



AADvance Controller

Catalog Numbers T9100, T9110, T9300, T9310, T9401/2, T9431/2, T9451, T9481/2

AADvance Eurocard Controller

Catalog Numbers T9120, T9501, T9531, T9551



Allen-Bradley

by ROCKWELL AUTOMATION

PFH and PFDavg Data

Original Instructions

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.

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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 document presents the PFH and PFDavg Data for the AADvance® and AADvance Eurocard® controllers. It includes examples on how to calculate the final figures for different controller configurations.

This technical manual is for qualified control system engineers who install, commission or operate OPC clients or the AADvance or AADvance Eurocard controller.

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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 or AADvance Eurocard option is displayed.

Double click on the AADvance or AADvance Eurocard 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 1.41.

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 TechConnectSM 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.

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Environmental Compliance

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

Abbreviations

Abbreviation	Description
FMEDA	Failure Mode Effect and Diagnostic Analysis
FPMH	Failures Per Million Hours
HFT	Hardware Fault Tolerance
MTBF	Mean Time Between Failures
MTTR	Mean time to Repair
PFDavg	Probability of Dangerous Failure on Demand - average
PFD _e	Probability of Dangerous Failure on Demand - energized to action
PFD _{de}	Probability of Dangerous Failure on Demand - de-energized to action
PFH _e	Probability of Dangerous Failure per Hour - energized to action
PFH _{de}	Probability of Dangerous Failure per Hour - de-energized to action
SFF	Safe Failure Fraction
SIF	Safety Instrumented Function

Definitions

Abbreviation	Description
Mission time	The time that the SIF (Safety Instrumented Function) is designed to be operational.

Download Firmware and Associated Files

Download firmware and associated files (such as OPC 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.

Changes described in the table are denoted in the document with black bars in the left margin, unless the change is noted as occurring throughout the publication.

Subject	Reason
Updated for the AADvance Eurocard 1.41 system release.	Added Eurocard variant to the existing document with no technical changes.

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 System Build Manual, ICSTT-RM448	This technical manual describes how to assemble a system, switch on and validate the operation of your system.
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 Solutions Handbook, ICSTT-RM447	This technical manual describes the features, performance and functionality of the AADvance controller and systems. It provides guidance on product selection 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.
AADvance Eurocard Controller Safety Manual, ICSTT-RM456	This technical manual defines how to safely apply AADvance Eurocard 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 Eurocard System Build Manual, ICSTT-RM455	This technical manual describes how to assemble a system, switch on and validate the operation of your system.

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

Notes:

	Preface	3
	About This Publication	3
	Download Firmware and Associated Files	5
	Summary of Changes.....	5
	Additional Resources	5
	Table of Contents	7
	Chapter 1	
PFH and PFDavg Data	Introduction.....	9
	Assumptions	9
	I/O Module Common Part and I/O Point Part.....	10
	1002 Same Module vs 1002 Different Module.....	11
	Module failure rates	12
	AADvance Failure Rates	12
	PFH and PFD Data - 24 Hour MTTR.....	13
	Binding and Peer-to-Peer Communications Data	14
	Safe Failure Fraction (SFF) and Hardware Fault Tolerance (HFT)	14
	System Configurations	15
	Example 1.....	16
	Example 2	17
	Example 3.....	18
	Example 4.....	19
	Example 5.....	20
	Appendix A	
History of Changes	23

PFH and PFDavg Data

Introduction

The information in this document has been compiled as part of the AADvance IEC 61508:2010 certification, the failure modes, reliability data sources, and Failure Mode Effect and Diagnostic Analysis (FMEDA) of each module having been inspected and verified by TÜV Rheinland.

The tables and examples in this document provide failure rates and PFH & PFDavg channel data for use in calculating SIL performance for SIFs using combinations of AADvance or AADvance Eurocard controllers and I/O modules used in applications with a 24-hour MTTR and with a 20-year Mission Time. Where appropriate, the data is provided for Single, Dual, and Triple module configurations.

If a de-energize to action system is configured to provide a shutdown on the first fault, the MTTR has a negligible effect, hence, the tables in the PFD Data can be used for any MTTR.

Assumptions

The following assumptions apply to the PFD and PFH calculations of the AADvance system:

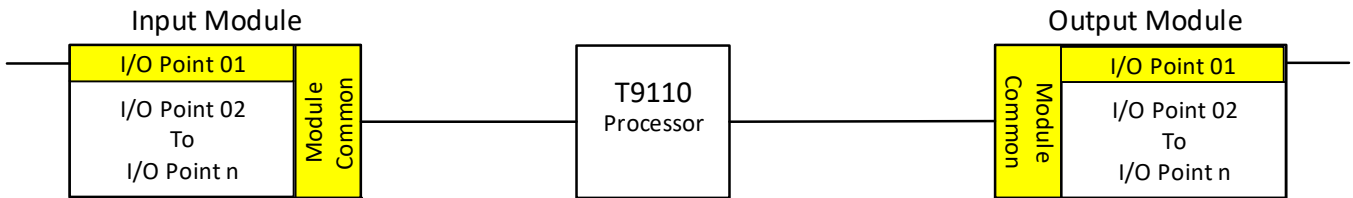
- PFD and PFH values in this manual are calculated with formulas explained in IEC 61508, Part 6, Annex B. See IEC 61508, Part 6, for more information about calculating PFD values for your system.
- Base Units and Termination Assemblies are included in the module calculations or the Binding and Peer-to-Peer Communications Data.
- The random hardware failure rates assume that the ambient temperature of the environment in which the system is operating is 40 °C. System operation at an elevated ambient is likely to have a detrimental effect on failure rates.
- Exposure to Neutrons is assumed to be at sea level (NY, NY) in common with industry standard (JESD89A). The exposure to Neutrons experienced by a system under use at altitude is expected to be at much greater levels.
- Capacitors are operated at 50% of the maximum ratings.
- The mission time is assumed to be 20 years.
- The Module Failure Rates are the sum of the individual components that result in non-operation of the module, identified in the FMEDA.
- The λ values are calculated based on the internal architecture of the products for an individual channel.
- For I/O Modules, the Common Part and the I/O Point Part λ s are calculated separately.
- $\beta_S = 1\%$, $\beta_D = 0.5\%$

I/O Module Common Part and I/O Point Part

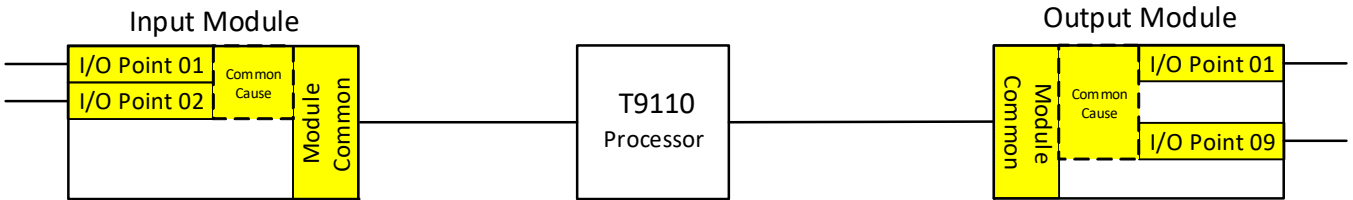
In addition to the Single, Dual, and Triple data provided, the λ values, PFD values, and PFH values in the tables are provided in three forms for I/O modules:

- Common Part
- I/O Point Part
- Common + 1 I/O Point

The Common + 1 I/O Point values can be used when a single I/O point on a module is used in a Safety Function.



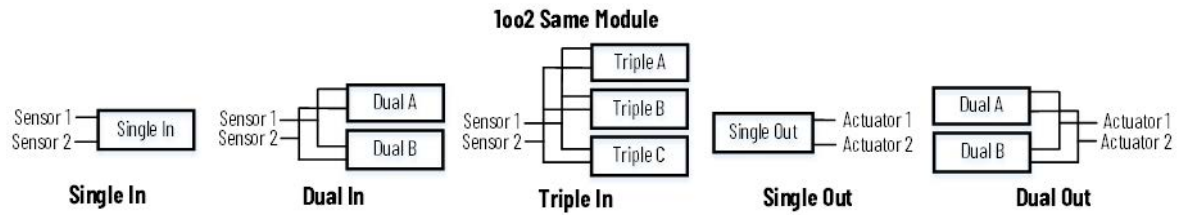
When multiple I/O on the same module are used in a Safety Function, the Common Part and I/O Point Part values can be used.



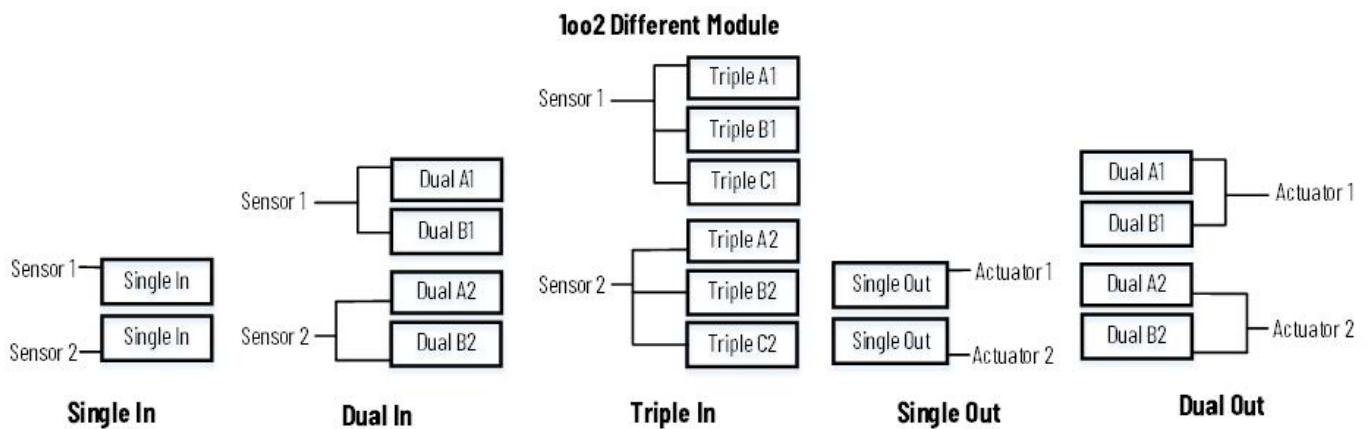
1oo2 Same Module vs 1oo2 Different Module

In addition to the data described above, data and examples are provided for typical 1oo2 sensor or actuator configurations.

- When the two sensors or actuators are connected to the same Single module, the same Dual-pair of modules, or the same Triplicated modules, it is referred to as 1oo2 Same Module.



- When the two sensors or actuators are each connected to different Single modules, different Dual-pairs of modules, or different Triplicated modules, it is referred to as 1oo2 Different Module.



Module failure rates

Refer to this table for information about module failure rates.

Table 1 - Module Failure Rates

Module	Module Description		MTBF Years	FPMH
T910, T9120	Processor		45.72	2.50
T9401, T9501	Digital input module, 24Vdc, 8 channel	Common + 1 I/O Point	106.24	1.07
		Common + All Points	70.67	1.62
T9402	Digital input module, 24Vdc, 16 channel	Common + 1 I/O Point	106.24	1.07
		Common + All Points	70.67	1.62
T9431, T9531	Analog input module, 24Vdc, 8 channel	Common + 1 I/O Point	106.24	1.07
		Common + All Points	70.67	1.62
T9432	Analog input module, 24Vdc, 16 channel	Common + 1 I/O Point	106.24	1.07
		Common + All Points	70.67	1.62
T9451, T9551	Digital output module, 24Vdc, 8 channel	Common + 1 I/O Point	91.06	1.25
		Common + All Points	81.45	1.40
T9481	Analog output module, 3 channel	Common + 1 I/O Point	343.29	0.33
		Common + All Points	145.21	0.79
T9482	Analog output module, 8 channel	Common + 1 I/O Point	343.29	0.33
		Common + All Points	59.45	1.92

AADvance Failure Rates

Table 2 - De-energize to Action Failure Rates

Module	Module Configuration		λ_s	λ_d	λ_{su}	λ_{du}	λ_{sd}	λ_{dd}
T9110, T9120 Processor	Dual		1.26E-08	1.27E-08	1.51E-10	1.53E-10	1.24E-08	1.26E-08
	Triple		1.16E-08	1.18E-08	2.04E-10	2.08E-10	1.14E-08	1.16E-08
T9401, T9501, T9402 Digital Input	Single	Common	4.98E-07	4.99E-07	5.08E-10	5.08E-10	4.98E-07	4.98E-07
		1 I/O Point	3.85E-08	3.88E-08	3.15E-10	3.18E-10	3.82E-08	3.85E-08
	Dual	Common	2.60E-09	2.69E-09	9.07E-11	9.40E-11	2.51E-09	2.60E-09
		1 I/O Point	3.11E-10	4.04E-10	7.10E-11	9.20E-11	2.40E-10	3.11E-10
	Triple	Common	2.95E-09	2.44E-09	1.14E-10	9.40E-11	2.83E-09	2.34E-09
		1 I/O Point	3.12E-10	4.04E-10	7.11E-11	9.20E-11	2.41E-10	3.12E-10
T9431, T9531, T9432 Analog Input	Single	Common	4.98E-07	4.99E-07	5.08E-10	5.08E-10	4.98E-07	4.98E-07
		1 I/O Point	3.85E-08	3.88E-08	3.15E-10	3.18E-10	3.82E-08	3.85E-08
	Dual	Common	2.60E-09	2.69E-09	9.07E-11	9.40E-11	2.51E-09	2.60E-09
		1 I/O Point	3.11E-10	4.04E-10	7.10E-11	9.20E-11	2.40E-10	3.11E-10
	Triple	Common	2.95E-09	2.44E-09	1.14E-10	9.40E-11	2.83E-09	2.34E-09
		1 I/O Point	3.12E-10	4.04E-10	7.11E-11	9.20E-11	2.41E-10	3.12E-10
T9451, T9551 Digital Output	Single	Common	1.21E-06	2.31E-08	1.56E-08	2.99E-10	1.19E-06	2.28E-08
		1 I/O Point	2.04E-08	6.78E-10	5.59E-12	1.86E-13	2.04E-08	6.77E-10
	Dual	Common	3.49E-09	4.09E-09	5.11E-10	5.98E-10	2.98E-09	3.49E-09
		1 I/O Point	7.35E-11	7.39E-11	3.69E-13	3.71E-13	7.31E-11	7.35E-11
T9481, T9482 Analog Output	Single	Common	5.27E-08	5.31E-08	4.11E-10	4.15E-10	5.23E-08	5.27E-08
		1 I/O Point	7.41E-08	1.38E-07	5.00E-11	9.34E-11	7.40E-08	1.38E-07
	Dual	Common	3.53E-10	1.18E-09	2.47E-10	8.29E-10	1.05E-10	3.53E-10
		1 I/O Point	7.48E-10	9.35E-10	1.49E-10	1.87E-10	5.98E-10	7.48E-10

Table 3 - Energize to Action Failure Rates

Module	Module Description		λ_s	λ_d	λ_{su}	λ_{du}	λ_{sd}	λ_{dd}
T9110, T9120 Processor	Dual		1.11E-08	1.13E-08	2.38E-10	2.43E-10	1.08E-08	1.11E-08
	Triple		1.12E-08	1.16E-08	3.49E-10	3.60E-10	1.09E-08	1.12E-08
T9401, T9501, T9402 Digital Input	Single	Common	5.22E-07	5.23E-07	7.62E-10	7.63E-10	5.21E-07	5.22E-07
		1 I/O Point	3.85E-08	3.88E-08	3.15E-10	3.18E-10	3.82E-08	3.85E-08
	Dual	Common	2.56E-09	2.66E-09	9.31E-11	9.66E-11	2.47E-09	2.56E-09
		1 I/O Point	3.11E-10	4.51E-10	9.63E-11	1.39E-10	2.15E-10	3.11E-10
	Triple	Common	2.71E-09	2.62E-09	9.97E-11	9.67E-11	2.61E-09	2.53E-09
		1 I/O Point	3.12E-10	4.58E-10	9.96E-11	1.46E-10	2.12E-10	3.12E-10
T9431, T9531, T9432 Digital Input	Single	Common	5.22E-07	5.23E-07	7.62E-10	7.63E-10	5.21E-07	5.22E-07
		1 I/O Point	3.85E-08	3.88E-08	3.15E-10	3.18E-10	3.82E-08	3.85E-08
	Dual	Common	2.56E-09	2.66E-09	9.31E-11	9.66E-11	2.47E-09	2.56E-09
		1 I/O Point	3.11E-10	4.51E-10	9.63E-11	1.39E-10	2.15E-10	3.11E-10
	Triple	Common	2.71E-09	2.62E-09	9.97E-11	9.67E-11	2.61E-09	2.53E-09
		1 I/O Point	3.12E-10	4.58E-10	9.96E-11	1.46E-10	2.12E-10	3.12E-10
T9451, T9551 Digital Output	Single	Common	2.39E-06	2.23E-07	7.74E-09	7.22E-10	2.38E-06	2.22E-07
		1 I/O Point	2.94E-08	1.57E-09	8.06E-12	4.30E-13	2.94E-08	1.57E-09
	Dual	Common	5.16E-06	8.25E-08	8.01E-09	1.28E-10	5.16E-06	8.23E-08
		1 I/O Point	6.22E-08	8.77E-11	6.02E-10	8.49E-13	6.16E-08	8.69E-11
T9481, T9482 Analog Output	Single	Common	8.11E-07	8.13E-07	1.51E-09	1.51E-09	8.10E-07	8.11E-07
		1 I/O Point	5.39E-08	1.57E-07	4.78E-11	1.39E-10	5.38E-08	1.57E-07
	Dual	Common	3.25E-06	7.73E-09	6.54E-09	1.55E-11	3.25E-06	7.71E-09
		1 I/O Point	4.21E-07	2.23E-09	2.63E-10	1.39E-12	4.21E-07	2.23E-09

PFH and PFD Data - 24 Hour MTTR

The following table provides the probability of failures per hour and the probability of failures upon demand for the energize to action and de-energize to action SIF configurations. The Mission Time is 20 years. The table includes PFD and PFH values when two inputs or outputs are used in a 1002 configuration. There values are provided when the 1002 I/O are connected to the same module and when the 1002 I/O are connected to two different modules. A β value of 1% and a β_D of 0.5% are used in the 1002 calculations.

Table 4 - PFD Data for a SIF with Mission Time = 20 years

Module	Module Configuration	De-energize to Action		Energize to action		
		PFHde	PFDde	PFHe	PFDde	
T9110, T9120 Processor	Dual	1.53E-10	1.37E-05	2.43E-10	2.16E-05	
	Triple	2.08E-10	1.85E-05	3.60E-10	3.18E-05	
T9401, T9501, T9402 Digital Input	Single	Common + 1 I/O Point	8.26E-10	8.53E-05	1.08E-09	1.08E-04
		Common Part	5.08E-10	5.65E-05	7.63E-10	7.94E-05
		I/O Point Part	3.18E-10	2.88E-05	3.18E-10	2.88E-05
		1002 Same Module	5.12E-10	5.68E-05	7.66E-10	7.97E-05
		1002 Different Module	8.40E-12	7.99E-07	3.20E-12	2.84E-07
	Dual	Common + 1 I/O Point	1.86E-10	1.64E-05	2.36E-10	2.07E-05
		Common Part	9.40E-11	8.29E-06	9.66E-11	8.52E-06
		I/O Point Part	9.20E-11	8.07E-06	1.39E-10	1.22E-05
		1002 Same Module	9.49E-11	8.38E-06	9.80E-11	8.64E-06
		1002 Different Module	1.87E-12	1.64E-07	1.40E-12	1.22E-07
	Triple	Common + 1 I/O Point	1.86E-10	1.64E-05	2.43E-10	2.14E-05
		Common Part	9.40E-11	8.29E-06	9.67E-11	8.53E-06
I/O Point Part		9.20E-11	8.07E-06	1.46E-10	1.28E-05	

Module	Module Configuration	De-energize to Action		Energize to action			
		PFHde	PFDde	PFHe	PFDde		
T9431, T9531, T9432 Analog Input		1oo2 Same Module	9.49E-11	8.37E-06	9.82E-11	8.66E-06	
		1oo2 Different Module	1.87E-12	1.64E-07	1.47E-12	1.29E-07	
	Single	Common + 1 I/O Point	Common Part	8.26E-10	8.53E-05	1.08E-09	1.08E-04
			I/O Point Part	5.08E-10	5.65E-05	7.63E-10	7.94E-05
			I/O Point Part	3.18E-10	2.88E-05	3.18E-10	2.88E-05
		1oo2 Same Module	1oo2 Same Module	5.12E-10	5.68E-05	7.66E-10	7.97E-05
			1oo2 Different Module	8.40E-12	7.99E-07	3.20E-12	2.84E-07
			1oo2 Different Module	8.40E-12	7.99E-07	3.20E-12	2.84E-07
	Dual	Common + 1 I/O Point	Common Part	1.86E-10	1.64E-05	2.36E-10	2.07E-05
			Common Part	9.40E-11	8.29E-06	9.66E-11	8.52E-06
			I/O Point Part	9.20E-11	8.07E-06	1.39E-10	1.22E-05
		1oo2 Same Module	1oo2 Same Module	9.49E-11	8.38E-06	9.80E-11	8.64E-06
1oo2 Different Module			1.87E-12	1.64E-07	1.40E-12	1.22E-07	
1oo2 Different Module			1.87E-12	1.64E-07	1.40E-12	1.22E-07	
Triple	Common + 1 I/O Point	Common Part	1.86E-10	1.64E-05	2.43E-10	2.14E-05	
		Common Part	9.40E-11	8.29E-06	9.67E-11	8.53E-06	
		I/O Point Part	9.20E-11	8.07E-06	1.46E-10	1.28E-05	
	1oo2 Same Module	1oo2 Same Module	9.49E-11	8.37E-06	9.82E-11	8.66E-06	
		1oo2 Different Module	1.87E-12	1.64E-07	1.47E-12	1.29E-07	
		1oo2 Different Module	1.87E-12	1.64E-07	1.47E-12	1.29E-07	
T9451, T9551 Digital Output	Single	Common + 1 I/O Point	Common Part	2.99E-10	2.68E-05	7.23E-10	6.87E-05
			Common Part	2.99E-10	2.67E-05	7.22E-10	6.86E-05
			I/O Point Part	1.86E-13	3.25E-08	4.30E-13	7.52E-08
		1oo2 Same Module	1oo2 Same Module	2.99E-10	2.67E-05	7.22E-10	6.86E-05
			1oo2 Different Module	3.01E-12	2.66E-07	4.30E-15	5.64E-10
			1oo2 Different Module	3.01E-12	2.66E-07	4.30E-15	5.64E-10
	Dual	Common + 1 I/O Point	Common Part	5.98E-10	5.25E-05	1.29E-10	1.33E-05
			Common Part	5.98E-10	5.25E-05	1.28E-10	1.32E-05
			I/O Point Part	3.71E-13	3.43E-08	8.49E-13	7.64E-08
		1oo2 Same Module	1oo2 Same Module	5.98E-10	5.25E-05	1.28E-10	1.32E-05
			1oo2 Different Module	6.05E-12	5.28E-07	8.49E-15	7.54E-10
			1oo2 Different Module	6.05E-12	5.28E-07	8.49E-15	7.54E-10
T9481, T9482 Analog Output	Single	Common + 1 I/O Point	Common Part	5.08E-10	4.91E-05	1.65E-09	1.68E-04
			Common Part	4.15E-10	3.76E-05	1.51E-09	1.52E-04
			I/O Point Part	9.34E-11	1.15E-05	1.39E-10	1.60E-05
		1oo2 Same Module	1oo2 Same Module	4.15E-10	3.77E-05	1.51E-09	1.52E-04
			1oo2 Different Module	5.13E-12	4.71E-07	1.40E-12	1.41E-07
			1oo2 Different Module	5.13E-12	4.71E-07	1.40E-12	1.41E-07
	Dual	Common + 1 I/O Point	Common Part	1.02E-09	8.90E-05	1.69E-11	1.72E-06
			Common Part	8.29E-10	7.27E-05	1.55E-11	1.55E-06
			I/O Point Part	1.87E-10	1.64E-05	1.39E-12	1.76E-07
		1oo2 Same Module	1oo2 Same Module	8.31E-10	7.28E-05	1.55E-11	1.55E-06
			1oo2 Different Module	1.03E-11	9.01E-07	1.39E-14	1.49E-09
			1oo2 Different Module	1.03E-11	9.01E-07	1.39E-14	1.49E-09

Binding and Peer-to-Peer Communications Data

The PFH and PFD values for the Bindings and Peer-to-Peer Communications Data for each segment are as follows (Mission Time is 20 years):

- PFH = 1E-9
- PFD = 1E-5

Safe Failure Fraction (SFF) and Hardware Fault Tolerance (HFT)

The following tables provides the SFF and HFT data for SIF configurations energize to action and de-energize to action mode.

SFFde applies to a normally energized system that is de-energized to action.

Table 5 - Module SFFde, SFFe

Module	Module Description	SFF de	SFFe
T9110, T9120	Processor module	>99%	>99%
T9401, T9501,	Digital input module, 24Vdc, 8 channel	>99%	>99%
T9402	Digital input module, 24Vdc, 16 channel	>99%	>99%
T9431, T9531	Analog input module, 8 channel	>99%	>99%
T9432	Analog input module, 16 channel	>99%	>99%
T9451, T9551	Digital output module, 24Vdc, 8 channel	>99%	>99%
T9481	Analog output module, 3 channel	>99%	>99%
T9482	Analog output module, 8 channel	>99%	>99%

Table 6 - Module HFT

Module	Module Description	Single	Dual	Triple
T9110, T9120	Processor module	0	1	1
T9401, T9501,	Digital input module, 24Vdc, 8 channel	0	1	1
T9402	Digital input module, 24Vdc, 16 channel	0	1	1
T9431, T9531	Analog input module, 8 channel	0	1	1
T9432	Analog input module, 16 channel	0	1	1
T9451, T9551	Digital output module, 24Vdc, 8 channel	1	1	1
T9481	Analog output module, 3 channel	1	1	1
T9482	Analog output module, 8 channel	1	1	1

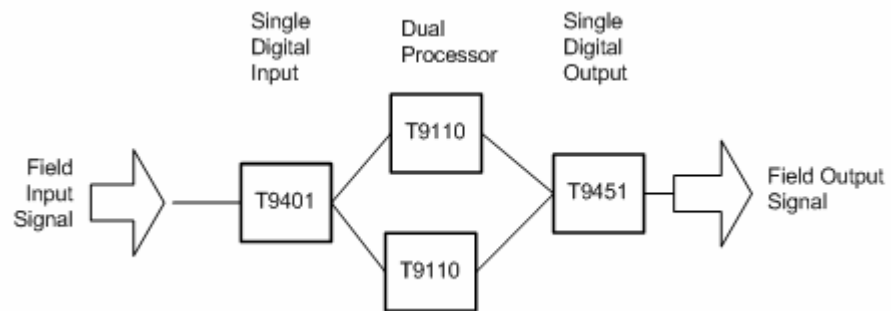
System Configurations

The PFH and PFD calculations are derived from IEC61508-6:2010 and the examples below show how the calculations are used to define the probability of failure for a Safety Instrumented Function.

NOTE The Soft Error values used to calculate PFD/PFH figures are, in line with industry common practice and JESD89a, calculated with Neutron flux values at sea level (NY,NY).
 Values measured at high altitude would be expected to yield worse values. Similarly subsea applications are likely to experience lower values of Neutron flux.
 Contact Rockwell Automation for additional information.

Example 1

This illustrates a SIL3 SIF with one signal input and one signal output; it has a Mission Time of 20 years and a MTTR of 24 hours, it is configured as a de-energized to action arrangement.



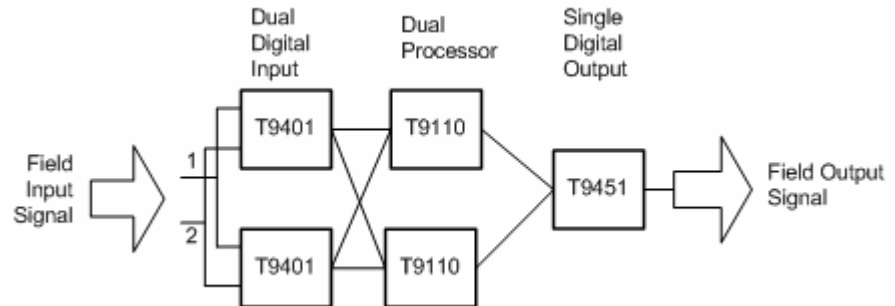
Refer to the [Table 4](#).

$$\begin{aligned}
 \text{AADvance SIF PFDavg} &= \text{PFDavg (T9401 Single, Common + 1 I/O Point)} \\
 &+ \text{PFDavg (T9110 Dual)} \\
 &+ \text{PFDavg (T9451 Single, Common + 1 I/O Point)}
 \end{aligned}$$

$$\begin{aligned}
 &= 8.53\text{E-}05 + 1.37\text{E-}05 + 2.68\text{E-}05 \\
 &= 1.26\text{E-}04
 \end{aligned}$$

Example 2

This illustrates a SIL 3 SIF with 2 inputs configured as 1002 on dual input modules and 1 output with a Mission Time of 20 years and MTTR = 24 hours, configured as 1002 de-energize to action.



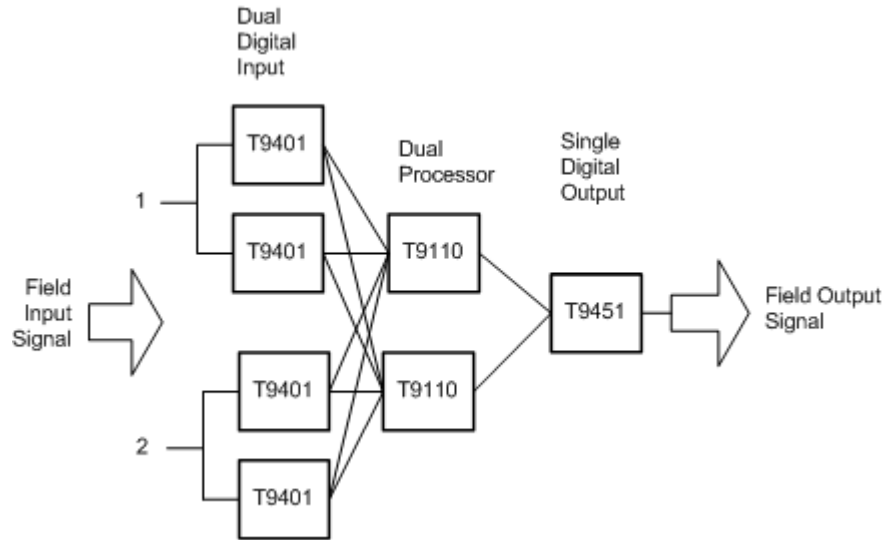
Refer to the [Table 4](#).

$$\begin{aligned} \text{AADvance SIF PFDavg} &= \text{PFDavg (T9401 Dual, 1002 Same Module)} \\ &+ \text{PFDavg (T9110 Dual)} \\ &+ \text{PFDavg (-T9451 Single, Common + 1 I/O Point)} \end{aligned}$$

$$\begin{aligned} &= 8.38\text{E-}06 + 1.37\text{E-}05 + 2.68\text{E-}05 \\ &= 4.89\text{E-}5 \end{aligned}$$

Example 3

This illustrates a SIL3 SIF with 2 inputs on dual input modules and 1 output, with a Mission Time of 20 years and MTTR = 24 hours. The 2 inputs are configured as 1002 de-energize to action.



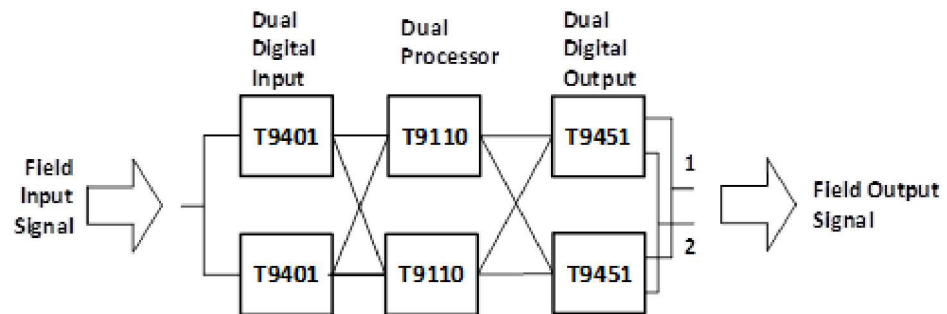
Refer to the [Table 4](#).

$$\begin{aligned} \text{AADvance SIF PFDavg} &= \text{PFDavg (T9401 Dual, 1002 Different Modules)} \\ &+ \text{PFDavg (T9110 Dual)} \\ &+ \text{PFDavg (T9451 Single, Common + 1 I/O Point)} \end{aligned}$$

$$\begin{aligned} &= 7.99\text{E-}07 + 1.37\text{E-}05 + 2.68\text{E-}05 \\ &= 4.13\text{E-}05 \end{aligned}$$

Example 4

This illustrates a SIL 3 SIF with 1 dual input and 2 outputs, with a Mission Time of 20 years and MTTR =24 hours. The 2 outputs are configured as 1002 de-energize to action.



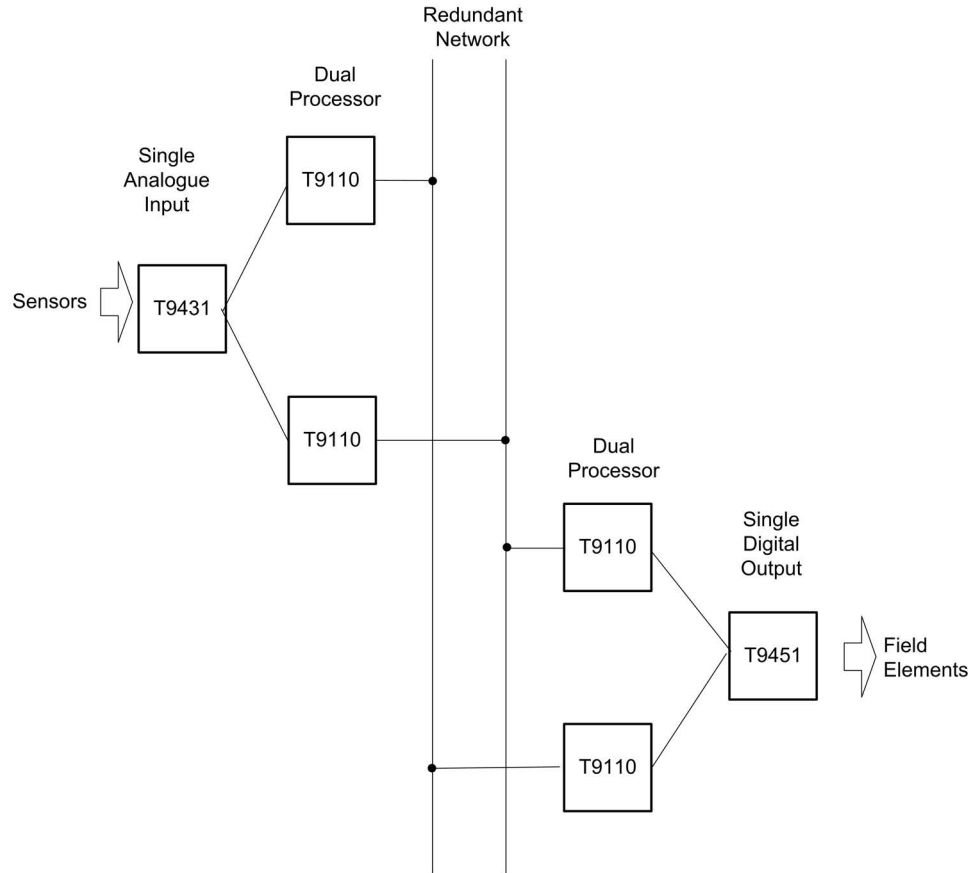
Refer to the [Table 4](#).

$$\begin{aligned} \text{AADvance SIF PFDavg} &= \text{PFDavg (T9401 Dual, Common + 1 I/O Point)} \\ &+ \text{PFDavg (T9110 Dual)} \\ &+ \text{PFDavg (T9451 Dual, 1002 Same Module)} \end{aligned}$$

$$\begin{aligned} &= 1.64\text{E-}05 + 1.37\text{E-}05 + 5.25\text{E-}05 \\ &= 8.26\text{E-}05 \end{aligned}$$

Example 5

This illustrates a SIL 3 SIF distributed between two controllers, with one signal input and one signal output; it has a Mission Time of 20 years and a MTTR of 24 hours, it is configured as a de-energize to action arrangement.



Refer to the [Table 4](#).

$$\begin{aligned}
 \text{AADvance SIF PFDavg} &= \text{PFDavg (T9401 Dual, Common + 1 I/O Point)} \\
 &+ \text{PFDavg (T9110 Dual)} \\
 &+ \text{PFDavg (network)} \\
 &+ \text{PFDavg (T9110 Dual)} \\
 &+ \text{PFDavg (T9451 Single, Common + 1 I/O Point)} \\
 \\
 &= 8.53\text{E-}05 + 1.37\text{E-}05 + 1.00\text{E-}05 + 1.37\text{E-}05 + 2.68\text{E-}05 \\
 &= 1.50\text{E-}04
 \end{aligned}$$

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-RM449I-EN-P, December 2023

Changes

Updated for the AADvance Eurocard 1.41 system release. Added Eurocard variant to the existing document with no technical changes.

ICSTT-RM449H-EN-P, August 2021

Change

Updated for AADvance system release 1.41 TÜV Rheinland certification.

ICSTT-RM449G-EN-P, February 2021

Change

Updated for AADvance system release 1.40 TÜV Rheinland certification.

Applied latest publication template.

Added reference to AADvance-Trusted SIS Workstation Software User Guide, [ICSTT-UM002](#).

Removed references 20 years Manual Test Interval (MTI). Added information about 20 years Mission Time.

Updated data for tables in the AADvance Failure Rates section.

Updated data for tables in the PFD Data - 8 Hour MTTR section.

Updated data for tables in the PFD Data - 24 Hour MTTR section.

Updated data for tables in the PFH Data section.

Updated calculations in the System Configurations section.

ICSTT-RM449F-EN-P, July 2019

Change

Updated for Release 1.34 IEC 61508 Edition 2.0 certification

ICSTT-RM449E-EN-P, April 2018

Change

Added Chapter 2 and updated hypertext links.

Issue 06A, March 2015

Change

R1.34 Version

Issue 05, February 2014

Change

Removed AADvance Eurocard Version Data from the Issue 04 Rockwell format

Issue 04, November 2013

Change

Release 1.32 Rockwell format added Eurocard Values

Issue 03, June 2013

Change

Update for Release 1.3 and 9481/2 values added

Issue 02, May 2012

Change

Updates and corrections from peer review and from TUV review, add distributed SIF example, added Analog Output Module values, Release 1.3 issue.

Issue 01, March 2011

Change

First Issue Release 1.32

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
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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