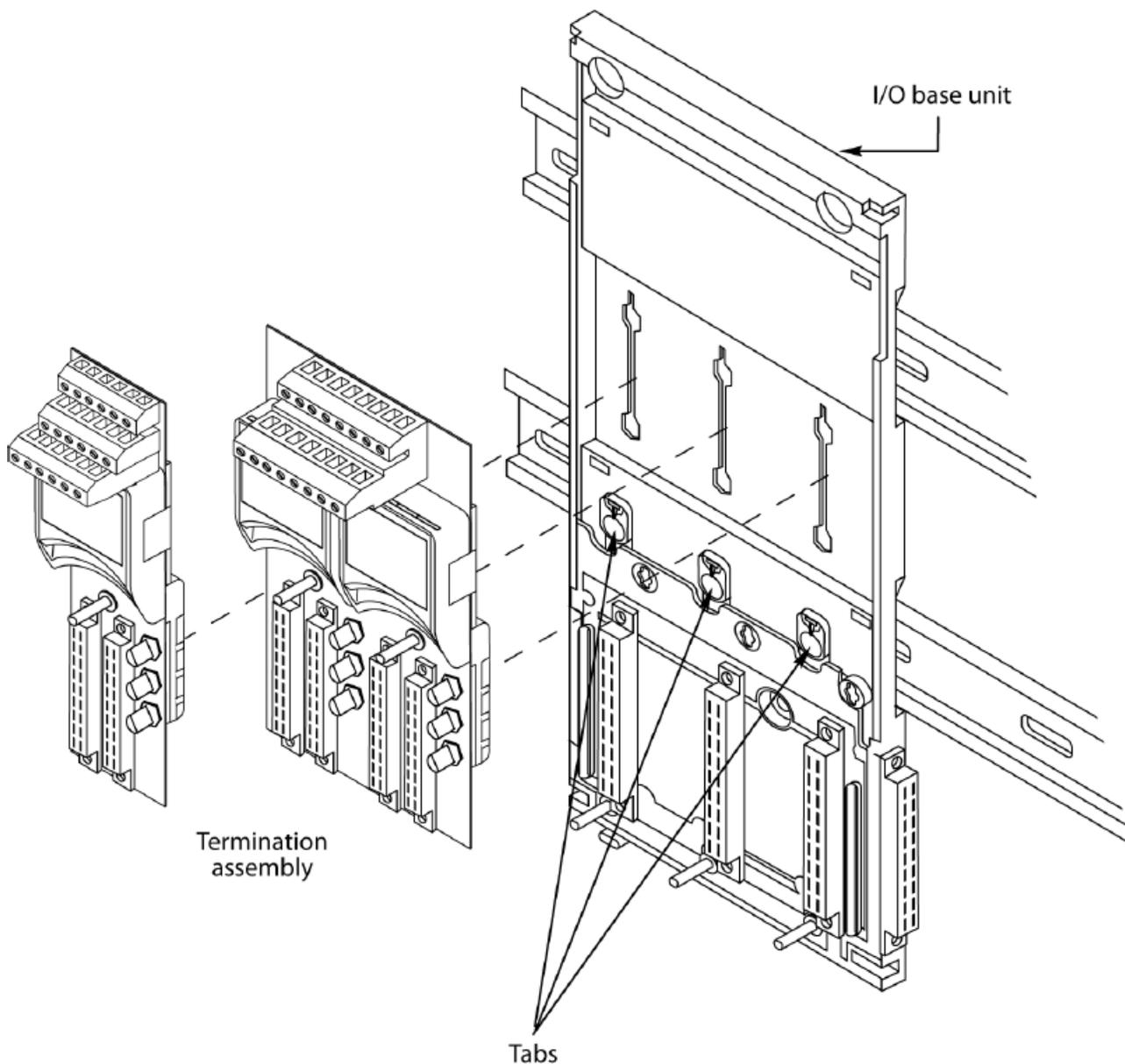
1. To fit termination assemblies do the following:

- 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.
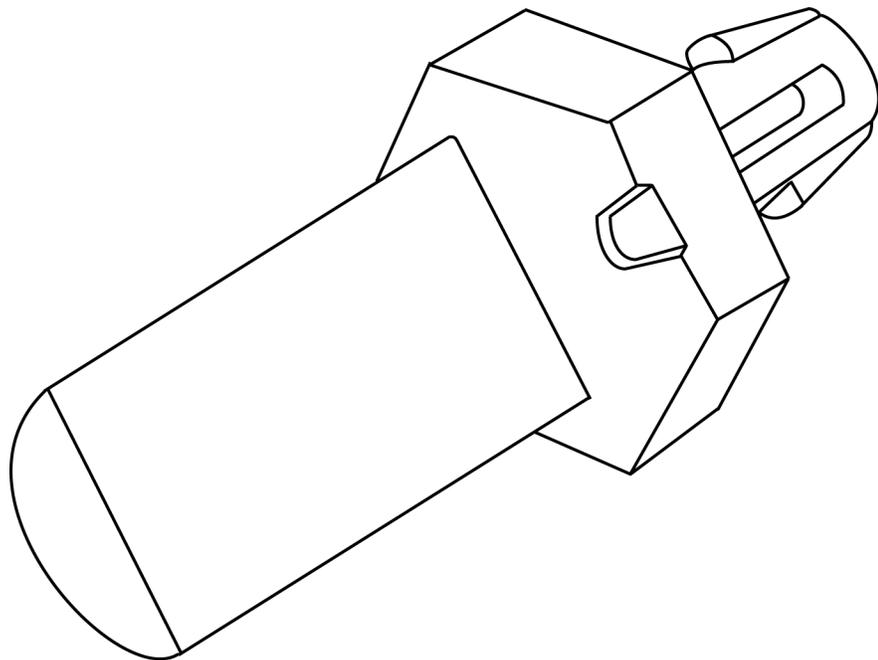

- Refer to the **following table** and verify each **coding peg** is fitted so its index recess is adjacent to the relevant numbered position.

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.
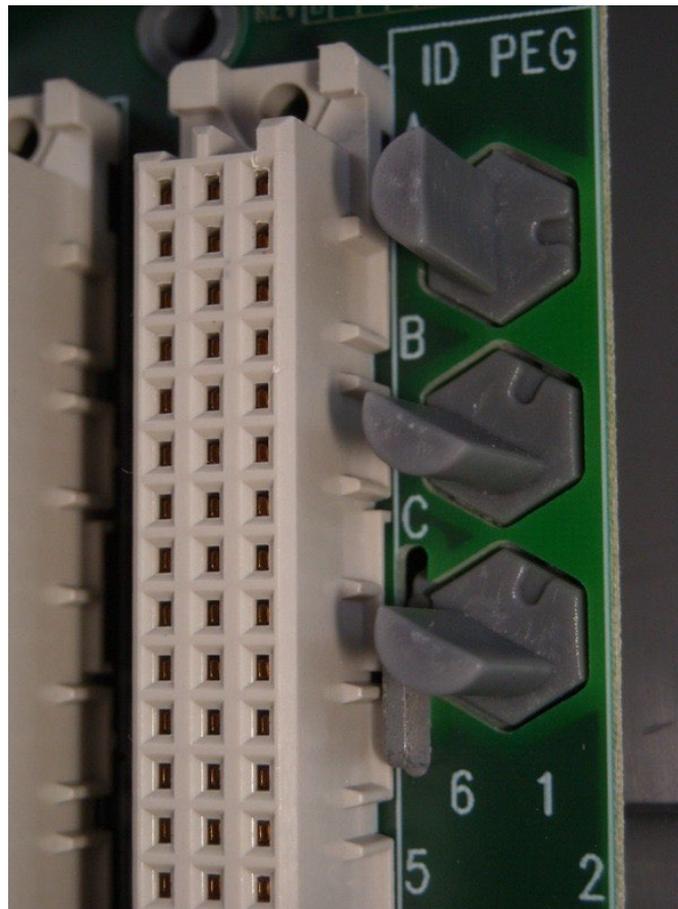
Connect the AC Safety Ground Connection

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.).

Refer to the **photograph** of the the earth stud is shown between the two power leads.

Connect the 24 Vdc System Power to an AADvance Controller

The dual redundant +24 Vdc system power, taken from the chosen power source, is connected to the controller at two plugs labeled PWR-1 and PWR-2 on the processor base unit:
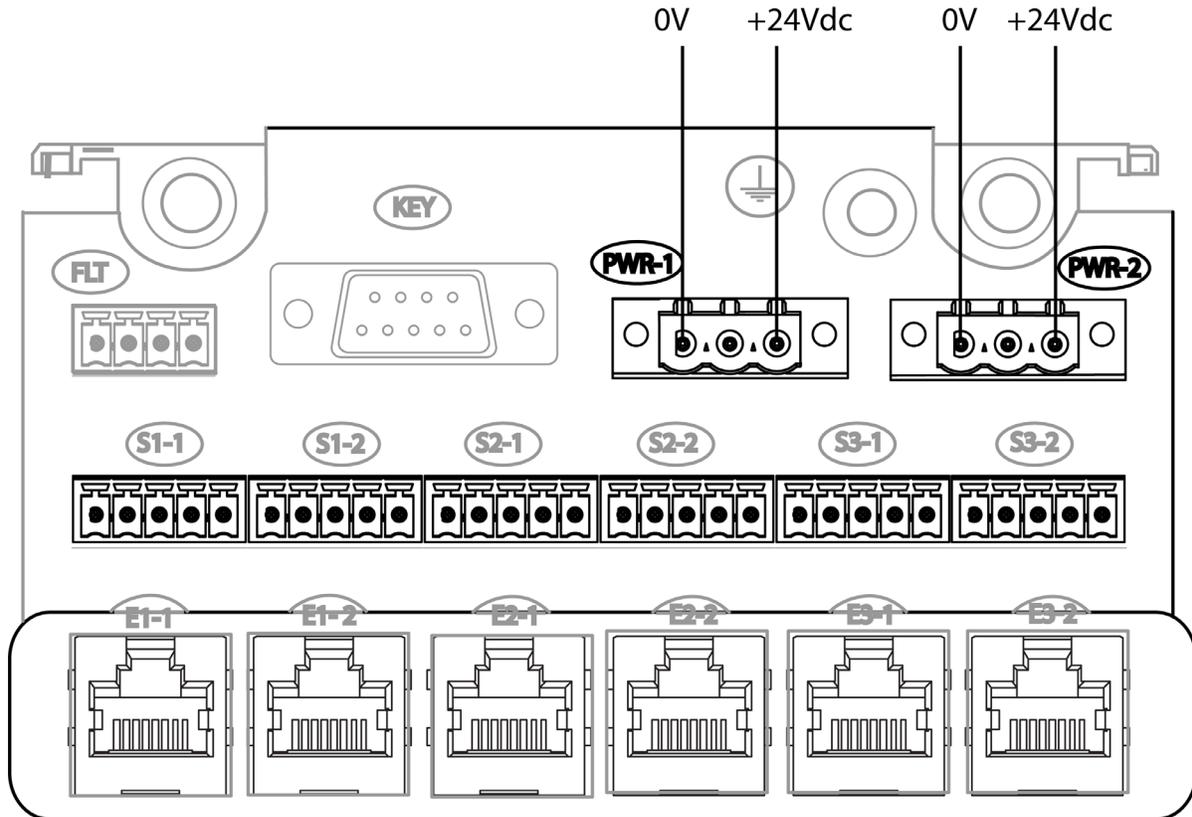
The processor base unit has a link between the +24 Vdc connections to the center terminal of each connector PWR-1 and PWR-2. This link may be useful to connect the +24 Vdc supply to further devices:
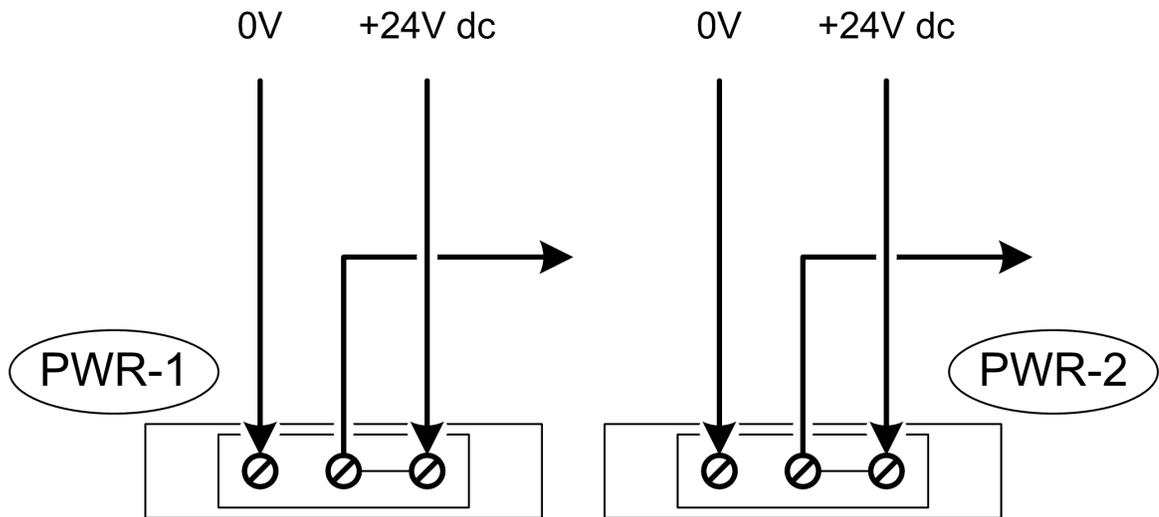
24 Vdc Power Connectors
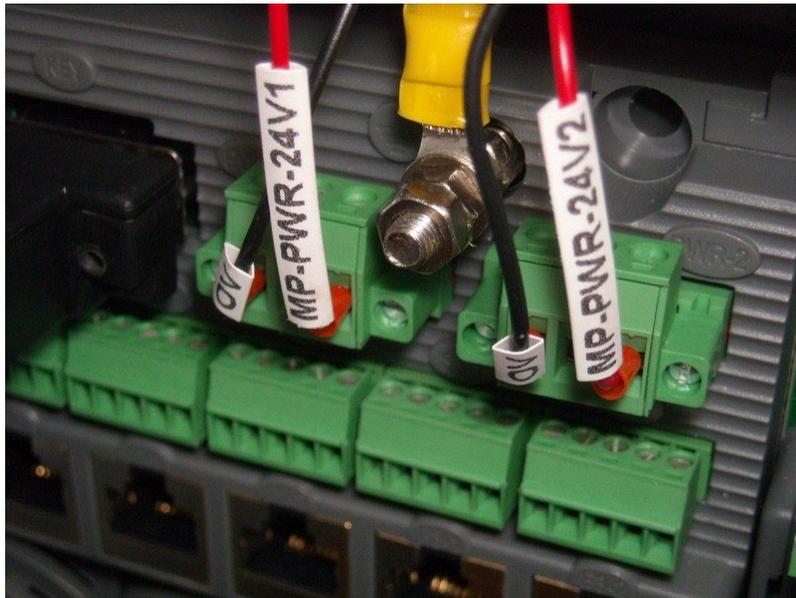
For each power supply connection, do the following:

- Connect the **negative line** from the power supply, typically labeled '0 V', to the left-hand terminal.
- Connect the **positive line** from the power supply, typically labeled '+24 V', to the right-hand terminal.
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the **terminal screws**.

> **IMPORTANT**   Make sure that PWR-1 and PWR-2 are supplied from independent 24 Vdc sources.

Procedure to Connect Serial Communications Cabling

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.

Each processor uses the two serial ports above it on the baseplate. Data is not mirrored between ports. Therefore a single processor system has two ports available, a dual processor system has four ports and a triple processor system has six ports available to it.

Connect the serial communications cabling to the six plugs labeled S1-1 through S3-2 on the T9100 processor base unit.

- For each **serial communications connection**, connect the **cabling** according to the following Serial Communications Illustration.
- Apply a minimum tightening torque of 0.22 Nm (0.16 ft. lb.) to the **terminal screws**.
- Make sure the length of the **cable** does not exceed 1,200 m (3,900 ft.).

Serial Communications Illustration
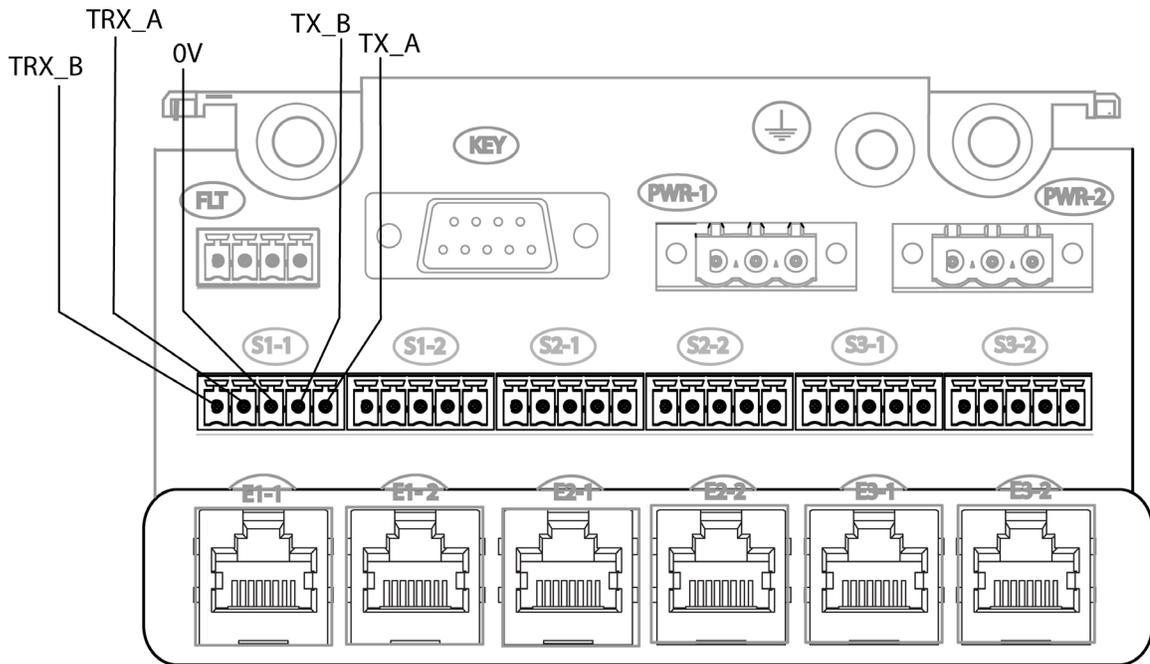
Terminal	Function Description (4-wire)[1]	Function Description (2-wire)[1]
TRX_A	Receive data A (inverting)	Transmit/receive data A (inverting)
TRX_B	Receive data B (non-inverting)	Transmit/receive data B (non-inverting)

Terminal	Function Description (4-wire)[1]	Function Description (2-wire)[1]
0V	Instrument ground (signal ground)	Instrument ground
TX_B	Transmit data B (non-inverting)	not used
TX_A	Transmit data A (inverting)	not used

(1)   The line functions shown in the table ("receive" and "transmit") are with respect to the processor base unit.

> **NOTE**   To connect to the external communication link you should terminate the receive end of the twisted pairs with a 120 Ω resistor in series with a 68nF capacitor at the receiver ends.

Connecting MODBUS Slave Devices to Serial Ports

You can use a full duplex or a half-duplex connection for a MODBUS Slave device on a serial port.

Connect a Slave Device, Full Duplex

You can use a full duplex serial connection to connect one MODBUS Slave device to the AADvance controller. To make the physical connection, do the following:

1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the T9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120 Ω resistor in series with a 68 nF capacitor at the receiver ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

> **IMPORTANT** Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the T9100 processor base unit.

Connect Multiple Slave Devices, Full Duplex

You can use a full duplex serial connection to connect multiple MODBUS Slave devices to the AADvance controller. To make the physical connection, do the following:

1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the T9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120 Ω resistor in series with a 68 nF capacitor at the receiver ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

> **IMPORTANT**   Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the T9100 processor base unit.

Connect a Slave Device, Half Duplex

You can use a half-duplex serial connection to connect a single MODBUS Slave device to the AADvance controller. To make the physical connection, do the following:
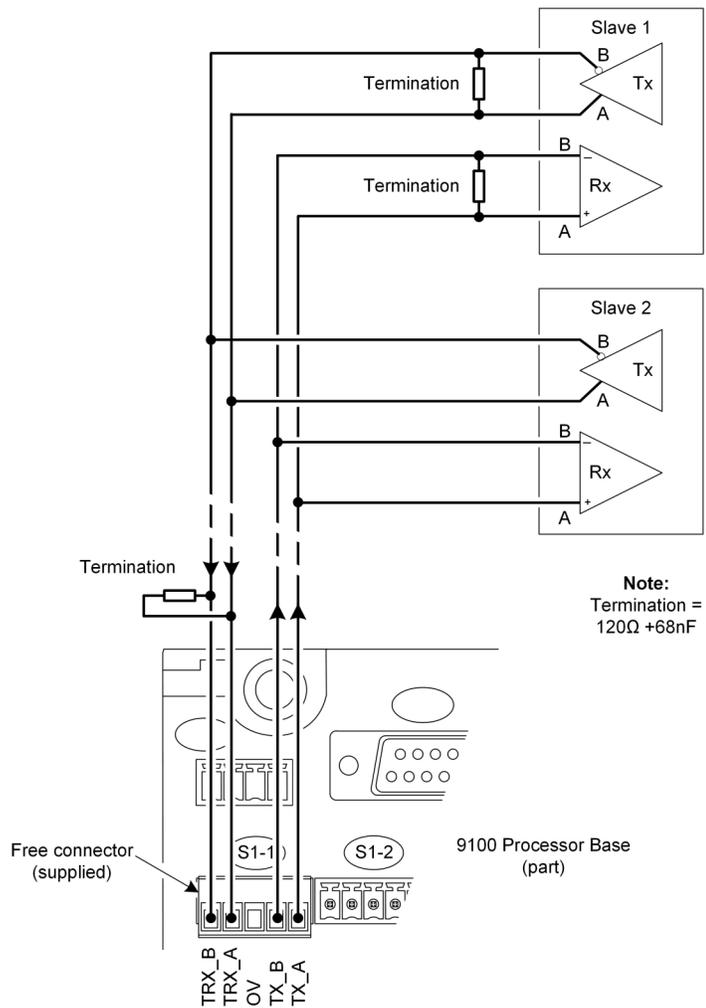
1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the T9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120 Ω resistor in series with a 68 nF capacitor at the receiver ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

> **IMPORTANT**   Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the T9100 processor base unit.

Connect Multiple Slave Devices, Half Duplex

You can use a half-duplex serial connection to connect multiple MODBUS Slave devices to the AADvance controller. To make the physical connection, do the following:
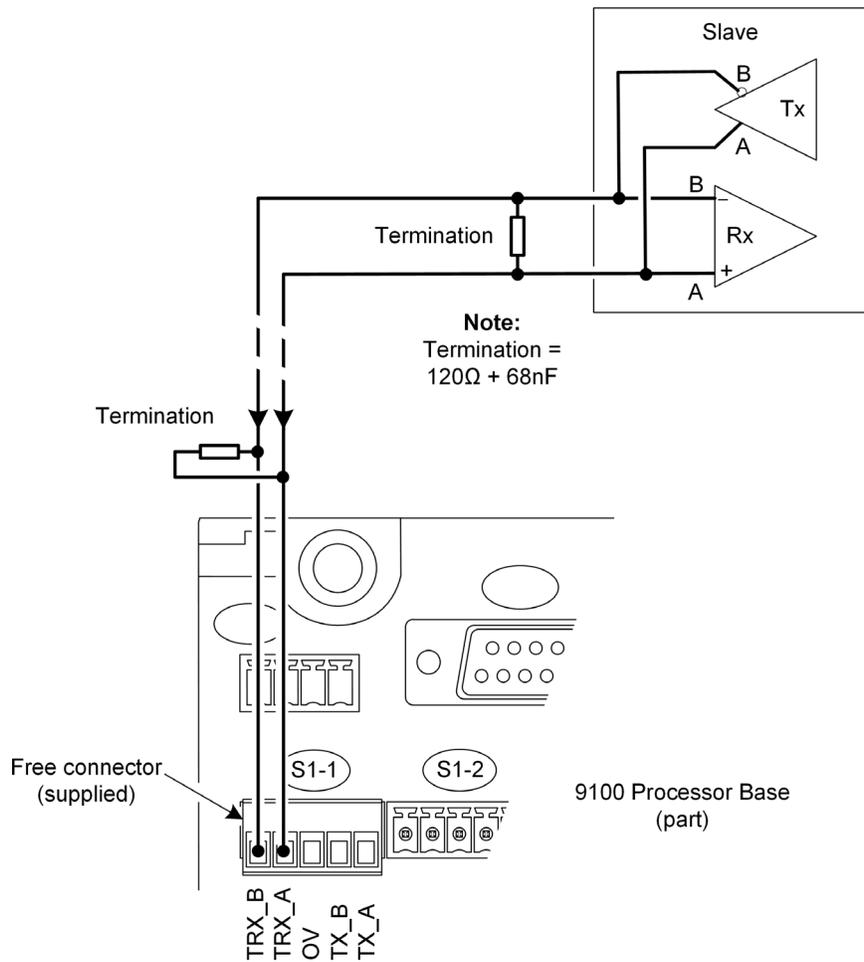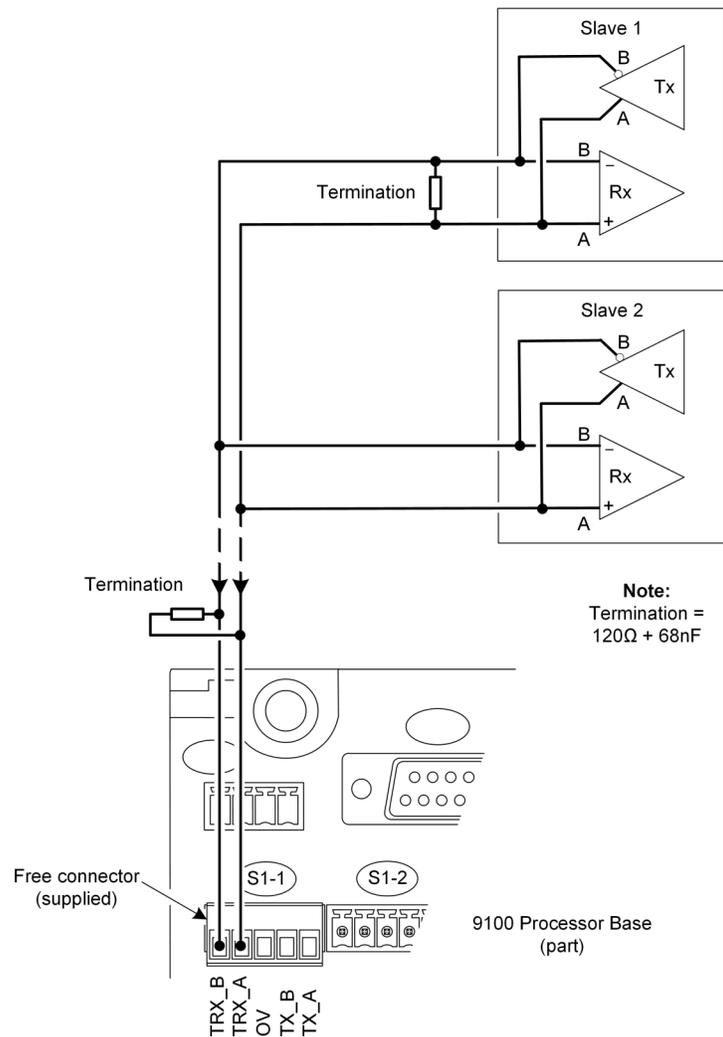
1. Select an applicable cable. We recommend 3-pair, overall shielded cable.
2. Remove the serial port connector from the T9100 processor base unit.
3. Make the connections shown in the illustration. Terminate the twisted pairs with a 120 Ω resistor in series with a 68 nF capacitor at the receiver ends.
4. Connect the signal ground (not illustrated) from the 0 V terminal to the slave device.

> **IMPORTANT**   Do not connect the signal ground to the AC safety ground.

5. Insert the connector into the T9100 processor base unit.

System Security

Serial networks are closed and local and have limited protocol functionality, so they are immune to any external attack apart from local deliberate sabotage. The AADvance system, however, with its computers and DCS interfaces, uses Ethernet networks which are frequently part of a larger corporate network and can expose the system to accidental or malicious infection or attack.

These steps help prevent such issues:

- Consider network and computer security, for example:

- The AADvance system must not be on a network with open unsecured access to the Internet.
- The Firewall must be active on the computer, helping prevent access to the relevant Ethernet ports on each communication interface. Anti-virus software must be installed and be kept up-to-date.

IMPORTANT	Firewalls have been known to change the operation of the AADvance Discover tool.

- The computer must be password-protected. If using a laptop, keep the laptop locked when not in use.
- If the software uses a hardware license USB dongle, keep the USB dongle secure. The software will not run without the USB dongle.
- The application must be password-protected.
- Removable media, such as USB storage devices and CDs, must be virus checked before use in the system.

Connecting Field Wiring

Connect the field wiring to the screw terminal blocks on the termination assemblies.

Use conductor wire with a cross section of 16 AWG. The stripping length should be 6mm (1/4 in.) and a conductor temperature rating of 85 °C. Apply a tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Digital Input Field Loop Circuits

Recommended Field Loop Circuits

This section contains recommended field loop circuits for line monitoring digital inputs used in Emergency Shutdown or Fire & Gas applications.

Field Loop Circuit for Digital Input
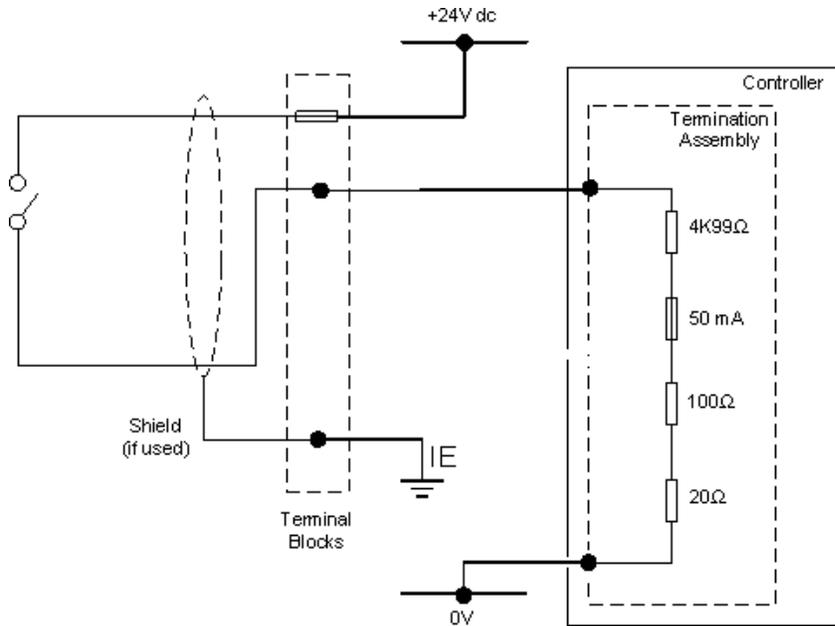
Field Loop Circuit for Line Monitored Digital Input for Emergency Shutdown Systems (ESD)
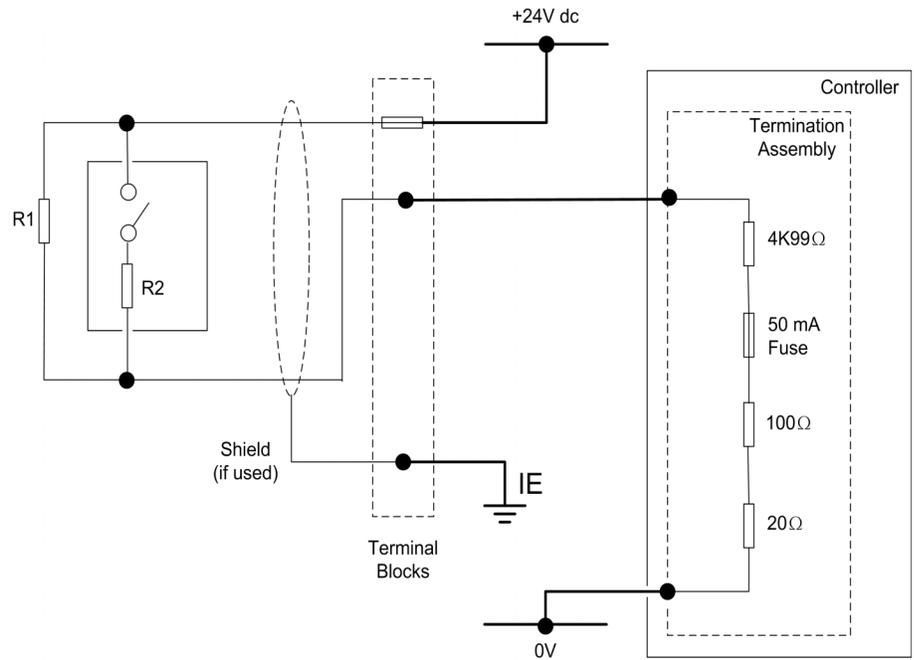
The suggested values for R1 and R2 are as follows:

R1 = 15K Ω 1%, 1W (maximum power dissipated is 47mW at 26.4V)

R2 = 3K9 Ω 1%, 1W (maximum power dissipated is 182mW at 26.4V)

Suggested range of values for both of the above circuits are as follows:

Range		Value (mV)
Maximum Allowed	=	32000
		SHORT CIRCUIT
High	=	19000
Low	=	18500
		ON (nominal 16V)
High	=	11000
Low	=	10500
		INDETERMINATE
High	=	6500
Low	=	6000
		OFF (nominal 8V)
High	=	3500
Low	=	3000
		OPEN CIRCUIT

Assumptions:

- Loop supply voltage = 24V ± 10%
- Maximum Field Cable Line Resistance: < 100 Ω total; this means < 50 + 50 Ω for the two cables.
- Minimum Isolation is 0.75M Ω between the field loop conductors.
- These values will allow the input to detect more accurately different voltage levels that represent OPEN CCT - OFF - ON - SHORT CCT and will also detect Over Voltage and an input which is neither ON nor OFF. The values verify that a line fault will be declared before it becomes possible for a false declaration of On and Off states due to a combination of resistor value drift and loop voltage variation.

Field Loop Circuit for Line Monitored Digital Input for Fire and Gas Systems (F & G)
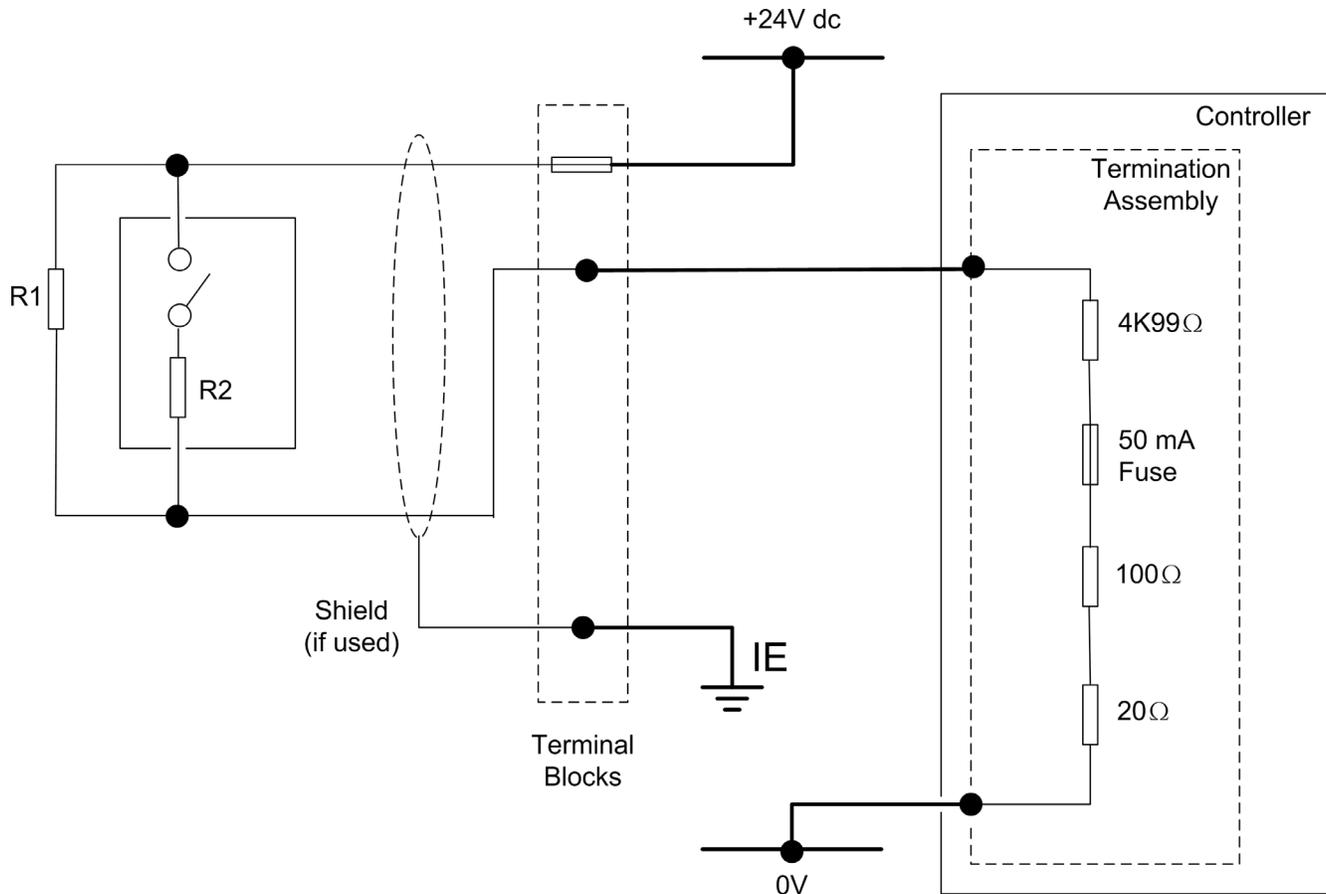
- The F&G circuit will also allow two devices to be in alarm without reporting short circuit.
- All of the input circuits are suitable for simplex, dual and TMR configurations.
- The F&G circuit assumes that the devices are volt-free contacts.
- For further information, please refer to application note AN-T90001 Field Loop Configuration, which is located in the Rockwell Automation Knowledgebase Support Center. This also includes advice for fire detectors which are not simple volt free contacts.

Digital Input Slew Tolerance

It is possible during sustained periods of abnormal input voltage slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to verify that the channels are operating within their designed safety accuracy.

To avoid spurious declaration of channel faults it is necessary to ensure that the input signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the input signal such as by filtering or by appropriate choice of process safety time.

Connections to T9801 Non-isolated Digital Input TA — 16 Channel Simplex
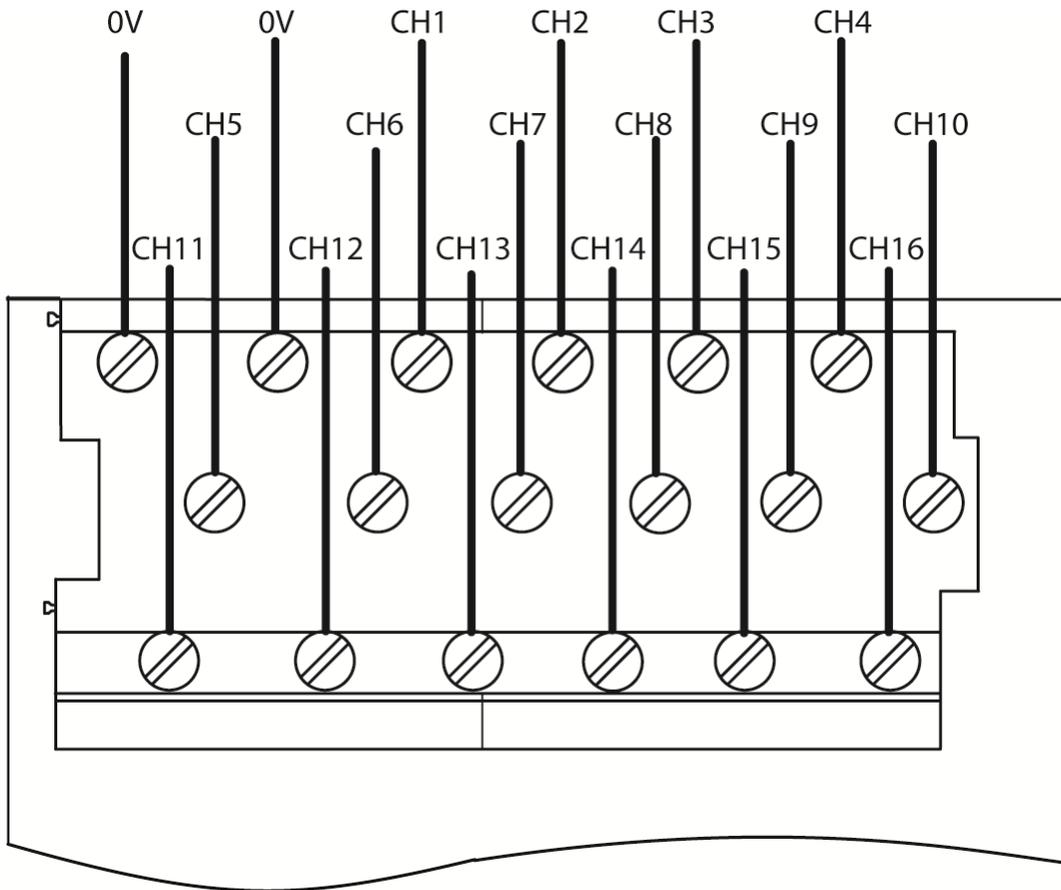
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Connections to T9802/T9803 Isolated Digital Input TA — 16 Channel Dual/TMR
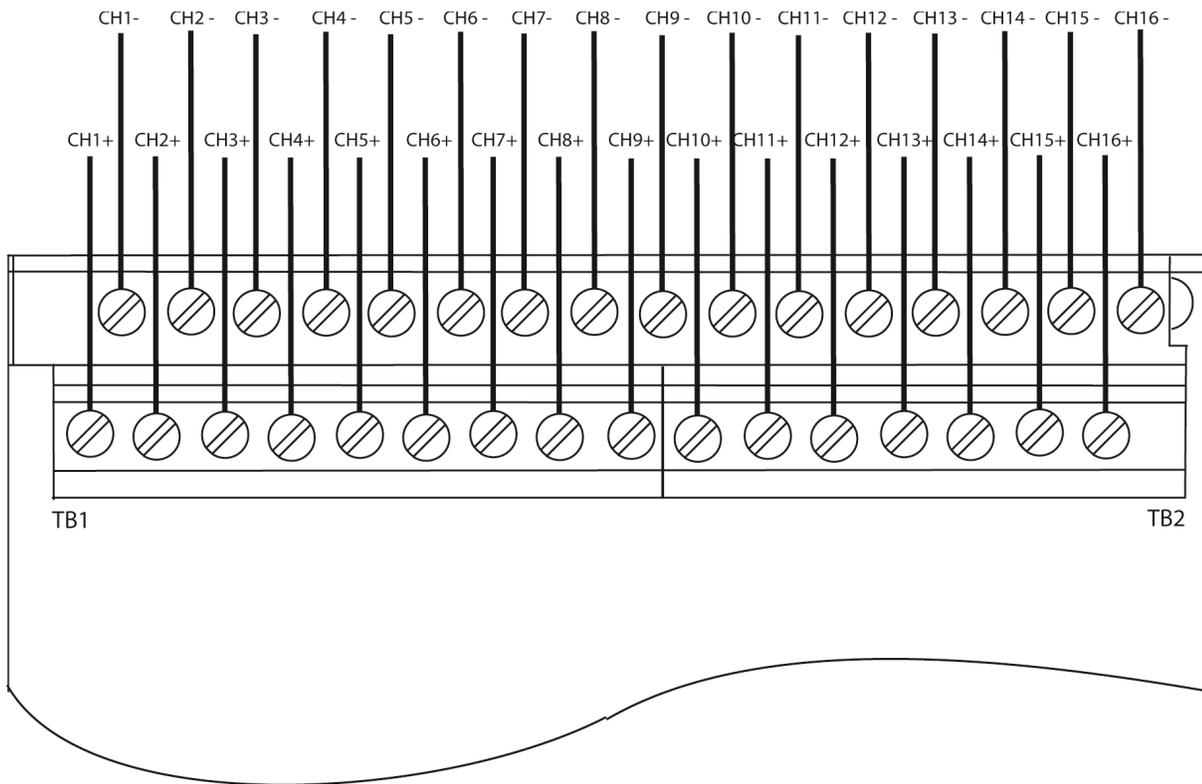
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Analogue Input Field loop Circuits

These circuits can be used for simplex, dual and triple configurations of analogue input modules. Fit a fuse (as shown) in each circuit to protect the field wiring.

The recommended field loop circuits for analogue inputs are as shown below.

Field Loop Circuit for 2-Wire Analogue Input

Figure 17 - Wire Analogue Input Field Loop
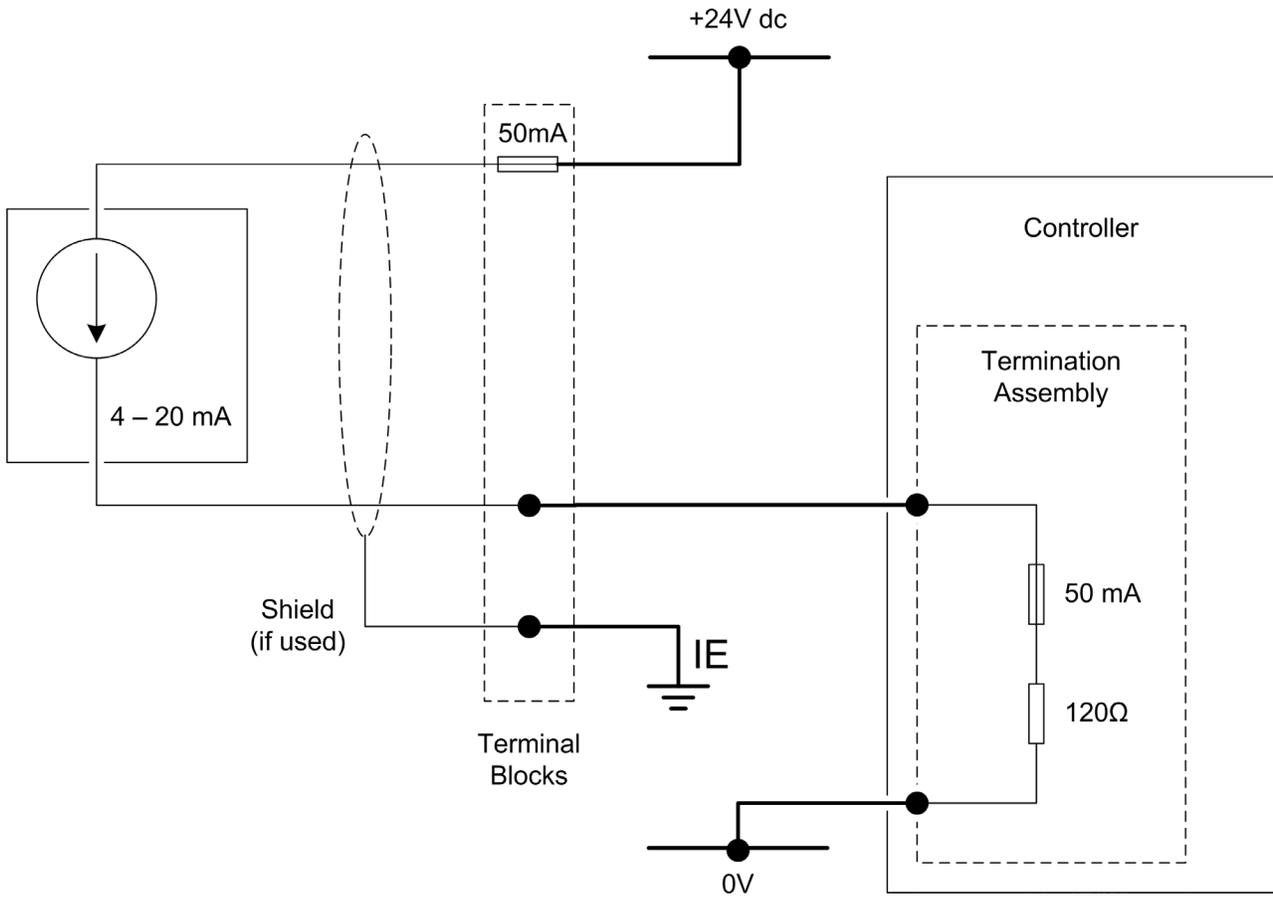
Field Loop Circuit for 3-Wire Analogue Input

Figure 18 - Wire Analogue Input Field Loop
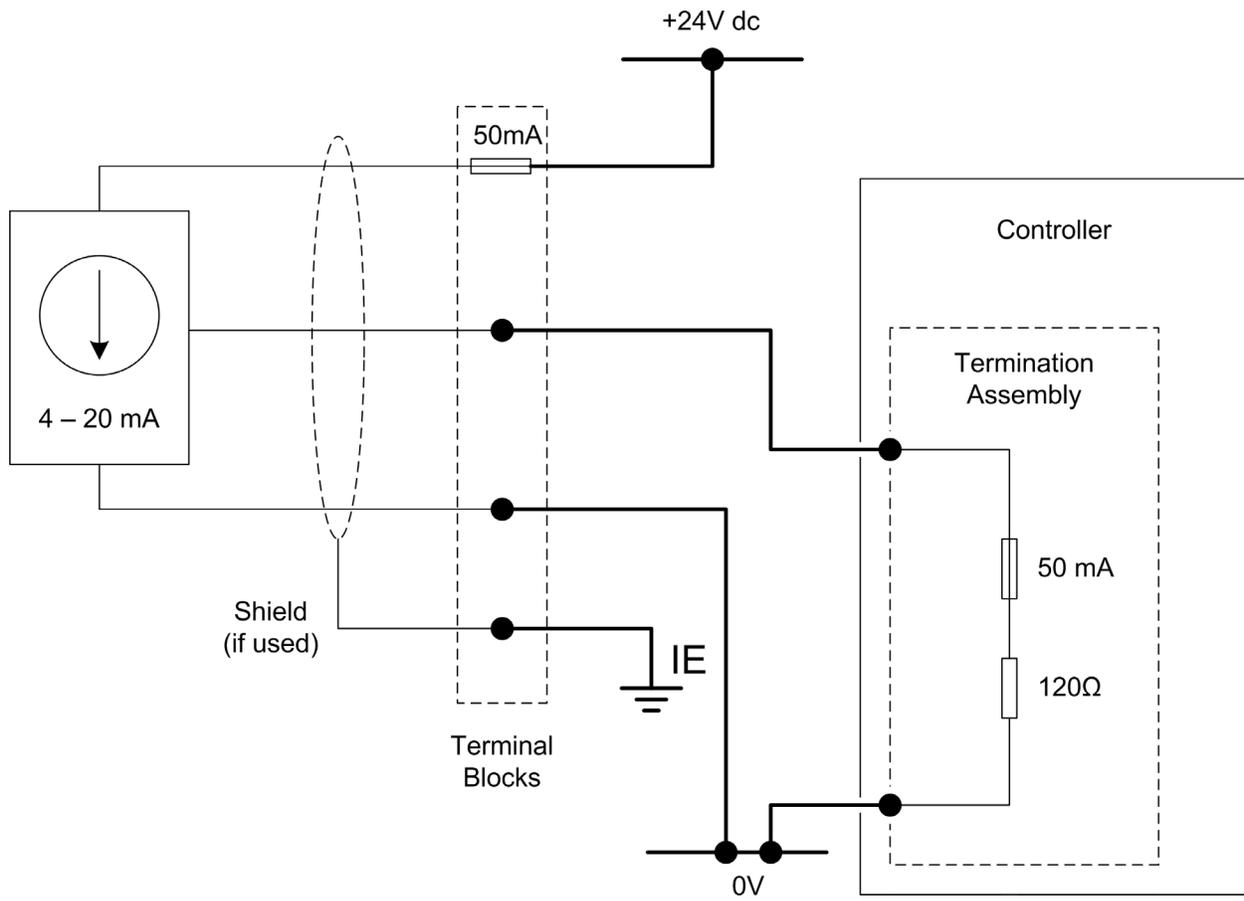
Field Loop Circuit for 4-Wire Analogue Input

Figure 19 - Wire Analogue Input Field Loop
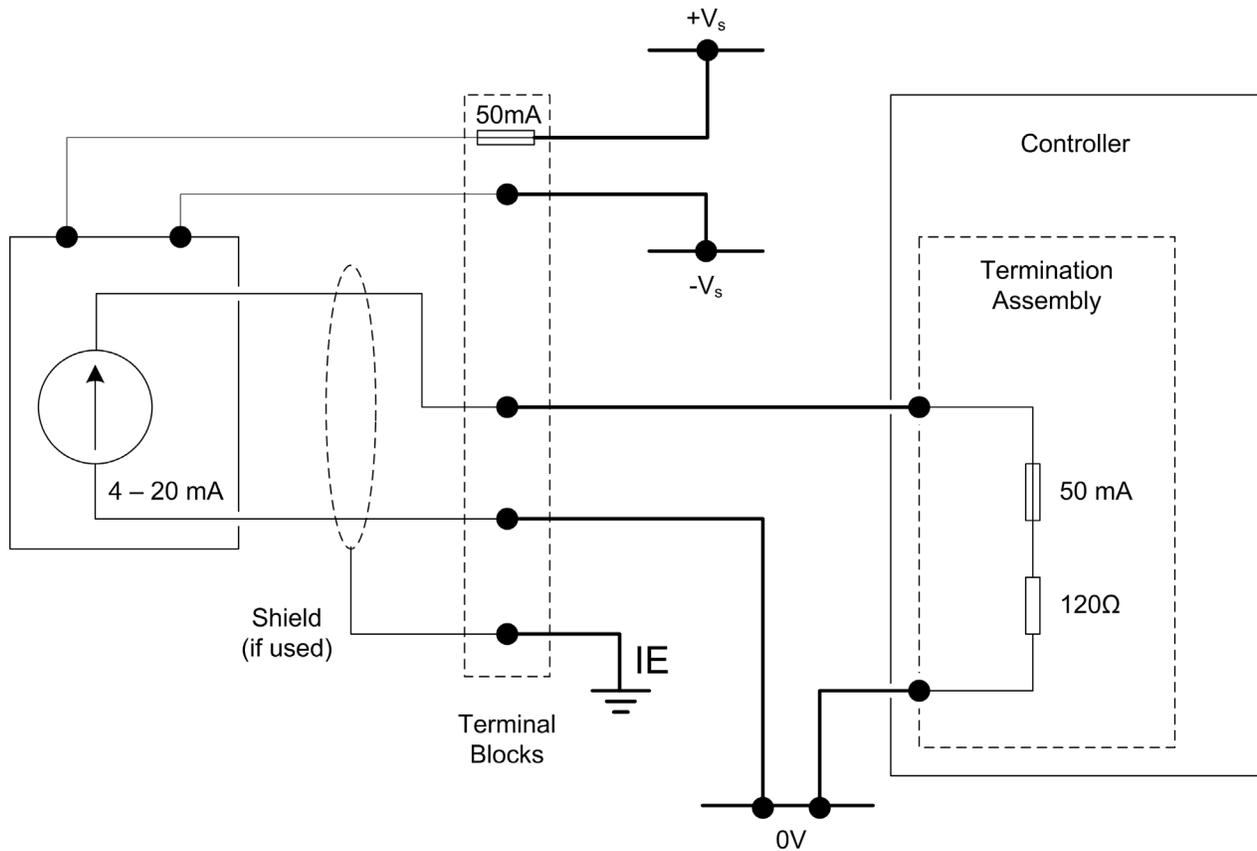
Analogue Input Slew Tolerance

It is possible during sustained periods of abnormal input current slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to verify that the channels are operating within their designed safety accuracy.

To avoid spurious declaration of channel faults it is necessary to ensure that the input signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the input signal such as by filtering, sensor slew rate configuration or by appropriate choice of process safety time.

Connections to T9831 Non-isolated Analogue Input TA — 16 Channel Simplex
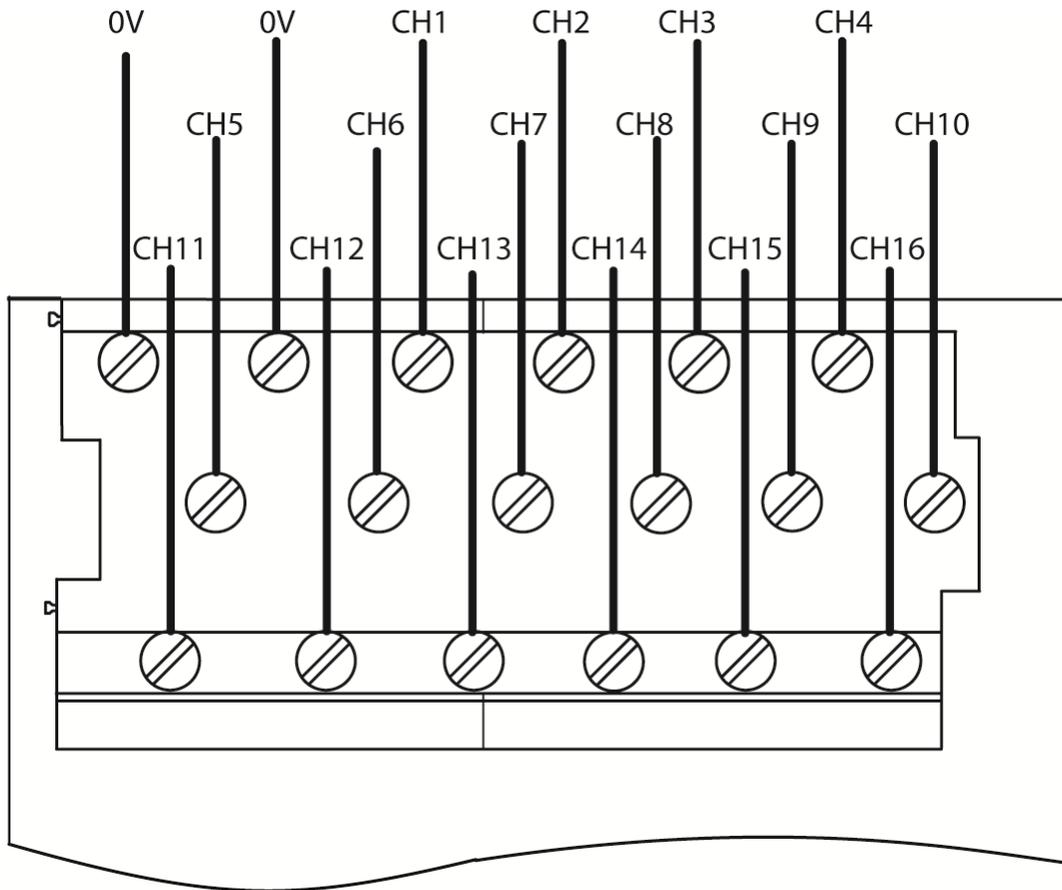
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Connections to T9832/T9833 Isolated Analogue Input TA — 16 Channel TMR
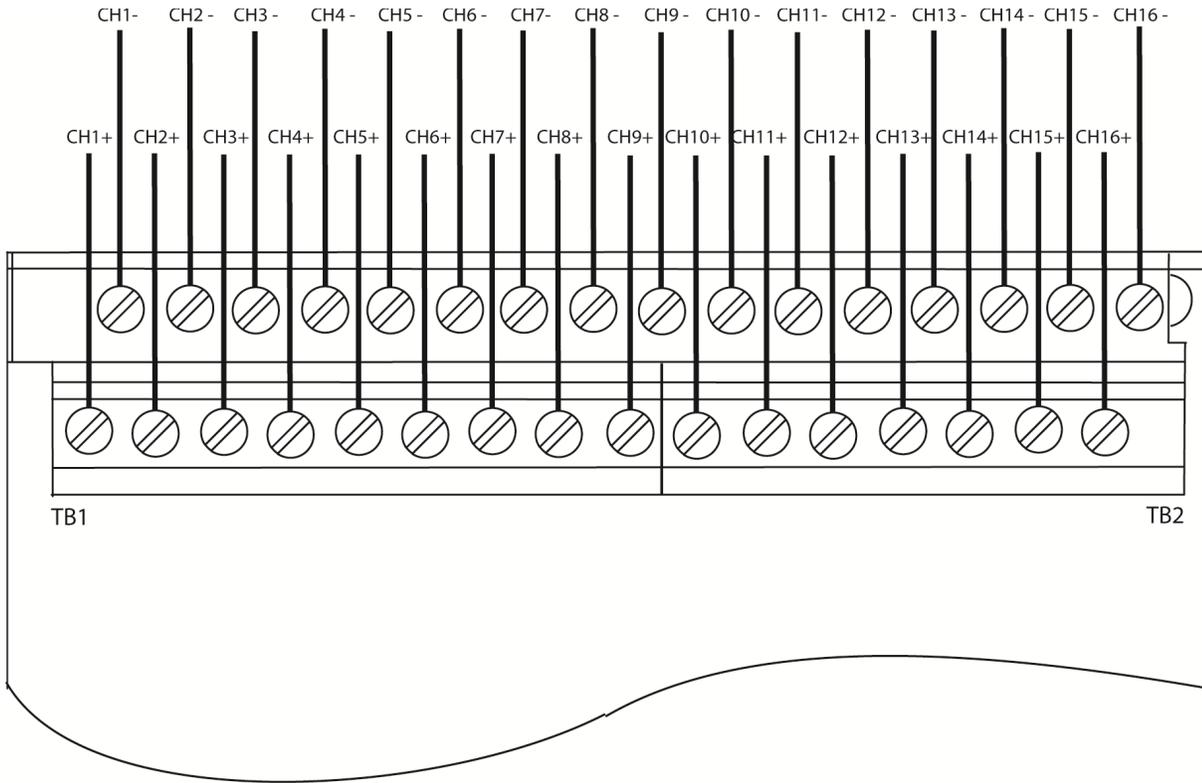
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Recommended Field Circuit for Digital Outputs

This circuit is applicable for simplex and dual configurations of digital output modules. The two 10 A fuses shown are included on the termination assembly within the controller. The 5 A fuses satisfy UL508 requirements for digital output field supplies, see illustration below:

Figure 20 - Digital Output Field Circuit
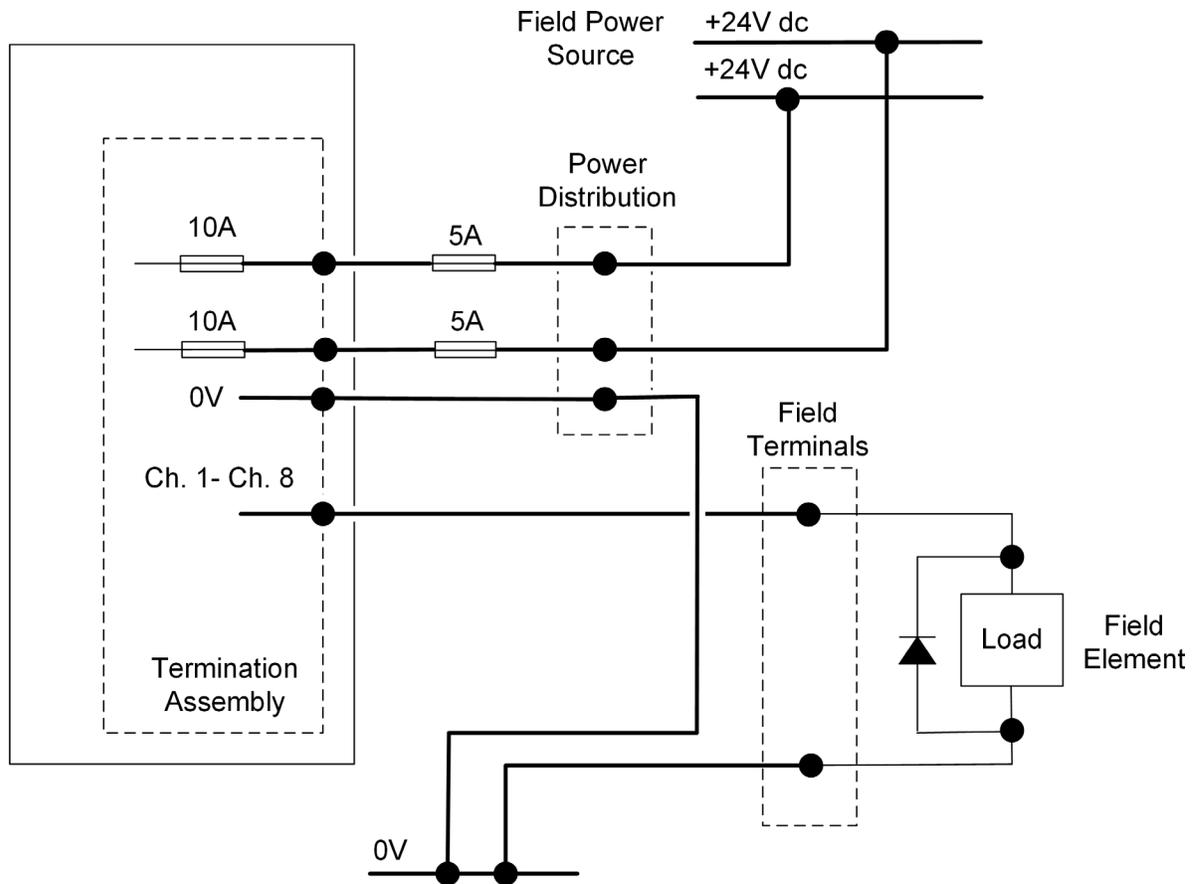
⚠️ **WARNING:** For inductive loads, a back EMF protection diode shall be fitted at the load.

⚠️ **WARNING:** A fuse rated minimum 32 Vdc, maximum 5 A for an input of 0 - 28.3 V and a maximum fuse current rating of 100 V for an input of 28.3 - 42.4 V must be installed in series with the field power terminals on modules T9451 to comply with the UL 508 certification.

⚠️ **Avertissement:** Pour les charges inductives, une diode de protection FEM arrière doit être installée à la charge.

⚠️ **Avertissement**: Un fusible d'une capacité minimum de 32 Vdc, d'une capacité maximum de 5A pour une entrée de 0 à 28,3 V et d'un fusible pour courant d'une capacité maximum de 100V pour une entrée de 28,3 à 42,4 V doit être installé en série avec les bornes d'alimentation sur les modules T9451 pour se conformer à la certification UL 508.

Recommended Fuse Types

The 10A fuses are fitted into the termination assembly and are:

- T9902: SMF Omni-Block, Surface Mount Fuse Block 154 010, with a 10A, 125V Fast Acting Fuse, Littelfuse.

The field power input fuses installed must be 5 A / 125 V, Slow Blow and comply to UL 248 - 14.

> **NOTE** 1. Alternatively instead of fitting two 5A fuses you can use Class 2 power supplies for the +24 Vdc field voltage. Class 2 is defined by the NEC as providing less than 100 watts (at 24V).
>
> 2. The field power must be wired using 12 AWG wire.
>
> 3. The field power must be supplied with an isolating source.
>
> 4. The minimum current required for line monitoring is 20mA for a dual pair.

*Digital Output Slew Tolerance*

It is possible during sustained periods of abnormal input current slewing that channels can be declared faulted as a consequence of diagnostics otherwise designed to verify that the channels are operating within their designed safety accuracy.

To avoid spurious declaration of channel faults it is necessary to ensure that the field supply voltage and output signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the field supply voltage or output signal such as by filtering or by appropriate choice of process safety time.

For further information regarding how the AADvance digital output module detects field faults, see Knowledgebase Document ID: [QA23147 AADvance/ bulletin 1715: Digital output channel diagnostic test](#).

💡 Sign in to your Rockwell Automation account to view Knowledgebase articles

Connections to T9851/T9852 Digital Output TA — 8 Channel Simplex/Dual

The field element wiring, and field power connections are as shown:

**Figure 21 - Digital Output Termination Assembly Wiring**
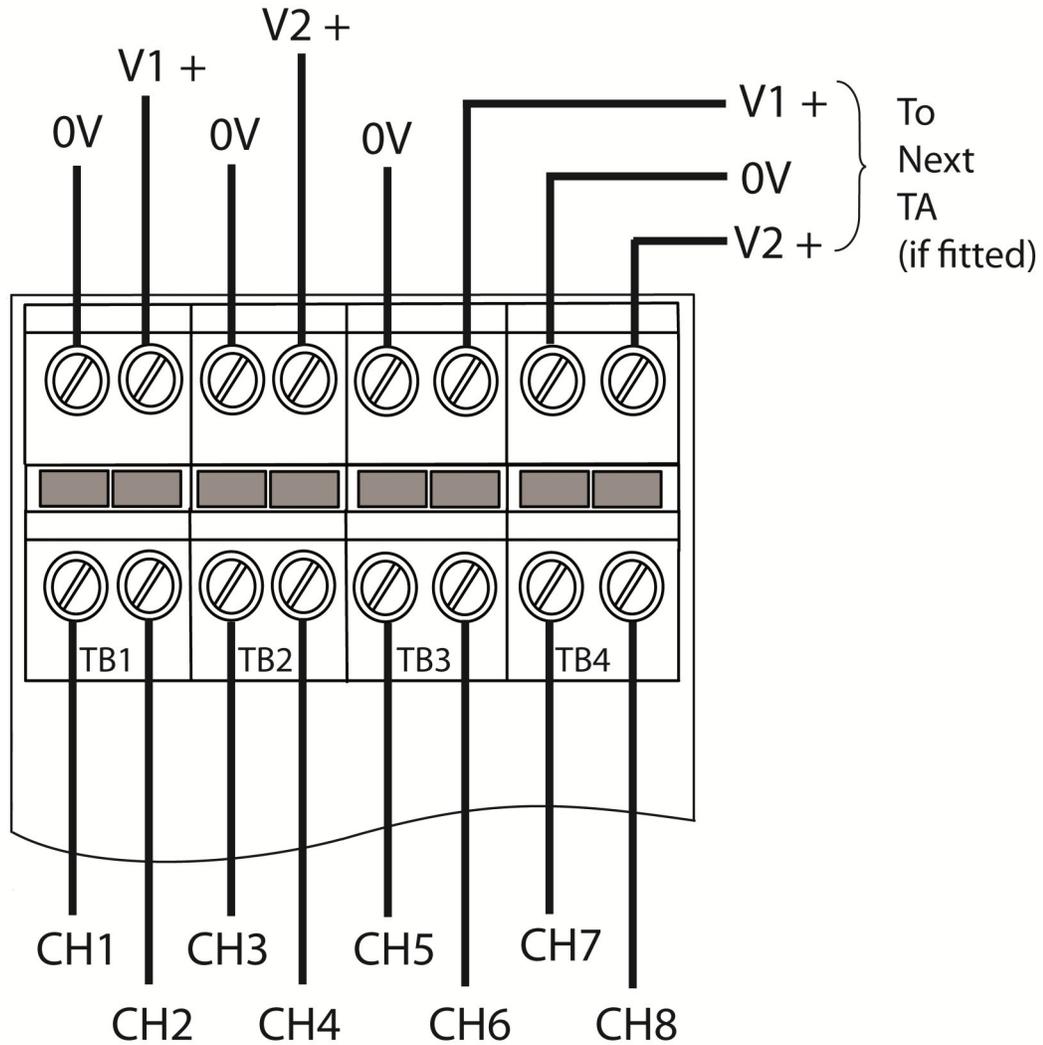
- Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Recommended Circuit for Analogue Outputs

These circuits are suitable for simplex and dual configurations of analogue output modules. All channels are isolated from each other but may be bridged at the '+' terminal if fed by a common system mounted supply.

System powered devices
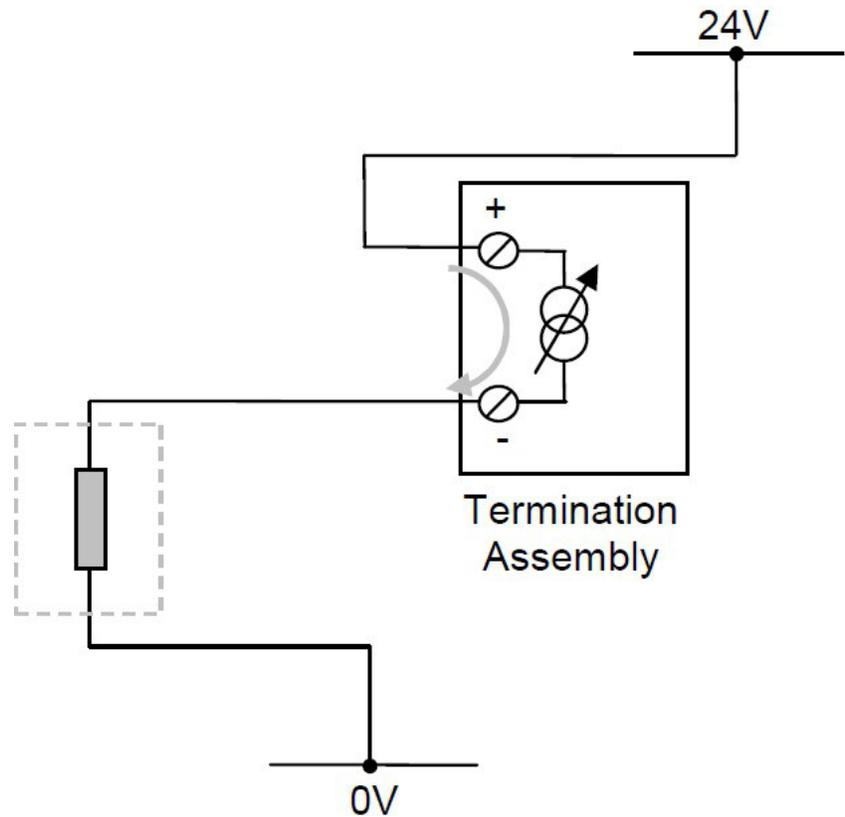
The above circuit is appropriate for devices that are powered by the system. The channel will pass a requested current between 0mA and 24mA. The field device could also be connected between the 24V supply and the Loop Plus terminal.

IMPORTANT	If the 24 V supply is shared between channels or between modules, the field loops will not be isolated from each other.

IMPORTANT	Si l'alimentation 24 V est partagée entre les canaux ou entre les modules, les boucles de terrain ne seront pas isolées les unes des autres.

Field powered devices
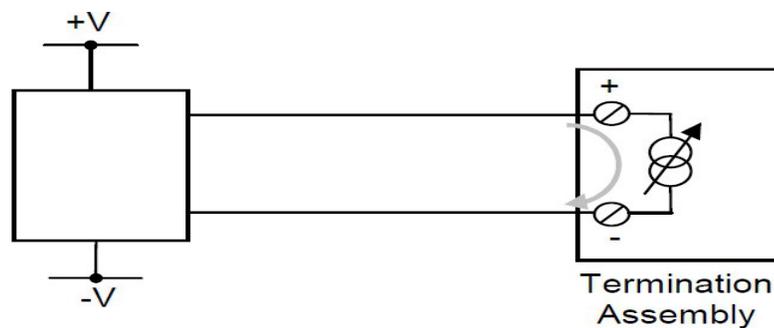
The above circuit is appropriate for devices that are powered locally and expect a current-controlled signal loop. Ensure that the loop is wired to pass current to the Loop Plus terminal and return it on the Loop Minus terminal.

Analogue Output Slew Tolerance

Analogue output channels voltage slew is unconstrained with the limits set by the module's compliance operating voltage range.

To avoid spurious declaration of channel faults it is necessary to ensure that the field supply voltage and output signal condition satisfies the maximum slew rate criteria defined in the Solutions Handbook. Accordingly it may be necessary to condition the field supply voltage or output signal such as by filtering or by appropriate choice of process safety time.

Connections to T9881/T9882 Analogue Output TA - 8 Channel Simplex/Dual

This diagram shows the T9882. The T9881 has the same terminal arrangement.

CH1   CH3   CH5   CH7

CH2   CH4   CH6   CH8

LOOP -

D - AOTA

ASSY

LOOP +

BATCH

TB1   TB2   TB3   TB4

CH 1   2   3   4   5   6   7   8

CH2   CH4   CH6   CH8

CH1   CH3   CH5   CH7
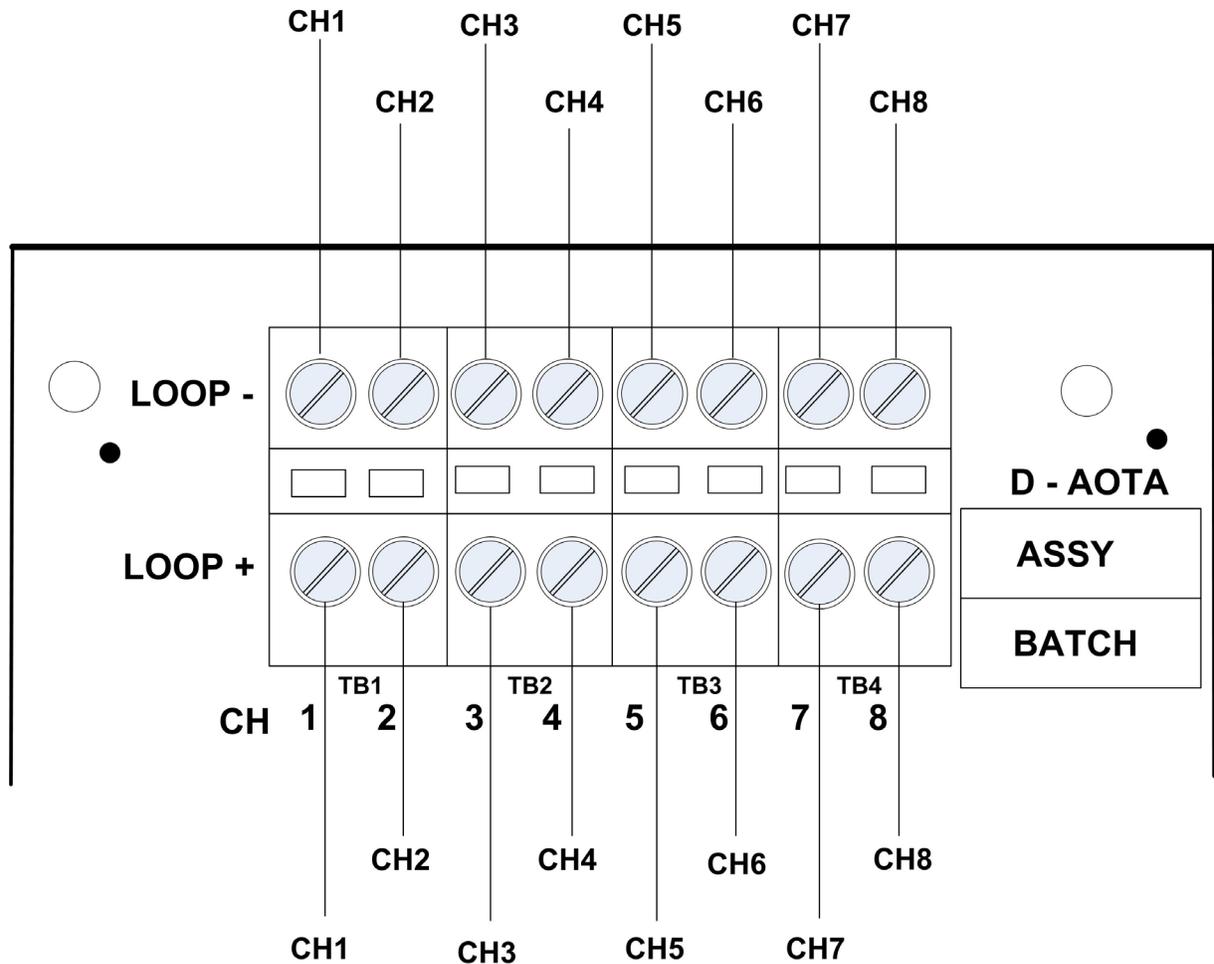
Apply a minimum tightening torque of 0.5 Nm (0.37 ft. lb.) to the terminal screws.

Install Modules

The modules of the AADvance controller mount onto the base units. The processor module(s) mount onto the T9100 processor base unit, while the various I/O modules mount onto the T9300 I/O base unit and associated termination assemblies.

The product range includes two sizes of blanking covers to conceal unused module positions. The shorter cover is for a spare position on the processor base unit, while the taller cover is for a spare position on an I/O base unit.

Install a T9110 Processor Module

Do the following:

- Before inserting a new processor module, examine it for damage.
- The identification labels on the sides of the module will be hidden after the module is installed. Therefore before installation make a record of the location of the module and the details shown on the label.
- If you are installing more than one processor module make sure they all have the same firmware build.

Installation

1. Examine the coding pegs on the T9100 processor base unit and make sure they complement the sockets on the rear of the processor module:
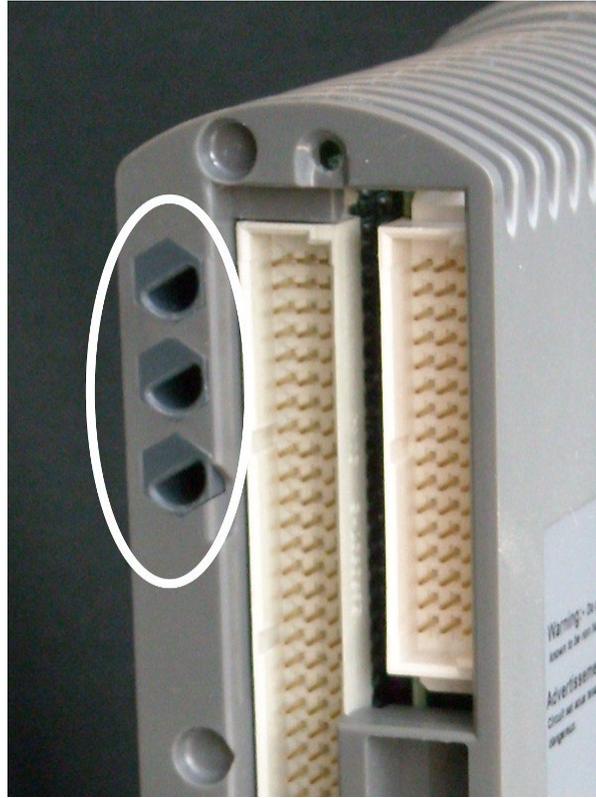
2. Place the processor module on to the coding pegs. Make sure the slot on the head of the module locking screw is vertical and then push the module home until the connectors are fully mated.

3. Using a broad (9mm) flat blade screwdriver turn the module locking screw clockwise to lock.

> **NOTE**   The locking screw acts as a power interlock device and must be locked or the module will not boot up.

Replace a Faulty Processor Back-up Battery

Use the following official Rockwell Automation battery or one of an equivalent specification.

Part No and Description

T9905: Polycarbon monofluoride Lithium Coin Battery, BR2032 (recommended type), 20 mm dia; Nominal voltage 3 V; Nominal capacity (mAh.) 190; Continuous standard load (mA.) 0.03; Operating temperature -30 °C to +80°C, supplied by Panasonic.

Battery design life is based on operating at a constant 25 ° C and low humidity (high humidity, temperature and frequent power cycles are all factors that will shorten the batteries operational life).

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.

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

> ⚠ **ATTENTION:** La pile peut exploser si elle est maltraitée. Ne tentez pas de la recharger, désassembler ou de la brûler.

> ⚠ **WARNING:** Batteries must only be changed in an area known to be non-hazardous.

> ⚠ **AVERTISSEMENT:** Les piles ne doivent être remplacées que dans une zone réputée non dangereuse.

Procedure

To replace a faulty battery, do the following:

1. Use a small cross head screwdriver to release and remove the battery cover.
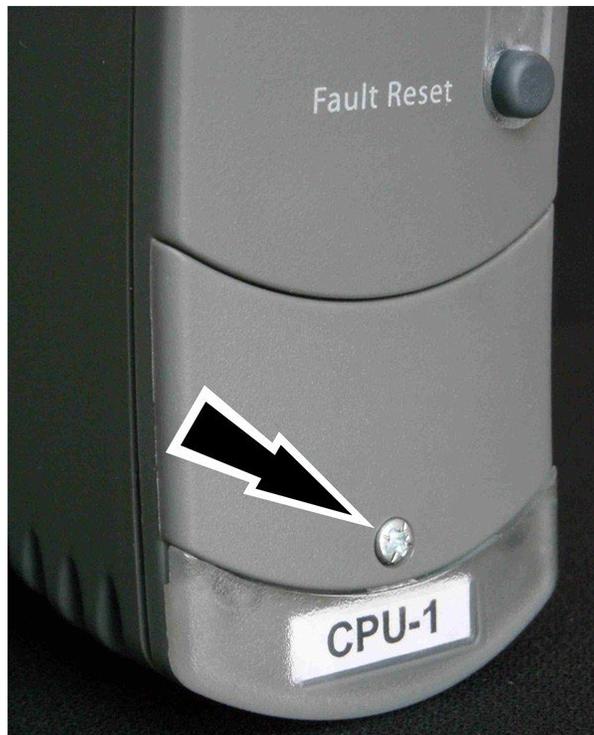
2. Remove the battery by pulling on the blue ribbon.

3. Insert a new battery, orientate it the positive (+) terminal to the right. Trap the ribbon behind the new battery so it can be removed in the future and then push the battery into the holder.

4. Put the cover back and secure it with the cross head screw.

5. Push the Fault Reset button on the processor module. The processor Healthy LED will go green (applies if the module is part of a running system).

If the battery is replaced when more than one processor module is installed then the processor clock will be updated automatically through synchronization.

If you have previously set up SNTP when you set up your processor module then the clock will be reset to the current time automatically. If you have not set up SNTP it is recommended that you do so, as this will not only reset the processor clock but will also keep the time accurately during operation. Refer to the applicable software publication for SNTP set up instructions:

*   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

The following applies:

*   If the battery is replaced when only one processor module is installed and the processor module is not powered up and SNTP has not been set up, you must set the clock to the current time as soon as practicable.

*   The battery does not do any function while the processor module is powered and the application is running. The Processor's Real Time Clock provides Date and Time data for SOE functions and also for the Processor diagnostic log entries.

The specific functions that the battery maintains on complete loss of power are the following:

- Real Time Clock – The battery provides 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 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 scan.
- Diagnostic logs – The processors diagnostic logs are stored in the portion of RAM backed by the battery.

Set the Real Time Clock Manually

If the system has only one controller and does not have a different time server, you have to set the processor real-time clock manually using RTC variables. The following procedure assists in setting the clock:

Set up the following variables in the Dictionary

RTC Control Rack Variables (all BOOLEAN Outputs)
- RTC Control: RTC_Read
- RTC Control: RTC_Write
- RTC Control: Year
- RTC Control: Month
- RTC Control: Day of Month
- RTC Control: Hours
- RTC Control: Minutes
- RTC Control: Seconds
- RTC Control: Milliseconds

RTC Status Variables (All Word Inputs)
- RTC Status: Year
- RTC Status: Month
- RTC Status: Day of Month
- RTC Status: Hours
- RTC Status: Minutes
- RTC Status: Seconds
- RTC Status: Milliseconds

RTC Program Rack Variables
- RTC Program: Year
- RTC Program: Month
- RTC Program: Day of Month
- RTC Program: Hours
- RTC Program: Minutes
- RTC Program: Seconds
- RTC Program: Milliseconds

Procedure to Check the Current Date and Time

1. Wire the processor variables. Refer to the topic "Wire Processor Variables".
2. Build and download the program or perform an on-line update.
3. Check the current date and time settings:
   - Enter Debug mode
   - Request IXL Restricted Access
   - Force the RTC Read Boolean and all the time fields in the RTC Control Rack Variables to TRUE

> **IMPORTANT**   Do not force the RTC Write Boolean at this point.

   - The RTC Status Variables will show the current date and time in the processor

Procedure to Set the Date and Time

1. Unlock the RTC Read variable so it turns FALSE.
2. Select each RTC Program Rack variable and enter the date and time values.
3. Toggle the RTC Write variable TRUE then FALSE to write the new date and time setting to the processor.
4. Lock and force the RTC Read variable to TRUE.
5. The RTC Status rack now displays the new date and time of the processor.
6. Unlock all the RTC Control variables.

Install I/O Modules

Do the following:

- Before inserting a new I/O module, examine it for damage.
- The identification labels on the sides of the I/O module will be hidden when the module is installed. Therefore before installation write down the location of the module and the details shown on the label.

Installation

1. Examine the coding pegs on the termination assembly and make sure that they complement the sockets on the rear of the new I/O module.
2. Place the I/O module on to the dowel pins on the T9300 I/O base unit. Make sure the slot on the head of the module clamp screw is vertical and then push the module home until the module connectors are fully mated with the I/O base unit and termination assembly connectors.
3. The locking screw requires a quarter turn clockwise to lock. Use a broad (9mm) flat blade screwdriver to lock the clamp screw. The locking screw acts as a power interlock device and must be in the locked position when power is applied otherwise the module will not be configured.

Install T9310 Expansion Cables

Use T9310 expansion cables to connect additional groups of T9300 I/O base units.

The ferrites supplied with the expansion cable are snap on components. Fit the ferrites 50 mm (2 in.) from each end and secure with cable ties either side of the ferrites.

Item	Description
1	SCSI-3 Cable
2	Ferrite
3	Cable-Tie
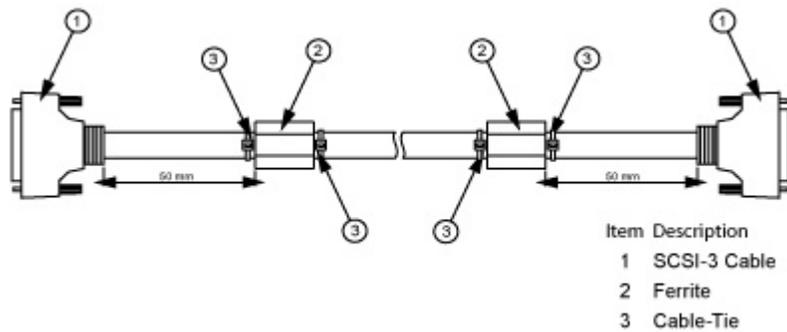
Connect Expansion Cable between T9100 Base Unit and T9300 I/O Base unit (I/O Bus2)

Extending from Left Hand side

Extending from Right Hand side

9100

Item	Description
1	M3 Socket Cap Screw
2	Cable Plug Assembly
3	Cable Socket Assembly
4	M3 Nut
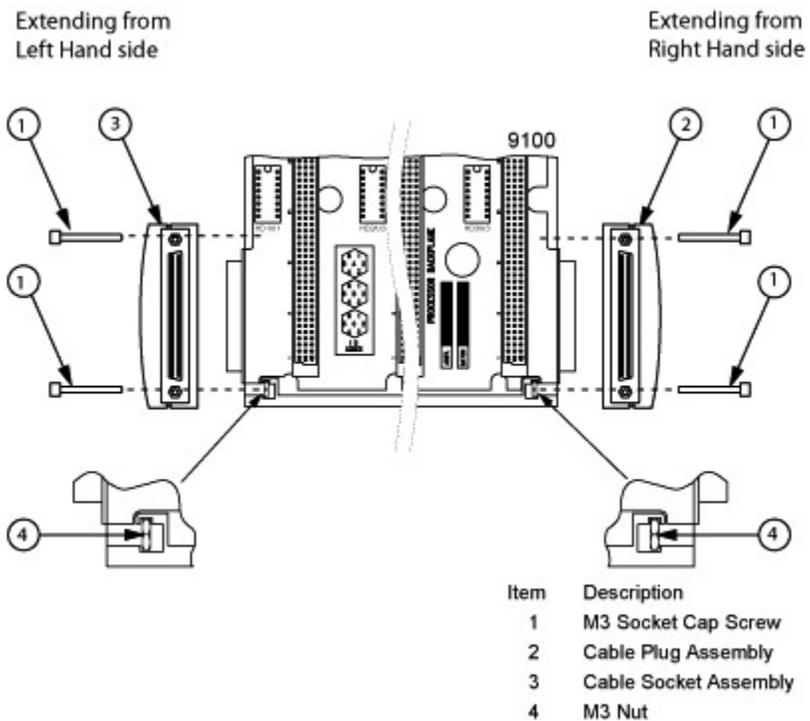
1. Connect the expansion cable to a T9100 processor base unit for an I/O Bus 2 connection.
   - Insert a cable socket assembly into the left hand connector of the T9100 processor base unit.
   - Secure the socket assembly by inserting the two M3 socket cap screws.
   - Tighten the screws with a 2.5 mm Allen key.
   - Install the cable to the socket assembly and tighten the retaining screws by hand.

2. Insert the free end of the expansion cable into a right hand socket of a T9300 I/O base unit.
   - Insert a cable plug assembly into the right hand socket of the processor or I/O base unit.
   - Secure the plug assembly by inserting the two M3 socket cap screws.
   - Tighten the screws with a 2.5 mm Allen key.
   - Install the cable to the plug assembly and tighten the retaining screws by hand.

Connect Between a T9300 I/O Base Unit and a T9300 I/O Base Unit
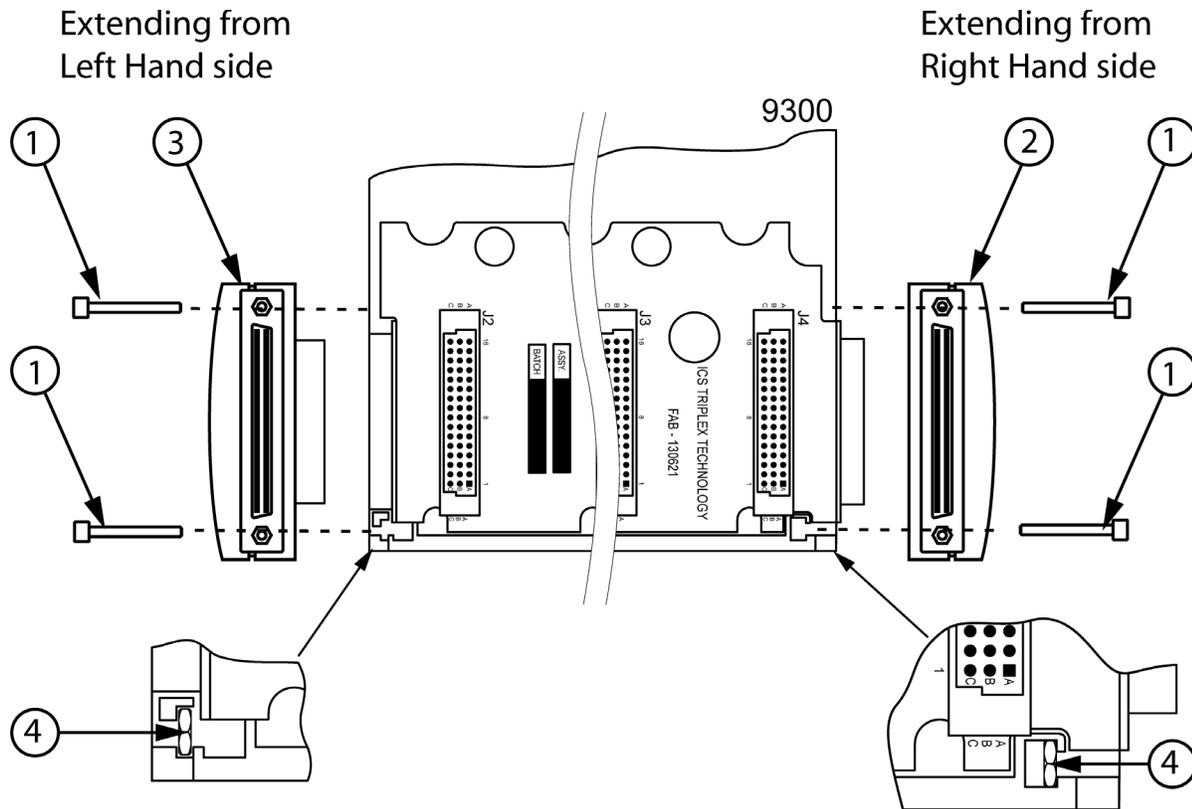
Extending from
Left Hand side

Extending from
Right Hand side

Item	Description
1	M3 Socket Cap Screw
2	Cable Plug Assembly
3	Cable Socket Assembly
4	M3 Nut

1. Connect the expansion cable between a T9100 processor base unit (or a T9300 I/O Base unit) to a T9300 I/O base unit.
   - Insert a cable plug assembly into the right hand socket of the processor or I/O base unit.
   - Secure the plug assembly by inserting the two M3 socket cap screws.
   - Tighten the screws with a 2.5 mm Allen key.
   - Install the cable to the plug assembly and tighten the retaining screws by hand.

2. Connect the free end of the expansion cable to the left hand plug of an I/O base unit using a cable socket assembly.
   - Insert a cable socket assembly into the left hand connector of the T9300 processor base unit.
   - Secure the socket assembly by inserting the two M3 socket cap screws.
   - Tighten the screws with a 2.5 mm Allen key.
   - Install the cable to the socket assembly and tighten the retaining screws by hand.

Fault Reporting Reference Information

Each module has a set of front panel status indicators. The function and meaning of these indicators related to each module is as follows:

Status Indicators on the T94xx Series Input and Output Module

Table 10 - Status Indicators on the T94xx Series Input and Output Module

Indicator	Status	Description
	GREEN	No module faults present.
	RED	The module has one or more faults. • The Healthy indicator can turn RED immediately after power is applied to the module, before then turning GREEN • If Healthy is GREEN and the Ready and Run are RED then the module is said to be in its "shutdown state" refer to the Troubleshooting Manual - Chapter 3 for more information on the shutdown state.
Ready	OFF	No power or module is unlocked.
	GREEN	Locked and prepared to report channel values.
	RED	Locked but not prepared to report channel values.
Run	OFF	No power or module is unlocked.
	GREEN	Module is on-line and supplying data to/receiving data from application
	AMBER	Module is inserted into a running system but not on-line. Push the Fault Reset button on any processor module to set the module to go on-line.
	RED	Module is prepared to go on-line but no application is running.
Channel 1 - 8	OFF	Input module: field switch is open. Output module: output is in its de-energized condition. **Note:** If the run indicator is not green (the module is not reporting channel values), all channel indicators will be off.
	GREEN	Input module: input is on. Output module: output is in its energized condition.
	AMBER	Field fault.
	RED	Channel fault.

Status Indicators on the T9110 Processor Module

Table 11 - Status Indicators on the T9110 Processor Module

Indicator	Status	Description
Healthy	OFF	No power.
	RED	• Flashes RED briefly after being installed as the module is booting up • Continuous RED means a Module has a fault.
	GREEN	As the module boots up it goes GREEN, this lasts for 10 to 20 seconds. When the module is operational the LED stays GREEN. When in the recovery mode and no faults are present the LED is GREEN. Fault Indications: • If Healthy is GREEN and all the other indicators on the module are OFF then the module has failed to boot up. • If Healthy is GREEN and Ready and Run are RED then the module is in its shutdown state.

Table 11 - Status Indicators on the T9110 Processor Module

Indicator	Status	Description
Ready	OFF	No power or Module is in Recovery Mode (Recovery Mode versions 1.020.x and after with Update of I/O modules feature enabled).
	RED	• Module is booting up (10 to 20 seconds) or not educated or synchronized with partners. • Module is in the shutdown state.
	Flashing GREEN	The module is being educated or synchronized.
	GREEN	Module is educated and synchronized with partners.
	AMBER	Module is in Recovery Mode (Recovery Mode versions before 1.020.x)
Run	OFF	No power and stays off while the module is booting up (10 to 20 seconds) or Module is in Recovery Mode (Recovery Mode versions before 1.020.x)
	RED	• Module is not educated/synchronized; No application loaded; the processor module is in the Recovery Mode and the base level firmware is running. • Module is in the shutdown state.
	GREEN	The module contains an application and it is running.
	AMBER	Module is in Recovery Mode (Recovery Mode versions before 1.020.x)
System Healthy	OFF	No power and stays off while the module is booting up (10 to 20 seconds).
	RED	There is a fault on one or more modules. or The application has stopped because the module has entered Recovery Mode.
	GREEN	No system or module faults present or The system is in Recovery Mode.
Force	OFF	No power and stays off while the module is booting up (10 to 20 seconds)
	GREEN	No variables are being locked/forced
	AMBER	Module is in the Recovery Mode. or An operating controller has at least one variable being locked/forced.
Aux	OFF	No power and stays off while the module is booting up (10 to 20 seconds), or under application control.
	GREEN	The module is under application control.
	AMBER	Module is under application control. or The module is in the Recovery Mode.
Serial 1 and 2	OFF	No power and stays off while the module is booting up (10 to 20 seconds).
	RED	Serial port pulse stretched Tx.
	GREEN	Serial port pulse stretched Rx.
	AMBER	Quickly alternating Tx and Rx activity.
Ethernet 1 and 2	OFF	No power and stays off while the module is booting up (10 to 20 seconds)
	GREEN	Ethernet link present
	AMBER	Tx or Rx activity on Ethernet Port

System Startup

This chapter describes a structured approach to the startup of a controller system.

When the checks, module installation, and startup is completed successfully, Configure the system using the AADvance® Workbench software or AADvance®-Trusted® SIS Workstation software, and then carry out Functional Acceptance Testing.

Refer to the applicable software publication for setup and configuration procedures:

- 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

Recommendations to Manage Test Documentation

It is important that the system is documented when it is installed and this documentation is maintained throughout the testing process system.

1. Obtain these items of documentation:
   - I/O wiring database with checklist.
   - Complete set of drawings.
   - Bill of materials.
2. Ensure that each item of documentation is the latest issue.
   - Mark each item as 'Test Copy'.
3. Create a system activity log book and ensure the log book accompanies the system into test.
   - Allocate an entry number for each **test** and record each test against its number in the log book.
   - If, during functional tests, the system does not behave as expected, record the problem in the log book. Allocate a new entry and fault number for each problem.

System Physical Design Check

Assess the physical design of the system to determine whether it is ready to be tested. Do the following:

- Verify there is physical segregation of any mains supply circuits from the 24 Vdc controller circuits.
- Review the arrangements of terminals and the provision of cable entries for field wiring.

• Evaluate the ease of access for maintenance activities.

Procedure to Verify Build State

Assess the build state of the system against the test documentation. Do the following:

• Compare the arrangement of the system with the General Arrangement drawings to make sure the system has been manufactured and assembled correctly.
• Verify that every item shown in the bill of materials on the General Arrangement drawings is either in place or is available to be installed.
• Check that any special features, configurations or options called for on the drawings are present and correct.
• Check nameplates and identification labels against the drawings.

Identify any non-conformance found between the system and the drawings. If appropriate, correct the drawing. Record each non-conformance in the log book.

Procedure to Conduct the Mechanical Inspection

Carry out a mechanical inspection to verify that an acceptable standard of workmanship has been achieved in the assembly and wiring and that the test arrangements are correct. Do the following:

• Visually inspect the controller and verify that base units, modules and terminals are free of damage.
• Review the termination of system cabling against the drawing

Procedure to Check Ground Bonding

> **SHOCK HAZARD:** Connect the AC safety busbar to the building earth (ground) before doing electrical testing or applying power to the system. Failure to follow these instructions can cause injury to persons.

> **RISQUE D'ÉLECTROCUTION:** Connectez la barre omnibus de sécurité C.A. à la mise à la terre du bâtiment (sol) avant d'effectuer des essais électriques ou d'appliquer l'alimentation au système. Le non-respect de ces instructions peut causer des blessures aux personnes.

• Check that the ground continuity does not exceed 0.2 Ω.
• Check that the isolation between grounds is 10M Ω.

Procedure to Check Power Distribution Integrity

> **IMPORTANT**   Before you begin this task, you must have checked the ground bonding.

> **IMPORTANT**   Avant de commencer cette tâche, vous devez avoir vérifié la connexion avec la mise à terre.

Check the integrity of the power distribution system to verify that each power distribution sub-section is wired in accordance with the drawings and that the subsections are isolated from each other. Do the following:

1. Make sure all power sources are isolated.
2. Switch off all circuit breakers and open distribution fuses.
3. Remove all modules from the controller.
4. Check that the circuit breakers and fuses of the correct capacity and

rating are installed in the correct locations.

5.   Check that all subsections are isolated from each other.

Power Distribution and First Power Up

> **NOTE**   Before you begin this task, you must have checked the power distribution integrity.

> **Remarque** Avant que vous commenciez cette tâche, vous devez avoir vérifié l'intégrité du réseau de distribution électrique.

The power distribution and first power up verifies that the power distribution circuits function as designed and as detailed in the drawings. It shows the correct voltages are appearing, and only in the correct places. It also provides an opportunity to verify correct operation of any power indicators outside the controller itself.

Do the following:

1. Make sure all modules are removed.
2. Trip all circuit breakers and disengage all power distribution fuses and field fuses.
3. Apply power to the incoming power terminals.
4. It is good practice to switch on power supplies to field devices before supplies to the controller. Devise a formal sequence in which to switch on individual circuits.
    *   In sequence, check each circuit breaker or fuse for zero volts on the destination side, and then close the circuit breaker or fuse and verify that the appropriate voltage appears.
    *   Check that any associated power indicator is lit.
    *   As each circuit breaker is tested, leave the breaker in the 'on' position so that any unwanted connection between different power circuits can be detected.
5. Trip and re-instate each circuit breaker in turn and verify the correct circuits are isolated and restored. Similarly disengage and replace each fuse and verify the associated circuits.
6. At the same time verify correct operation of any power indicators supplied with the system.

Startup Process

Once the procedures for power distribution tests have been successfully completed, the controller is ready for installation of its modules and its second power up. The installation process should be completed in the following order:

1. Switch off power to the controller — both field power and controller power sources.
2. Make a record of the module and base unit serial numbers for future reference.
3. Reinstate the power.
4. Install the modules in the following sequence.
5. Install the **program enable key** to the connector labeled **KEY** on the processor base unit.
6. Install the first Processor module.

- Refer to the Processor Module startup process.

7. Install the second or the third processor module (if required).

- Refer to the Processor Module startup process.

8. Install the I/O modules.

- Refer to the I/O Module startup process.

9. Check system status indications show the system is on-line and operating as expected.

System Configuration and Application Programming

When the hardware is installed and running, set up the system configuration by using the AADvance Workbench software or AADvance-Trusted SIS Workstation software.

Refer to the applicable software publication for system configuration instructions:

- 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

Processor Module Startup Process

NOTE	When inserting more than one processor module they MUST be inserted one at a time and the module be allowed to educate (in the case of a 2nd and 3rd processor).

Table 12 - Single Processor Module Installation Procedure (New Processor Module)

Step	Task	
1.	With the power switched on place the processor module into slot A on the Base Unit connectors and push the module home until the connectors are fully mated. Turn the locking screw and lock the module in position.	
2.	All LEDs are off and after applying power the processor will show the following status indications:	
	Healthy	Flashes RED for a second then goes GREEN as the module boots up (10-20 seconds)
	Ready	Will stay OFF as the module boots up (10 to 20 seconds) then goes RED
	Run	Will stay OFF as the Module boots up (10 to 20 seconds) then goes RED
	System Healthy	Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN
	Force	Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated.
	Aux	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection.
	Serial 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection
	Serial 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection
	Ethernet 1	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection
	Ethernet 2	Will stay OFF as the Module boots up (10 to 20 seconds) then depends on data connection

Table 12 - Single Processor Module Installation Procedure (New Processor Module)

Step	Task	
	Install a Program Enable Key. Download a correct application and push the FAULT RESET button. When a valid application is downloaded the module shows the following indications:	
		Valid application downloaded
	Healthy	GREEN
	Ready	GREEN
	Run	RED to GREEN (Flashes GREEN as the module educates)
3.	System Healthy	GREEN
	Force	GREEN
	Aux	Off (Depends on application)
	Serial 1	Depends on data connection
	Serial 2	Depends on data connection
	Ethernet 1	Depends on data connection
	Ethernet 2	Depends on data connection

Procedure for Installation of a Second and Third Processor

The second and third processor modules must have the same firmware version as the first processor. If the firmware revision is different upgrade the firmware using the ControlFLASH™ utility.

IMPORTANT	When inserting a second and third processor module they MUST be inserted one at a time and allowed to educate before inserting the next one.

Table 13 - Procedure for Installation of a Second and Third Processor

Step	Task	
	Place the processor module on slot B on the Processor Base Unit connectors and push the module home until the connectors are fully mated. Turn the locking screw with a flat bladed screwdriver and lock the module in position. All the Module LEDs are OFF until the module is installed. As soon as the module receives power it will boot up then educate and show the following indications:	
	Healthy	Flashes RED for a second then goes GREEN as the module boots up (10 to 20 seconds)
	Ready	Will stay OFF as the module boots up (10 to -20 seconds) then goes RED for 10 seconds then flashes GREEN as it educates and lastly it goes to steady GREEN
	Run	Will stay OFF as the module boots up (10 to 20 seconds) then goes RED until educated and then it goes AMBER
	System Healthy	Will stay OFF as the Module boots up (10 to 20 seconds) then goes GREEN
1.	Force	Will stay OFF as the Module boots up (10 to 20 seconds) then stays OFF until the module has educated and the application is running
	Aux	Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Serial 1	Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Serial 2	Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Ethernet 1	Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	Ethernet 2	Will stay OFF as the Module boots up (10 to 20 seconds) then is depends on data connection
	When the Run indicator goes AMBER push the Fault Reset button and the processor will show the following indications:	
2.	Healthy	GREEN
	Ready	GREEN (will flash for a short time as the module educates)
	Run	AMBER to GREEN (AMBER as the module educates)
	System Healthy	GREEN

Table 13 - Procedure for Installation of a Second and Third Processor

Step	Task	
	Force	Off to GREEN
	Aux	Depends on application
	Serial 1	Depends on data Connection
	Serial 2	Depends on data Connection
	Ethernet 1	Depends on data Connection
3.	To insert a 3rd processor module repeat step 1 and insert in slot C.	

I/O Module Startup Process

The startup sequence is different when a module is installed into an on-line system that is running compared to installing the module into a system that is off-line and has processor modules but no I/O modules installed.

Table 14 - Single Module or First Module of a group Installation Procedure

Step	Task	
1.	This procedure applies to a single module installation or the first module of a redundant group installation.	
2	Install the I/O module and turn the locking screw to the lock position.	
3.	The input module will show the following status indications:	
	Healthy	GREEN
	Ready	RED
	Run	RED
	Channel 1 – 8	Off
4.	The input module will follow its startup sequence and the module will educate.	
5.	After approximately 3 seconds the module will now show the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	AMBER
	Channel 1 – 8	Off
6.	Push the Fault Reset button on the processor module and the Run indication goes GREEN.	
7.	The module will now be on-line with the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	GREEN
	Channel 1 – 8	Dependent on channel status
8.	If the module fails to educate (and go on-line) replace the module.	

Table 15 - Second or third Module of a Group Installation Procedure

Step	Task	
1.	This procedure applies to a second or third module of a redundant group installation.	
2	Install the Input/Output Module and turn the locking screw to the lock position.	
3.	The module will provide the following status indications:	
	Healthy	GREEN
	Ready	RED
	Run	RED
	Channel 1 – 8	Off
4.	The input module will follow its startup sequence and the module will educate.	

Table 15 - Second or third Module of a Group Installation Procedure

Step	Task	
5.	After approximately 3 seconds the module will now make the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	AMBER
	Channel 1 – 8	Off
6.	Push the Fault Reset button on the processor module and the Run indication goes GREEN.	
7.	The module will now be on-line with the following status indications:	
	Healthy	GREEN
	Ready	GREEN
	Run	GREEN
	Channel 1 – 8	Dependent on channel status
8.	If the module fails to educate and go on-line replace the module.	

Processor Firmware Upgrades

The firmware revision in the processor modules can be checked using RSLinx® RSWho. If the firmware needs to be upgraded, this can be done using ControlFLASH.

Required software:
- **ControlFLASH version 13 or later**
- RSLinx Classic Lite version 3.90.00 or later

Required ControlFLASH files for the T9110 Processor Module:
- T9110 Normal Mode ControlFLASH.
- T9110 Recovery Mode ControlFLASH.

The processor module contains two sets of firmware. The normal firmware is the operational firmware and allows the application to execute and communicates with the I/O modules. The recovery firmware is used to update the firmware in the processor module and help diagnose problems. The normal and recovery firmware are updated with separate ControlFLASH files.

Before starting check that:
- ControlFLASH and RSLinx® Gateway has been installed and configured
- The PC is connected via Ethernet to the processor module
- The correct ControlFLASH file for the processor module has been installed
- The processor modules are in recovery mode - restart the modules and press the Fault Reset button, hold until the Aux LED changes to amber

Dual and triple processor modules are updated at the same time.

Update procedure:
- Run the ControlFLASH program
- Select the T9110 module from the list
- Browse to the T9110 module and select it
- Select the version of firmware to be sent to the module
- Update the module

- The firmware will be downloaded and stored on the module - this take 5 to 10 minutes
- ControlFLASH will report the success or failure of the update.

Refer to document <u>1756-UM105</u> ControlFLASH Firmware Upgrade Kit User Manual in the Literature Library for detailed instructions for using ControlFLASH.

Setting the Controller IP Address for Communications

The AADvance system uses Internet Protocol (IP) to carry communications between the controller and the AADvance Workbench software or AADvance-Trusted SIS Workstation software. This chapter shows you how to set up the IP address in the controller. It is convenient to set up the controller resource number at the same time.

Controller IP Address

The AADvance controller stores its IP address data in non-volatile memory in the T9100 processor base unit. The data is independent of the T9110 processor modules in the controller, and so the controller keeps the address information when you remove a processor module.

You must set up the IP address data when you create a new system, or if you fit a new processor base unit.

After having set up the IP address data in the controller, you can configure the AADvance Workbench software or AADvance-Trusted SIS Workstation software to find the controller on the network.

Troubleshooting AADvance Discover Communications

This procedure describes how to activate communications using the AADvance Discover tool. After completing the steps, refresh the AADvance Discover tool's list of modules to test for communications.

1. Ensure that the Ethernet cable is plugged into a socket above a fitted AADvance controller – communications will not 'pass through' unused slots.
2. Ensure that the controller is activated by turning the locking bar. Wait for the Ready LED to go green before refreshing the AADvance Discover tool. (The communications tasks are not active until it is 'Ready').
3. Do not use an office network. Use an isolated hub or switch between the computer and AADvance controller. Check that the hub/switch has LEDs lit for the ports to both computer and controller, showing that the ports are working.
4. Open the **Network Connections** window. Open the **Properties** of the computer's network adapter (as used for configuring AADvance). Un-tick all protocol "**items**" which are not immediately necessary, especially "**Check Point SecuRemote**" and "**iPass Protocol**" (if present). You will need to leave "**Internet Protocol**" (or) "**IPv4**" and "**IPv6**", "**Client for Microsoft Networks**", "**File and Printer Sharing**" and "**Network Monitor Driver**" (if present) for normal Windows operation.
5. Disable the **Windows Firewall**, or any **third-party firewalls and shields.**
6. If using a laptop, disable **Wireless**. If there are multiple network connections, disable **the connections not being used**. The AADvance

Discover tool does not discover controllers if there are multiple network connections enabled.

Configure the Controller Resource Number in the Controller

When assembling a new AADvance controller (or install a new T9100 processor base unit) you have to configure the resource number stored in the controller. The resource number is a type of device address, and it must also be configured in the application.

The procedure to configure the resource number uses the AADvance Discover utility. To set the resource number do the following:

1. Write down the controller's MAC address (Controller ID) displayed on a label on the processor base unit. Install at least one T9110 processor module into the processor base unit.

2. Make sure the program enable key is inserted in the KEY connector on the processor base unit.

3. Start the AADvance Discover tool from the Start menu:

   The AADvance Discover utility scans the network for controllers and creates a list.

4. Locate the **controller** in the list and make sure that the status of the controller is **Configurable**.

5. Double-click the **MAC address** in the Controller ID field.

   • The resource and IP Address dialog box is displayed.

6. Enter the **resource value** into the Resource Number field, then click
    Apply.
    *   Returning to the main window of the utility, the controller status will
        show Pending Restart.
7. To finish the update, turn off the power to the controller.
8. Start the controller. Refresh the screen to make sure that the new
    resource number is shown in the resource field and that the controller
    status is configurable.

> **IMPORTANT**   The Resource Number must also be configured in the application
> in the Resource Properties.

Configure the IP Address in the Controller

When you assemble a new AADvance controller, or install a new T9100
processor base unit, you have to configure the IP Address stored in the
controller.

The procedure to configure the IP Address uses the AADvance Discover utility.
Changes occur immediately and you do not have to start the controller again.
To set the IP Address do the following:

1. Write down the controller's MAC address (the Controller ID) displayed on a label on the processor base unit. Install at least one T9110 processor module into the processor base unit.

2. Make sure the program enable key is inserted in the KEY connector on the processor base unit.

3. Start the AADvance Discover tool from the Start menu:

   • The AADvance Discover utility scans the network for controllers, and creates a list.

   • It can also be launched from within the AADvance Workbench software or AADvance-Trusted SIS Workstation software from the **View** menu.

4. Locate the **controller** in the list and make sure that the status of the controller is Configurable.

5. Double-click on the **MAC address** in the Controller ID field.

   • The resource and IP address dialog box is displayed.

6. Enter the **IP Address and Subnet Mask** into the fields for each Ethernet port.

7. Enter the **Gateway values** for each processor module, then click **Apply**.

   • Returning to the main window of the utility, the controller status will shows In Progress and then Configurable.

- The controller uses the new settings.

Functional Acceptance Testing

Functional acceptance testing, also known as factory acceptance testing or integration testing, tests the controller and its application software to make sure that it satisfies the requirements specified in the requirements for the integrated system. If the controller is applied to a safety related application then the safety requirements are also tested.

Devising tests for Functional Acceptance

The tests performed during functional acceptance testing must include the following:

- Performance tests, including timing, reliability and availability, integrity, and safety requirements and constraints.
- Interface testing.

Write down the test cases and define the pass criteria for every test. Make sure that the test cases allow for the associated systems and their interfaces which the system needs to communicate with.

If a requirement cannot be physically demonstrated, devise a written analysis to show how the system achieves the requirement.

The AADvance® controller has been tested to the limits given in its module specifications. If appropriate, do the following:

- Environmental tests, including electromagnetic compatibility, life- and stress-testing.
- Testing in degraded modes and fault modes.
- Exception testing.

Test Environment for Functional Acceptance

It is recommended that the testing is done in a factory environment, before installing and commissioning at the plant.

Managing Functional Acceptance Testing

Define the person or authority which will be responsible for doing each test and also the person or authority (such as the customer or their representative) who will witness each test.

Testing must be done on a known version of the controller. Record the type, serial number and physical location of each module so that the system can be dismantled, shipped and built with the modules in the same locations.

Review and finalize the technical manuals which have been prepared for the maintenance and operation of the system.

Dismantling the AADvance System

About Dismantling a System

Dismantling

Dismantling is the opposite of the system assembly procedure.

Disposal

It is necessary to make a plan for the collection, treatment, recovery and environmentally sound disposal of the equipment at the end of its life. Contact Rockwell Automation to discuss the applicable way to do this.

Re-use

Before disposing of serviceable items, contact Rockwell Automation and find out if it is possible to return unwanted items for possible future reconditioning.

Notes:

Parts List

Base Units

Part No.	Part Description
T9100	Processor base unit
T9300	I/O base unit (3 way)

Modules

Part No.	Part Description
T9110	Processor module
T9401	Digital input module, 24 Vdc, 8 channel, isolated
T9402	Digital input module, 24 Vdc, 16 channel, isolated
T9451	Digital output module, 24 Vdc, 8 channel, isolated, commoned
T9431	Analogue input module, 8 channel, isolated
T9432	Analogue input module, 16 channel, isolated
T9481	Analogue output module, 3 channel, isolated
T9482	Analogue output module, 8 channel, isolated

Special Application Modules

Part No.	Part Description
T9441	Frequency Input Module (Product not yet released. Contact Sales for more information)

Termination Assemblies

Part No.	Part Description
T9801	Digital input TA, 16 channel, simplex, commoned
T9802	Digital input TA, 16 channel, dual
T9803	Digital input TA, 16 channel, TMR
T9831	Analogue input TA, 16 channel, simplex, commoned
T9832	Analogue input TA, 16 channel, dual
T9833	Analogue input TA, 16 channel, TMR
T9851	Digital output TA, 24Vdc, 8 channel, simplex, commoned
T9852	Digital output TA, 24Vdc, 8 channel, dual
T9881	Analogue output TA, 8 channel, simplex commoned

Part No.	Part Description
T9882	Analogue output TA, 8 channel, dual
T9844	Frequency Input Module TA, Simplex, Active (not yet released)
T9845	Frequency Input Module TA, Dual, Active (not yet released)
T9846	Frequency Input Module TA, TMR, Active (not yet released)
T9847	Frequency Input Module TA, Simplex, Passive (not yet released)
T9848	Frequency Input Module TA, Dual, Passive (not yet released)
T9849	Frequency Input Module TA, TMR, Passive (not yet released)

Expansion Cable Assembly

Expansion cable assembly, comprising expansion cable and two adapters

Part No.	Part Description
T9310-02	Backplane expansion cable, 2 meter

Blanking Covers

Part No.	Part Description
T9191	Blanking cover (tall) for I/O positions with no TA fitted
T9193	Blanking cover (short) for I/O positions with TA or a Processor

Spares and Tools

Part No.	Part Description
T9901	Replacement input fuse 50 mA for T9801/2/3 and T9831/2/3, pack of 20 [1]
T9902	Replacement output fuse 10A for T9851/2, pack of 20 [2]
T9903	Replacement coding pegs (pack of 20)
T9904	Replacement backplane clips (pack of 20)
T9905	Replacement processor 3 V lithium cell, pack of 20 [3]
T9906	Replacement program enable key
T9907	Installation tool kit
T9908	Fuse Extractor Tool

[1]   T9901: No 396/TE5 50 mA time lag fuse; UL 248-14, 125 V, Leadfree; manufactured by Littelfuse.

[2]   T9902: SMF Omni-Block, Surface Mount Fuse Block 154 010, with a 10 A, 125 V Fast Acting Fuse, Littelfuse.

[3]   T9905: Polycarbon monofluoride Lithium Coin Battery, BR2032, 20 mm dia; Nominal voltage 3 V; Nominal capacity (mAh) 190; Continuous standard load (mA) 0.03; Operating temperature -30 °C to +80 °C, supplied by Panasonic.

Software

Part No.	Part Description
T9082U	IEC 61131 Workbench, USB key, single user, single controller
T9082D	IEC 61131 Workbench, hard disk key, single user, single controller
T9083U	IEC 61131 Workbench, USB key, multiple controllers
T9083D	IEC 61131 Workbench, hard disk key, multiple controllers
T9084U	IEC 61131 Workbench, 5 user USB key, multiple controllers

Part No.	Part Description
T9087	IEC 61131 Workbench 2
T9090	AADvance®-Trusted® SIS Workstation software AADvance® license
T9030	OPC portal server
T9033	AADvance DTM (for use with HART Pass-Through feature)

Demonstration Unit

Part No.	Part Description
T9141	AADvance Demonstration Unit (Including HMI)

Miscellaneous Items

Part No.	Part Description

Notes:

History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

ICSTT-RM448N-EN-P, September 2024

Change
Updated for AADvance® system release 2.011 TÜV Rheinland certification.
Applied latest publication template.
Added French translations where necessary.
Added new terms to the glossary.
Changed the image in Module Label section.
Added changes related to the Installation Requirements for Hazardous Environment.

ICSTT-RM448M-EN-P, February 2021

Change
Updated for AADvance® system release 1.40 TÜV Rheinland certification.
Applied latest publication template.
Changed *workstation* to *computer*.
Added AADvance®-Trusted® SIS Workstation software information where applicable.
Changed *Workbench* to *software* where applicable.
Changed *Workbench* to *AADvance Workbench software* where applicable.
Added reference to AADvance-Trusted SIS Workstation Software User Guide, publication ICSTT-UM002.
Updated AADvance system release and software information in the AADvance Release section.
Added IMPORTANT and ATTENTION tables with information on supported languages in the The AADvance Safety Controller section.
Removed information indicating that AADvance processor modules are designed to meet the requirements for SIL 2 in a simplex configuration in Safety Features section.
Removed footnote on Minimum cycle time overhead in the Scan Times section.
Changed The AADvance Workbench and Software Development Environment section to The AADvance Software Development Environment. Updated section content.
Updated reference to the Product Compatibility and Download Center (PCDC) in the Operating Systems section.
Updated supported file formats in the Importing and Exporting Data section.
Updated section. title and content. Added links to software publications in the Software Licenses section.
Updated table in the Ethernet Communication Protocols section.
Added IMPORTANT and ATTENTION tables with information on supported languages in the Programming Language Support section.
Updated reference to the Product Compatibility and Download Center (PCDC) in the Specify software requirements section.
Updated security steps in the System Security section.
Updated suggested range of values in the Digital Input Field Loop Circuits section.

Removed row for T9085. Added row for T9090, removed rows for T9901...T9906, in the Software section.

Removed **NFPA 87** from Glossary.

Updated definition for **proof test** in Glossary.

ICSTT-RM448L-EN-P, July 2019

Change
Updated for Release 1.34 IEC 61508 Edition 2.0 certification

ICSTT-RM448K-EN-P, November 2018

Change
Updates to catalog numbers, ATEX and IECEx UL certificates, and module label

ICSTT-RM448J-EN-P, April 2018

Change
Update for AADvance Release 1.40

Issue 11, May 2015

Change
Correct Documentation Feedback URL and Issue Record

Issue 10, March 2015

Change
Updates for Release 1.34.

Issue 09, May 2014

Change
Updates for UL ATEX/IECEx Certification and T9892 information.

Issue 08, July 2012

Change
Updates for release 1.3 and 1.31

Issue 07, August 2011

Change
Updated for UL Requirements

Issue 06, March 2011

Change
Updated for Release 1.2

Issue 05, October 2010

Change
Updates for UL Certification

Issue 04, July 2010

Change
Update for Release 1.1.1

Issue 03, November 2009

Change
Update for Release 1.1

Issue 02, February 2009

Change
Update for Product Titles

Issue 01, April 2008

Change
First Issue

Notes:

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1.

A

accuracy The degree of conformity of a measure to a standard or a true value. See also 'resolution'.

achievable safe state A safe state that is achievable.

NOTE	Sometimes, a safe state cannot be achieved. An example is a non-recoverable fault such as a voting element with a shorted switch and no means to bypass the effect of the short.

actuator A device which cause an electrical, mechanical or pneumatic action to occur when required within a plant component. Examples are valves and pumps.

AITA Analogue input termination assembly.

alarms and events (AE) An OPC data type that provides time stamped alarm and event notifications.

allotted process safety time The portion of the total process safety time allotted to a sub function of that process.

application software Software specific to the user application, typically using logic sequences, limits and expressions to read inputs, make decisions and control outputs to suit the requirements of the system for functional safety.

architecture Organizational structure of a computing system which describes the functional relationship between board level, device level and system level components.

asynchronous A data communications term describing a serial transmission protocol. A start signal is sent before each byte or character and a stop signal is sent after each byte or character. An example is ASCII over RS-232-C. See also 'RS-232-C, RS-422, RS-485'.

availability The probability that a system will be able to carry out its designated function when required for use — normally expressed as a percentage.

B

backplane clip A sprung, plastic device to hold together two adjacent AADvance® base units. Part number T9904. Used in pairs.

base unit One of two designs which form the supporting parts of an AADvance controller. See 'I/O base unit' and 'processor base unit'.

bindings Bindings describe a "relationship" between variables in different AADvance controllers. Once a variable is "bound" to another variable, a unique and strong relationships is created between the two variables and the SIL 3 Certified SNCP protocol is used to verify that the consuming variable is updated with the data from the producing variable.

black channel A communication path whose layer (i.e. cabling, connections, media converters, routers/switches and associated firmware/software, etc.) has no requirement to maintain the integrity of safety critical data transferred over it. Measures to detect and compensate for any errors introduced into the black channel must be implemented by the safety critical sender and receiver (by software and/or hardware means) to make sure the data retains its integrity.

blanking cover A plastic moulding to hide an unused slot in an AADvance base unit.

boolean A type of variable that can accept only the values 'true' and 'false'.

BPCS Basic process control system. A system which responds to input signals and generates output signals causing a process and associated equipment to operate in a desired manner, but which does not perform any safety instrumented functions with a claimed safety integrity level of 1 or higher.

Refer to IEC 61511 or to ANSI/ISA−84.00.01−2004 Part 1 (IEC 61511-1 Mod) for a formal definition.

Equivalent to the Process Control System (PCS) defined by IEC 61508.

breakdown voltage The maximum voltage (AC or DC) that can be continuously applied between isolated circuits without a breakdown occurring.

BS EN 54 A standard for fire detection and fire alarm systems.

BS EN 60204 A standard for the electrical equipment of machines, which promotes the safety of persons and property, consistency of control response and ease of maintenance.

bus A group of conductors which carry related data. Typically allocated to address, data and control functions in a microprocessor-based system.

bus arbitration A mechanism for deciding which device has control of a bus.

C

CIP Common Industrial Protocol. A communications protocol, formally known as 'CIP™ over Ethernet/IP™', created by Rockwell Automation for the Logix controller family, and which is also supported by the AADvance controller. AADvance controllers use the protocol to exchange data with Logix controllers. The data exchange uses a consumer/producer model.

clearance The shortest distance in air between two conductive parts.

coding peg A polarization key, fitted to the T9100 processor base unit and to each termination assembly, which verifies that only a module of the correct type may be fitted in a particular slot. Part number T9903.

coil In IEC 61131-3, a graphical component of a Ladder Diagram program, which represents the assignment of an output variable. In MODBUS language, a discrete output value.

Compiler Verification Tool (CVT) An automatic software utility that validates the output of the application compilation process.

configuration A grouping of all the application software and settings for a particular AADvance controller. The grouping must have a 'target', but for an AADvance controller it can have only one 'resource'.

consumer The consuming controller requests the tag from the producing controller.

contact A graphical component of a Ladder Diagram program, which represents the status of an input variable.

continuous mode Where the Safety Instrumented Function in the Safety System is continually maintaining the process in a safe state.

controller A logic solver; the combination of application execution engine and I/O hardware.

controller system One or more controllers, their power sources, communications networks and computers.

coverage The percentage of faults that will be detected by automated diagnostics. See also 'SFF'.

creepage distance The shortest distance along the surface of an insulating material between two conductive parts.

cross reference Information calculated by the AADvance® Workbench software or AADvance®-Trusted® SIS Workstation software relating to the dictionary of variables and where those variables are used in a project.

D

data access (DA) An OPC data type that provides real-time data from AADvance controllers to OPC clients.

de-energize to action A safety instrumented function circuit where the devices are energized under normal operation. Removal of power de-activates the field devices.

dictionary The set of internal input and output variables and defined words used in a program.

discrepancy A condition that exists if one or more of the elements disagree.

DITA Digital input termination assembly.

DOTA Digital output termination assembly.

E

element A set of input conditioning, application processing and output conditioning.

energize to action A safety instrumented function circuit where the outputs and devices are de-energized under normal operation. Application of power activates the field device.

EUC Equipment Under Control. The machinery, apparatus or plant used for manufacturing, process, transportation, medical or other activities.

expansion cable assembly A flexible interconnection carrying bus signals and power supplies between AADvance base units, available in a variety of lengths. Used in conjunction with a cable socket assembly (at the left hand side of a base unit) and a cable plug assembly (at the right hand side of a base unit).

F

fail operational state A state in which the fault has been masked. See 'fault tolerant'.

fail safe The capability to go to a pre-determined safe state in the event of a specific malfunction.

fault reset button The momentary action push switch located on the front panel of the T9110 processor module.

fault tolerance Built-in capability of a system to provide continued correct execution of its assigned function in the presence of a limited number of hardware and software faults.

fault tolerant The capability to accept the effect of a single arbitrary fault and continue correct operation.

fault warning receiving station A centre from which the necessary corrective measures can be initiated.

fault warning routing equipment Intermediate equipment which routes a fault warning signal from the control and indicating equipment to a fault warning receiving station.

field device Item of equipment connected to the field side of the I/O terminals. Such equipment includes field wiring, sensors, final control elements and those operator interface devices hard-wired to I/O terminals.

fire alarm device A component of a fire alarm system, not incorporated in the control and indicating equipment which is used to give a warning of fire — for example a sounder or visual indicator.

fire alarm receiving station A centre from which the necessary fire protection or fire fighting measures can be initiated at any time.

fire alarm routing equipment Intermediate equipment which routes an alarm signal from control and indicating equipment to a fire alarm receiving station.

function block diagram An IEC 61131 language that describes a function between input variables and output variables. Input and output variables are connected to blocks by connection lines. See 'limited variability language'.

functional safety The ability of a system to carry out the actions necessary to achieve or to maintain a safe state for the process and its associated equipment.

G

group A collection of two or three input modules (or two output modules), arranged together to provide enhanced availability for their respective input or output channels.

H

hand-held equipment Equipment which is intended to be held in one hand while being operated with the other hand.

HART HART (Highway Addressable Remote Transducer) is an open protocol for process control instrumentation. It combines digital signals with analogue signals to provide field device control and status information. The HART protocol also provides diagnostic data. (For more details of HART devices refer to the HART Application Guide, created by the HART Communication Foundation, and their detailed HART specifications. You can download documents from www.hartcomm.org.)

high demand mode Where the Safety Instrumented Function in the Safety System only performs its designed function on a demand, and the frequency of demands is greater than one per year.

hot swap See live insertion.

I

I/O base unit A backplane assembly which holds up to three I/O modules and their associated termination assembly or assemblies in an AADvance controller. Part number T9300. See 'I/O module' and 'termination assembly'.

I/O module A collation of interfaces for field sensors (inputs) or final elements (outputs), arranged in a self-contained and standardized physical form factor.

IEC 61000 A series of international standards giving test and measurement techniques for electromagnetic compatibility.

IEC 61131   An international standard defining programming languages, electrical parameters and environmental conditions for programmable logic controllers. Part 3, which is entitled 'Programming Languages', defines several limited variability languages.

IEC 61508   An international standard for functional safety, encompassing electrical, electronic and programmable electronic systems; hardware and software aspects.

IEC 61511   An international standard for functional safety and safety instrumented systems (SIS) for the process industry, encompassing electrical, electronic and programmable electronic systems, hardware and software aspects.

indicator   A device which can change its state to give information.

input (variable)   A value passed from an I/O module to the processor module.

instruction list   An IEC 61131 language, similar to the simple textual language of PLCs. See 'limited variability language'.

integer   A variable type defined by the IEC 61131 standard.

IXL   IXL stands for ISaGRAF® eXchange Layer. This is the communication protocol between ISaGRAF based components.

K

key connector   The receptacle on the AADvance controller for the program enable key. A 9-way 'D' type socket, located on the T9100 processor base unit.

L

ladder diagram   An IEC 61131 language composed of contact symbols representing logical equations and simple actions. The main function is to control outputs based on input conditions. See 'limited variability language'.

LAN   Local area network. A computer network covering a small physical area, characterised by a limited geographic range and lack of a need for leased telecommunication lines.

live insertion   The removal and then reinsertion of an electronic module into a system while the system remains powered. The assumption is that removal of the module and reinsertion will cause no electrical harm to the system. Also referred to as 'hot swap'.

low demand mode   Where the Safety Instrumented Function only performs its designed function on demand, and the frequency of demands is no greater than one per year.

M

manual call point   A component of a fire detection and fire alarm system which is used for the manual initiation of an alarm.

MODBUS   An industry standard communications protocol developed by Modicon. Used to communicate with external devices such as distributed control systems or operator interfaces.

MODBUS object   Represents the configuration settings for a MODBUS Master or for its associated slave links in the AADvance Workbench software or AADvance-Trusted SIS Workstation software. The settings include communication settings and messages.

module locking screw   The AADvance latch mechanism seen on the front panel of each module and operated by a broad, flat-blade screwdriver. Uses a cam action to lock to the processor base unit or I/O base unit.

N

NFPA 85   The Boiler and Combustion Systems Hazards Code. Applies to certain boilers, stokers, fuel systems, and steam generators. The purpose of this code is to contribute to operating safety and to help prevent uncontrolled fires, explosions, and implosions.

NFPA 86   A standard for Ovens and Furnaces. Provides the requirements for the prevention of fire and explosion hazards in associated with heat processing of materials in ovens, furnaces and related equipment.

O

on-line   The state of a controller that is executing the application software.

OPC   A series of standards specifications which support open connectivity in industrial automation.

output (variable)   A value passed from the processor module to an I/O module.

P

peer to peer   A Peer to Peer network consists of one or more Ethernet networks connecting together a series of AADvance and/or Trusted® controllers to enable application data to be passed between them.

pinging   In MODBUS communications, sending the diagnostic Query Data command over a link and by receiving a reply ensuring that the link is healthy and the controller is able to communicate with the master. No process data is

transferred or modified. In the case of slave devices that will not support pinging then the Standby command will default to Inactive state, but no error will be returned.

portable equipment Enclosed equipment that is moved while in operation or which can easily be moved from one place to another while connected to the supply. Examples are programming and debugging tools and test equipment.

process safety time (PST) For equipment under control this represents the period of time a dangerous condition can exist without the protection of a safety instrumented system before a hazardous event occurs.

processor base unit A backplane assembly which holds all of the processor modules in an AADvance controller. Part number T9100. See also 'processor module'.

processor module The application execution engine of the AADvance controller, housed in a self-contained and standardized physical form factor.

producer A controller producing a tag to one or more consumers, at the request of the consumers.

program enable key A security device that protects the application from unauthorized access and change, in the form factor of a 9-way 'D' type plug. Part number T9906. Supplied with the processor base unit. See also 'key connector'.

project A collection of configurations and the definition of the linking between them. See 'configuration'.

proof test A periodic test performed to detect dangerous hidden faults in a safety instrumented system (SIS) so that, if necessary, a repair can restore the system to an 'as new' condition or as close as practical to this condition.

> Proof tests are designed to reveal both Systematic and Random failures, Proof tests may be required depending on how the technology has been implemented.
>
> AADvance product data is given for a Useful Life of 20 years. For a Mission Time of up to 20 Years, proof testing is not required. For Mission Times greater than 20 years, any products that are still in service once that time is reached should be replaced.

protocol A set of rules that is used by devices (such as AADvance controllers, serial devices and engineering computers) to communicate with each other. The rules encompass electrical parameters, data representation, signalling, authentication, and error detection. Examples include MODBUS, TCP and IP.

PST Process Safety Time. The process safety time for the equipment under control (denoted PSTEUC) is the period a dangerous condition can exist before a hazardous event occurs without a safety system as a protection.

R

real A class of analogue variable stored in a floating, single-precision 32-bit format.

redundancy The use of two or more devices, each carrying out the same function, to improve reliability or availability.

resolution The smallest interval measurable by an instrument; the level of detail which may be represented. For example, 12 bits can distinguish between 4096 values.

RS-232-C, RS-422, RS-485 Standard interfaces introduced by the Electronic Industries Alliance covering the electrical connection between data communication equipment. RS-232-C is the most commonly used interface; RS-422 and RS-485 allow for higher transmission rates over increased distances.

RTC Real-time clock.

RTU Remote terminal unit. The MODBUS protocol supported by the AADvance controller for MODBUS communications over serial links, with the ability to multi-drop to multiple slave devices.

S

safe state A state which enables the execution of a process demand. Usually entered after the detection of a fault condition; it makes sure the effect of the fault is to enable rather than disable a process demand.

safety accuracy The accuracy of a signal within which the signal is guaranteed to be free of dangerous faults. If the signal drifts outside of this range, it is declared faulty.

safety-critical state A faulted state which prevents the execution of a process demand.

sensor A device or combination of devices that measure a process condition. Examples are transmitters, transducers, process switches and position switches.

sequential function chart An IEC 61131 language that divides the process cycle into a number of well-defined steps separated by transitions. See 'limited variability language'.

SFF Safe Failure Fraction. Given by (the sum of the rate of safe failures plus the rate of detected dangerous failures) divided by (the sum of the rate of safe failures plus the rate of detected and undetected dangerous failures).

SIF Safety Instrumented Function. A form of process control that performs specified functions to achieve or maintain a safe state of a process when unacceptable or dangerous process conditions are detected.

SIL Safety Integrity Level. One of four possible discrete levels, defined in IEC 61508 and IEC 61511, for specifying the safety integrity requirements of the safety functions to be allocated to a safety-related system. SIL4 has the highest level of safety integrity; SIL1 has the lowest.

The whole of an installation (of which the AADvance system forms a part) must meet these requirements in order to achieve an overall SIL rating.

SNCP SNCP (Safety Network Control Protocol) is the Safety Protocol that allows elements of an AADvance System to exchange data. SNCP is a SIL 3 certified

protocol which provides a safety layer for the Ethernet network making it a "Black Channel".

SNTP Simple Network Time Protocol. Used for synchronizing the clocks of computer systems over packet-switched, variable-latency data networks.

SSH Secure Shell

structured text A high level IEC 61131-3 language with syntax similar to Pascal. Used mainly to implement complex procedures that cannot be expressed easily with graphical languages.

synchronous A data communications term describing a serial transmission protocol. A pre-arranged number of bits is expected to be sent across a line per second. To synchronise the sending and receiving machines, a clocking signal is sent by the transmitting computer. There are no start or stop bits.

T

TA See 'termination assembly'.

target An attribute of a 'configuration' which describes characteristics of the AADvance controller on which the configuration will run. Includes characteristics such as the memory model and the sizes of variable types for the controller.

TCP Transmission control protocol. One of the core protocols of the Internet Protocol suite. It provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. Common applications include the World Wide Web, e-mail and file transfer and, for an AADvance controller, MODBUS communications over Ethernet.

termination assembly A printed circuit board which connects field wiring to an input or output module. The circuit includes fuses for field circuits. The board carries screw terminals to connect field wiring to the controller, and the whole assembly clips onto the 9300 I/O base unit.

TMR Triple modular redundant. A fault tolerant arrangement in which three systems carry out a process and their result is processed by a voting system to produce a single output.

TÜV certification Independent third party certification against a defined range of international standards including IEC 61508.

U

U Rack unit. A unit of measure used to describe the height of equipment intended for mounting in a standard rack. Equivalent to 44.45mm (1-¾ inches).

V

validation In quality assurance, confirmation that the product does what the user requires.

verification In quality assurance, confirmation that the product conforms to the specifications.

voting system A redundant system (m out of n) which requires at least m of the n channels to be in agreement before the system can take action.

W

withstand voltage The maximum voltage level that can be applied between circuits or components without causing a breakdown.

Notes:

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

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