Honeywell

Experion PKS
PM I/O Hardware Troubleshooting and Maintenance Guide

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Contents

1 About this guide

This guide provides information about troubleshooting and maintaining the various components of the Process Manager I/O subsystem.

Revision history

Revision	Date	Description
A	February 2015	Initial release of document

2 Introduction

This user's guide provides you with troubleshooting information, a hardware description, maintenance procedures, and a recommended spare parts list for the Process Manager I/O subsystem as described in the following section summaries:

Isolating Faults

You can use this section to begin “Isolating Faults” on page 11 to PM I/O Input/Output cards and the Smart Transmitter IOP card. This section provides you with a listing of displayed error codes and status messages together with the recommended actions.

PM I/O Assemblies and Cabling

This section provides you with descriptions of “PM I/O subsystem assemblies” on page 26 such as IOP card types, card file types, and cable routing and wiring connections within the cabinet.

PM I/O Power System

You can use this section to find information about“Controlling the PM I/O power system” on page 49

Removing and Replacing PM I/O Assemblies

You can remove and replace “Following Electrostatic Discharge guidelines” on page 80 by following the procedures in this section. The operation of the Analog Output Standby Manual and the Digital Output Standby Manual devices are also described in this section.

Calibrating FTAs and IOPs

You can “Calibrating LLAI, HLAI, and AO IOPs” on page 102 using the procedures in this section.

Testing Redundancy

You can perform “Testing IOP redundancy” on page 126 for IOPs, power system modules, and power cables using the procedures in this section.

PM I/O Spare Parts List

This section contains a listing of “Isolating Faults” on page 11 and “Optimum Replaceable Unit (ORU) Parts” on page 137

3 Isolating Faults

The following section describes about isolating IOP faults.

Related topics

“PM I/O Processor block alarms and system info events” on page 12
“IOP Soft Failure error codes with corrective actions” on page 13
“IOP channel soft-failure error codes with corrective actions” on page 18
“Isolating Smart Transmitter IOP faults” on page 20

3.1 PM I/O Processor block alarms and system info events

The PM I/O Processor block reports diagnostic alarms if there is an IOP hardware failure, or a change in the IOP redundancy state. Specifically, the following diagnostic alarms listed in Table 1 are generated by the IOLIM for the PM I/O Processor block.

Table 1: PM I/O Processor block diagnostic alarms

Notification Type	Descriptor Message
Diagnostic Alarm	Communication Error
	Configuration Mismatch
	No Response
System Info Event	IOP Power On
	IOP Not Synchronized
	IOP Synchronized
	IOP Switchover
	IOP Swap Control

3.2 IOP Soft Failure error codes with corrective actions

The IOPs report soft failures to the Experion Server. The soft-failure error codes are located on the Control Builder configuration forms under the **Softfailures** tab as shown in Figure 1.

The IOP soft-failure error codes and corresponding corrective actions are listed in

Table 2.

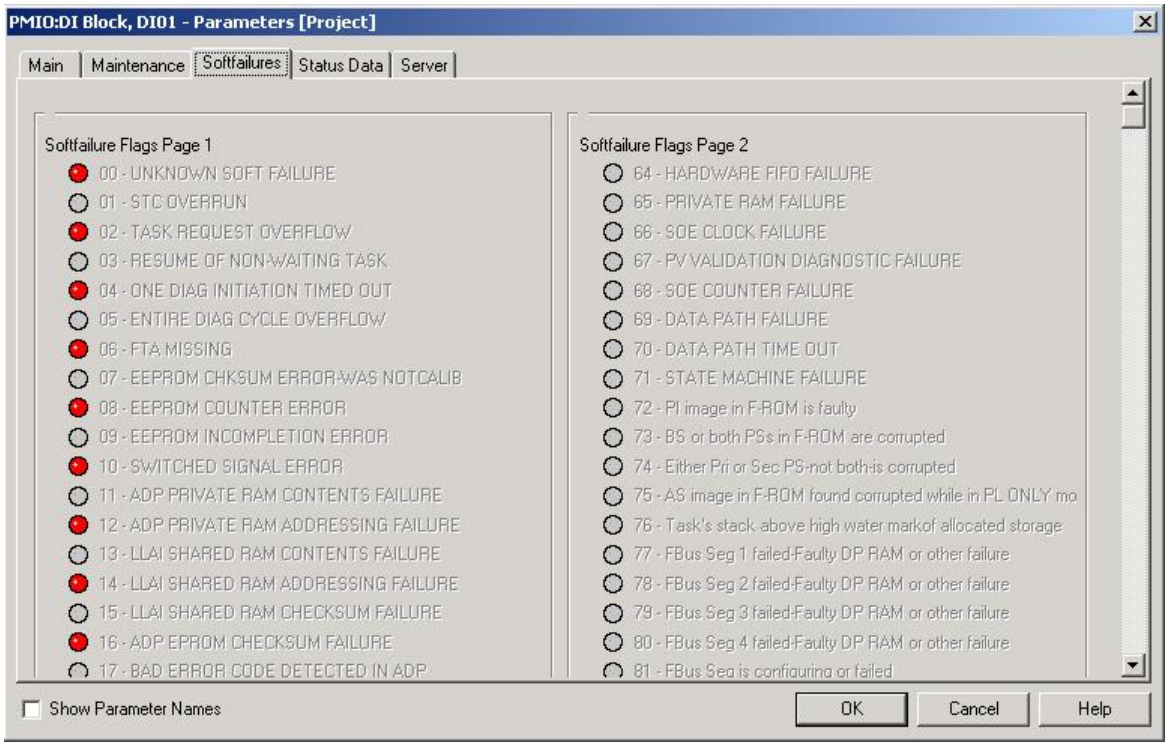


Figure 1: PM I/O Softfailures tab

Table 2: IOP soft-failure error codes

Error Code	Description	Corrective Action
00	Null Soft failure. No failure	None.
01	Sample time clock overrun - greater than 2 x period.	Investigate a possible I/O Link problem. Data access to the IOP cards may not be operating properly. Check the High-Performance I/O Link card, the I/O Link cable, and the IOP cards.
02	IOP task request overflow - excessive IOL activity.	Call TAC for assistance.
03	IOP executive resumed a non-waiting task - software bug indicated	Call TAC for assistance.
04	Diagnostics not run in at least 5 seconds indicates a processing overload.	Investigate control point mix/strategy for an excessive load. Otherwise, a possible I/O Link problem exists. Check the High-Performance I/O Link card, the I/O Link cable, and the IOP cards.
05	Entire diagnostic cycle overran the 2-minute allocated time in which diagnostics have to run to completion.	Investigate control point mix/strategy for an excessive load. Otherwise, a possible I/O Link problem exists. Check the High-Performance I/O Link card, the I/O Link cable, and the IOP cards.

Error Code	Description	Corrective Action
06	The FTA or LLMUX or power adapter is missing.	Install the FTA. If an FTA is present, replace the FTA or check the FTA cable. (Note: For the LLMux or RHMUX, this code refers to the Power Adapter assembly. RTD and TC FTAs are diagnosed by error codes 50 and 51.)
07	EEPROM (used to hold calibration information in Analog Output IOPs) checksum failure. It usually means an Analog Output IOP is not calibrated properly.	Calibrate the Analog Output IOP card (refer to the IOP Calibration Procedures section for the procedure). If the error persists, replace the HLAI or the AO IOP card, or the FTA.
08	EEPROM counter error. The number of writes to EEPROM has exceeded the safe number (10,000). This could indicate the IOP has not been calibrated because a virgin EEPROM will fail this test.	Calibrate the Analog Output IOP card (refer to the IOP Calibration Procedures section for the procedure). If the error persists, replace the HLAI or the AO IOP card, or the FTA.
09	EEPROM flag error -incomplete write or uncalibrated IOP.	Calibrate the Analog Output IOP card (refer to the IOP Calibration Procedures section for the procedure). If the error persists, replace the HLAI or the AO IOP card, or the FTA.
10	*No longer used*. Switched signal error - possible FTA problem	No action required.
11	ADP (Analog to Digital Processor) private RAM contents error - LLAI only - no conversion	Replace the appropriate IOP card because the ADP has failed.
12	ADP private RAM address error - LLAI only - no conversion	Replace the IOP card.
13	LLAI shared ROM contents failure - LLAI only - no AI conversion	Replace the IOP card.
14	LLAI shared ROM address error - LLAI only - no AI conversion	Replace the IOP card.
15	LLAI shared ROM checksum error - LLAI only - no AI conversion	Replace the IOP card.
16	ADP ROM checksum failure - LLAI only - no AI conversion	Replace the IOP card.
17	ADP has failed in communications with IOLP - recoverable- Application processor (LLAI or STI) has a communication failure with the High-Performance I/O Link card.	If the error persists, replace the IOP card.
18	ADP (LLAI only) failed on IOP startup - it will not recover	Replace the IOP card.
19	Input module scan overrun-excessive IOL activity to this IOP. Inputs have been lost.	Check for a chattering DI point. Another possible cause would be intermittently bad I/O link hardware.
20	Input module scan overrun.	No longer used. No action required.
21	Not used.	N/A
22	DOM secondary regulator is not working.	Replace the DO IOP card.
23	Not used.	N/A

Error Code	Description	Corrective Action
24	8051stack usage is dangerously close to its limit.	Call TAC for assistance.
25	Spare	N/A
26	Input/Output loopback failure.	Replace the appropriate IOP card.
27	No IOLP access to shared RAM. Input conversion will be prohibited.	Replace the IOP card.
28	No external AC line in the LLAI - input conversions continue.	Check optical coupler and associated fuse on the backpanel. Check that the primary (left-side) Power Supply Module in the Power System is installed and functional.
29	Not used.	N/A
30	Test voltage Reference >5% out of range - PVAUTO to MAN. The PV is set to NAN by the IOP.	Replace the IOP card.
31	Not used.	N/A
32	Zero Reference voltage out of range. The PV is set to NAN by the IOP.	Replace the IOP card.
33	LLAI Reference junction value is bad.	Check that the reference junction wire or jumper (P1) is correctly implemented on the FTA.
34	LLAI bad ADP branch taken - software bug.	Replace the LLAI IOP card for the LLAI FTA.
35	Not used.	N/A
36	LLMux or RHMUX: FTA #1 has a Soft failure.	LLMux or RHMUX: Check FTA 1. SI: Correct the error condition at the device connected to FTA 1.
37	LLMux or RHMUX: FTA #2 has a Soft failure.	LLMux or RHMUX: Check FTA 2. SI: Correct the error condition at the device connected to FTA 2.
38	Calibration of a module has been aborted due to a failure.	Check the precision voltage/resistance source for accuracy. Also, make sure that the correct calibration procedure is being followed
39	Calibration voltage out of range.	Replace the HLAI IOP card.
40	EEPROM store failed - calibration data may be lost.	If an HLAI or AO, replace the IOP. If an LLAI, replace the affected plug-in module.
41	LLMUX FTA reference voltage out of range	If the problem persists, replace the FTA.
42	Not used.	N/A
43	HLAI A/D is out of calibration by more than \3%.	Calibrate or replace the IOP card (refer to the IOP Calibration Procedures section).
44	AO module failure selection register is bad.	Replace the AO IOP card.
45	Secondary latch failure.	Replace the IOP. Use a standby-manual device if IOP is nonredundant.
46	Output disable buffer failure.	Replace IOP. Use a standby-manual device if IOP is nonredundant.
47	Calibration reference voltage out of range.	Replace the IOP or recalibrate the IOP.
48	LLMux: FTA 1 is not calibrated. SI: FTA 1 write buffer overflow.	LLMux or RHMUX: Calibrate FTA 1. SI: Reduce the number of writes to the FTA.

Error Code	Description	Corrective Action
49	LLMux: FTA 2 is not calibrated. SI: FTA 2 write buffer overflow.	LLMux or RHMUX: Calibrate FTA 2. SI: Reduce the number of writes to the FTA.
50	FTA 1 communication failure.	Check the connection from the Power Adapter to FTA 1. If the FTA is missing, install the FTA. If the FTA is present, replace the FTA.
51	FTA 2 communication failure.	Check the connection from the Power Adapter to FTA 2. If the FTA is missing, install the FTA. If the FTA is present, replace the FTA.
52	FTA 1 identification failure.	Verify/correct the FTA pinning.
53	FTA 2 identification failure.	Verify/correct the FTA pinning.
54	FTA 1 reference voltage failure.	Replace the FTA.
55	FTA 2 reference voltage failure.	Replace the FTA.
56	FTA 1 calibration failure.	Recalibrate the FTA.
57	FTA 2 calibration failure.	Recalibrate the FTA.
58	IOP lost synchronization with its primary.	If the primary IOP is in OK, resynch with the START command. If the primary IOP is in IDLE, resynch with the IDLE command.
59	AO or DO write enable protection failure.	Replace the IOP at the earliest convenience. IOP failure can result in indeterminate outputs.
60	Multiple input failure detected.	Replace the IOP.
61	Redundancy hardware diagnostic failure.	If an AO, replace the FTA's plug-in module after forcing IOP A to be the primary. If an HLAI, replace the IOPs one at a time following database synchronization.
62	Data bus failure.	
63	I/O redundancy configured on non-supportive hardware rev.	Replace the IOP with an IOP that supports redundancy (proper hardware revision).
64	Hardware FIFO diagnostic failed. PVs set BAD - replace IOP.	Replace the IOP.
65	Private RAM diagnostic failed. PVs set BAD - replace IOP.	Replace the IOP.
66	The SOE clock failed. PVs set BAD - replace IOP.	Replace the IOP.
67	PV validation diagnostic failed. PVs set BAD - replace IOP.	Replace the IOP.
68	SOE counter diagnostic failed. PVs set BAD - replace IOP.	Replace the IOP.
69	Data path failure.	Replace the FTA when convenient.
70	Data path failure.	Replace the FTA when convenient.
71	State machine diagnostic failed. PVs set BAD - replace IOP.	Recalibrate the FTA.
72	Bad personality image.	Ensure that you have the correct revision of the personality software. Reload the personality image. If the error appears again, call TAC.
73	Bad BS and/or PS image in Flash ROM.	-
74	Bad CRC for PS Flash ROM image.	-
75	Bad AS image in Flash ROM.	-

Error Code	Description	Corrective Action
76 to 114	Not used.	N/A
115	Spare	
116 to 160	Not used.	N/A
161	HART hardware error detected against DUART channel 1 or modem 1.	Replace the IOP card.
162	HART hardware error detected against DUART channel 2 or modem 2.	Replace the IOP card.
163	HART hardware error detected against DUART channel 3 or modem 3.	Replace the IOP card.
164	HART hardware error detected against DUART channel 4 or modem 4.	Replace the IOP card.
165	HART processor program stack above 90% usage level.	Replace the IOP card.
166	HART processor diagnostic task under-run	Replace the IOP card.

3.3 IOP channel soft-failure error codes with corrective actions

Diagnostic alarms for the IOP Channel Block are reported as error codes when there is an IOP hardware failure. These error codes are also located on the Control Builder IOP Block configuration forms under the **Channel Soft Failures** tab. The recommended corrective actions are included in the Table 2.

Table 3: IOP channel soft-failure error codes

Error Code	Description	Corrective Action
00	No error	N/A
01 to 06	Not used.	N/A
07	LLAI EEPROM checksum error or IOP not calibrated.	Replace the FTA plug-in module or recalibrate.
08	LLAI EEPROM counter error - too many writes or unformatted EEPROM.	Replace the FTA plug-in module or recalibrate.
09 to 20	Not used.	N/A
21	Input point failed diagnostic.	Replace the IOP or check the FTA wiring.
22	Not used.	N/A
23	Failure in output circuitry detected by AO or DO	Check the output connection at the FTA. If it is good, try replacing the FTA and/or the appropriate IOP card.
24 to 28	Not used.	N/A
29	Bad input or bad FTA plug-in module	Test that the slot is wired correctly. If it is, replace the FTA plug-in module.
30	Not used.	N/A
31	FTA type mismatch with slot configuration.	Reconfigure or replace the FTA.
32 to 34	Not used.	N/A
35	Illegal internal zero configuration attempted on this channel.	Check for an open thermocouple, fuse, or replace the IOP.
36	Spare failure indicator.	N/A
37	Spare failure indicator.	N/A
38	Calibration of this slot has aborted.	Check the precision voltage source for accuracy.
39 to 41	Not used.	N/A
42	A/D slot conversion on AIM slot underflowed min allowed count (HLAI only).	Check the input wiring at the FTA; possible open contact. Otherwise, replace the IOP card and/or the FTA.

Error Code	Description	Corrective Action
43 to 114	Not used.	N/A
115	Spare	N/A

3.4 Isolating Smart Transmitter IOP faults

This section lists the transmitter error codes and diagnostic messages associated with Smart Transmitter Interface (STI) or Smart Transmitter Interface Multivariable (STI_MV) IOP.

The error codes (Tables 3 through 5) may be sent to the Operator Station or Smart Field Communicator (SFC).

For error codes for multivariable field devices, refer to the user manual for the specific field device.

3.4.1 Smart Transmitter error codes

Table 4: ST 3000 Pressure Transmitter error codes

Critical	Noncritical
Char PROM Fault	Sensor Over Temp
Suspect Input	Excess Zero Corr
Electronic Fault	Excess Span Corr
	In Output Mode
	Meter Body Overload
	or Meter Body Fault
	Corrects Reset[1]

Table 5: STT 3000 Temperature Transmitter error codes

Critical	Noncritical
Self-Test Fail	Amb. Temp HI/LO
ISO Comm Fail	Uncertain Reading
Input Open	I/P out of Spec
Inval Cal Data	Uncertain CJC
Inval User Data	Excess Zero Corr.
NVM Write Fail	In Output Mode
	User Corr. Active

Table 6: MagneW 3000 Flowmeter Transmitter error codes

Critical	Noncritical	
Excit. Coil Fail.	Bad Config. Data	Empty Pipe
A.C. Power Loss	Local Mode	Ext. Zero Active
NVM Fault	DO Output Mode	Type/Dia Error
RAM Fault	Fixed Pulse Mode	Hi<Lo Alarm Error
A/D Fault	Output Mode	Span>Range
	In Cal. Mode	Pulse Weight Error
	Corrects Reset[1]	Pulse>70%
	Excit. Check Mode	Hysteresis Error

Critical	Noncritical
[1] **Corrects Reset**-This error message on an Smartline 3000 Pressure or MagneW transmitter means that someone has sent a **Reset Correct (Rst Cor)** command to the transmitter from the SFC or the US. This command sets the calibration values to those set into the transmitter's nonvolatile memory during the characterization phase of the transmitter's manufacture. To remove the Corrects Reset message, calibrate the transmitter using a lab standard. If you do not want to recalibrate, make sure that LRV is zero, vent the transmitter to zero inches, send a **Correct LRV** command, and then switch transmitter power off and on.	

3.4.2 Smart Transmitter IOP status messages with corrective actions

The status messages in Table 6 appear in the Transmitter Status field of an operator station detail display. The table lists the possible corresponding problem and the recommended corrective action.

Table 7: Smart Transmitter IOP status messages at Operator Station

Status Message	Problem	Corrective Action
XMTR DATABASE IS NOT YET AVAIL SYSTEM ACQUIRING DATABASE …WAIT (R230 or later)	Power-up.	No action required. Wait for system to acquire database.
XMTR DATABASE NOT AVAILABLE XMTR FAILED OR IN ANALOG MODE (R230 or later)	No DE data on a slot.	Attempt to switch transmitter to 6-byte DE mode. If you cannot do this, replace the transmitter.
XMTR DATABASE NOT AVAILABLE XMTR IN PV MODE W/O DB ACCESS (R230 or later)	STI IOP is in 4-byte DE mode.	No action required. If you want the database, switch to PV_DB or PV_SV_DB, 6-byte mode.
SFC MODIFIED XMTR DATABASE SYSTEM ACQUIRING DATABASE …WAIT (R230 or later)	SFC activity has modified the transmitter database.	6-byte mode column: upload or download if required, or wait for message to disappear. 4-byte mode column: (R230) download; (R300 or later) upload or download.
COMMAND FAILURE UNSUCCESSFUL COMMUNICATIONS (R300 or later)	Failed download or calibrate command from transmitter.	Try again; if command fails, investigate for problem in the transmitter or diagnostic procedure on the communication link.
COMMAND FAILURE INVALID REQUEST (R300 or later)	Failed download or calibrate command from transmitter.	Verify that the correct function has been requested.
COMMAND FAILURE LOCAL MODE (R300 or later, MagneW only)	Failed download or calibrate command from transmitter.	Refer to MagneW 3000 Magnetic Flowmeter User's Guide, 36-KI-25-01.
COMMAND FAILURE FIELD DEVICE IS WRITE PROTECTED (R300 or later, MagneW or ST only)	Failed download or calibrate command from transmitter.	Remove the write protect from the transmitter. Refer to MagneW 3000 Magnetic Flowmeter User's Guide, 36-KI-25-01 or ST 3000 Smart Transmitter User's Manual, 34-ST-32-02B.

Status Message	Problem	Corrective Action
COMMAND FAILURE NVM BAD (R300 or later)	Failed download or calibrate command from transmitter.	Replace transmitter.
COMMAND ALLOWED ONLY ON FIRST SLOT OF MULTIPLE PV XMTRS	Attempted to download database with DECONF change from slot 2, 3, or 4.	Call up slot 1 Detail display for PV1 and retry database download command.
COMMAND FAILURE . . . BUSY	Command could not be executed because transmitter is busy.	Retry the command.
CONFIGURATION MISMATCH MULTIPLE DEVICES ASSIGNED TO SLOT	Another transmitter is physically connected to a logical slot for a multivariable transmitter.	Disconnect offending transmitter or reconfigure the number of PVs for the SMV 3000 transmitter.
TRANSMITTER IS BROADCASTING A SUBSTITUTE VALUE PV	Transmitter is in output mode or input mode.	Use SCT 3000 to remove transmitter from output mode or input mode.

3.4.3 Smart Transmitter considerations

Process variable reliability: Replacing an analog PV signal with a digital PV signal can represent an increase in process value security if all the proper measures discussed below are implemented. The Digital Enhanced (DE) protocol provides for accurate secured communication of process signals between field devices and their controllers. When used in conjunction with a Smart Transmitter IOP board, increased knowledge of the field device is provided along with the signal processing required for the digital PV to attain its high level of performance.

The analog version of the PV contains no checks and balances of any form to indicate to the control system the instantaneous validity of the PV signal. Also, the analog PV signal is not impervious to noise and the control system has no means of recovering lost or corrupted analog PV signals.

It should be noted that the control system, in a DE protocol environment, functions as a passive listener only and is incapable of polling field sensors. As a result, lost or corrupted digital PV data cannot be retransmitted by request. In fact, if that were possible, more PVs would be lost due to the increased communication activity.

Since the DE protocol requires that the field device continuously broadcast PVs, loss of one sample is immediately followed by another sample. As a result, the control system (Smart Transmitter IOP) need only determine whether a given sample is good or bad. This analysis serves to establish the rate at which the controller can be expected to miss PVs due to a corrupted digital communication channel, and also to establish a rate at which the Smart Transmitter IOP can be expected to detect that corruption.

The analysis falls into three categories:

- Error detection
- Noise immunity
- Noise rejection

3.4.4 Error detection

The Digital Enhanced (DE) protocol incorporates two means of enhancing error detection:

- Field Device Status
- Information Redundancy

Field device status: The original analog version of the PV has no way of indicating field device failures to the control system, instantly. Many field devices use a **burnout** technique to indicate device failures-this is usually not instantaneous, and the controller may have already begun control on a signal being driven towards burnout. Consequently, there is no effective means to indicate to the control system the validity of an analog PV signal.

The DE protocol, however, requires that an indication of the field device status be transmitted with every digital PV value. As a result, a controller is never controlling a PV from a known bad field device.

Information redundancies: Redundancy is the addition of non-information carrying bits so that particular mathematical calculations can be made at the receive end to determine whether the group of bits, including the redundant bits, are the same as those transmitted. This process ensures that the original information was correctly received while allowing the capability to detect bad message blocks and have them rejected by the system. The DE protocol contains **Byte parity (VRC)** redundant bits in the message block.

The digital PV value is contained in bytes 2 through 4 of the message block. As a further means of screening potentially bad PV data, all consecutive byte parities (for bytes 1 through 4) must be good before a new digital PV value is accepted by the Smart Transmitter IOP.

Standardized tests: The following tests were performed on the actual hardware with the results focused on PV validity. Test reports are available from Honeywell by special request.

- Temperature
- Voltage Margin
- Power Cycling
- ANSI Surge
- RFI
- ESD
- Fault Insertion

3.4.5 Noise immunity

In DE protocol, increased noise immunity is gained by using a digital communication baud rate that is low in frequency relative to its environmental noise. The DE protocol transmits at a rate of 218 baud. The advantages of this are

- High frequency noise can be easily filtered out with simple RC filters (on the Smart Transmitter IOP board).
- It is less likely that burst noise will last long enough or contain enough energy to interfere with the signal.

Noise immunity is also gained by selecting significantly large and different voltage/current levels to represent a logical 1 and 0. For the DE protocol, these levels are 4 mA/1 volt and 20 mA/5 volts.

3.4.6 Noise rejection

The term **noise rejection** indicates that the digital PV signal is communicating through twisted pair wire in floating point numbers.

Since noise rejection assumes that noise has already corrupted the signal, all noise rejection techniques, in DE protocol, are only applicable to the Smart Transmitter IOP. The Smart Transmitter IOP has the capability of rejecting noise using four techniques:

- Digital input filtering-the IOP contains a simple RC input filter to eliminate high frequency noise. The -3db point is set at 482 Hz.
- Samples per bit-The IOP software UART will take five samples per bit and use a voting technique before declaring a given logic level. Four of the five bit samples must agree for data to be considered good.
- Floating point value check-The IOP software verifies that the received floating point value is of a valid form. All floating point values that do not conform are rejected.
- Digital noise filtering-The IOP software treats the received good digital PV as a real signal by not allowing unusually large instantaneous transitions to occur. This is accomplished by comparing the received digital PV sample with the previous sample. If the new sample differs by greater than 30% of the working range, the new value is discarded and the old value is used for control. The next digital PV value is always used. This technique allows the IOP to reject multi-bit errors which might pass undetected and corrupt the digital PV. Its limitations are that it can only reject one noise sample and it causes a temporary lag in the process.

4 PM I/O Assemblies and Cabling

This section provides descriptions of PM I/O assemblies and components. The descriptions can be helpful to you in troubleshooting PM I/O subsystem faults.

The Honeywell part numbers for all assemblies and components described in this section are listed in the *Spare Parts* section of this document.

Related topics

"PM I/O subsystem assemblies" on page 26
"IOP card types" on page 27
"IOP card-file types" on page 30
"FTAs" on page 32
"FTA mounting channels" on page 38
"I/O Link Extender (Fiber optic link)" on page 41
"FTA wiring connections" on page 43

4.1 PM I/O subsystem assemblies

PM I/O subsystem consists of major assemblies that are described in the following subsections.

Figure 1 is a view of a single PM I/O cabinet containing two non-redundant IOP card files and a power system.

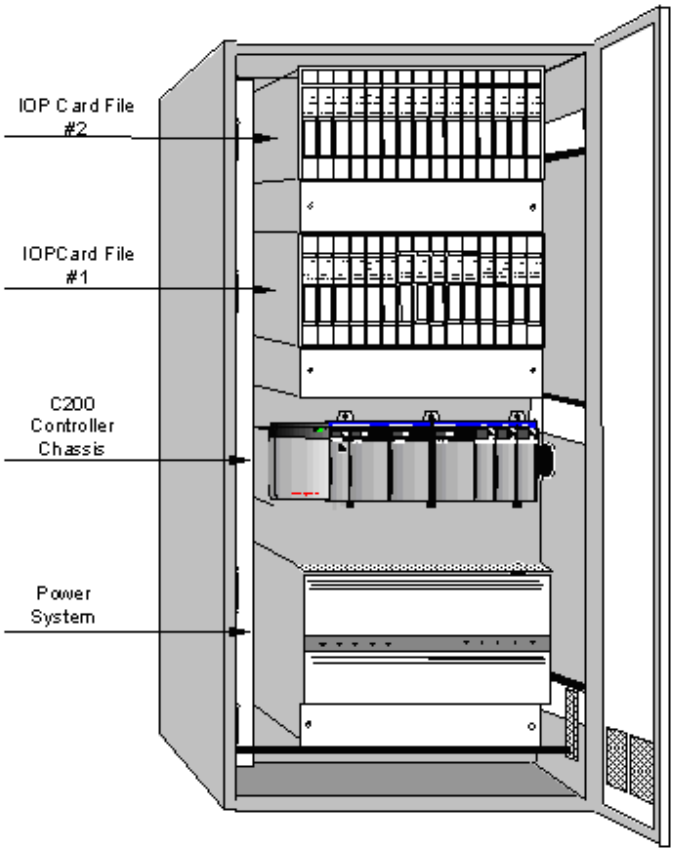


Figure 2: Single PM I/O cabinet

The PM I/O major assemblies that can be mounted within a cabinet are:

- Input/Output Processor Cards (IOPs)
- Left 7-Slot IOP Card File (Slots 1 through 7)
- Right 7-Slot IOP Card File (Slots 9 through 15)
- 15-Slot IOP Card File
- Field Termination Assemblies (FTAs)
- Link Extender
- Power System

4.2 IOP card types

There are various types of IOP card assemblies. Some IOP card types interface with more than one type of FTA.

The types of IOP cards are:

- High-Level Analog Input (HLAI)
- HART High-Level Analog Input (HLAI-H)
- Low-Level Analog Input (LLAI)
- Low-Level Analog Multiplexer (LLMUX)
- Remote Hardened Low-Level Analog Multiplexer (RHMUX)
- Digital Input (DI)
- Analog Output (AO)
- HART Analog Output (AO-H)
- Digital Output (DO)
- Smart Transmitter Interface (STI)
- Smart Transmitter Interface Multivariable (STIM)
- Digital Input Sequence of Events (DISOE)

Some of the functional types of PM IOPs support only certain associated FTA models because the number of channels (points) differ. Examples are the Analog Output (8 and 16 channels) and Digital Output (16 and 32 channels) IOPs.

Redundant IOPs

IOPs can be connected in a redundant configuration with both IOPs connected by separate cables to the same FTA.

Some models of the following IOP types support redundancy:

- Smart Transmitter Interface (STI)
- High Level Analog Input (HLAI)
- Digital Input (DI)
- Digital Output (DO)

Figure 2 illustrates an HLAI FTA that interfaces with a pair of HLAI IOPs that are installed in separate 7-Slot card files.

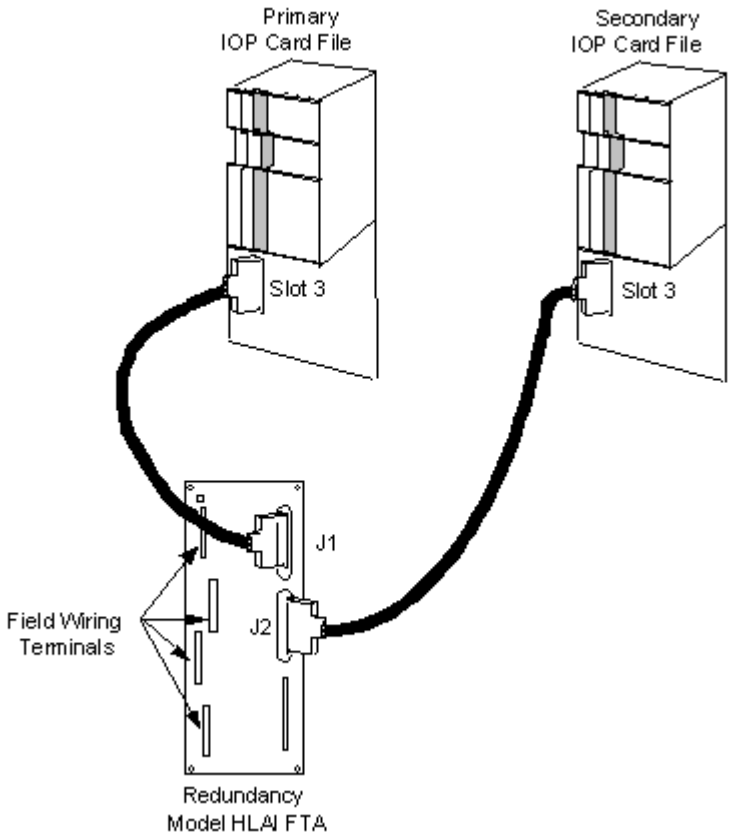


Figure 3: HLAI FTA with redundant HLAI IOPs

4.2.1 Redundant AO IOPs

When an Analog Output FTA interfaces with two IOPs through separate cables, an automatic selector switch on the FTA selects which IOP's output drives the field wiring terminal connectors on the FTA.

4.2.2 Low-Level Multiplexer IOPs

A Low-Level Analog Input Multiplexer (LLMUX) IOP processes up to 32 inputs from two 16 input FTAs.

Figure 3 shows the LLMUX2 FTA interconnections for CE Compliant LLMUX2 FTA models. All LLMUX2 FTA models are CE-compliant and are conformally coated. Refer to Process Manager I/O Installation and Wiring section in *Control Hardware Installation Guide* for detailed information. Also, refer to the *LLMUX2 TC & RTD User's Guide*.

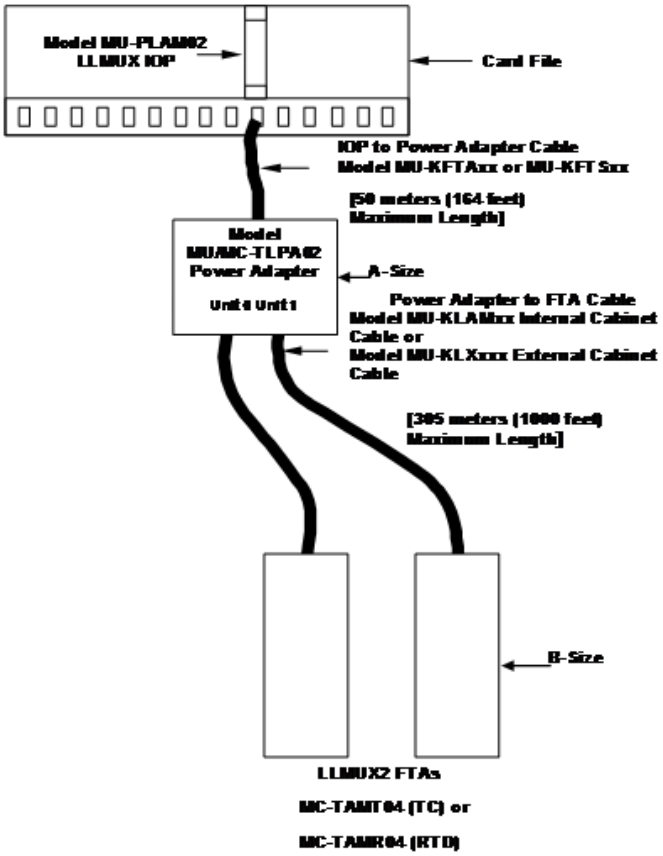


Figure 4: Low-Level Multiplexer interconnections

4.3 IOP card-file types

Table 7 lists three types of card files (with the respective model numbers) that can accommodate IOP cards.

Table 8: IOP card-file types and model numbers

Card File Description	CE Compliant	Non-CE Compliant
Left 7-Slot	MU-HPFI03	MU-HPFH01
Right 7-Slot	MU-HPFI13	MU-HPFH11
15-Slot	MU-HPFI23	MU-HPFX02

4.3.1 Total number of IOP card files

The number of card files that can exist in a single PM I/O subsystem depends on the mix of 7-Slot and 15-Slot card files. Eight I/O Link addresses are available for use in the PM I/O subsystem. Each card file must be assigned a unique I/O Link Interface address. Two 7-Slot card files can share the same I/O Link address if one is a Left card file (slots 1-7) and the other a Right card file (slots 9-15). The 15-Slot card file (Figure 4) cannot share its I/O Link address with another card file.

It is conceivable that sixteen 7-Slot card files can exist in a PM I/O subsystem (eight Left 7-Slot and eight Right 7-Slot card files).

4.3.2 Remote IOP card file

IOP card files can be installed at remote locations through the use of I/O Link Extender cards that are installed in the card files. I/O Link Extender cards provide the communications link between the local control cabinet or cabinet complex and the remote location card files.

4.3.3 Total number of IOP cards

Depending upon the configuration of IOP types, up to 40 primary IOPs, 40 secondary (redundant) IOPs, and 3 I/O Link Extenders (a maximum of 16 I/O Link Extender cards) can exist in a single PM I/O subsystem.

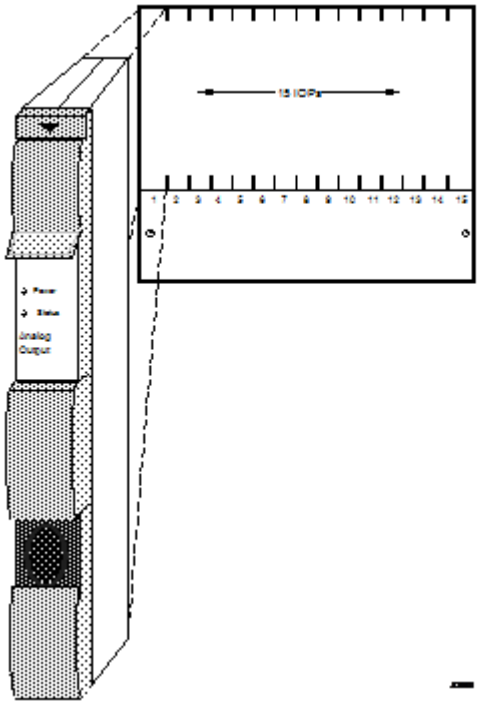


Figure 5: 15-slot IOP card file

4.4 FTAs

FTAs are the interfaces between the IOPs and the field devices for sensing, conditioning, and operating signals. IOPs communicate with process devices using the FTAs as wire-connection interfaces.

Connectors on FTAs provide connection points for:

- A 50-pin cable from each IOP that connects file backplane (IOLIM) to the respective FTA.
- Wiring between the FTA and the process devices.

Depending on the FTA being used, fuses, relays, or resistors protect the FTA circuits.

The FTA types are:

- Standard FTAs (listed and described in Table 8).
- Galvanically Isolated FTAs (listed and described in Table 9).

The model and part numbers for available individual FTAs of each type can be found in the the *Spare Parts* section.

Refer to the Process Manager I/O Hardware Installation and Wiring*Control Hardware Installation Guide*for a more detailed description and installation information of each FTA.

4.4.1 Standard FTAs

Table 9: Standard FTAs

FTA Type	Description
Analog Output (AO)	Provides 4-20mA analog outputs to proportioning loads such as valves.
Analog Output (AO) HART	Provides 4-20mA outputs, and incorporates circuitry to allow HART field devices to be connected to the FTA without using external filters. These FTAs also provide a connector for an external HART multiplexer.
120 Vac Digital Input (DI)	Similar to the 120Vac DI FTA, except it has a higher operating voltage and a lower sense current. The inputs are in four groups of eight circuits with a common return for each group. Groups are isolated from each other.
240Vac Digital Input (DI)	Accepts contacts grouped with an isolated common return. Two versions of the FTA are available, with and without pluggable input modules.
24Vdc Digital Input (DI)	Provides solid-state ac digital outputs that are isolated from each other and the IOLIM.
120/240Vac Solid-State Digital Output (DO)	Provides dc-power digital outputs that are isolated from each other and the IOLIM.
3-30Vdc Solid-State Digital Output (DO)	Provides dc-power digital outputs that are isolated from each other and the IOLIM.
31-200Vdc Solid-State Digital Output (DO)	Provides non-isolated digital outputs to loads such as lamps and relays. The signals are referenced to logic common.
24Vdc Non-isolated Digital Output (DO)	Provides isolated digital outputs to loads such as lamps and relays. The signals are not referenced to logic common.
24Vdc Isolated Digital Output (DO)	Provides independent electro-mechanical relays for ac or dc digital outputs.
120Vac/125Vdc Relay Digital Output (DO)	Provides independent electro-mechanical relays for ac or dc digital outputs.
240Vac/125Vdc Relay Digital Output (DO)	Similar to the 120Vac DI FTA, except it has a higher operating voltage and a lower sense current. The inputs are in four groups of eight circuits with a common return for each group. Groups are isolated from each other.

FTA Type	Description
High-Level Analog Input/ Smart Transmitter Interface (HLAI/STI)	Accepts high-level analog inputs. The inputs are configurable as single-ended or differential in relation to logic common. This FTA is also used to interface to a Smart Transmitter device.
High-Level Analog Input (HLAI)	Accepts high-level analog inputs. The inputs are configurable as single-ended or differential in relation to logic common.
Smart Transmitter Interface (STI)	Interfaces with Smart Transmitter devices. The interface is referenced to logic ground. The Smart Transmitter provides field isolation.
Low-Level Analog Input (LLAI)	Can be configured to accept low-level or high-level analog inputs. Low-level analog inputs include Thermocouples (TC), Resistance Temperature Detectors (RTDs), or millivolt sources. High-level inputs such as voltage sources (0-5V) and 4-20milliamp current-loop devices are acceptable. The inputs are isolated from each other and the IOLIM, but share a common bus for field wire shields.
Low Level Analog Input Multiplexer (LLMUX2) or Remote Hardened Low Level Analog Multiplexer (RHMUX)	The FTA accepts one set of low-level analog inputs, such as thermocouples (TC) or Resistance Temperature Detectors (RTDs). The set of inputs must be either thermocouples or RTDs. One or two FTAs of either type can be connected to one Power Adapter assembly and its IOP. The LLMUX2 FTA is a direct replacement for the LLMUX FTA. Detailed information about the LLMUX2 FTA can be found in the *LLMUX2 TC and RTD FTAs User's Guide.* The LLMUX2 FTA part numbers are used in the Optimum Replaceable Unit (ORU) Parts listing in Section 7 of this document.

4.4.2 Galvanically-isolated FTAs

Table 10: Galvanically Isolated FTAs

FTA Type	Description
High Level Analog Input (HLAI/STI)	Accepts high-level analog inputs. Some FTA models also interface with Smart Transmitter devices. All inputs are isolated from ground and each other.
24Vdc Digital Input (DI)	Accepts contact inputs. All inputs are isolated from each other.
Analog Output (AO)	Provides isolated 4-20mA outputs to proportioning loads such as valves.
Analog Output (AO) HART	Provides 4-20mA outputs, and incorporates circuitry to allow HART field devices to be connected to the FTA without using external filters. These FTAs also provide a connector for an external HART multiplexer.
24Vdc Digital Output (DO)	Provides isolated digital outputs to loads such as solenoid valves or lamps.

4.4.3 LLMUX2 FTAs

LLMUX2 TC and RTD FTAs are connected to the IOP through a Power Adapter assembly as shown in Figure 5. One TC FTA and one RTD FTA, or two of the same FTA types can be connected to one IOP through the Power Adapter.

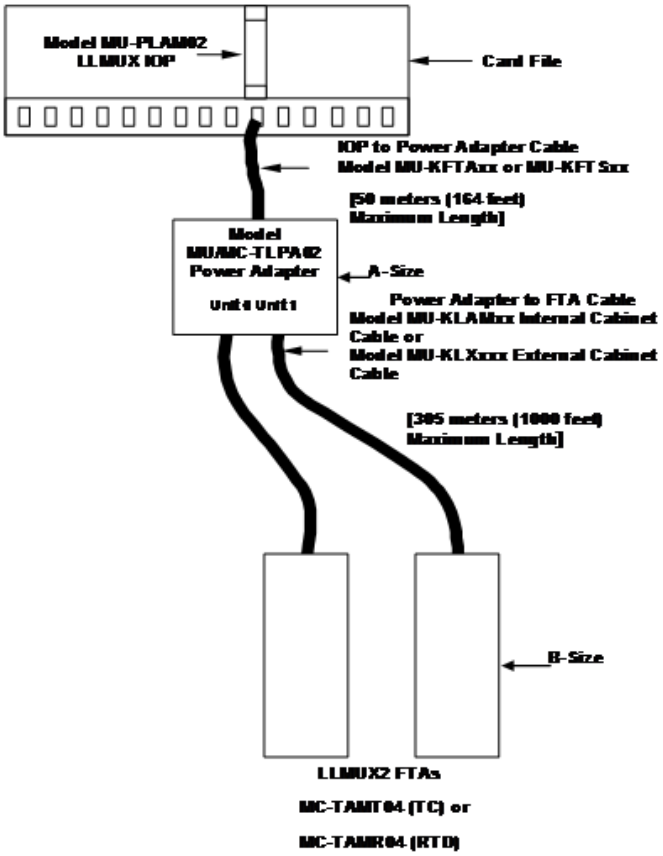


Figure 6: LLMUX2 FTA connections to LLMUX IOP

Power Adapter for FTAs: The Power Adapter provides power to the FTA(s) from the IOP, and can be installed on an FTA mounting channel.

The Power Adapter assembly has two LEDs, one for each cable that indicates a grounded or shorted cable. Each FTA has an LED that indicates the FTA is receiving power

IOP to Power Adapter connection: The IOP to Power Adapter connection is made using the standard model MU-KFTAxx IOP to FTA cable. (The suffix 'xx' in the model number represents the length of the cable in meters.) The maximum allowable length is 50 meters (164 feet).

For CE-compliant applications, the model MU-KFTSxx IOP-to-FTA cable must be used.

Power Adapter to FTA connection: The Power Adapter connects to either FTA type with a model MU-KLAMxx (internal cabinet use) or model MU-KLXxxx (external cabinet use) cable (one per FTA) as shown in the previous figure. The cable is limited to a maximum length of 305 meters (1000 feet).

The model MU-KLAMxx cable has two individually shielded, twisted pair wires. The shield must be connected to ground at the Power Adapter end of the cable only.

The model MU-KLXxxx external cabinet cable has four wires with a single braided shield. The braided shield must be connected to ground at both the Power Adapter and FTA ends of the cable.

For CE Compliant applications, Belden model 83654 braided shield cable must be used.

Refer to the *LLMUX2 TC and RTD FTAs User's Guide*.

4.4.4 Remote Hardened Low Level Multiplexer (RHMUX) PM IOP

The Remote Hardened Low-Level Analog Input Multiplexer (RHMUX) IOP can process up to 32 inputs from two 16-input FTAs. Figure 6 illustrates the RHMUX IOP, Power Adapter, and Thermocouple FTA interconnections for a CE-compliant application.

For non-incendive applications, Power Adapter Models MU/MC-TRPA01 GI/NI are available.

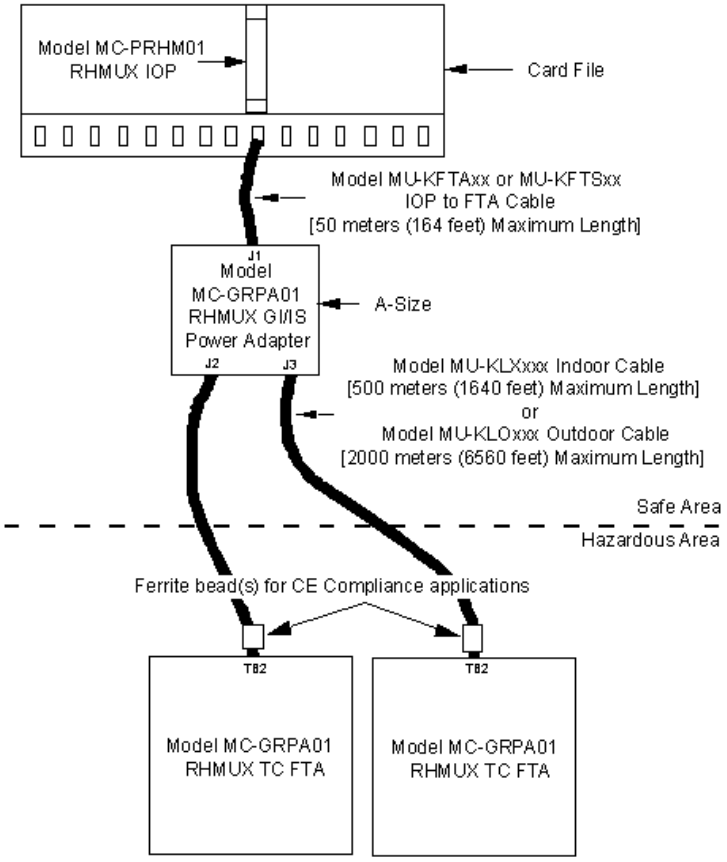


Figure 7: Remote Hardened Low-Level Multiplexer interconnections

4.4.5 RHMUX Thermocouple FTA

One or two Thermocouple (TC) type RHMUX FTAs can be connected to a RHMUX IOP through either an Intrinsically Safe (IS) or Non-Incendive (NI) Power Adapter assembly.

4.4.6 RHMUX FTA and Power Adapter

The Power Adapter provides power to the FTA(s) from the IOP. Both types of Power Adapters can be installed on an FTA mounting channel. The FTA' s dimensions (size) are non-standard and prevent installing the FTA on a standard FTA mounting channel.

The Power Adapter assembly has two LEDs, one for each cable, that indicate a grounded or shorted cable. Each FTA has an LED that indicates the FTA is receiving power.

IOP to Power Adapter connection: The IOP to Power Adapter connection is made using the standard model MU-KFTAxx IOP-to-FTA cable. The suffix 'xx' in the model number represents the length of the cable in meters. The maximum allowable length is 50 meters (164 feet).

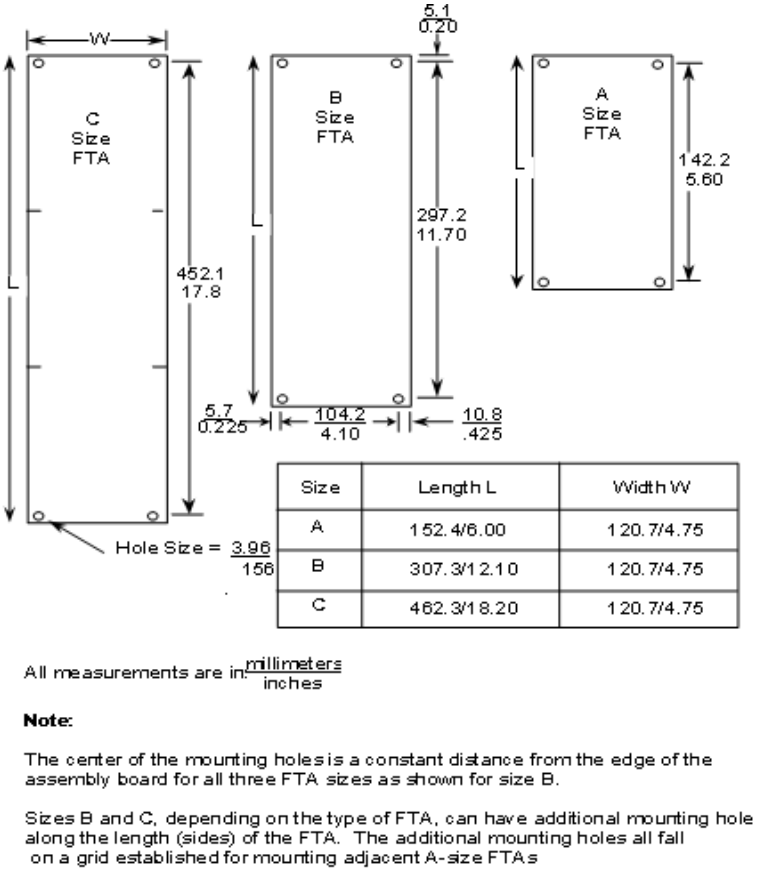
For CE-Compliant applications, the model MU-KFTSxx IOP-to-FTA cable must be used.

Power Adapter to FTA connection: The Power Adapter connects to the FTA through a model MU-KLXxxx (internal cabinet use) or model MU-KLO305 (external cabinet use) cable (one per FTA). The model MU-KLXxxx cable is limited to a maximum length of 305 meters (1000 feet), while the model MU-KLO305 cable is 305 meters in length, the cable type (Belden YC41926) can be used in lengths of up to 2000 meters (6560 feet).

Both types of cables have four conductors in a single-twist with a single braided shield. The shield must be connected to ground at both the Power Adapter and FTA ends of the cable.

4.4.7 FTA sizes

The standard FTAs have three physical sizes (referred to as A, B, and C) as illustrated in the Figure 7. The galvanically isolated FTAs are B-size only.



Size	Length L	Width W
A	152.4/6.00	120.7/4.75
B	307.3/12.10	120.7/4.75
C	462.3/18.20	120.7/4.75

Figure 8: FTA Sizes

4.4.8 Mounting FTAs

FTAs are installed at the rear or at the front of a dual access cabinet on one or more FTA mounting channels. In a single access cabinet, the FTAs are mounted on FTA mounting channels at the front of the cabinet. The FTA mounting channels also function as cable and wiring channels, or troughs.

CAUTION

The standard and galvanically isolated FTAs must not be mounted on the same FTA mounting channel. Mounting both types of FTAs on the same FTA mounting channel is an intrinsic safety violation because their field wiring will be routed together. See Process Manager I/O Hardware Installation and Wiring Installing Standard FTAs in the Control Hardware Installation Guide for additional information on FTA installation.

4.4.9 Vertically-oriented FTAs

Standard and galvanically isolated FTAs are mounted on vertically oriented 3-foot long FTA mounting channel segments.

CAUTION

Standard and galvanically isolated FTAs must not be mounted on the same FTA mounting channel. Mounting both types of FTAs on the same FTA mounting channel is an intrinsic safety violation because their field wiring will be routed together. See Process Manager I/O Hardware Installation and Wiring Installing Standard FTAs in the *Control Hardware Installation Guide* for additional information on FTA installation.

4.5 FTA mounting channels

FTA mounting channels are used for mounting the FTAs, and for organizing and separating the field wiring and IOP-to-FTA cables.

The FTAs are installed on FTA mounting channels located in the front of a single access control cabinet, and in the rear or front of a dual-access cabinet.

The number of FTA mounting channels that can be accommodated in a control cabinet depends on whether the cabinet is single access or dual access, and whether standard or wide vertically-orientated FTA mounting channels are installed.

Optionally, galvanically isolated FTAs can be mounted on horizontally-oriented FTA mounting channels.

4.5.1 Vertical FTA mounting channels

Vertical FTA mounting channels are available in two sizes (standard and wide) to better accommodate the amount of process-control wiring that connects to the FTAs. The FTA mounting channels provide both a mounting surface for the FTAs and dual channels (troughs) to route the IOP-to-FTA cabling, and the process control wiring.

When standard FTAs are mounted on the FTA mounting channel, the IOP-to-FTA or Power Distribution Assembly cabling is routed in the right channel and the process control wiring is routed in the left channel. The opposite is true when galvanically isolated FTAs are mounted on the FTA mounting channel because the vertical orientation of the FTA mounting channel is reversed.

4.5.2 Horizontal FTA mounting channels

Horizontal FTA mounting channels can be installed when galvanically isolated FTAs are mounted in the cabinet. Only galvanically isolated FTAs are mounted on the horizontal FTA mounting channels. They are approximately 61 centimeters (24 inches) long, and up to eight horizontal FTA mounting channels can be accommodated on one side of the cabinet.

IOP-to-FTA, Power Distribution Assembly, or Marshalling Panel cabling is routed in the upper channel to the left side of the cabinet, and the process-control wiring is routed in the lower channel to the right side of the cabinet.

4.5.3 Typical FTA channel mounting in PM I/O cabinet

Single vertical FTA channels mounted adjacent to each other can be used to accept FTAs installed in the front lower area of a single-access cabinet below an IOP card file and power system as shown in Figure 8.

A typical cabinet layout of FTA mounting channels and standard FTAs in the rear of a dual-access controller cabinet is shown in Figure 9.

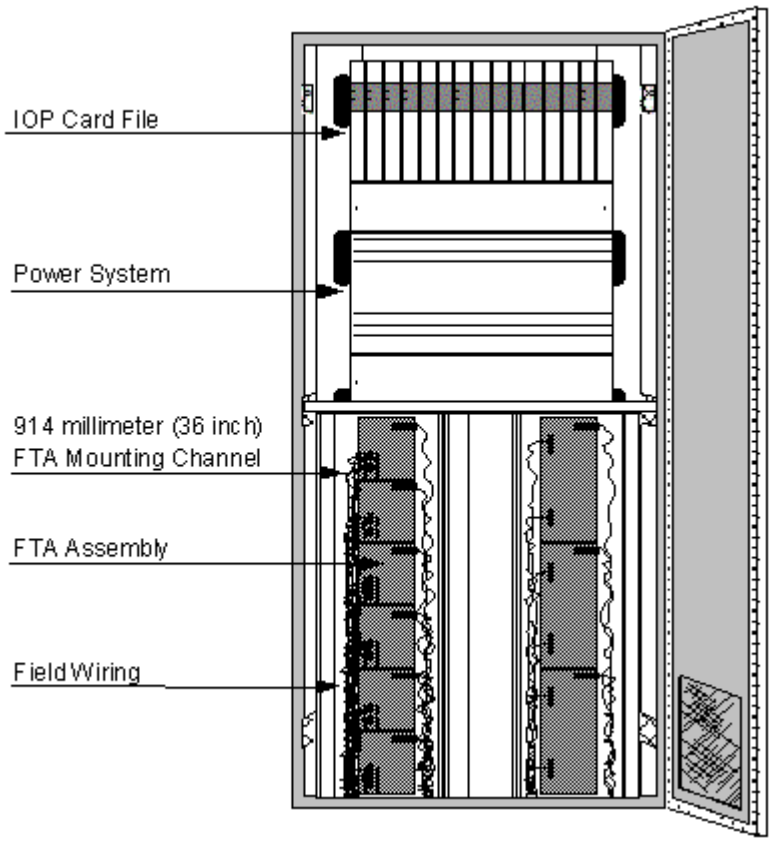


Figure 9: Vertical FTA mounting channel installation - single access cabinet

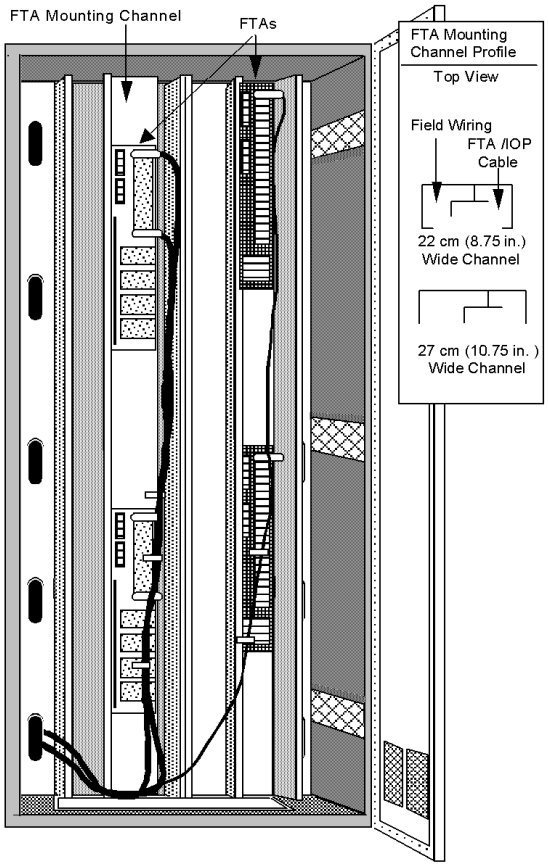


Figure 10: Vertical FTA mounting channel layout - dual access cabinet

4.6 I/O Link Extender (Fiber optic link)

The I/O Link Extender provides the capability to locate 7-slot and 15-slot IOP card files and associated FTAs up to 8 kilometers (5 miles) from the IOLIM.

The following two types of I/O Link extenders and their associated fiber-optic coupler modules are available:

- The standard I/O Link extender provides up to a 1.3-kilometer (4000 feet) link.
- The long-distance I/O Link extender provides up to an 8-kilometer (5 miles) link. The connection is made using a pair of fiber-optic transmission cables. The cables are driven and terminated by a fiber-optic coupler module that mates with the connector located directly below the card-file slot in which the I/O Link extender card is installed.

4.6.1 Features and guidelines

- Each I/O Link Extender consists of two I/O Link extender cards. One card for Link A and one card for Link B, which occupy two slots in the IOP card file.
- Each standard I/O Link extender card has an associated fiber-optic coupler module that can drive up to three pairs of fiber-optic cables. Each cable pair is terminated by a fiber-optic coupler module that terminates one fiber-optic cable pair.
- Each long-distance I/O Link extender card has an associated fiber coupler that drives a single pair of fiber-optic cables. Each cable pair is terminated by a fiber-optic coupler module that terminates one fiber-optic cable pair.
- Every remote card file or complex of IOP card files, requires two I/O Link extender cards and two fiber-optic coupler modules; one for Link A and one for Link B. The standard I/O Link extender card will drive and terminate Link A or Link B, depending on the card-file number and card-file slot number.
  - If the card-file number and card-file slot number are both odd or both even, the card will drive Link A
  - If the card-file number and card-file slot number are not both odd or both even, the card will drive Link B.
  - The Link A or Link B selection for the long-distance I/O Link extender is determined by a jumper on the card.
- Two standard I/O Link Extender cards connecting up to six remote card files, can be installed in an IOP card file, but the maximum number of other primary IOPs is still 40 (plus 40 redundant IOPs). The I/O Link Extender cards do not count as part of the 40 primary IOP maximum limit.
- The maximum fiber optic cable length depends on the number of splices and quality of the cable (dB loss per meter of cable). This maximum length can be between 0.98 and 1.3 kilometers for the Standard I/O Link Extender and 8 kilometers for the Long Distance I/O Link Extender. See Appendix B-Signal Loss Budget,Signal Loss Budget Calculation In Control Hardware Planning Guide for more information.

4.6.2 Front panel indicators

Two front-panel indicators are provided on the I/O Link Extender card that are consistent with the display of IOP card indicators. The upper indicator is lighted if the fused +24 Vdc is present on the card (the input voltage is acceptable). The lower indicator shows the status of the I/O Link Extender card.

4.6.3 Status indicators

In normal operation, the lower indicator is lighted when messages are being transmitted from the fiber optic cable. The indicator should be fully lit or flickering, depending on system loading.

Abnormal operation will result in the anti-jabber circuit locking up the transmitter circuit when the transmission period has been too long. The indicator will then be off.

The anti-jabber circuit can be reset by cycling the upper extractor/insertion lever power switch on the I/O Link extender card. For the long distance I/O Link extender, cycling power resets both ends of the link. The standard I/O Link extender must be manually reset at both ends of the link. The long distance I/O Link extender can be reset by cycling power at one end of the link.

If the fiber optic coupler module is improperly installed, the indicator will blink at a 50% duty cycle.

For detailed information on I/O Link Extender installation and system components, refer to Installing Remote I/O in *Control Hardware Installation Guide* .

4.7 FTA wiring connections

Most standard FTA types are available with either compression-type or screw-type terminal connectors.

Some exceptions are the 6-inch Analog Output (AO), 6-inch High Level Analog Input (HLAI), 6-inch Low Level Analog Input Multiplexer (LLMux), and the 6-inch Digital Input Power Distribution Assembly that are available with only compression-type terminal connectors.

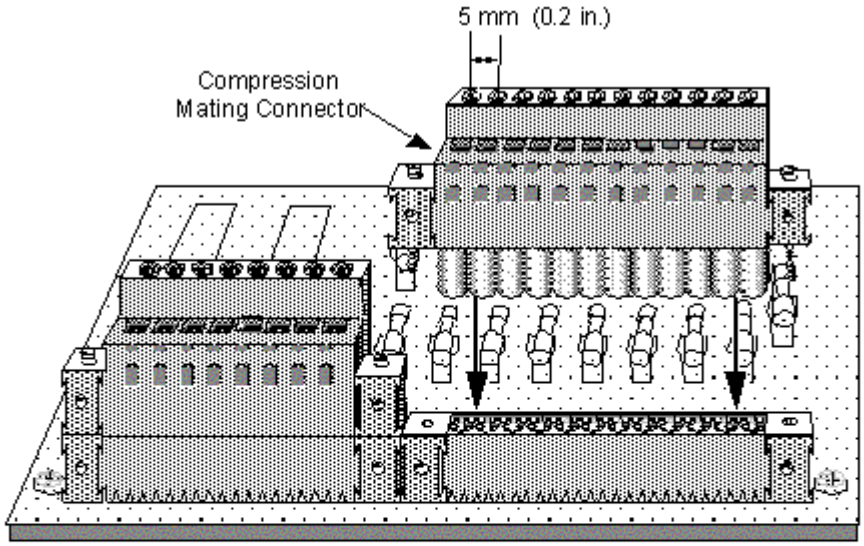
The Remote Hardened Low Level Analog Input Multiplexer (RHMUX) is available only with screw-type terminal connectors. The number of terminals for both the compression-type and screw-type terminal connector can vary depending on the type of standard FTA.

All galvanically isolated FTAs are available with both crimp pin-type and compression-type terminal connectors.

The Marshalling Panel and Combiner Panel are available only with screw-type terminals.

4.7.1 FTA compression-type terminal connector

Figure 10 shows a typical compression-type terminal connector connection to a standard FTA.



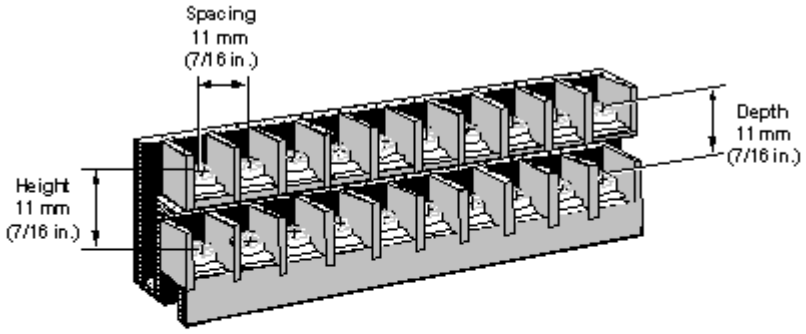
Compression Mating Connector

Number of Connections	Honeywell Part Number
8 11 12	511190694 - 108, - 208, - 408 - 111, - 411 - 112, - 412

Figure 11: Typical FTA compression-type terminal connector

4.7.2 FTA fixed screw-type terminal connector

Figure 11 shows a typical fixed screw-type terminal connector as it would appear on a standard FTA.



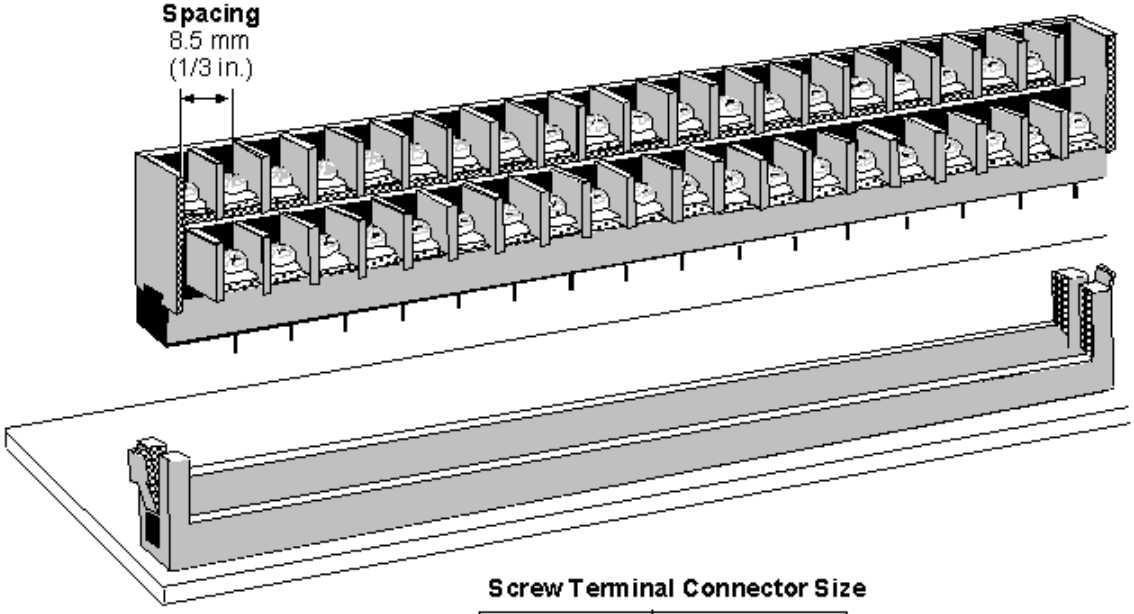
Screw Terminal Strip Sizes

Number of Terminals	Connector Length
8	52 mm (2.0 in.)
12	74 mm (2.9 in.)
24	140 mm (5.5 in.)

Figure 12: Typical FTA fixed screw-type terminal connector

4.7.3 FTA removable screw-type connector

Figure 12 shows a typical removable screw-type terminal connector.



Screw Terminal Connector Size

Number of Terminals	Connector Length
40	176 mm (6.9 in.)

Figure 13: Typical FTA removable screw-type terminal connector

4.7.4 PM IOP Galvanic Isolation Module connectors

Crimp pin-type and compression-type terminal connectors are available for galvanically isolated FTAs. Terminal connectors on the Galvanic Isolation Modules have six terminals. Depending on the type of terminal connector, the terminals accept size 0.3 to 3.5 mm^2 (12 to 22 AWG) wiring.

4.7.5 Galvanic Isolation Module crimp-pin type terminal connector

Wire Size	Crimp Pin Part Number	Crimp Tool
14-20 AWG	51191737-201	51191787-100

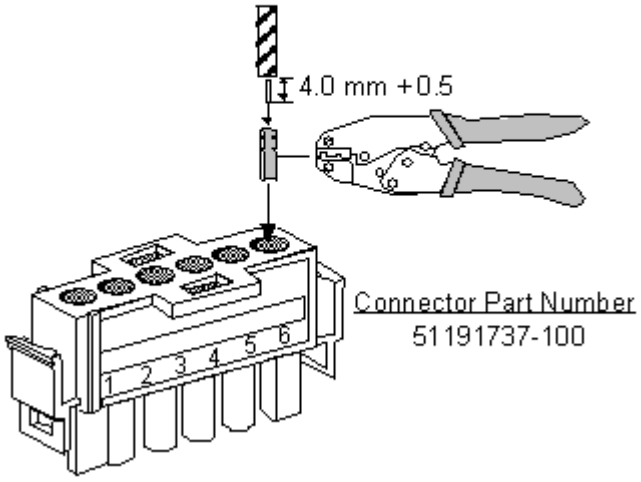


Figure 14: Crimp-pin type Galvanic Isolation Module terminal connector

4.7.6 Galvanic Isolation Module compression-type terminal connector

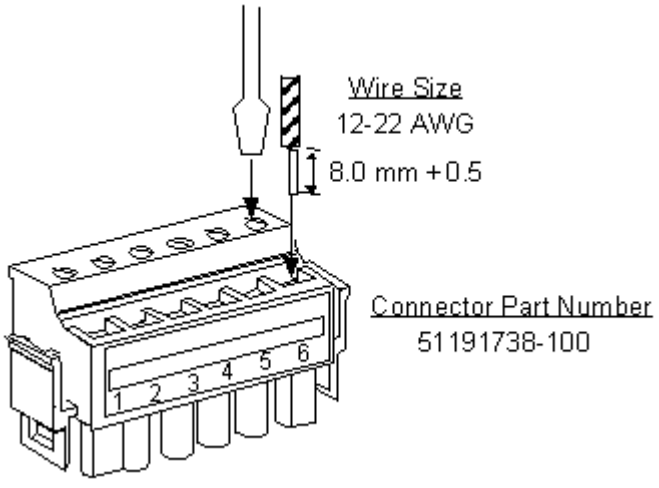


Figure 15: Compression-type Galvanic Isolation Module terminal connector

5 PM I/O Power System

The following section describes about Controlling the PM I/O power system.

Related topics

5.1 PM I/O Power System

The following section describes about Controlling the PM I/O power system.

5.2 Controlling the PM I/O power system

Controlling AC input power

All ac input power to the control cabinet, which includes any cabinet fan assemblies, is controlled by a dedicated circuit breaker supplied by the user for each power supply module in the power system. Additional ac power supply module control is provided by a power switch that is mounted at the front of each module.

Controlling DC power

Since the standard power system can contain redundant power supply modules, placing a module's power switch in the OFF position does not necessarily remove power from the controller chassis, IOP card files, and FTAs in the cabinet because the second power supply module will continue to supply power unless its power switch is in the OFF position.

If the standard power system contains a battery backup module, 24Vdc power will continue to be supplied to the controller chassis, card files, and FTAs unless the BATTERY switch is placed in the OFF position or the battery backup module is discharged. All three switches must be in the OFF position to completely remove power from the equipment.

AC-Only Power System

In a cabinet that contains an AC-Only Power System, no battery backup module exists to provide 24Vdc power to the equipment. Control of dc power to the controller chassis, card files, and FTAs is provided exclusively by user-supplied ac circuit breakers. When redundant power supply modules exist, each module has its own circuit breaker that is provided by the user. There is no On-Off switch at the front of the power supply module.

IOP Card Power Interrupt Switches

PM I/O Link cards and each IOP card have a 24 Vdc power interrupt switch that is activated by unlocking and lifting the upper card extractor/insertion lever. Activating an IOP card power interrupt switch removes power only from that IOP card, thereby allowing the IOP card to be removed from the card file. Power is removed only while the switch is activated.

WARNING

The loss of power to an analog or digital output IOP causes the loss of the IOP's outputs to the field connections. Analog output IOP outputs drop to a nonpowered state (-6.9%), and the digital output IOP outputs are set to their off state.

The nonpowered state of the output IOPs should result in a safe condition for personnel, the plant, and the process under control.

5.3 PM I/O power system outputs

The power systems for the PM I/O provide:

- 24Vdc power for operation of all controller chassis, IOP cards, and FTAs
- Nominal 3.6Vdc battery output for backup of the IOP memory circuits.
- Nominal 6Vac @ 0.25 ampere output for operation of an LLAI line frequency noise cancellation clock circuit.

There are two types of PM I/O power systems and they are listed in Table 10.

Table 11: Power system types

Power System Type	Description
Standard Power System (Model MU/MC-PSSX04)	Power system with optional redundant power supply module and battery backup module.
AC Only Power System (optional)	This power system is intended for use with an uninterruptible ac power source. It does *not* provide a battery backup option for continuous operation in the event of a primary power loss.

5.3.1 Standard power system

The standard power system shown in Figure 15 has many versatile attributes that include:

- An optional redundant Power Supply Module (model MU-PSRX04)
- 120Vac or 240Vac input power. A single or dual source of input power can be connected when the optional redundant power supply module option is implemented
- Dual AC Mains power feed
- Single and redundant power supply module failure detection
- CMOS memory NiCad battery backup (3.6Vdc) with failure detection
- Optional 48Vdc Battery Backup Module (model MU-PSRB04) with a disconnect connector that provides continuous backup power in the event of a primary power loss
- Provides fused ac power for 4 cabinet-fan assemblies

The standard power supply contains twelve 24Vdc power distribution output connectors, four cabinet fan assembly power connectors with associated fuse holders, and a NiCad battery holder on the backpanel. Alarm contacts available at the power supply provide alarm signals (for external alarm mechanisms) from each power supply module and the CMOS battery backup. The alarm signals are normally wired in series to a 24Vdc Digital Input FTA to notify the system when a power supply module fails

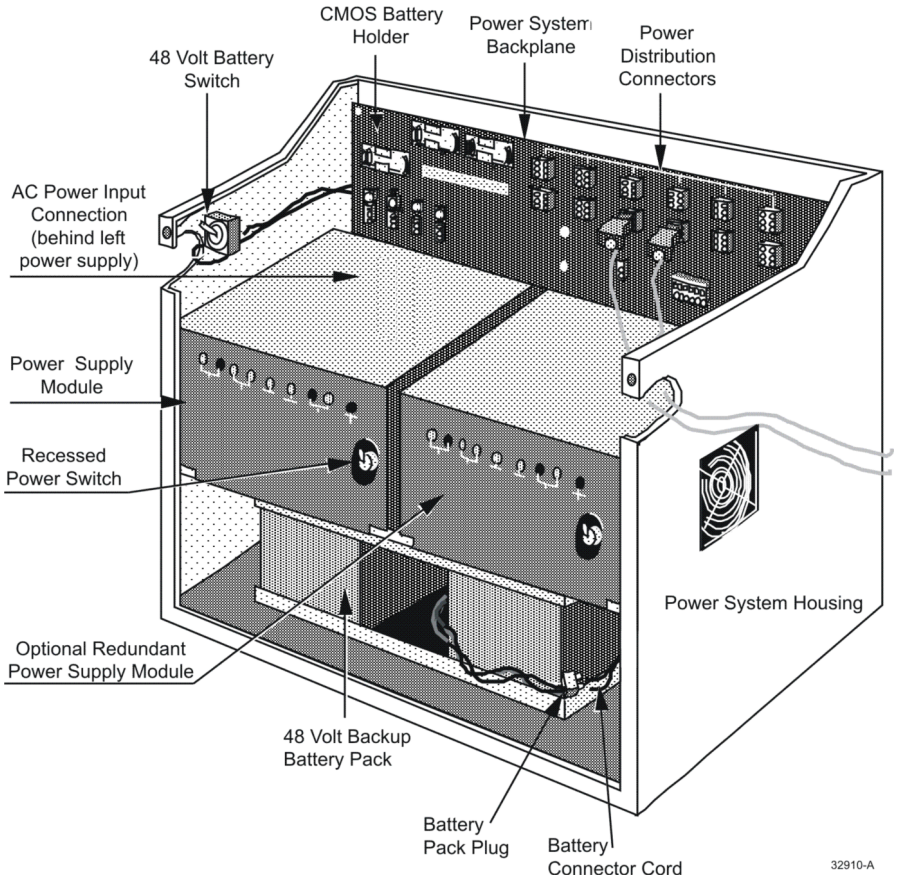


Figure 16: Standard power supply

48 volt battery backup time duration

The 48 volt battery backup time duration for a redundant control cabinet containing 40 IOPs (40 nonredundant or 20 redundant pairs) is approximately 20 minutes for a fully charged battery.

CMOS backup-time duration

The following CMOS backup durations are defined for a redundant control cabinet containing 40 IOPs (40 nonredundant or 20 redundant pairs). The time duration depends on which type of power system exists in the specific control cabinet.

Standard Power System = 45 hours (uses three C size NiCad batteries)

AC Only power system = 55 hours, with new batteries (use three alkaline batteries)

The current draw of each IOP is almost negligible.

5.3.2 AC-Only power system

The AC-Only Power System shown in Figure 16 is intended for use with an uninterruptible ac power source. It does not provide a battery backup option for continuous operation in the event of a primary power loss.

The AC-Only power system offers optional 8- or 16-ampere redundant power supply modules, but does not offer the optional 48Vdc battery backup module feature and rechargeable NiCad CMOS memory backup power. Nonrechargeable alkaline battery CMOS memory backup power is provided instead.

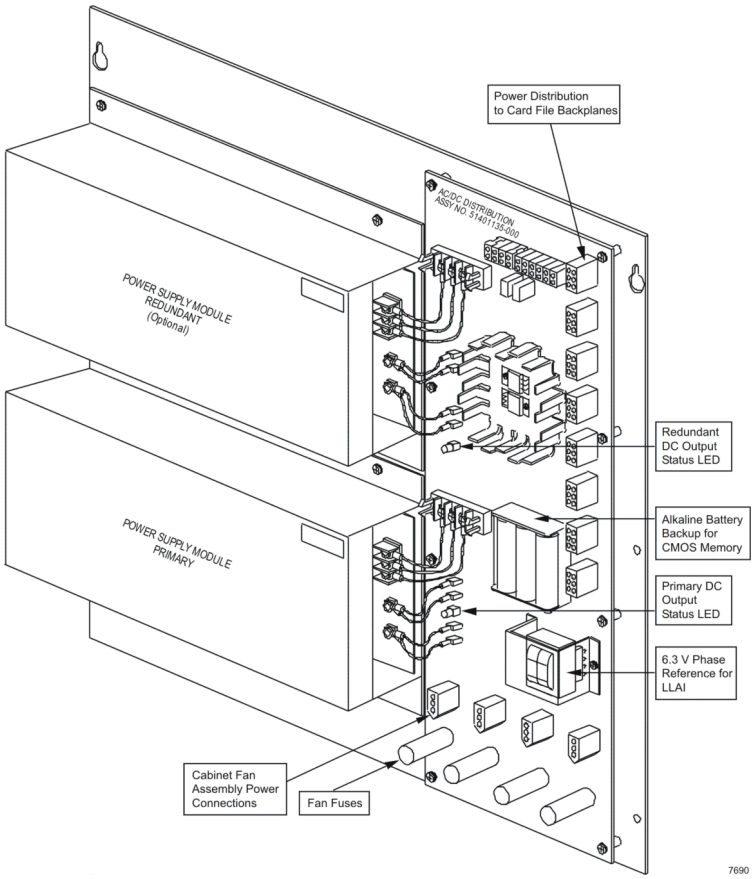


Figure 17: AC-Only power system

The AC-Only power system has eight power distribution output connectors and four fused Cabinet Fan Assembly power connectors. There are two sets of normally-open relay alarm contacts that signal a power supply module failure. The alarm signals are normally wired in series to a 24Vdc Digital Input FTA to notify the system when a power supply module fails. Two LED indicators, mounted on the AC-Only AC/DC Distribution Assembly, offer a visual indication of a power supply module failure when the LED is extinguished.

5.4 Power distribution

A schematic of PM I/O power distribution is shown in “Figure 18: Power distribution”.

In the standard power system, AC input power connections are located on the lower left side of the backpanel, behind the left power supply module (refer to Figure 17). Primary and redundant terminals can be wired in parallel from a single power line source, or wired separately from two power line sources.

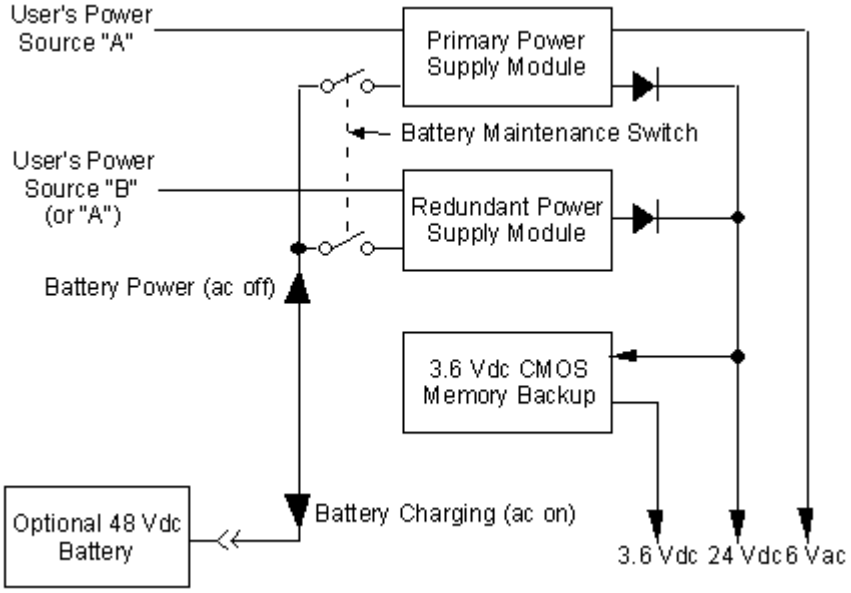


Figure 18: Power distribution

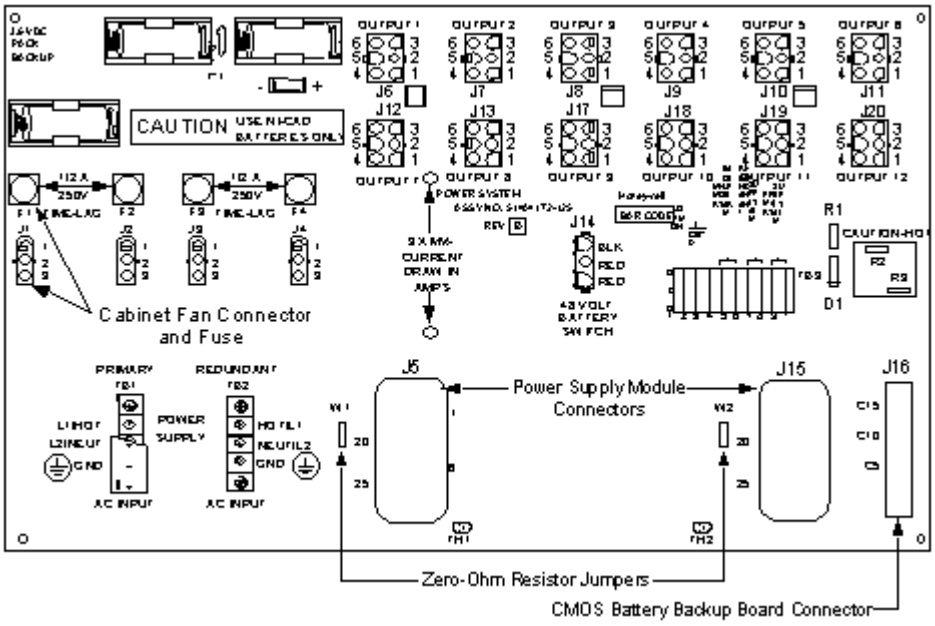


Figure 19: Standard power system backpanel

5.4.1 AC-Only power system ac power distribution

AC input power connections to the AC-Only power system are made to the AC Input terminal strips at the left side of the AC/DC Distribution board as shown in Figure 16. The upper AC Input terminal strip powers the optional redundant power supply module, and the lower AC Input terminal strip powers the primary power supply module. The primary and redundant terminals can be wired in parallel from a single power line source, or wired separately from two power line sources.

5.5 Battery backup module

The Battery Backup Module used to power the 24Vdc power supply modules is a 48Vdc lead-acid battery that provides backup power for approximately 25 minutes with a full charge. The charging circuit is active in both power supply modules whenever ac power is available to the power supply module(s). At least one power supply module must be present to allow the battery to supply power to the card files.

5.5.1 48-Volt Battery switch

A 48-Volt Battery switch located at the left side of the standard power system chassis provides a means of preventing the power supply modules from discharging the battery backup module when ac power is removed from one or both power supply modules. Placing the switch in the Off position disconnects the battery to power supply module paths.

5.5.2 No battery backup

When there is no battery backup, a battery backup failure is reported unless the zero-ohm resistor jumpers, W1 and W2, located next to the power supply module connectors are cut. This is done at the factory before shipping. If a battery backup is later installed, the connections must be restored.

5.6 CMOS battery backup

Depending on the power system configuration, three rechargeable NiCad or three nonrechargeable alkaline batteries provide a nominal 3.6Vdc for CMOS memory backup power. The batteries support all the memory circuits in the IOPs. NiCad batteries are long-lived, and they are automatically tested periodically. Every 8 seconds the batteries' output voltage is tested for the proper level, and every 2 hours a load is applied to the batteries and the voltage level is again tested.

Attention
A bad-batteries alarm occurs when the CMOS batteries are discharged.

The standard power system uses 3 C-size NiCad batteries which provide approximately 45 hours of backup.

Refer to “Figure 19: Standard power system backpanel” for the location of the CMOS battery backup board assembly connector on the backpanel.

5.6.1 Standard power system CMOS battery backup

The standard power system configuration has NiCad batteries located at the upper left of the power system chassis backpanel, and the supporting CMOS battery backup assembly is inserted into a connector at the lower right-hand side of the backpanel (refer to Figure 15).

The right-side power supply module must be removed to view the CMOS battery backup assembly. The assembly provides both charging circuitry and monitoring circuitry for failure alarm reporting. “Figure 20: CMOS battery backup assembly (standard power system)” is the latest version of the CMOS battery backup assembly.

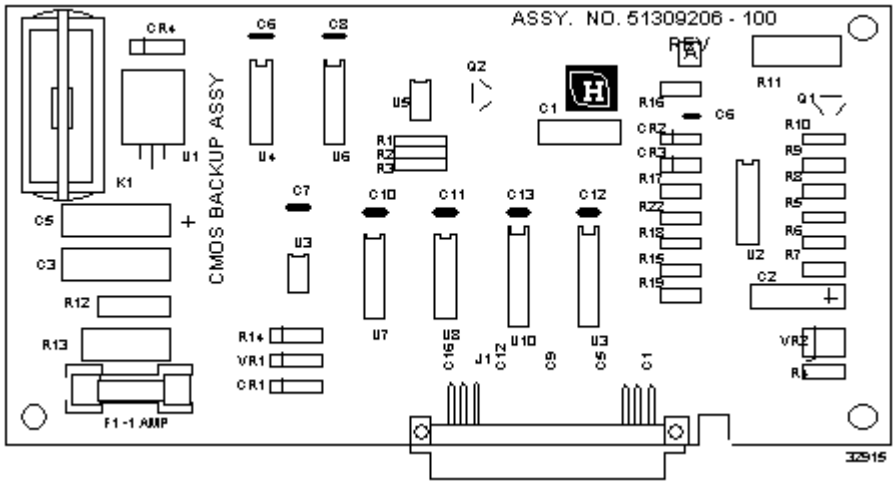


Figure 20: CMOS battery backup assembly (standard power system)

5.6.2 AC-Only power system battery backup

The AC-Only power system uses alkaline batteries which must be replaced frequently. A new set of batteries provide approximately 55 hours of backup time. The three alkaline batteries are located at the center of the AC/DC Distribution Assembly as shown in Figure 16.

The AC-Only power system does not provide battery charging or battery monitoring for the alkaline batteries.

5.7 24Vdc power distribution

The following section describes about 24dc power distribution system.

5.7.1 Dual power distribution cables

To improve reliability, redundant 24Vdc distribution to the IOP card files is always provided by two separate power distribution cables.

5.7.2 Standard power system

The standard power system shown in Figure 15 has many versatile attributes that include:

- An optional redundant Power Supply Module (model MU-PSRX04)
- 120Vac or 240Vac input power. A single or dual source of input power can be connected when the optional redundant power supply module option is implemented
- Dual AC Mains power feed
- Single and redundant power supply module failure detection
- CMOS memory NiCad battery backup (3.6Vdc) with failure detection
- Optional 48Vdc Battery Backup Module (model MU-PSRB04) with a disconnect connector that provides continuous backup power in the event of a primary power loss
- Provides fused ac power for 4 cabinet-fan assemblies

The standard power supply contains twelve 24Vdc power distribution output connectors, four cabinet fan assembly power connectors with associated fuse holders, and a NiCad battery holder on the backpanel. Alarm contacts available at the power supply provide alarm signals (for external alarm mechanisms) from each power supply module and the CMOS battery backup. The alarm signals are normally wired in series to a 24Vdc Digital Input FTA to notify the system when a power supply module fails

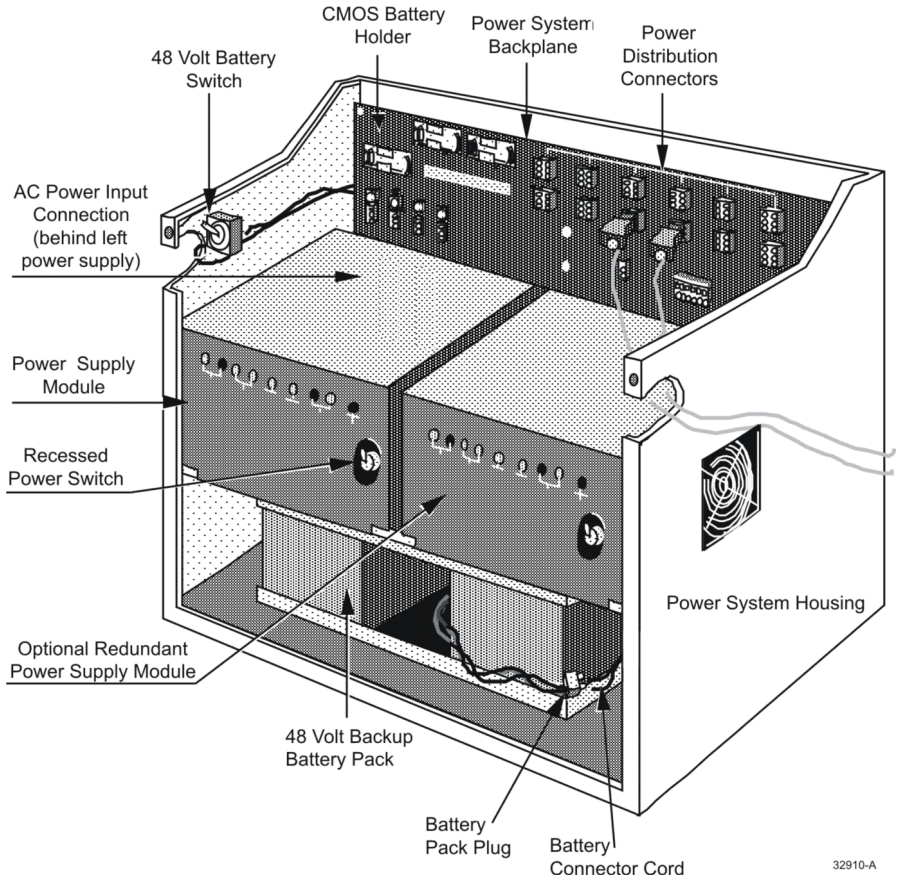


Figure 21: Standard power supply

48 volt battery backup time duration

The 48 volt battery backup time duration for a redundant control cabinet containing 40 IOPs (40 nonredundant or 20 redundant pairs) is approximately 20 minutes for a fully charged battery.

CMOS backup-time duration

The following CMOS backup durations are defined for a redundant control cabinet containing 40 IOPs (40 nonredundant or 20 redundant pairs). The time duration depends on which type of power system exists in the specific control cabinet.

Standard Power System = 45 hours (uses three C size NiCad batteries)

AC Only power system = 55 hours, with new batteries (use three alkaline batteries)

The current draw of each IOP is almost negligible.

5.7.3 AC-Only power system

The AC-Only Power System shown in Figure 16 is intended for use with an uninterruptible ac power source. It does not provide a battery backup option for continuous operation in the event of a primary power loss.

The AC-Only power system offers optional 8- or 16-ampere redundant power supply modules, but does not offer the optional 48Vdc battery backup module feature and rechargeable NiCad CMOS memory backup power. Nonrechargeable alkaline battery CMOS memory backup power is provided instead.

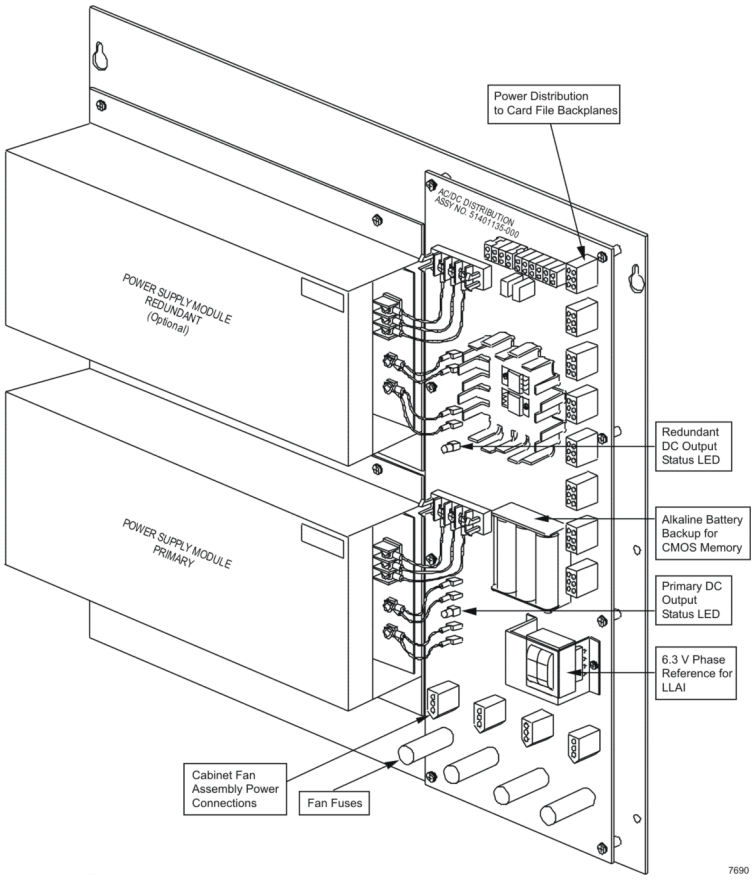


Figure 22: AC-Only power system

The AC-Only power system has eight power distribution output connectors and four fused Cabinet Fan Assembly power connectors. There are two sets of normally-open relay alarm contacts that signal a power supply module failure. The alarm signals are normally wired in series to a 24Vdc Digital Input FTA to notify the system when a power supply module fails. Two LED indicators, mounted on the AC-Only AC/DC Distribution Assembly, offer a visual indication of a power supply module failure when the LED is extinguished.

5.7.4 Typical cabinet power distribution

“Figure 23: Typical cabinet 24Vdc power distribution” illustrates the typical 24Vdc cabinet power distribution to the card files, Digital Input Power Distribution Assembly, and the Galvanic Isolation Power Distribution Assembly for the various power system configurations.

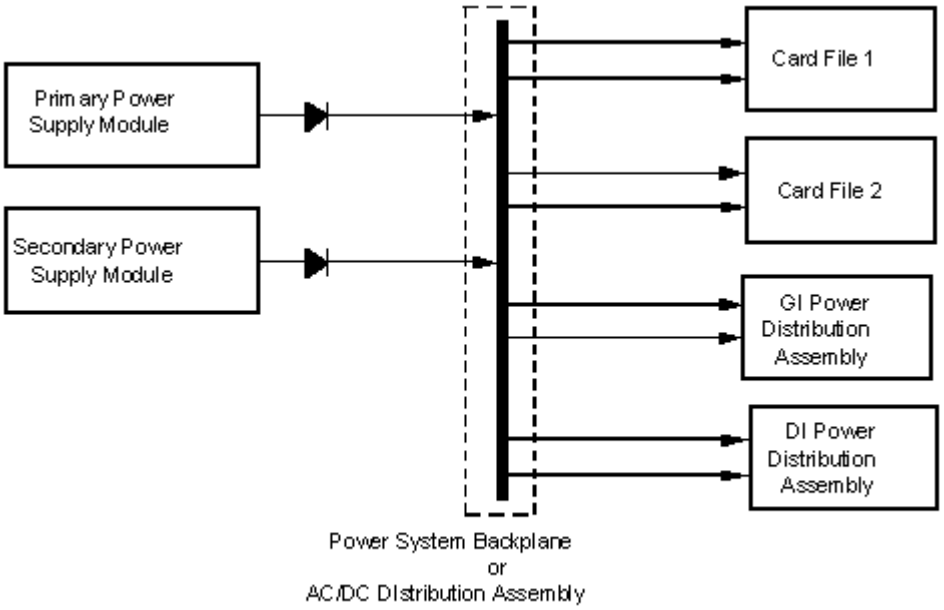


Figure 23: Typical cabinet 24Vdc power distribution

5.8 Cabinet fan assembly

Fused 0.5A 120Vac or 240Vac power is provided by the power system for PM I/O cabinet fan assembly operation.

Up-to-four cabinet fan assemblies can be powered by 120Vac or 240Vac provided by the four 3-pin connectors of the standard or AC-Only power system configurations. The connectors and fuses are located at the left side of the standard power system backpanel (as shown in “Figure 19: Standard power system backpanel”) and at the bottom of the AC-Only power system AC/DC Distribution assembly (refer to Figure 16).

5.8.1 Optional Cabinet fan assembly

An optional cabinet fan assembly has an LED indicator that indicates normal operation of both fans, and an alarm signal that is represented by normally-open contacts at terminal board TB1. The contacts are closed when the cabinet fan assembly is operating normally. The operation of the cabinet fan assembly can be monitored by a 24Vdc Digital Input FTA by providing the 24Vdc alarm signal source from the FTA and returning it to the FTA through the alarm contacts.

5.9 LLAI line frequency clock voltage

A pluggable solid-state optical-coupler module (U1) on each type of card-file backpanel generates a line frequency phase reference signal. The signal is used by the IOPs to improve the common and normal mode noise rejection ratio.

The module is located at the bottom right of a 7-slot card file backpanel and in a similar position on the 15 slot card file. Its 6Vac output is routed to the LLAI IOPs through power cables and card file backpanels. The power system provides a nominal 6Vac half-wave-rectified phase-reference signal to the IOP card file assemblies through the power cable.

5.9.1 LLAI source of line frequency in standard power system

In the standard power system configuration, the power supply module located at the left side of the assembly is the source of the line-frequency phase-reference signal. If the left power supply module is removed, the LLAI IOPs in the same cabinet will report a soft failure and continue to operate, but at a lesser degree of accuracy.

5.9.2 LLAI source of line frequency in AC-only power system

The line frequency phase reference signal in the AC-Only power system configuration does not depend on the presence of the left or right-side power supply modules, since a constant voltage is supplied by the AC/DC Distribution Assembly.

5.10 24 Vdc protection

Fuse protection is provided for the IOP card files. The following protection philosophy applies to both 7-slot and 15-slot IOP card files.

- Each IOP card in the card file and the associated standard FTA are protected by a common fast-action fuse located on the IOP backpanel. The fuse has a 2A rating.
- In addition to the 2A protection, each individual IOP card has a fast-action 0.5A fuse protection located on the card. The fast-action 0.5A fuse is soldered in place and is not field replaceable. You must replace the IOP card.
- A fast-action 2A fuse also protects the LLAI optical-coupler module (U1) mounted on the backpanel.

5.10.1 Replacing 24 Vdc fuses

A Honeywell designed fuse puller is required for extracting and inserting fuses in the IOP backpanels because of the restricted space between components. The Honeywell part number is 51190586-100.

The fuse puller is comprised of three parts;

- An inner barrel that grasps the fuse.
- An end cap that is attached to one end of the inner barrel,
- An outer barrel in which the inner barrel moves.

Extracting the 24Vdc fuse from the backpanel

1. Hold the outer barrel of the fuse puller with the fingers of one hand and depress the fuse puller's end cap with your other hand.
2. Place the protruding end of the inner barrel around the fuse. The fuse puller must be perpendicular to the backpanel.
3. Release the end cap while still holding the outer barrel.
4. Move the outer barrel towards the backpanel. The greater the movement, the greater the gripping force will be on the fuse.

Inserting the 24Vdc fuse into the backpanel

1. Hold the outer barrel of the fuse puller with the fingers of one hand and depress the fuse puller's end cap with the thumb.
2. Hold the fuse in position with the fingers of your other hand and place the protruding end of the fuse puller's inner barrel around the fuse.
3. Release the end cap while still holding the outer barrel and the fuse.
4. Move the outer barrel towards the fuse. The greater the movement, the greater the gripping force will be on the fuse.
5. Insert the fuse in its backpanel position by vertically moving the fuse puller towards from the backpanel. Depress the end cap to release the fuse.

5.11 IOP card-file fuse protection

The following section describes about IOP card-file fuse protection.

5.11.1 Left 7-slot IOP card file 24Vdc fuse protection

Table 12: Left 7-slot card file fuse protection

Fuse	Rating	Protection Application
F1-F7	2A fast-action	IOP cards in slots 1-7 and associated FTAs. One fuse for each slot.
F8	2A fast-action	LLAI-8 Optical Coupler Module, U1

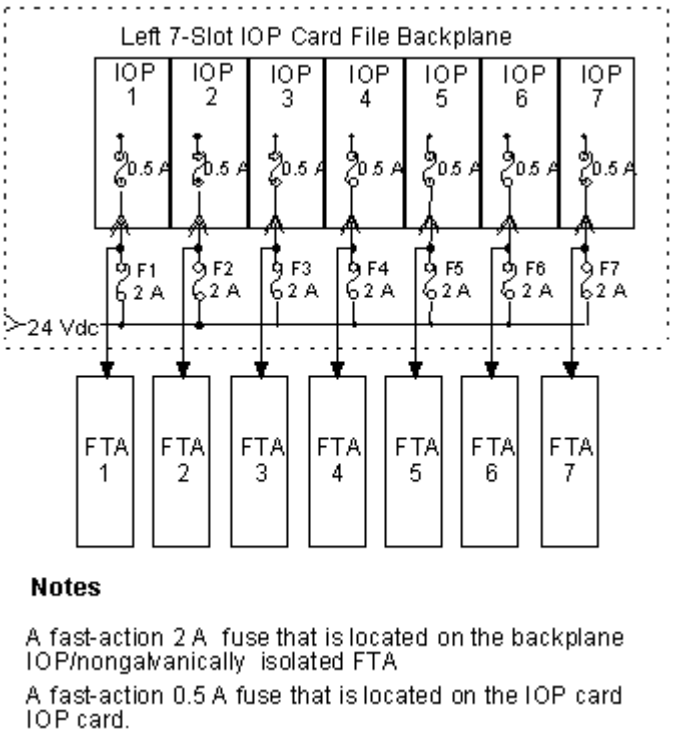


Figure 24: Left 7-slot IOP card file backpanel 24 Vdc distribution

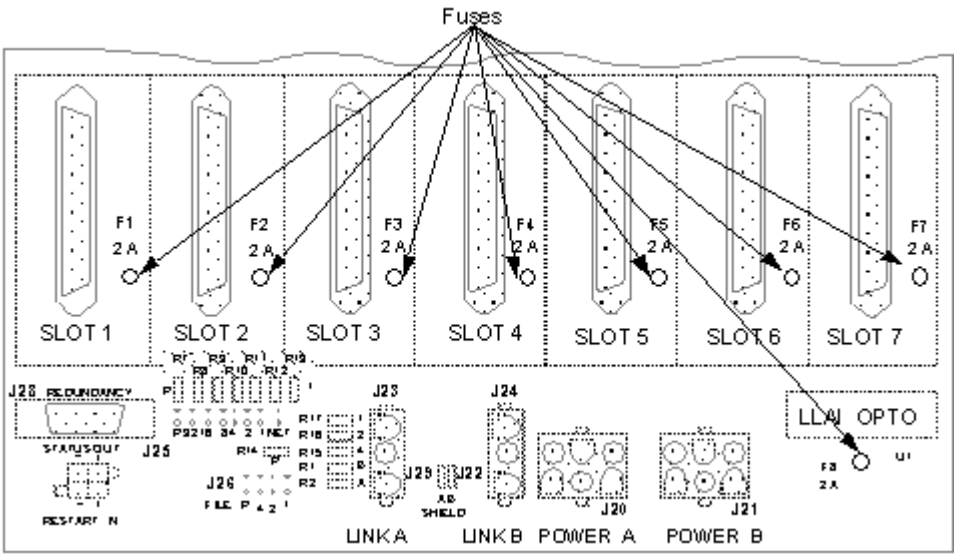
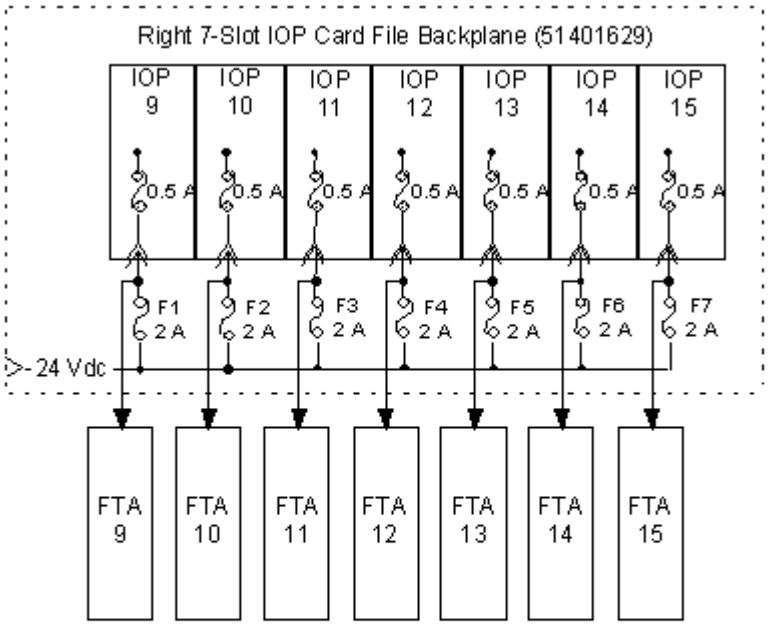


Figure 25: Left 7-slot card file backpanel fuse locations

5.11.2 Right 7-slot IOP card file backpanel 24 Vdc protection

Table 13: Right 7-slot IOP card file backpanel fuse protection

Fuse	Rating	Protection Application
F1-F7	2A fast-action	Slots 9-15 IOP cards and associated FTAs. One fuse for each slot.
F8	2A fast-action	LLAI Optical Coupler Module (U1)



Notes:

A fast-action 2 A fuse that is located on the backplane protects each IOP/nongalvanically isolated FTA combination.

A fast-action 0.5 A fuse that is located on the IOP card protects the IOP card.

Figure 26: Right 7-slot IOP card-file backpanel 24Vdc distribution

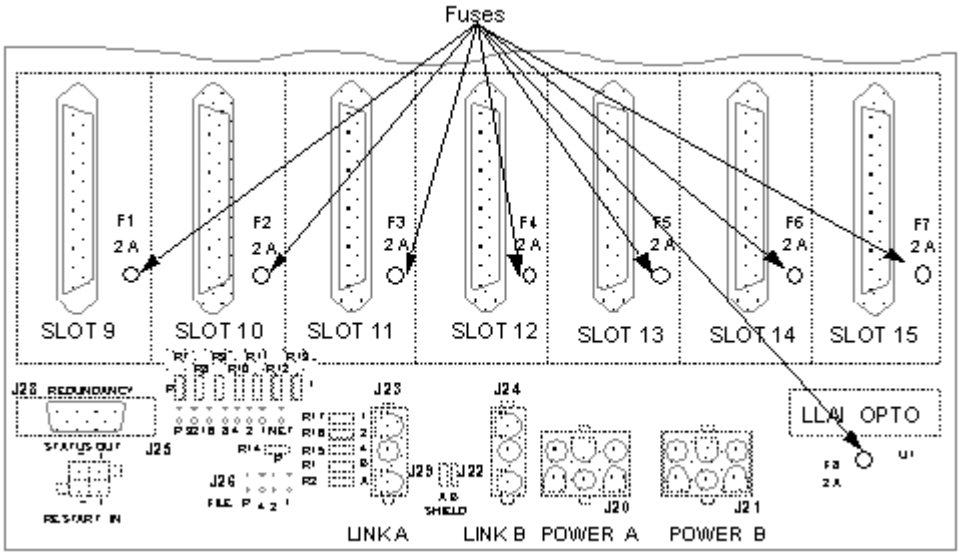


Figure 27: Right 7-slot card file backpanel fuse locations

5.11.3 15-Slot IOP card file backpanel 24 Vdc fuse protection

Backpanel assembly 51401129 revision B or later have 3A time-delay fuses for protecting the IOP card and its associated standard FTA. All revisions of the 51401406 and 51402599 backpanel assemblies have fast-action 2A fuse card and FTA protection. All card file backpanel assemblies provide a fast-action 0.5A fuse for the LLAI optical coupler module (U1) on the backpanel. Refer to Table 13.

Table 14: 15-Slot card file fuse protection

Fuse	Rating	Protection Application
F1-F15	2A fast-action / 3A time-delay	Slots 1-15 IOP card and associated FTA.
F16	0.5A fast-action	LLAI Optical Coupler Module (U1)

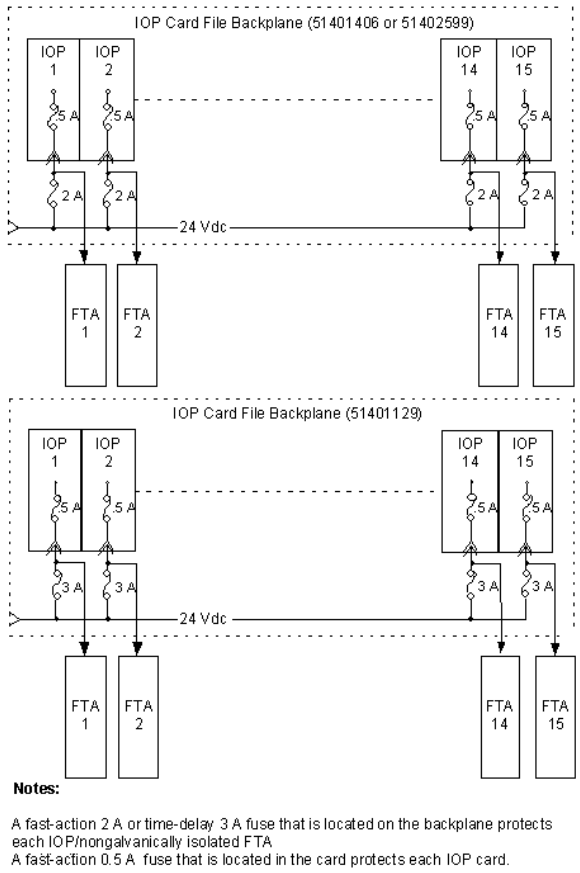


Figure 28: 15-Slot IOP card-file backpanel 24Vdc power distribution

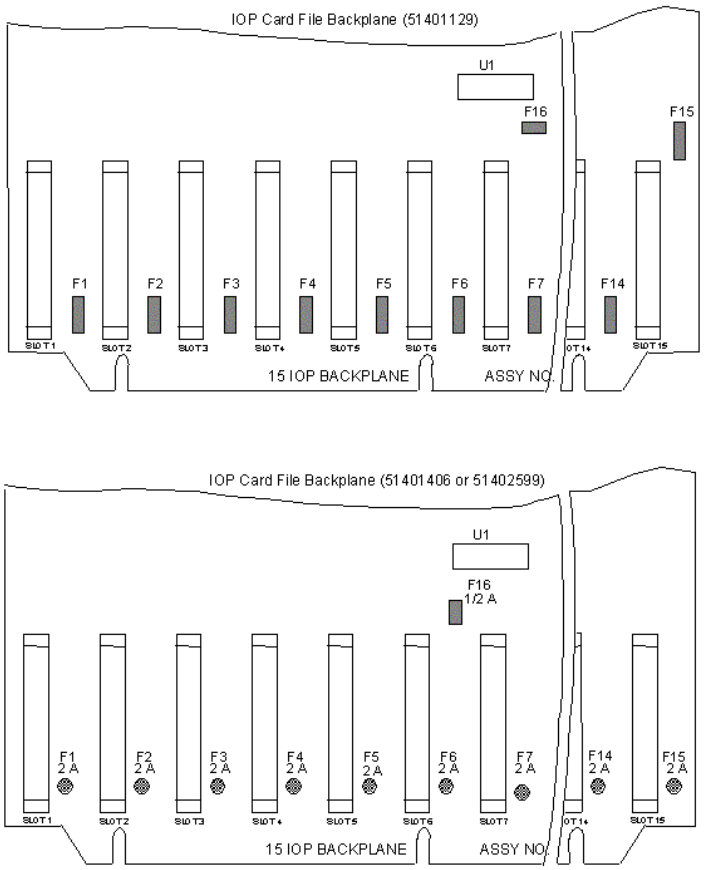


Figure 29: 15-Slot IOP card-file backpanel fuse locations

5.12 FTA and cabinet fan fuse protection

Some individual FTAs may have fuse protection on the assembly. In general, output type FTAs are fused, but not exclusively. Fuse information for the individual FTAs can be found in Appendixes C and D In *Control Hardware Installation Guide*.

5.12.1 IOP Cabinet Fan assembly fuse protection

Each Cabinet Fan Assembly is protected by fast-action 0.5A fuse located on the power system backpanel assembly. A control cabinet can contain two individually fused Fan Assemblies. Both the Standard, and AC-Only power system configurations provide fused circuits for four fan assemblies. Refer to Figures 16 and 18 for the locations of the Fan Assembly fuses.

5.13 IOP card file power cabling

Each IOP card file receives power (24Vdc, 3.6Vdc, and 6Vac) from the power system through dual cables. The dual power connectors on the 7-slot and 15-slot IOP card file backpanels are listed in the Table 14.

Table 15: Card file power cabling

Card File Type	Dual Power Connectors
7-Slot	J20 and J21
15-Slot	J46 and J47

5.13.1 DI and galvanic isolation power

Digital Input Power Distribution assemblies and Galvanic Isolation Power Distribution assemblies require 24Vdc power and the same type of power cable as the card files.

5.13.2 IOP power system connectors

The standard power system has 12 power output connectors, labeled **OUTPUT 1** through **OUTPUT 12**. Connectors are not assigned to any particular card file or Power Distribution assembly. The power output connectors are located at the upper right side of the backpanel of the standard power system. The AC-Only power system power connectors are located at the right side of its AC/DC Distribution assembly as shown in Figures 16 and 18.

5.13.3 IOP power distribution examples

“Figure 30: 15-Slot Card File with power distribution assemblies” through 30 illustrate typical power cabling of various combinations of card files and Power Distribution assemblies using the standard power system. The AC-Only power system cabling would be similar.

5.13.4 IOP power distribution methods

The AC-Only power system is limited to eight power output connectors. The eight connectors provide power for various combinations, depending on card-file power requirements, Digital Input Power Distribution assemblies, and Galvanic Isolation Power Distribution assemblies. Redundant power cabling to each assembly is recommended.

However, an exception must be made when three card files, a Digital Input Power Distribution assembly, and a Galvanic Isolation Power Distribution assembly are present in the cabinet, since only eight power output connectors are available. The power cables are then daisy-chained. See “Figure 34: Power distribution assemblies for redundant cabling”.

The PM IOP standard power system provides 12 power output connectors which eliminates the need to daisy-chain power from one file to file.

5.13.5 15-Slot PM IOP card file power cabling

The following figure illustrates power cabling for a typical PM I/O configuration of a single 15 Slot card file and Power Distribution assemblies.

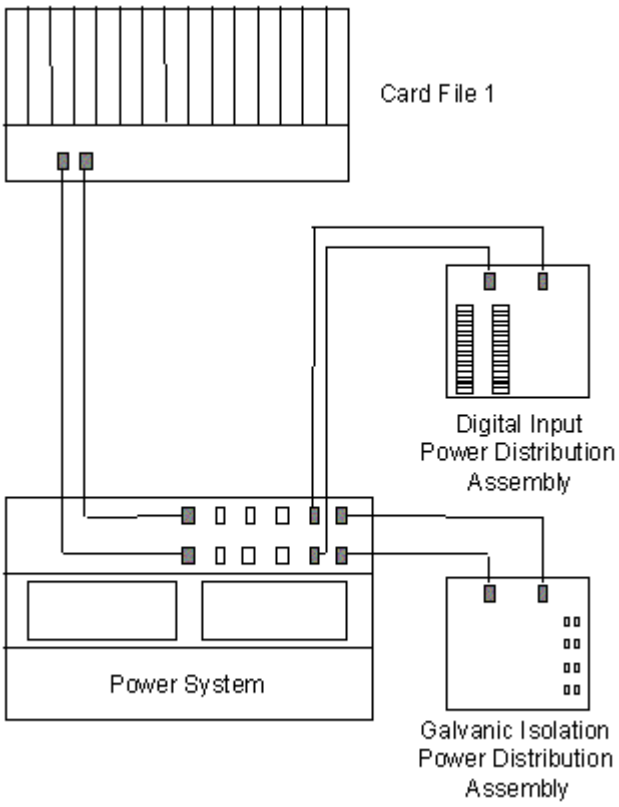


Figure 30: 15-Slot Card File with power distribution assemblies

5.13.6 Two 15-Slot PM IOP card files power cabling

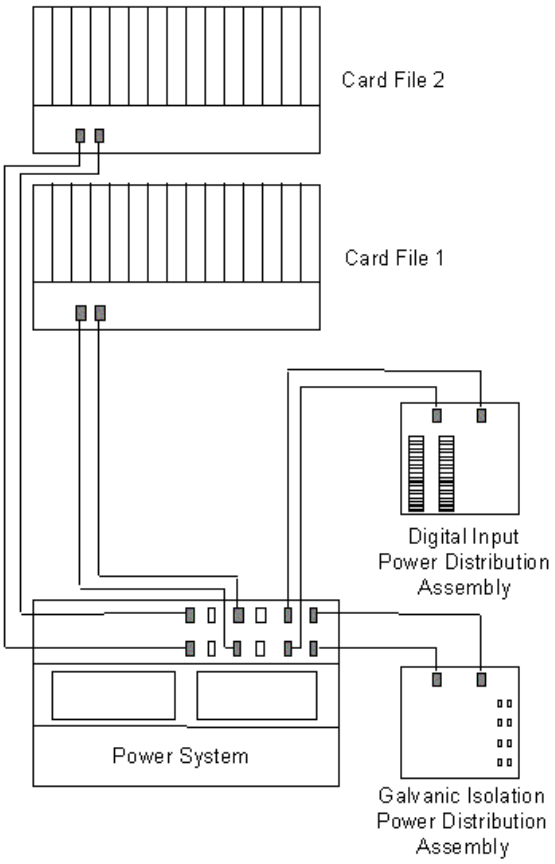


Figure 31: Two 15-slot card files with power distribution assemblies

5.13.7 Power cabling for three 15-Slot PM IOP card files

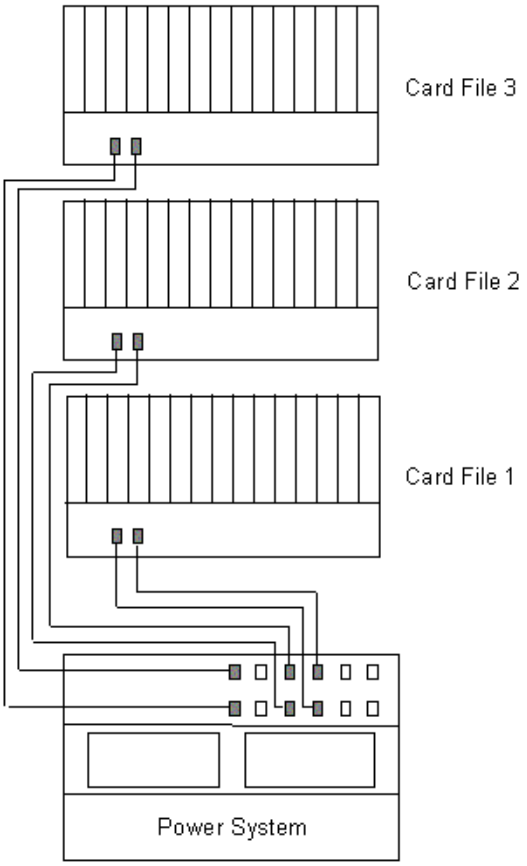


Figure 32: Three 15-slot IOP card file power cabling

5.13.8 Power cabling for three 15-Slot IOP card files and two power distribution assemblies

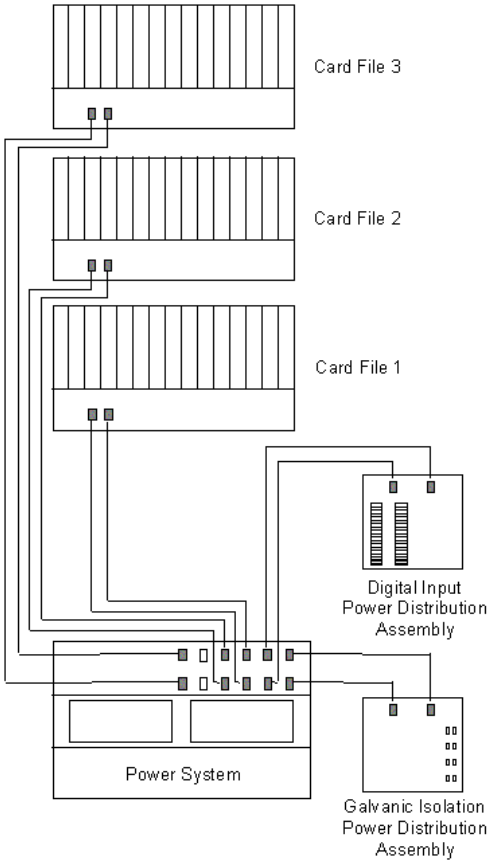


Figure 33: Three 15-slot IOP card files with two power distribution assemblies

5.13.9 IOP AC-Only cabling power cabling illustration

AC-Only Power Systems are limited to eight power output connectors. Figure 31 shows how power is distributed when the number of available connectors does not meet the total need for redundant cabling.

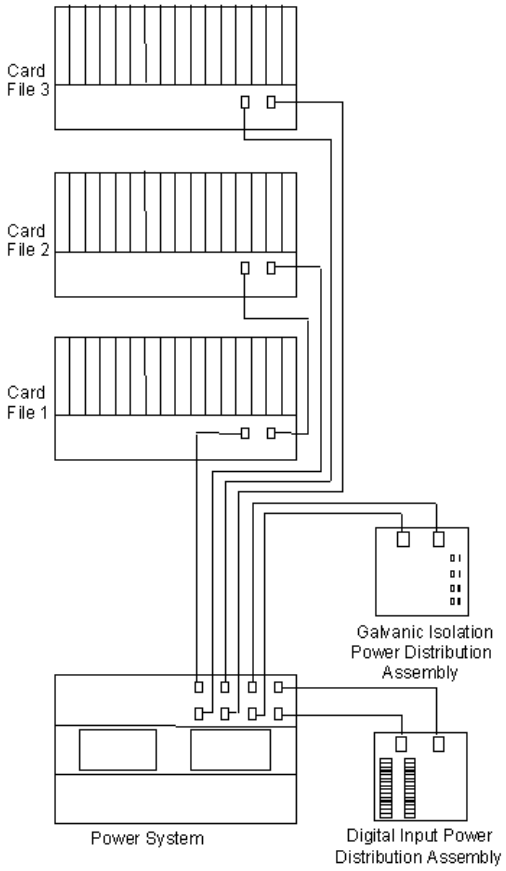


Figure 34: Power distribution assemblies for redundant cabling

5.14 IOP-to-FTA cabling

Each IOP has a cable that connects the IOP to its associated FTA. A sample cable wiring diagram is shown in Figure 32

5.14.1 IOP standard FTA cabling

The cables for standard FTAs leave the FTAs at the top or center, travel up or down the right side of the vertical FTA mounting channel, go over or under the center divider, and then connect to the associated IOP card file connector on the 7-Slot or 15-Slot card file backpanel.

5.14.2 IOP galvanically isolated FTA cabling

When mounted on a horizontal FTA mounting channel, the cables for galvanically isolated FTAs leave the top side of the FTAs, travel up or down the left side of the horizontal FTA mounting channel, go over or under the center divider, and then connect to the associated IOP connector on the 7-Slot or 15-Slot card file backpanel.

Galvanically isolated FTAs can also be mounted on vertical FTA mounting channels. When they are, the reverse of the cabling rules that apply for the standard FTAs apply for galvanically isolated FTAs because the vertical orientation of the FTA mounting channel is reversed.

5.14.3 IOP external cabinet installation cabling

The FTAs can also be installed on a panel that is external to the cabinet, up to 50 meters (164 feet) cable length from the IOP. Shielded FTA cables must be used whenever the FTA is located outside of the control cabinet complex. See Remote FTA Installation in the *Control Hardware Installation Guide* for additional information.

5.14.4 Typical IOP-to-FTA cabling

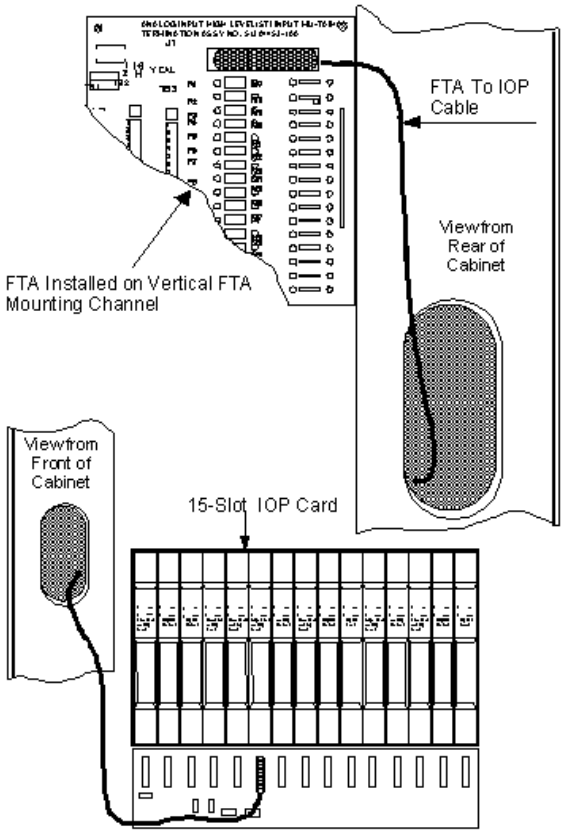


Figure 35: IOP-to-FTA Cabling

5.15 FTA power adapter cabling

Using a standard FTA cable, the model MU-TLPA02 Power Adapter can be located up to 50 meters (164 feet) distance from the card file containing the associated IOP card. The Power Adapter connects to one or two FTAs that can be installed at a remote location up to 305 meters (1000 feet) from the Power Adapter. “Figure 36: Power adapter connections - LLMUX application” illustrates its application with LLMUX2 FTAs.

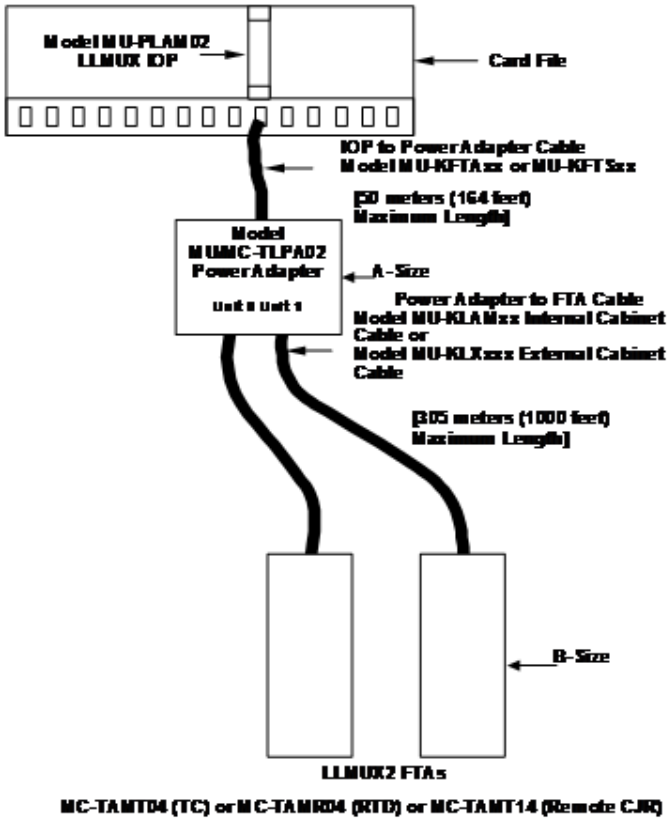


Figure 36: Power adapter connections - LLMUX application

6 Removing and Replacing PM I/O Components

Removal and replacement procedures should only be performed by a qualified service person.

Note

Related topics

“Following Electrostatic Discharge guidelines” on page 80
“Replacing IOP cards” on page 81
“Using Standby Manual devices” on page 82
“Operating Analog Output Standby Manual” on page 84
“Operating Digital Output Standby Manual” on page 86
“Replacing IOP card case” on page 89
“Replacing IOP-to-FTA Cables” on page 90
“Replacing PM I/O power system assemblies” on page 92
“Removing PM I/O cabinet side panels” on page 97
“Replacing I/O Link Extender optical coupler module” on page 98

6.1 Following Electrostatic Discharge guidelines

It is extremely important that you wear a properly-connected Electrostatic Discharge (ESD) wrist strap while removing, handling, and installing PM I/O components.

Slip the strap onto your wrist like a wristwatch and connect its clip to the ground bus located inside the left-front-side of the cabinet. There is no danger of you receiving a shock by wearing an approved wrist strap.

Ensure that you to place the component in a static-safe carrying pouch. When appropriate, place the card in the static-safe carrying pouch immediately after its removal.

6.1.1 Ordering an Electrostatic Discharge (ESD) kit

The Honeywell ESD kit (part number 30185H) contains the following components:

- 10-megaohm static discharge probe
- Static discharge wrist strap (AESOPS Inc. Model 31531)
- Static discharge cord, 15 feet (AESOPS Inc. Model 30204)
- □Static discharge cord, 6 feet (AESOPS Inc. Model 30205)
- Anti-static work surface with bag

6.1.2 Building a static discharge probe

A static discharge probe can be built by placing a 10-megaohm resistor in series with any available probe or clip lead.

6.1.3 Preventing Electrostatic Discharge

When installing a firmware upgrade or replacing or adding an IOP card, you should adhere to the following rules to prevent ESD from affecting the IOP cards.

- Ground the antistatic work surface to the card file chassis.
- Ground the wrist strap before removing or inserting an IOP card at the card file chassis.
- Ground the wrist strap to the antistatic work surface when upgrading card firmware.
- When removing or inserting a card, touch only the card frame. Do not touch the circuit board or the components
- The 10-megaohm static discharge probe must be grounded to the card-file chassis.

6.2 Replacing IOP cards

CAUTION

Cycling power or removing nonredundant Analog or Digital Output IOPs from a card file results in the card outputs going to the unpowered state regardless of the configured FAILOPT value.

Follow the Analog or Digital Standby Manual device instructions in this section when replacing Analog or Digital Output IOPs.

Attention

When you are inserting an IOP card into a card file and follow the normal ESD procedures, other cards in the card file can go **OFFNET** because of electrostatic discharge. It does not result in damage to any of the components on the card when an ESD wrist strap is worn, but does affect subsystem integrity.

The procedure for discharging the card using a 10-megaohm static discharge probe is as follows:

When inserting an IOP card, insert the card 3/4 of the way into the slot and then discharge the card with the 10-megaohm static discharge probe by touching the lower lead of the upper LED. If there is a daughter board, touch the minus/lower lead of the bypass capacitor labeled C1 or C2.

Replacing IOP card

1. Connect your ESD wrist strap to the cabinet's ground bar inside the left-front-side of the cabinet.
2. Before removing an analog or digital output IOP from a card file, your Operations Policy may require that a standby manual device be connected to the FTA to control operations while the IOP is removed.
3. Remove the IOP card by simultaneously pulling on the upper and lower extractor levers. When the upper extractor is first moved, power is disconnected from the card. Further operation of both extractors moves the card away from its backpanel connector.
4. After the card is free from the connector, carefully slide it out on the card rails and into your hands. Immediately place the card in a static-safe pouch for transport.
5. With your ESD wrist strap still attached, remove the replacement card from its pouch.
6. Carefully slide the card onto the card rails, checking to ensure that the card is inserted in the upper and lower rails.
7. Slide the card into the card file until it has made contact with the backpanel connectors.
8. Firmly press on the front of the card with the heel of your hand. Do not use excessive force! If the card doesn't slip easily into its connectors, remove the card and locate the source of the obstruction. Check for bent contacts at the backpanel connectors.

6.3 Using Standby Manual devices

You can use standby manual devices to maintain output signals from an Analog Output or 24Vdc Digital Output FTA while its nonredundant IOP is replaced. An Analog Output IOP-to-FTA cable can be replaced if an external power source is connected directly to the standby manual device, since the cable is the FTA's normal 24Vdc source.

You can also replace the IOP switching module on the Analog Output FTA using the Analog Output Standby Manual (AOSM) device.

The Digital Output Standby Manual (DOSM) device does not have an external power source option.

6.3.1 Connecting the Standby Manual device

The AOSM device connects by cable to a unique connector on the FTA that is labeled **STANDBY MANUAL**.

The DOSM device connects to one of the two IOP interface connectors as shown in the Figure 24 for a model MU-TDON12 24Vdc Digital Output FTA.

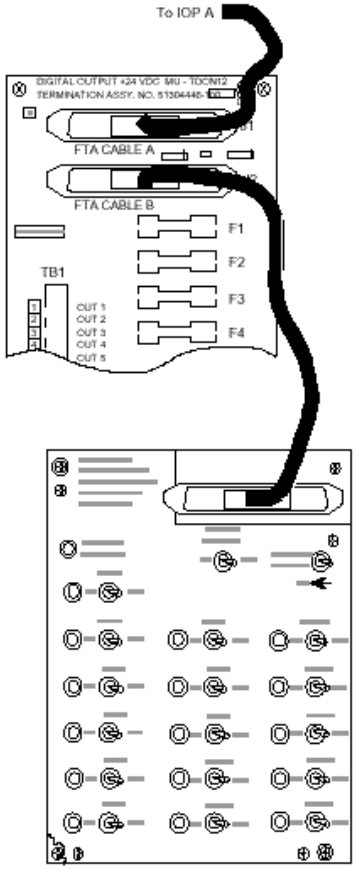


Figure 37: DOSM connection to Redundant FTA

6.3.2 Device interchangeability

There is an interchangeability problem with the DOSM devices. The TPN software Release 300 and later model of the DOSM device is not compatible with a TPN Release 230 or earlier Digital Output FTA, nor is the Release 230 (or earlier) DOSM device compatible with a software Release 300 (or later) FTA. Software Release 300 (or

later) devices are identified by having phone-type cable connectors, while software Release 230 (or earlier) devices have DIN-type cable connectors.

6.3.3 DIN to phone connector adaptor cable

A DIN-to-phone-connector adaptor cable (Honeywell part number 51201561-xxx, where the suffix 'xxx' is the length of the cable in meters) can be used to interconnect an incompatible DOSM to an FTA, provided the circuit board inside the DOSM is the proper revision as follows:

- DOSM with phone connector (PWB 51304451-100, Revision B)
- DOSM with DIN connector (PWB 51304076-100, Revision C)

6.3.4 Board revision level

The 24Vdc required by the DOSM will be missing if the DOSM circuit board is not at the listed revision level. The R230 and R300 AOSMs do not have the same problem.

6.4 Operating Analog Output Standby Manual

You can use the AOSM to control the loads connected to an Analog Output FTA while its associated Analog Output IOP will be removed from service and replaced. The AOSM connects to the Analog Output FTA and provides control of any or all eight of the outputs that are normally controlled by the IOP.

6.4.1 Analog Output Standby Manual MU-SMAC01/MU-SMAC02

The model MU-SMAC01/MU-SMAC02 AOSM shown in Figure 35, monitors the outputs of an AO IOP by displaying its output values as a percentage of the range on front-panel meters.

When you press one of the **BAL** switches on the AOSM, the corresponding meter indicates the IOP's output value. Using the **VALVE** knob, you can adjust the AOSM's output to match the output of the IOP. Then, you can switch control of the FTA output to the AOSM by moving the mode switch to the **MAN** position.

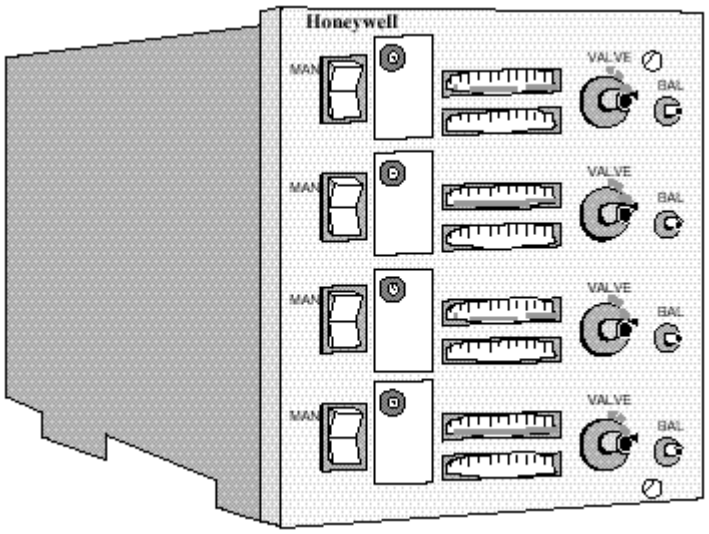


Figure 38: AOSM

6.4.2 Controlling FTA outputs

To use an AOSM to control the FTA outputs to the field while an AO IOP or the IOP switching module on a redundant AO FTA is being replaced, place all of the mode switches on the AOSM to the position opposite the **MAN** position after you have duplicated the IOP's outputs.

6.4.3 Connecting to the FTA

Connect the AOSM to the **STANDBY MANUAL** connector on the FTA with its cable.

Attention
If the FTA cable to be connected to the AOSM has a phone-type connector, use the adapter cable (Honeywell part number 51201561-xxx) to make the connection. (The suffix xxx represents the length of the cable in meters.)

Switching control to AOSM from normal control

1 In **Monitor** tab of Control Builder, click **Controller-** > **Upload** and click **Continue** to upload IOP data from the Controller to the Monitor database.

2 Click **Controller-** > **Update to Project** and click **Continue** to update IOP data in Project.

3 For the first output, press the **BAL** switch and note the IOP's output value.

4 Release the **BAL** switch and adjust the **VALVE** knob to make the output of the AOSM equal to the IOP output.

5 Place the mode switch for this output in the **MAN** position.

6 Repeat Steps 3 through 5 for all remaining outputs from the same IOP.

7 Remove and replace the IOP or switching module, as appropriate, and perform the *Returning control from AOSM to normal control* procedure

Returning control from AOSM to normal control

1 In Project tab of Control Builder, click applicable IOP icon and click **Controller-** > **Load** to call up the **Load** Dialog. Click **OK** to reload the IOP data from Project.

2 In Monitor tab, open the Control Module containing the strategy that is controlling the first output channel for the IOP. Put this point in Manual mode.

3 Manually set the output of the first IOP channel to match that of the AOSM.

4 On the AOSM, change the mode switch for this output to the position opposite the **MAN** position.

5 Return the point controlling the output to its Normal mode and close the Control Module.

6 Repeat Steps 2 through 5 for all remaining outputs from the IOP.

7 Disconnect the AOSM cable from the **STANDBY MANUAL** connector on the FTA, if desired.

6.5 Operating Digital Output Standby Manual

The primary function of the model MU-SMDC02 (Figure 36) or model MU-SMDX02 Digital Output Standby Manual (DOSM) device is to control Digital Output FTAs while the associated DO IOP card is serviced. Except in the case of the +24Vdc nonisolated FTA which has no relays, the FTA's relays are controlled, not their loads.

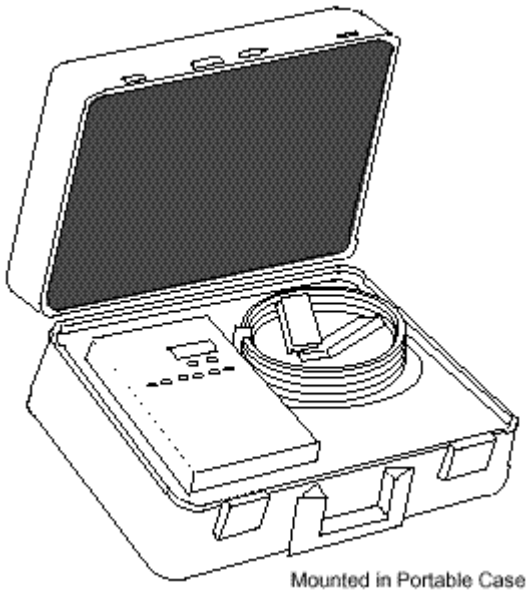


Figure 39: DOSM in portable case

A secondary function of the DOSM is to indicate the state of each IOP output (LED on = output on). The LEDs indicate the output state of the IOP as soon as the connection is made.

Attention
The DOSM does not support DO32 IOP cards.

6.5.1 Mounting the DOSM

Model MU-SMDX02 DOSM can be mounted on an FTA mounting channel in an HPM cabinet. DOSM model MU-SMDC02 is mounted in a carrying case for portable applications.

6.5.2 Connecting the DOSM cable

Connection of the DOSM to the FTA Standby Manual connector is made using a standard IOP-to-FTA cable. A 3-meter cable is included with model MU-SMDC02 DOSM.

6.5.3 Disabling DOSM output control switches

The DOSM output control switches are disabled when the DOSM is first connected to the FTA, or whenever the **ENABLE STANDBY** switch on the DOSM is in the **OFF** position.

6.5.4 Activating the DOSM

When the **ENABLE STANDBY** switch is in the **ON** position, momentary operation of the **ACTIVATE STANDBY** switch latches the manual mode of the DOSM and activates the 16 output switches to control the FTA as discussed below.

Attention

The IOP-to-FTA cable (from the card-file backpanel to the FTA), must be connected to carry the +24Vdc and the common from the IOP backpanel to the FTA and the DOSM. Also, the DOSM cannot be used with the 24Vdc nonisolated Digital Output FTA if the FTA load voltage for any output is other than +24 Vdc.

6.5.5 Switching to DOSM control from normal control

Use the Controller menu commands **Upload** and **Update to Project** for the IOP(s) in the **Monitor** tab of Control Builder, if desired, and then use the following procedure to have the DOSM control the FTA field devices.

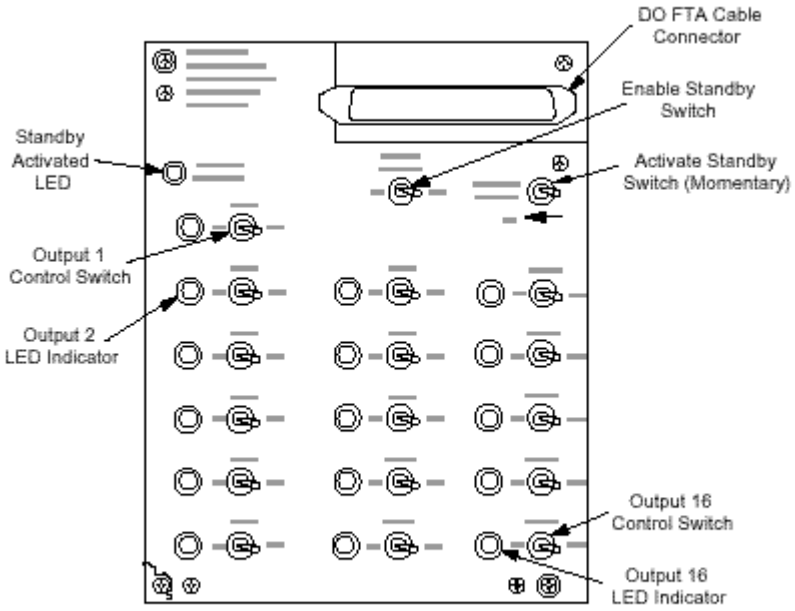
Switching to DOSM control

1 Set **ENABLE STANDBY** switch on the DOSM to the **OFF** position.

2 Connect the DOSM cable to the **FTA CABLE B** connector (J2) on the Digital Output FTA.

Any IOP output that is On will light the corresponding indicator on the DOSM. The following figure shows a model MU-SMDX02 DOSM panel. If you only want to display outputs, stop at this Step.

Digital Output Standby Manual Device Panel



Note:
The Digital Output Standby Manual device is designed to install on an FTA Mounting Channel, but it can be installed elsewhere.

Attention

While the DOSM and the FTA's associated IOP card are both present and controlling outputs (they are connected in parallel to the FTA), either can override an 'OFF' output from the other, but not an 'ON' output. Until the IOP card is removed or reset, the DOSM device's output LEDs indicate the resultant outputs actually delivered to the FTA's switching elements.

3 If you want to use the DOSM to hold the current FTA output states while you are servicing the associated Digital Output IOP, set the 16 output switches equal to the output state that is displayed by the DOSM LEDs and perform steps 4 through 6. You can also set any of the 16 output switches to an alternate state, if desired.

4 Place the **ENABLE STANDBY** switch on the DOSM device to the **ON** position.

5 Toggle the momentary **ACTIVE STANDBY** switch. The **STANDBY ACTIVATED** LED should be lighted. This allows you to use switch settings to control the Digital Output FTA for each output, and also to send a status signal to the IOP to indicate that the connected DOSM is armed and possibly controlling FTA outputs.

6 While the DOSM is controlling outputs, the IOP can be placed in the idle state and removed/replaced for servicing. The FTA outputs will be held in their current states by the DOSM. After servicing the IOP, perform the following procedure to restart the IOP.

Returning control from DOSM to normal control

1 In **Project** tab of Control Builder, click applicable IOP icon and click **Controller** > **Load** to call up the **Load Dialog**.

Click **OK** to reload the IOP data from Project.

2 In **Monitor** tab, open the Control Module containing the strategy that is controlling the first status output (SO) channel for the IOP.

3 Manually set the output of the first SO to match that of the DOSM.

4 Repeat Steps 2 and 3 for the remaining IOP channels.

5 Set the **ENABLE STANDBY** switch on the DOSM to the **OFF** position. The **STANDBY ACTIVATED** LED should be extinguished, indicating that the DOSM is no longer controlling the FTA digital outputs. Control has been returned exclusively to the DO IOP.

6 Remove the DOSM connection to the DOSM, if desired.

Attention

When a digital output point indicates Standby Manual mode **(STDBYMAN**) on an operating display such as a Group or Detail display, the output cannot be changed using that display. To set the point output to match the DOSM setting, the output point must be set through the applicable control drawing in Control Builder.

6.6 Replacing IOP card case

ESD HAZARD

It is extremely important that you wear a properly connected Electrostatic Discharge (ESD) wrist strap while removing, handling, and installing these IOP components.

Note

Replacing plastic case of IOP card assembly

1. Remove the card assembly from the card file. Place the card on a static free work surface.
2. Remove the two screws at the corners near the connector edge of the card as illustrated in the following figure.
3. Lift the connector end of the card to approximate 30-degree angle with the case.
4. Lift the card from the plastic pins at the front-left corners of the circuit board. If the card has a daughter board attached, the plastic pins are hidden under the daughter circuit board.
5. To insert the card in a new case, place the front of the card on the plastic pins while holding the card at approximately a 30-degree angle. If a daughter board is attached, the two alignment studs at the front edge of the case must fit between the two circuit boards. See the previous illustration.
6. Lay the card flat on the work surface and replace the two screws removed in step 2.
7. Check the alignment of the LEDs with the openings in the front of the plastic case for visibility.
8. Reinstall the card in the card file.

6.7 Replacing IOP-to-FTA Cables

Replacing nonredundant IOP-to-FTA cable: All outputs or inputs carried by the IOP-to-FTA cable, as well as the 24Vdc from the IOP that powers the FTA, are disconnected when the cable is removed. The use of an AOSM or DOSM may be appropriate to maintain the present outputs of an output type FTA. See one of following sections for more information.

- Operating Analog Output Standby Manual
- Operating Digital Output Standby Manual
- Replacing redundant IOP-to-FTA cables

Before removing an IOP-to-FTA cable from a redundant IOP, ensure that the IOP-to-FTA cable to be removed is not currently controlling analog output field terminals on the FTA or providing inputs. When the green **DS1**LED on an AO redundant FTA is illuminated, the 'B' IOP-to-FTA cable can be removed, because the 'A' IOP-to-FTA cable is controlling the FTA output field terminals. When the green DS1 LED on an AO redundant FTA is not illuminated, the 'A' IOP-to-FTA cable can be removed, because the 'B' IOP-to-FTA cable is controlling the FTA output field terminals. The IOP forms in the Monitor tab can also be used to determine whether the 'A' or 'B' IOP-to-FTA cable is controlling the FTA output field terminals.

For critical analog outputs, it is recommended that the 'A' AO IOP be removed before the 'A' IOP-to-FTA cable is removed. It is also recommended that the 'B' AO IOP be removed before the 'B' IOP-to-FTA cable is removed.

When removing IOP-to-FTA cables from High Level Analog Input (HLAI) IOPs, use the IOP configuration forms in Monitor mode to determine whether or not the cable being removed is being used to provide subsystem inputs.

6.7.1 Replacing PM I/O FTA

CAUTION
Remove power from the FTA by unplugging the IOP-to-FTA cable before disconnecting the process wiring.

Procedure for replacing PM I/O FTA

1. At the FTA, disconnect the cable(s) from the associated IOP card.
2. Remove the field power serving the FTA to be replaced.
3. Unplug the field wiring terminal-strip from the FTA.
   It is not necessary to unscrew the field wiring if compression terminals are used.
4. Remove the screws that hold the FTA to the mounting channel. Carefully remove the FTA.
5. Compare the replacement FTA with the removed FTA. Ensure that any
   250-ohm or zero-ohm resistors that have been clipped on the removed FTA are also clipped on the replacement FTA. Ensure that all fuses are in place and jumpers are properly positioned.
6. Install the replacement FTA with the screws that were removed in step 4. Rotate them counterclockwise until they fall into the original threads, then tighten them clockwise.
7. Reconnect the field-wiring terminal connector to the FTA.
8. Reconnect the IOP-to-FTA cable to the FTA

6.7.2 Replacing FTA modules and relays

Risk of electric shock exists when removing and replacing an FTA module or relay.

Note

Procedure for replacing FTA modules and relays

1. Remove the screws holding the module or relay to the FTA circuit board.
2. Then, firmly lift the module or relay straight away until it is free of the FTA.
3. Align the replacement module or relay with the holes and connector on the FTA circuit board before inserting it.
4. Replace and tighten the retaining screws.

6.7.3 Replacing PM LLAI Module

The LLAI plug-in module can be replaced while power is applied to the FTA. After replacement, cycle the LLAI IOP +24Vdc power by flipping the upper extractor up and down. Cycling the power will initiate background diagnostics. Allow at least two minutes for the IOP to complete the background diagnostics before analyzing the results.

6.7.4 Replacing PM AO redundancy switching module

Before removing the Analog Output Redundancy Switching Module from a redundant AO FTA for testing or replacement, ensure that the associated 'A' AO IOP is controlling the FTA outputs. When the green **DS1**LED on the FTA is illuminated, the associated 'A' AO IOP is controlling the FTA's output. The HPM Status display at the Universal Station also can also be used to determine if the 'A' AO IOP is controlling the FTA output.

For critical analog outputs, it is recommended that the 'B' AO IOP be removed, or an AOSM be connected before removing the Analog Output Redundancy Switching Module.

6.7.5 Replacing Galvanic Isolation module

If the field device is controlled by a Galvanic Isolation Module that must be replaced, ensure that the loss of control is acceptable. Also, when the environment is Division 2, ensure that the atmosphere is non-hazardous.

The module can be removed and replaced while power is applied to the FTA. Remove the module's pluggable field connector. Loosen the screws that retain the module. Lift the module from its connector on the FTA and replace it. Reinstall the pluggable field connector.

Replacing PM I/O card file

1. Disconnect all power and signal cables from the card file.
2. Record the position of the IOP cards in the file slots. Remove all IOP cards from the card file
3. Remove the side plates connecting the card file to the card file above and/or below by first removing the two screws at the inside of the panel.
4. Loosen, but do not remove the four screws holding the card file to its supports.
5. Grasp the card file firmly and lift it about 1 cm (1/2 inch) to release the card file into your hands.
6. Install the replacement card file in a reverse manner, ensuring that the card file is engaged by all four mounting screws. Tighten the screws when the card file is in place.
7. Re-install the IOP cards in the proper card slots.
8. Reconnect the power and signal cables that were disconnected in Step 1.

6.8 Replacing PM I/O power system assemblies

If all options are installed, most of the major assemblies in the PM I/O Power System can be removed and replaced while the controller remains in operation because of Power Supply Module redundancy and battery backup power.

Observe all precautions mentioned in this text when replacing the Power System components.

6.8.1 Replacing CMOS Batteries

CAUTION

Batteries may contain toxic materials that are not biodegradable. Batteries should be disposed of safely in accordance with local laws and regulations.

Replacing NiCad batteries: Three NiCad batteries that are installed in the PM I/O standard power system to provide standby power for the CMOS memory have a tendency to age over a period of time. Aging occurs even if the batteries have been regularly recharged throughout their lifetime. For this reason, the NiCad batteries should be replaced after every two years of operation.

Replacing Procedure

1 Note that It is not necessary to remove power from the NiCad batteries while they are being replaced. Remove the old NiCad batteries from the battery holder and replace them with fresh ones.

2 Observe and match the polarity marked on the case of each battery and the holder. After all the batteries are in place, rotate each one slightly with your finger to ensure that it makes good contact with the holder.

Replacing Alkaline batteries: The alkaline batteries that are installed in the AC-Only Power System are not rechargeable and, therefore, must be replaced every 6 months. The six-month replacement cycle is a suggested replacement cycle and should be followed unless an equipment power failure has occurred for a prolonged period. Then, the batteries should be replaced after the equipment has been brought up to an idle condition.

6.8.2 Replacing 48V Backup Battery

The following sections describes about replacing 48V Backup Battery.

Battery operational and service life: The lead acid batteries provide 20 minutes of standby power for the controller and PM I/O Power System and have a normal stand-by service life of 4 to 5 years. However, usage and high environmental temperatures will reduce the service life. For this reason, environmental temperature, battery storage time, and battery usage should be monitored and recorded. In the absence of this attention, it is recommended the battery performance be checked on a yearly basis, or be replaced every 3 years to ensure proper performance.

Battery performance: All batteries of the same capacity, rating, and specifications, do not provide equivalent performance or reliability. For optimum system backup realization, use only

Honeywell-recommended and approved batteries.

48V Battery pack end-of-life: The battery end-of-life is defined as the time when the battery capacity, meaning its ability to accept and hold a charge, has decayed to 60% of the original capacity.

There are several factors that determine useful service life. The standby service life is reduced by events other than a continual 20-degrees C standby condition and is defined as follows.

- Standby (float) service life means that the batteries are connected to a charger and only occasionally discharged. Honeywell 48-volt batteries are designed to operate in standby (float) service for 4 to 5 years at 20-degrees C. The service life of a battery can be shortened by an improper charging voltage. The charging voltage from the power supplies should be checked every 6 months for the proper voltage level. Refer to the following Power Supply Module section for the recommended procedure.

- As shipped from Honeywell, the batteries are fully charged. However, if a system is stored in a non-powered state, the batteries will self-discharge and can become unusable. The time required for this to happen is a function of storage temperature as shown in the following chart.

If the Storage Temperature is . . .	Then, the Self-Discharge Time is . . .
0-degrees to 20-degreesC (32-degrees to 68-degreesF)	12 months
21-degrees to 30-degreesC (69-degrees to 86-degreesF)	9 months
31-degrees to 40-degreesC (87-degrees to 104-degreesF)	5 months
41-degrees to 50-degreesC 105-degrees to 122-degreesF)	2.5 months

- Batteries should not be left in a discharged condition for extended periods of time, because the ability of the battery to accept a charge thereafter is affected. The batteries should be charged periodically if they are stored or in a non-powered system.
- The IOP provides proper charging current to the batteries while the subsystem is powered up and running.

  When ac power is removed from the subsystem, the Power System automatically draws power from the batteries to maintain the subsystem's 24Vdc power. Anytime the system is intentionally shutdown and left non-powered, the **BATTERY**switch at the front of the Power System assembly should be placed in the **OFF**position to prevent discharge of the batteries.
- Heat destroys batteries. Battery service life is directly reduced by high ambient temperatures. While the battery operating temperature range is -15-degreesC to 50-degreesC (5-degreesF to 122-degreesF), maximum service life will be realized when the batteries are operated at an ambient temperature of 20-degreesC (68-degreesF). Brief exposure to higher temperatures for a few days will not have an adverse effect on the service life. However, if such usage is over extended periods of time or occurs repetitively (such as an environment that is not air-conditioned), the service life will be reduced. This reduction may be as much as 20% of service life (1 year) for each 10 degreesC above the reference ambient of 20-degreesC (68-degreesF).

48V Battery service life: Service life is reduced by the number of discharges and the depth of each discharge. The batteries can provide 200 cycles at 100% depth of discharge, 550 cycles at 50% depth of discharge, 1200 cycles at 30% depth of discharge, or 2000 cycles at 10% depth of discharge. This effect is superimposed on the standby aging effect stated above.

- With an expected 5 year life, 200 cycles would represent one power outage approximately every 9 days, or approximately 2000 ampere-hours of 24Vdc subsystem backup.

Checking 48V battery voltage

1. Locate the test points marked **COMMON** (-) and **BATTERY** (+) at the front of the primary Power Supply Module and connect a dc voltmeter with an accuracy of +/- 0.05-volts across the test points.
2. The voltage should read between 54.0-volts minimum to 55.2-volts maximum at 20-degreesC. For each degree that the battery enclosure temperature deviates from 20-degreesC, the following adjustments in Power Supply Module's battery charge output voltage are applicable.
   - Above 20-degreesC, the battery charge voltage limits are decreased by 72 mv/deg C.
   - Below 20-degreesC, the battery charge voltage limits are increased by 72 mv/deg C.

   If the charge voltage is outside of these limits, replace the Power Supply module.

> **Attention**
> Steps 3-5 should be performed during plant shutdowns because they require disconnecting the battery pack and placing the redundant Power Supply Module's power switch in the **OFF**position.

3 Disconnect the battery pack. With the voltmeter connected to the primary Power Supply Module's battery test points, place the redundant Power Supply Module's power switch in the **OFF**position. The voltage should not fall below the minimum voltage specified in Step 2. If it does, replace the redundant Power Supply Module.

4 Place the redundant Power Supply Module's power switch in the **ON**position. Move the test leads to the battery test points on the redundant Power Supply Module and place the primary Power Supply Module's power switch in the **OFF**position. The voltage should not fall below the minimum voltage specified in step 3. If it does, replace the redundant Power Supply Module.

5 Reconnect the battery pack to the Power System.

Checking for end of battery pack life

1 Set the**BATTERY**switch on the power system control panel to the **OFF**position.

2 Remove the Power System's lower cover. You can use either a screwdriver or a coin to remove the two screws while holding the lower cover in place.

3 Release the Power System cord connector at the battery.

4 Disconnect the battery pack from the subsystem.

5 Attach two pairs of leads to the battery pack terminals. One pair of leads are for attaching a load resistor and must be a minimum of 1.0 mm 2 (18 AWG) wire. The second pair is for attaching a voltmeter and can be a smaller gauge.

6 Using a voltmeter set to a range of 60Vdc for monitoring the battery voltage, attach the voltmeter to the smaller gauge leads.

7 The battery load for the test must be 5-ohms and rated at 500-watts. Five 1-ohm, 100-watt resistors placed in series are recommended.

8 Attach the resistors to the larger test leads. Note the time of attachment.

9 The battery voltage must remain above 40 Vdc for a minimum of 20 minutes. If the battery voltage is not maintained, the battery is considered at the end of its life and must be replaced.

10 All batteries of the same capacity, rating, and specifications do not provide equivalent performance or reliability. For optimum battery backup performance, use only Honeywell recommended and approved batteries.

Attention

Using the following procedure will cause alarms to be activated. Ensure that you notify Plant Operations in advance that alarms will occur during the procedure.

Removing battery pack

1 Set the **BATTERY**switch on the power system control panel to the **OFF**position.

2 Remove the Power System's lower cover. You can use either a screwdriver or a coin to remove the two screws while holding the cover in place.

3 Release the Power System cord connector at the battery.

4 Remove two screws holding the front lip of the battery pack to the base of the Power system chassis.

5 Move the Power System cord out of the way so it will not be damaged when the battery pack is removed.

6 Slowly slide the battery pack out into your hands, but be careful, the pack is heavy.

Refer to the next procedure for installing the Battery Pack.

Installing battery pack

1 Slide the new battery pack into the Power System chassis, being careful not to damage the battery pack connector cord within the compartment.

2 Secure the pack by replacing the two screws through the front lip of the pack into the base of the chassis.

3 Connect the pack to the system by inserting the polarized battery pack plug into the polarized connector cord in the compartment. Carefully dress the cord and connectors to prevent damage.

4 Replace the metal cover.

5 Apply power to the battery by switching the **BATTERY**switch to the **ON** position. Unless it is already in a charged condition, the battery pack may need to be initially charged for 16 hours before it will be capable of providing backup power to the system.

6.8.3 Replacing PM I/O Power Supply Module

The following procedure assumes that redundant Power Supply Modules are in use.

CAUTION

If the system is operational, do not remove both Power Supply Modules at the same time. The batteries will not power the system unless at least one Power Supply Module is present. If one of the Power Supply Modules fails, the backup batteries will not be drained.

Attention

When the optional redundant Power Supply Module is installed, the HPM will remain in operation while you replace a Power Supply Module. Ensure that you notify Plant Operations that you will cause alarms during the replacement process.

If the primary (left side) Power Supply Module is removed from the system or turned off, 6-Vac power is not provided to the card files because the redundant Power Supply Module does not provide 6-Vac. This can cause a Soft Failure Alarm Notification for any LLAI card that is present.

Replacing the Module

1 If the Power Supply Modules have ac present **(AC In**LED is lighted), the **BATTERY** switch can be placed in the **OFF** position.

Place the **BATTERY** switch in the **OFF** position before removing the Power Supply Module. Set the recessed toggle switch on one, and only one, Power Supply Module in the **(OFF**) position.

2 Remove two screws at the bottom of the module that hold it to the shelf of the Power System chassis.

3 Pull the Power Supply Module straight out of the housing.

4 Before installing the replacement Power Supply Module, ensure that the recessed toggle switch of the replacement Power Supply Module is in the **OFF** position.

5 Carefully slide the replacement module into the Power System chassis. Don't slam it into its housing. Be careful and ensure that the contacts at the back of the module mate properly with the fixed contacts at the back of the Power System backpanel.

6 Secure the replacement power supply module with two screws at the bottom of the module. Check that the green indicators on the supply are operating satisfactorily and that alarms can be reset.

7 Set the recessed toggle switch of the power supply module to the **ON** position.

8 Set the **BATTERY** switch to the **ON** position.

6.8.4 Replacing CMOS battery backup assembly

Replacing the CMOS Battery Backup Assembly (Figure 37) requires the removal of the redundant (right-side) Power Supply Module. Refer to the previous section for the Power Supply Module removal procedure.

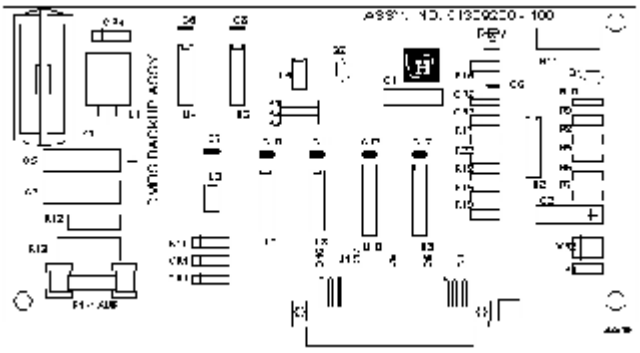


Figure 40: CMOS Battery Backup assembly

Replacing battery backup assembly

1. Remove the screw located at the front middle of the CMOS Backup Assembly.
2. Extract the circuit board from the Power System backpanel assembly. Refer to Figure 38.
3. Insert the replacement circuit board in the connector on the Power System backpanel assembly and fasten the screw.

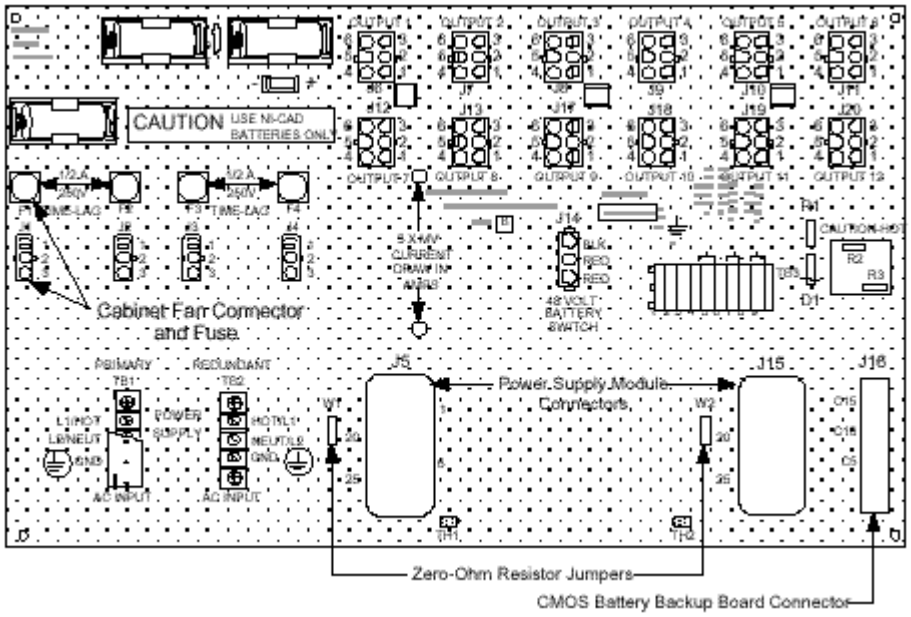


Figure 41: Standard power system backpanel

6.9 Removing PM I/O cabinet side panels

The following section describes the procedures for removing PM I/O cabinet side panels

Removing Markhon cabinet side panels

1. To remove the cabinet side panels either for cabinet complexing or for service requirements, first remove the two external Phillips screws.
2. Lift up on the side panel approximately 1 to 2 inches, and pull the panel outward from the cabinet.
3. If the panel does not release, additional lifting of the panel may be required.

Removing PM I/O Rittal cabinet side panels

1. To remove the cabinet side panels either for cabinet complexing or for service requirements, first remove the six external Phillips screws.
2. Lift up on the side panel approximately 1 to 2 inches, and pull the panel outward from the cabinet.
3. If the panel does not release, additional lifting of the panel may be required.

6.10 Replacing I/O Link Extender optical coupler module

There are two replacement procedures for the I/O Link Extender Optical Coupler. The procedure that you use depends on whether the Fiber Optic Coupler module is mounted in a non-CE Compliant card file or a CE Compliant card file. The CE Compliant card file requires an adapter kit because of the IOP connector ground plate.

Attention
Remove the I/O Link Extender card before removing the associated defective fiber Optical Coupler module. Removing the I/O Link Extender card first prevents the transmission of erroneous signals on the I/O Link.

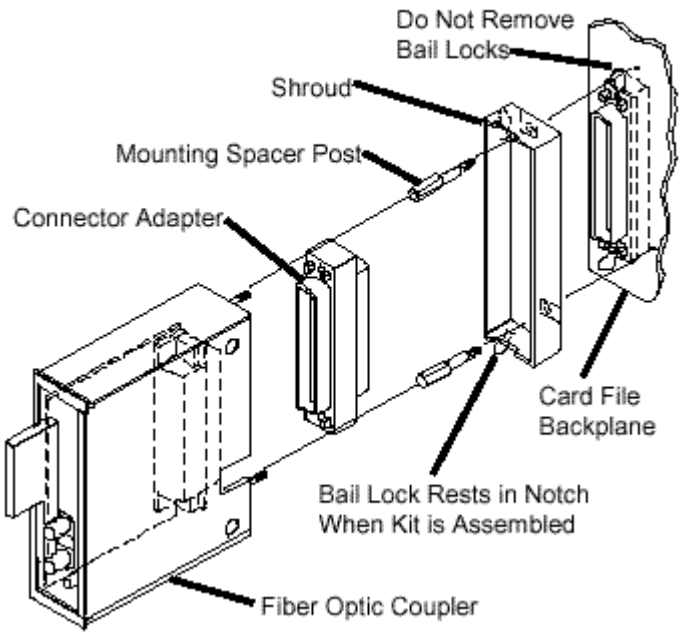
Replacing PM I/O Link Extender coupler in Non-CE Compliant card file

1. Grasp the upper and lower extractors on the I/O Link Extender card and pull them outward in unison.
   Move the card toward you until the card is disengaged from the card file backpanel connector. It is not necessary to remove the card from the card file.
2. Ensure the fiber optic cables are properly labeled. Disconnect the fiber optic cables from the Fiber Optic Coupler module.
3. Using a screwdriver with a small blade, loosen the two screws that secure the Fiber Optic Coupler module to the backpanel connector.
   Grasp the module firmly in your hand and pull it towards you.
   Place the module on an antistatic surface or in an antistatic container.
4. Replace the defective module with a new module by performing the actions in step 3 in reverse order.
5. Reconnect the fiber optic cables to the module.
6. Reinstall the I/O Link Extender card by performing the actions in step 1 in reverse order.
7. When you replace a standard I/O Link Extender Fiber Optic Coupler module, you must initialize both ends of the links by manually resetting the I/O Link Extender cards using the upper card-extractor on the card.
   When a Long Distance I/O Link Extender Fiber Optic Coupler module is replaced, reinstalling either I/O Link Extender card produces initialization at both ends of the link.

Replacing PM I/O Link Extender coupler in CE Compliant card file

1. Grasp the upper and lower extractors on the I/O Link Extender card and pull them outward in unison.
   Move the card toward you until the card is disengaged from the card file backpanel connector. It is not necessary to remove the card from the card file.
2. Ensure the fiber optic cables are properly labeled. Disconnect the fiber optic cables from the Fiber Optic Coupler module.
3. Using a screwdriver with a small blade, loosen the two screws that secure the fiber optic coupler to the backpanel connector. Grasp the module firmly in your hand and pull it towards you.
   The adapter connector that is between the Fiber Optic Coupler module and the backpanel connector may remain in place in the backpanel connector or disengage with the module. See the following figure for an illustration of the Fiber Optic Coupler module components.
   Remove the adapter connector from the module and place the module on an antistatic surface or in an antistatic container.

I/O Link Extender Fiber Optic Coupler Module Adapter Kit



4 Replace the defective module by performing the actions in step 3 in reverse order.

5 Replace the defective module by performing the actions in step 3 in reverse order.

6 Reconnect the fiber optic cables to the module.

7 Reinstall the I/O Link Extender card by performing the actions in step 1 in reverse order.

8 When you replace a Standard I/O Link Extender Fiber Optic Coupler module, you must initialize both ends of the links by manually resetting the I/O Link Extender cards using the upper card-extractor on the card. When a Long Distance I/O Link Extender Fiber Optic Coupler module is replaced, reinstalling either I/O Link Extender card produces initialization at both ends of the link.

7 Calibrating IOPs and FTAs

This section describes the calibration procedures for calibrating the PM I/O IOPs and FTAs.

Calibration may require access to hazardous live circuits and should only be performed by a qualified service person. More than one switch may be required to deenergize units before calibration.

Note

There are no manual adjustments, such as Power Supply Module settings in the IOP cabinet. However, there are some semi-automatic calibration procedures for the Low Level Analog Input (LLAI), High Level Analog Input (HLAI), and Analog Output (AO) subsystems that may be required periodically.

CAUTION
Do not attempt recalibration without the proper equipment and a working knowledge of the equipment.

Related topics

“Calibrating LLAI, HLAI, and AO IOPs” on page 102
“Calibrating the LLAI IOP” on page 103
“Calibrating the Nonredundant HLAI FTA” on page 110
“Calibrating Redundant HLAI IOPs” on page 113
“Calibrating the Nonredundant AO IOP” on page 114
“Calibrating Redundant AO IOPs” on page 116
“Calibrating LLMUX2 TC FTA” on page 117
“Calibrating the LLMUX2 RTD FTA” on page 119
“Calibrating the RHMUX IOP” on page 121
“Verifying Thermocouple Input Accuracy” on page 123

7.1 Calibrating LLAI, HLAI, and AO IOPs

Each LLAI, AO, and HLAI subsystem maintains on-board calibration constants for each analog channel that is stored in nonvolatile memory. Field calibration can probably be an annual event or more often during a plant or unit shutdown, if necessary.

7.1.1 Substituting components instead of recalibrating

If you suspect that an IOP or FTA is out of calibration, Honeywell recommends substitution of the component instead of recalibrating the IOP or FTA with an on-line Controller.

7.1.2 Required test equipment

You will need precision equipment to accurately recalibrate these subsystems. The following table lists typical precision test equipment that you can use.

Item	Tolerance	Honeywell	Model
Programmable Voltage Source: (with 10V and 100 mV range) (For precision simulation of thermocouple inputs)	\(0.002% setting +.0005% range +3µV)	Electronic Development Co. 11 Hamlin Street Boston, MA 02127	501 J1 (with option D)
Precision Resistors: 100-ohm 500-ohm 2000-ohm (For precision simulation of RTD inputs)	\ 0.005% \ 0.005% \ 0.005%	C. T. Gamble 605 Perkins Lane Delanco, NJ 08075	1608AL or 1608PC for each
Digital Multimeter with 10V range (1\V/count) and 100mV range (0.1 \V/count) (For accurate calibration value measurements)	\ 0.0025 reading + 40 counts	John Fluke Mfg. Co. Inc. PO Box C9090 Everett, WA 98206	8505A

7.2 Calibrating the LLAI IOP

Calibration may require access to hazardous live circuits and should only be performed by a qualified service person. More than one switch may be required to deenergize units before calibration.

Note

7.2.1 Calibrating the ranges

The LLAI IOP has seven different ranges that require calibration on a per slot basis, and a special range type for its reference junction calibration. At any one time, only one of the given gain ranges is being used by a given slot. Each range usage is independent from another slot's usage (for example, performing a calibration for one range does not affect the calibration constants of another range).

Although the LLAI performs calibration on an individual slot basis, only calibration affecting all eight slots can be performed.

7.2.2 Selecting ranges for calibration

Calibration of a slot assumes that the range type selected is applied to the slot. The range type is internally derived from the slot's current configuration of sensor type (SENSRTYP), PV character (PVCHAR), and thermocouple range option (TCRNGOPT for a thermocouple input).

Attention

The user is responsible for reconfiguration of the slots so that the input voltage or resistor applied to each channel is appropriate for the configuration. Any violation, due to a configuration mismatch during calibration, will result in calibration abort errors.

CAUTION

Although mixed ranges of calibration are allowed, never configure slot 1 as an RTD input if there is at least one slot configured for a thermocouple. This is because the reference junction for a thermocouple input is connected to slot 1.

7.2.3 Selecting RTD or TC calibration

When performing RTD calibration, all eight points must be configured as RTD. The same is true when performing thermocouple calibration. All eight points must be configured as thermocouple.

CAUTION

When performing the following calibration sequences, ensure that you use only high-quality solid copper wire for all the wire jumpers and voltage-source wires to the FTA's inputs. Failure to use high-quality solid copper wire can result in calibration errors and reduced accuracy.

An excellent source of high-quality solid copper wire is the copper wire conductor of type-T thermocouple wire (usually color-coded blue).

Attention

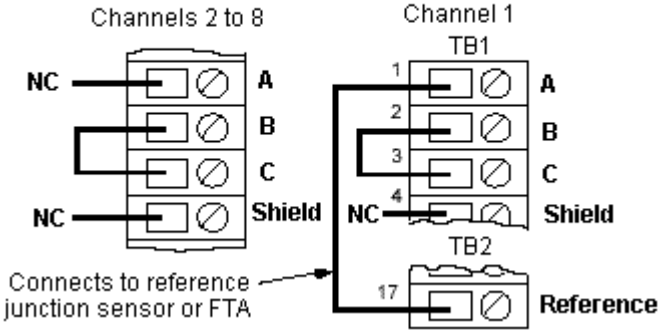
Each LLAI IOP card and FTA has been calibrated at the factory for all input types. If recalibration must be performed in the field, power must be applied to the LLAI for at least 30 minutes for temperature stabilization before starting the calibration. The calibration procedure calibrates all channels on one FTA simultaneously, rather than each channel singularly.

Calibrating the LLAI IOP

1. Set the IOP card to the IDLE state using the Execution State command on its configuration form in the Monitor tab of Control Builder, or the Station Detail display.
2. If the FTA has screw terminal strips, temporarily remove the plastic cover.
3. Remove the field wiring from the FTA .and
4. Substitute 'zero input'sources for all channels. These inputs are short copper-wire jumpers across the input terminals. Use the appropriate figure that follows for reference.

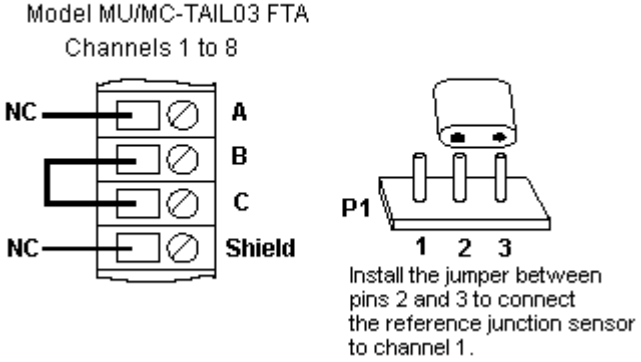
Thermocouple and All Linear Zero

Model MU/MC-TAIL01 and MU/MC-TAIL02 FTAs



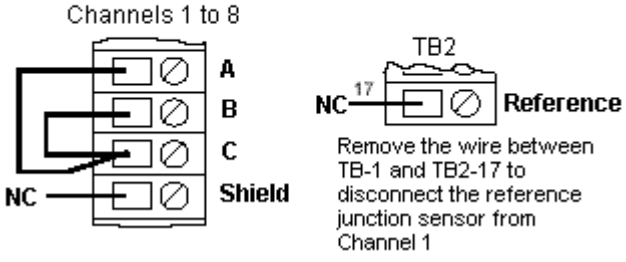
Thermocouple and All Linear Zero

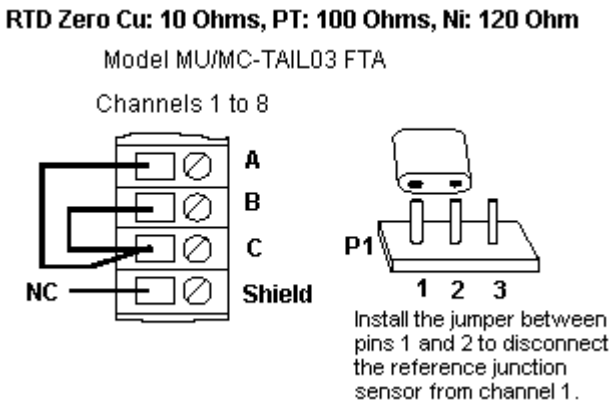
Model MU/MC-TAIL03 FTA



RTD Zero Cu: 10 Ohms, PT: 100 Ohms, Ni: 120 Ohm

Model MU/MC-TAIL01 and MU/MC-TAIL02 FTAs

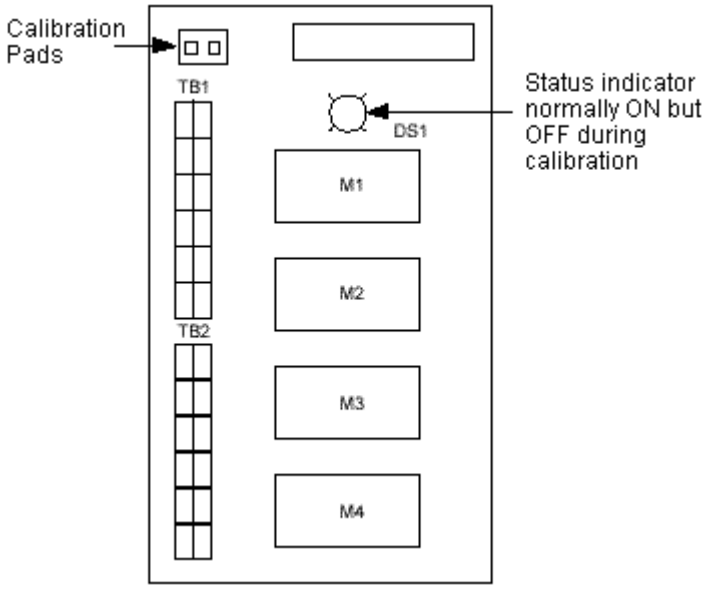




5 Select the ENABLE CALIBRATION (or ENABLE RJ CALIBRATION if an RJ calibration is being performed) target through the Calibration Status field on the **Calibration** tab of the configuration form for the LLAI in the **Monitor** tab of Control Builder, or on the Station Detail display.

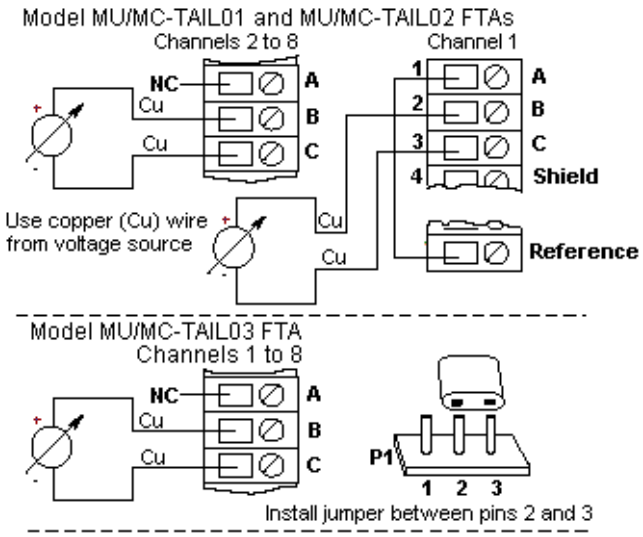
6 Momentarily short the two square calibrate pads in the upper-left corner of the FTA under test, as shown in the following figure.

7 Check the **STATUS** indicator (DS1) on the associated LLAI FTA. You will find that it extinguishes immediately, and then comes back on in approximately 30 seconds. During this time, the IOP card has performed its 'zero input' calibration.

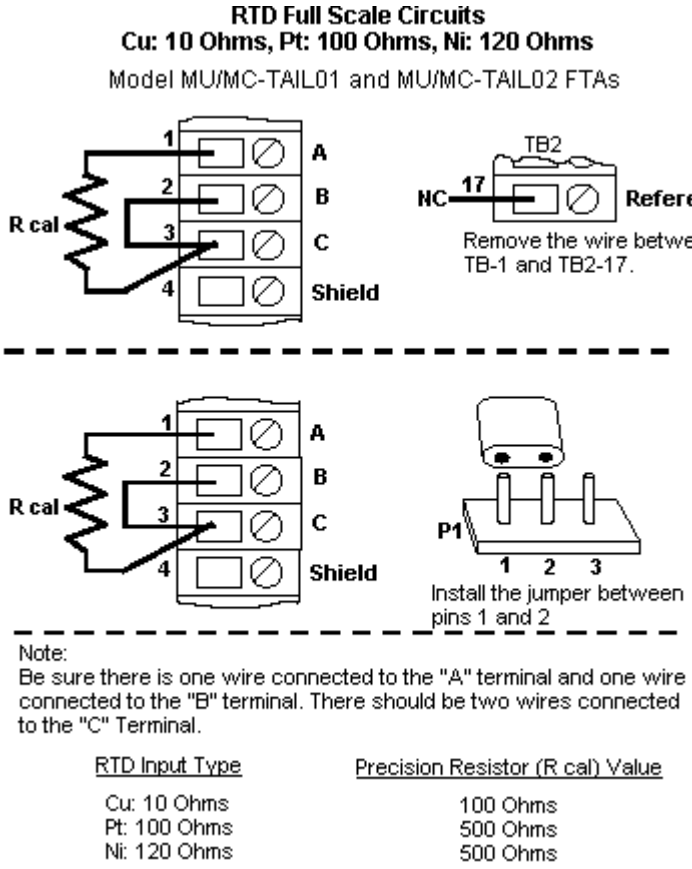


8 Remove the 'zero inputs' and replace them with full-scale signals. Refer to the appropriate figure that follows for the full-scale input value and the connection to the screw or compression terminals.

Thermocouple and All Linear Full Scale Circuits



User Input Device	Full-Scale Calibration Values Normal Range	Extended Range
Input Voltage: 0-100 mVdc	100 mV	N/A
0-5 Volt	5V	N/A
Current Input: 4-20 mA	20 mA (5 V)	N/A
10-50 mA	50 mA (5 V)	N/A
Thermocouple: ANSI J	40 mV	100 mV
ANSI K	40 mV	40 mV
ANSI E	40 mV	100 mV
ANSI T	40 mV	40 mV
ANSI B	20 mV	20 mV
ANSI S	20 mV	20 mV
ANSI R	20 mV	20 mV
Japanese Type R	20 mV	20 mV

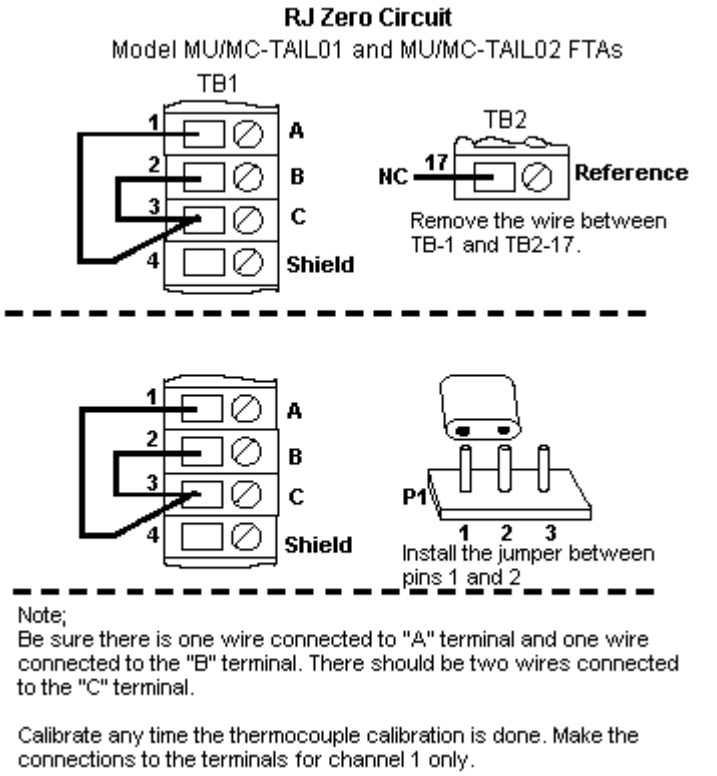


9 Again, momentarily short the calibration pads at the upper-left corner of the FTA under test, then check the **STATUS** indicator (DS1) on the LLAI.

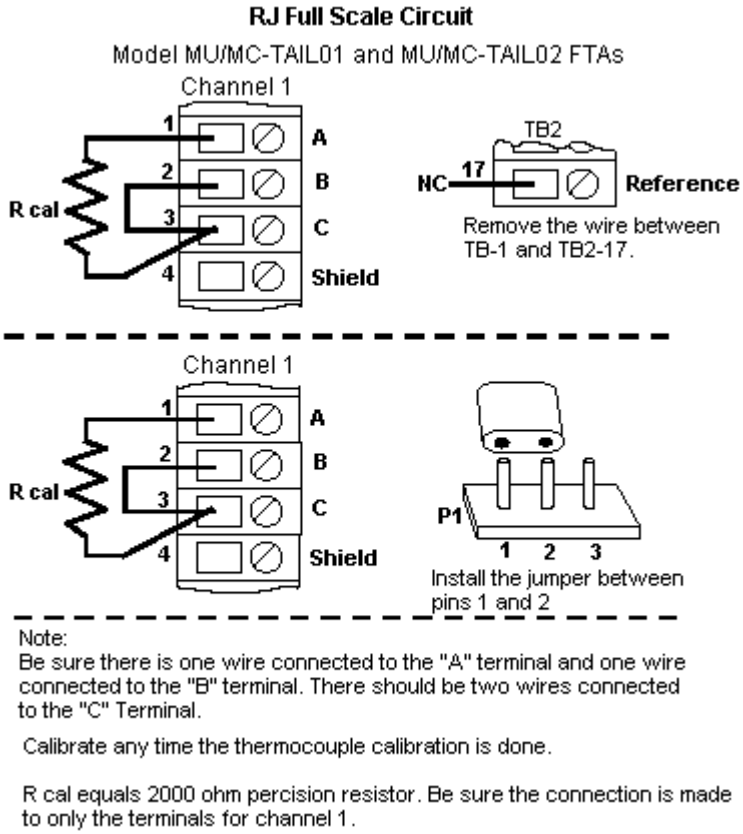
The **STATUS** indicator remains extinguished for approximately 30 seconds while the IOP card performs its 'full-scale' calibration.

10 If a thermocouple input is connected to the LLAI subsystem, it is recommended that you recalibrate the Reference Junction (RJ) input each time the thermocouple is recalibrated. Only channel 1 requires a zero ohm jumper connected to it.

Connect a zero-ohm jumper to channel 1 as shown in the following figure. Repeat Steps 5 through 7.



11 Connect a 2000 ohm resistor jumper to channel 1 as shown in the following figure. Repeat Step 9.



12 Ensure the target (accessed through the Calibration Status field on the **Calibration** tab of the configuration form for the LLAI in the **Monitor** tab of Control Builder or on the Station Detail display) has returned to ENABLE CALIBRATION, indicating that the zero and span calibration process has completed.

13 Check the LLAI IOP card for Soft failures.

If a Soft failure occurred, find the source of the failure, correct it, and repeat the calibration procedure. If soft failures did not occur, remove the test equipment from the FTA and reconnect the field wiring. If the FTA has screw terminal strips, replace the plastic cover over the strips.

14 Inform the operator that the LLAI subsystem can be returned to on-line operation.

7.3 Calibrating the Nonredundant HLAI FTA

Calibration may require access to hazardous live circuits and should only be performed by a qualified service person. More than one switch may be required to deenergize units before calibration.

Note

The following calibration procedure is for the nonredundant model MU-TAIH02 HLAI FTA and the model MU-TAIH03 HLAI FTA, but the procedure can also be used for the following redundant FTA models:

- MU-TAIH12
- MU-TAIH13
- MU-TAIH22
- MU-TAIH23
- MU-TAIH52
- MU-TAIH53
- MU-TAIH62
- MU-GAIH12/82
- MU-GAIH13/83
- MU-GAIH14/84
- MU-GAIH22/92

7.3.1 Galvanically-isolated HLAI FTA connection points

The connection points for the calibration-voltage source and the shorting location that starts the calibration differs for the model MU-GAIH12/82, MU-GAIH13/83, and MU-GAIH14/84 Galvanically-Isolated FTAs. Because of circuit density on the FTA board assembly, the IOP calibration terminals that are similar to those on a standard FTA could not be added to the assembly. Instead, unused pins in the FTA's 50-pin auxiliary connector J19 provide a calibration interface for the Galvanic Isolation HLAI Calibration tool, Honeywell part number 51201450-100.

The following chart lists the voltage input pins and calibration start pins that are shown together with the tool in Figure 39.

Description	Pins
Primary IOP Voltage Source	19 (+) and 44 (-)
Secondary IOP Voltage Source	20 (+) and 45 (-)
Calibration Start (Short together)	21 and 46

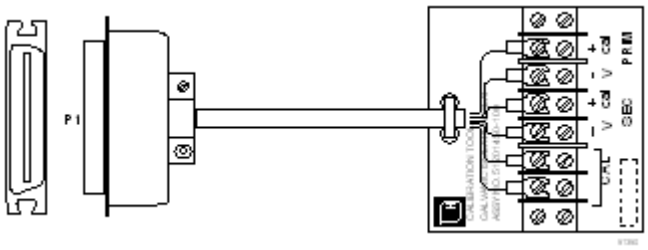


Figure 42: Galvanic Isolation Tool for HLAI calibration

7.3.2 HLAI IOP calibration terminals

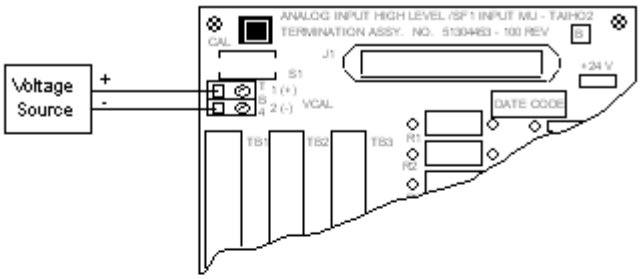
The signals required for calibration of the HLAI IOP are provided at the screw terminals at the end of the tool's cable when the cable is connected to the auxiliary connector on the HLAI FTA. The calibration procedure is the same procedure used for the standard HLAI FTA.

Attention
This calibration procedure calibrates all channels simultaneously, rather than each channel individually.

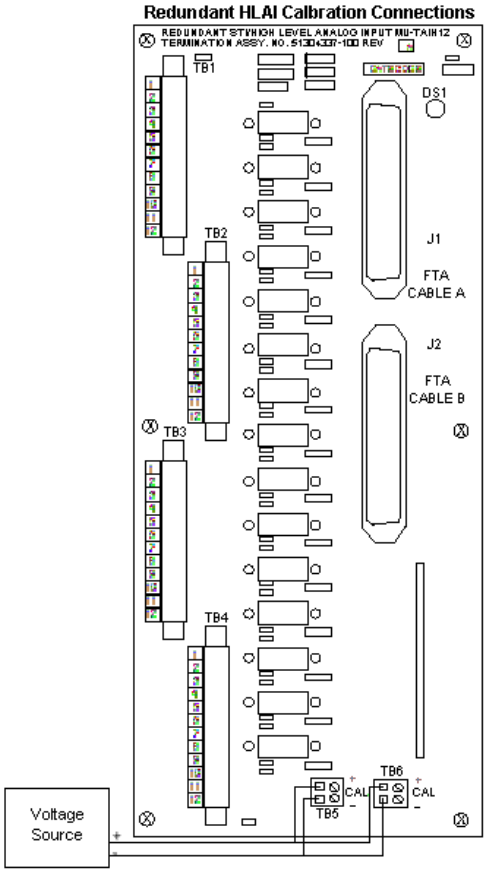
Calibrating the HLAI IOP

1. Set the IOP card in its IDLE state through the Execution State command on its configuration form in the **Monitor** tab of Control Builder or the Station Detail display.
2. Select the ENABLE CALIBRATION target through the Calibration Status field on the **Calibration** tab of the configuration form for the HLAI in the **Monitor** tab of Control Builder, or on the Station Detail display.
3. If the voltage source is connected before idling the IOP and enabling calibration, the HLAI will report a Soft failure.
4. Connect the calibration voltage source to the FTA and adjust the voltage to 5Vdc (4.9995 - 5.0005Vdc).

   See the following figures for the assembly layout of the nonredundant model MU-TAIH02 FTA and the redundant model MU-TAIH12 FTA, respectively. The assembly layouts of all the HLAI FTAs are illustrated in the *Control Hardware Installation Guide*.



User Input Device		VCAL Voltage Source
Voltage Input:	0-5 volt	5 V
	1-5 volt	5 V
Current Input:	4-20 mA	5 V
	10-50 mA	5 V



5 Short the two calibration pads at the upper-left corner of the HLAI FTA to start the calibration.
For Galvanically Isolated FTAs, two pins in the Marshalling Panel connector are shorted together.

6 Ensure that the calibration target on the form in the **Monitor** tab of Control Builder or Station Detail display has changed back to DISABLE CALIBRATION, indicating that the zero and span calibration process has completed. Check for the Soft failure CALIB ABORT, which indicates bad calibration.

7 Disconnect the calibration voltage-source wiring.

8 Inform the operator that the HLAI can be returned to on-line operation.

7.4 Calibrating Redundant HLAI IOPs

You can recalibrate each HLAI IOP separately with an off-line Controller or follow the previous procedure for the nonredundant HLAI FTA to simultaneously calibrate both IOPs. The calibration voltage source must be connected to both sets of calibration terminals on the redundant model FTA simultaneously with parallel wiring as shown in the figure in the previous procedure for the model MU-TAIH12 FTA.

	Calibration may require access to hazardous live circuits and should only be performed by a qualified service person. More than one switch may be required to deenergize units before calibration.

7.5 Calibrating the Nonredundant AO IOP

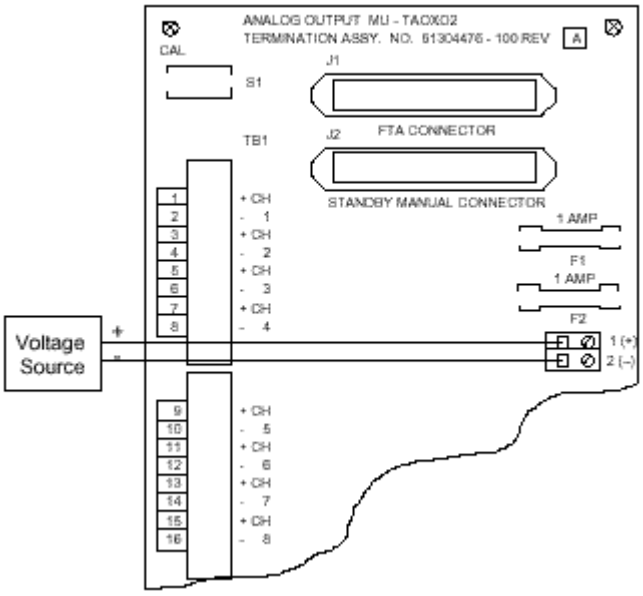
You can use the following procedure for calibrating nonredundant AO FTA model MU-TAOX02. The procedure can also be used for nonredundant models MU-GAOX02 and MU-GAOX72 FTAs, and redundant models MU-TAOX12, MU-TAOX52, MU-GAOX12, and MU-GAOX82 FTAs.

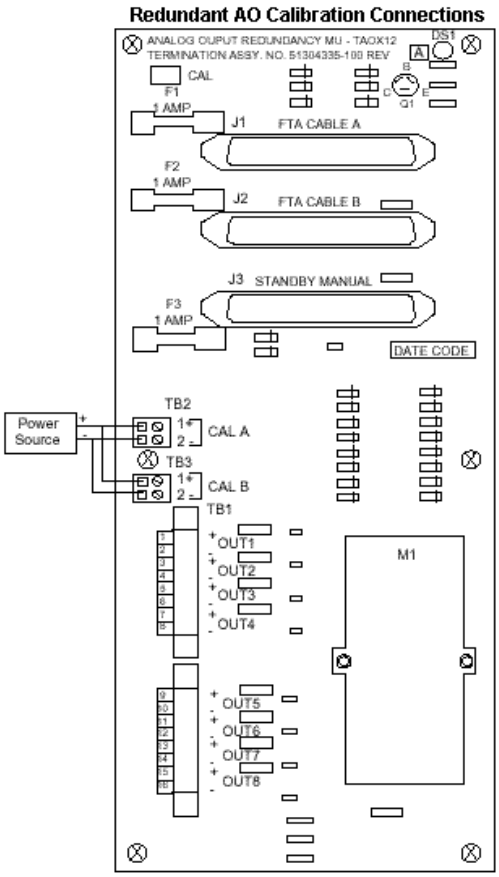
Calibrating Procedure for Nonredundant AO IOP

1. Isolate the AO IOP outputs. Use an Analog Output Standby Manual (AOSM) to control the devices connected to the FTA. The AOSM provides isolation from the IOP outputs.
2. Set the IOP card to the IDLE state through the Execution State command on its configuration form in the **Monitor** tab of Control Builder, or the Station Detail display.
3. Select the ENABLE CALIBRATION target through the Calibration Status field on the **Calibration** tab of the configuration form for the HLAI in the **Monitor** tab of Control Builder, or on the Station Detail display.
4. Connect an adjustable floating voltage source to the FTA output terminals as shown in the following figures for the nonredundant model MU-TAOX02 FTA or redundant model MU-TAOX12, respectively. Adjust the voltage source to between 4.9995 and 5.0005Vdc. The AO IOP uses this precision voltage reference to do an accurate short term calibration of the internal loopback ADC. The circuitry is then used to calibrate each output channel.

   (Refer to the *Control Hardware Installation Guide* for layouts of other model AO FTAs.)

Nonredundant AO Calibration Connections





5 Short together the calibration pads at the upper-left corner of the FTA. The procedure takes approximately 5 seconds.

6 Disconnect the calibration source.

7 Inform the operator that the AO IOP can be used for process operations.

7.6 Calibrating Redundant AO IOPs

To simultaneously calibrate the redundant AO IOPs, follow the previous calibration procedure for the nonredundant Analog Output FTA. The calibration voltage source must be connected to both sets of calibration terminals on the redundant FTA simultaneously with parallel wiring as shown in the redundant AO calibration connections figure in the previous procedure.

7.7 Calibrating LLMUX2 TC FTA

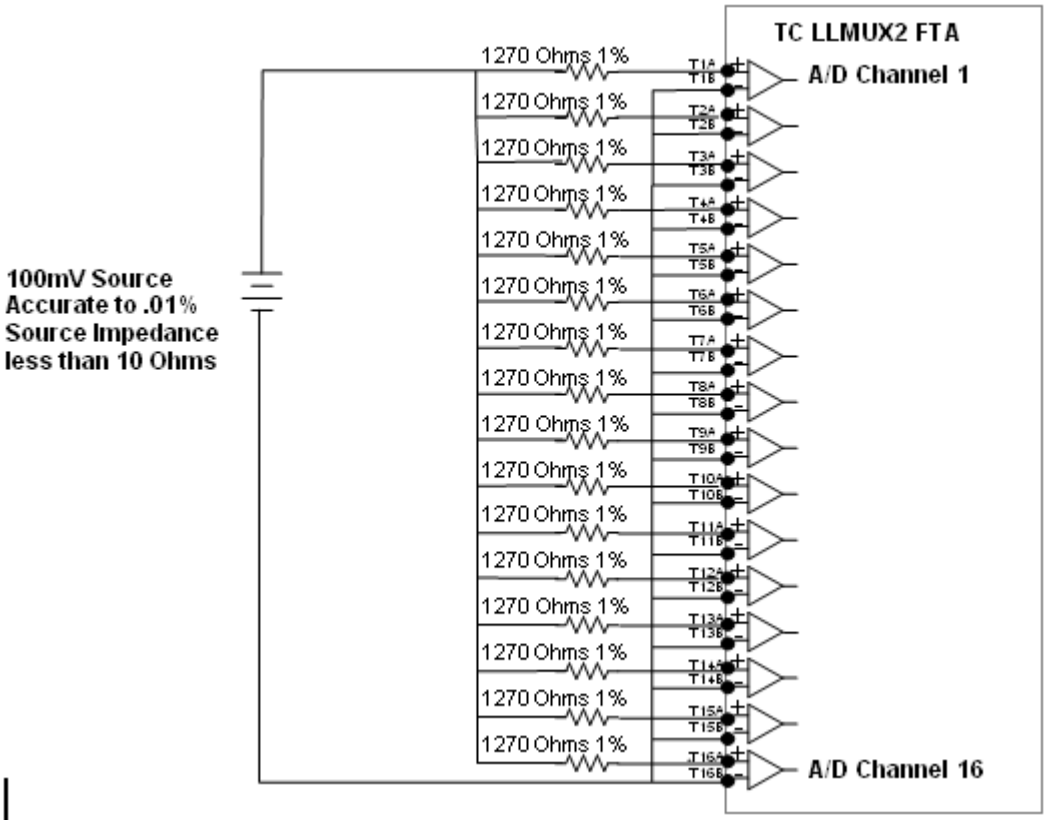
There are no adjustments on the LLMUX2 TC subsystem for calibration purposes. Calibration in the field is not recommended.

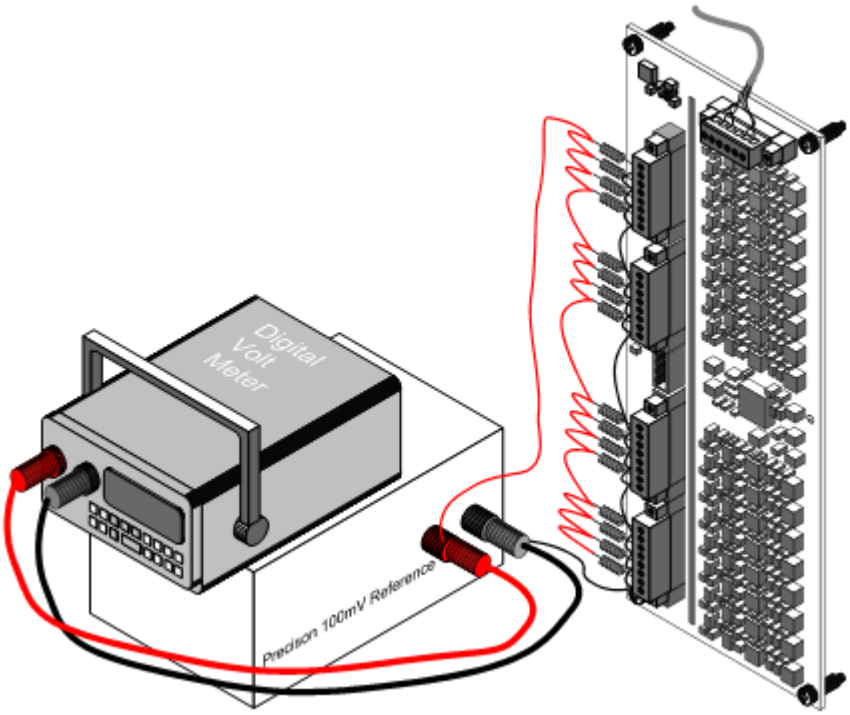
However, if you decide to perform calibration, the setup for the LLMUX2 TC is not the same as it was for the older LLMUX TC FTAs. The older LLMUX TC FTAs included only one A/D converter, whereas the LLMUX2 TC includes 16 A/D converters (one per channel). Therefore, the calibration setup for the LLMUX2 TC is different and more complex than the original LLMUX calibration setup.

The calibration process involves the FTA reading the precision source and then storing this data in non-volatile EEPROM on the FTA. Both the millivolt and the open-thermocouple detection functions are calibrated by this operation.

Calibrating Procedure for LLMUX2 TC FTA

1 Connect a precision 100 millivolt (0.01%) voltage source to each FTA channel through a 1270 (1%) ohm resistor as shown in the following illustrations. set the voltage to 100 millivolts (99.995 - 100.005 millivolts).





2 Apply power for 5 minutes.

3 Calibration is initiated by a single command for each FTA. Set the IOP card in its IDLE state through the Execution State command on its configuration form in the Monitor tab of Control Builder or the Station Detail display.

4 Select the **ENABLE CALIBRATION** target through the Calibration Status field on the Calibration tab of the configuration form for the LLMUX2 TC in the Monitor tab of Control Builder or on the Station Detail display. The calibration procedure is automatic and completes in less than one second.

The red LED on the LLMUX2 FTA will be blinking during the millivolt calibration process and the yellow led will be blinking during the open thermocouple calibration process. The blinking is a result of the FTA cycling through the 16 channels, calibrating them independently and sequentially.

5 When calibration is completed, remove the voltage source, disconnect the precision resistors, and restart the LLMUX2 subsystem.

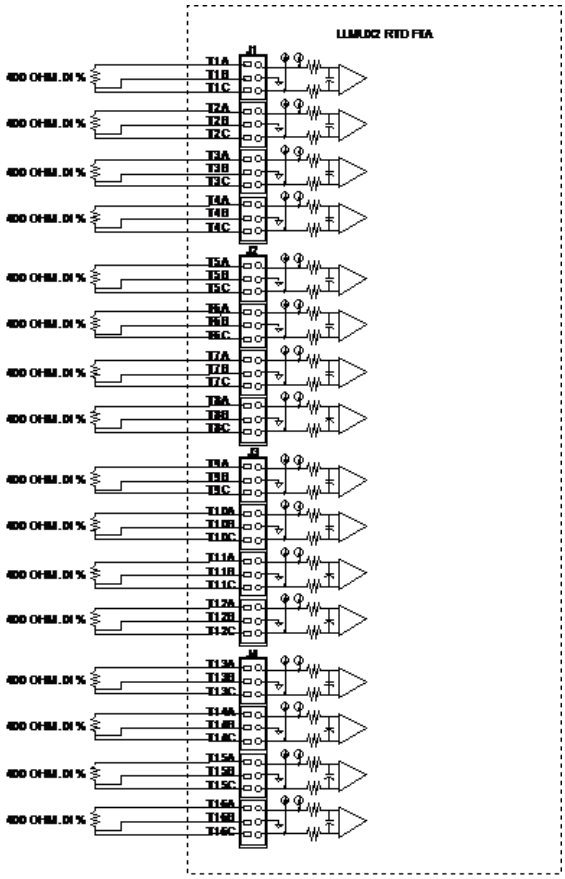
7.8 Calibrating the LLMUX2 RTD FTA

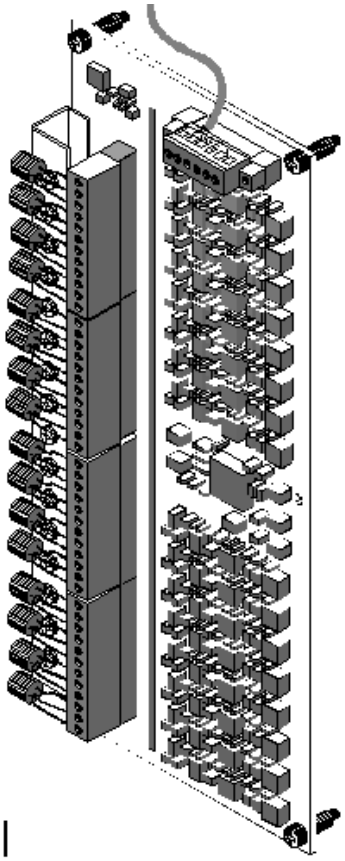
There are no adjustments on the LLMUX2 RTD subsystem for calibration purposes. Calibration in the field is not recommended.

However, if you decide to perform calibration, the setup for the LLMUX2 RTD is described in this section. Note that the older LLMUX RTD FTAs did not have a calibration procedure.

Calibrating Procedure for LLMUX2 RTD FTA

1. Connect a precision 400-ohm 0.01% resistor to each channel as shown in the following illustrations.
2. Apply power for 5 minutes.
3. Calibration is initiated by a single command for each FTA. Set the IOP card in its IDLE state through the Execution State command on its configuration form in the Monitor tab of Control Builder or the Station Detail display.
4. The calibration process involves the FTA reading the precision resistance and then storing the value in non-volatile EEPROM on the FTA. Calibration takes less than 1.0 minute.
5. When calibration is completed, remove the precision resistors and restart the LLMUX2 subsystem.





7.9 Calibrating the RHMUX IOP

The main calibration constants for the Remote Hardened Low Level Multiplexer (RHMUX) IOP are determined during factory calibration, and are used to calibrate the gain block error and the A/D reference.

A subsequent field calibration calibrates only the A/D reference and is performed only for the 100mV range which results in the field calibration factor being set to a ratio of the original factory calibration gain to the field calibration gain. This factor is then used to modify the original factory calibration constants such that the original factory calibration gain constants still exist.

7.9.1 Calibrating method

The input to the RHMUX IOP is calibrated by using two input voltages for each scale; one at 20% of full range, and one at 80% of full scale. The RHMUX IOP will check to see if the voltage that is present is within 20% of what is expected for each step in the calibration procedure.

If the input voltage is out of the expected voltage range, a signal with the led and in the case of automated factory calibration is generated. When the input voltage is digitized, the firmware will take 34 readings, eliminate the highest and lowest readings, and average the remaining readings.

The gain can then be computed from the factor:

- Delta Input/Delta Expected

The resultant gain constants are stored in nonvolatile memory within the RHMUX IOP microprocessor. The field calibration factor is also set to 1.

If field calibration is performed at 50 hertz, rather than 60 hertz, the calibration coefficients have a ratio of 545/655 prior to storage. This figure is not the exact ratio of 50 hertz to 60 hertz because of a peculiarity in the A/D converter in the RHMUX IOP. Since calibration coefficients are stored just for 60 hertz, the firmware compensates accordingly when 50 hertz operation for the RHMUX IOP is selected.

In all cases, millivolts are computed as:

- (A/D Counts - ZERO Counts) x GAIN.

GAIN is determined at calibration time as:

- (Factory mV/Count) x (Field Calibration Factor) x (50 Hz/60 Hz Factor)

7.9.2 Calibrating procedure

The field calibration procedure is designed with the assumption that the RHMUX FTA may be some distance from the control room and the console when calibration is performed. Therefore, the procedure provides for all the interaction between the person performing the calibration and the RHMUX FTA when the initial calibration command is executed at the console and the tasks that must be performed locally at the RHMUX FTA.

In addition, the RHMUX IOP will not exit the calibration sequence if it is unsuccessful, but rather remains at the failed step in the calibration sequence in order to allow it to be repeated. This means that to use the RHMUX IOP again, or restart the calibration sequence, power to the RHMUX IOP must be cycled off and then on again.

Calibrating RHMUX IOP

1. Set the IOP card in the IDLE state through the Execution State command on its configuration form in the **Monitor** tab of Control Builder or the Station Detail display.
2. Verify that the IOP is configured for the correct frequency by looking at the RHMUX configuration form in the **Monitor** tab of Control builder.
3. Disconnect any field wires from channels 1 and 16 at the FTA.
4. Select the ENABLE CALIBRATION target through the Calibration Status field on the **Calibration** tab of the configuration form for the RHMUX in the **Monitor** tab of Control Builder, or on the Station Detail display.

5 At the RHMUX FTA, verify that the voltage at the factory-calibration pin is a logic one which indicates that field calibration is in process.

   Verify that the FTA's Status LED is off and not blinking randomly.

6 Connect the calibration device to channel-1 input terminals. Set the voltage to 100mV, +/- 5 microvolts.

7 Short the channel-16 input terminals for a minimum of 0.1 seconds and then remove the short. The firmware uses burnout to read the state of the channel-16 input. The multiplexer digitizes the input in about 4 seconds, turns on the Status LED for 0.2 seconds, and turns the Status LED off if the voltage is within 20% of the expected voltage. If not, the Status LED will blink twice.

8 Set the calibration voltage to 20mV, +/- 5uV. Short the channel-16 terminals again for a minimum of 0.1 seconds and then remove the short.

   The RHMUX IOP will do another conversion. The firmware extracts a new slope coefficient for the reference diode and overwrites the previous field calibration factor.

9 If the calibration is successful and complete, the Status LED returns to the normal blinking cycle. The RHMUX IOP will respond to a Status command with an OK status. If the calibration was not successful, the response will be the CALIBRATION FAILURE status.

7.9.3 Failing the calibration

If the RHMUX IOP senses that the calibration voltage is off by more than 20% during the calibration procedure, the Status LED will blink twice (0.2-seconds on, and 0.2-seconds off) to indicate a failure. This requires that the calibration voltage be checked and reset to the proper value.

The channel-16 input terminals must be shorted again for a minimum of 0.1-seconds and then opened to cause the RHMUX IOP to retry the voltage. If the calibration sequence can not be successfully completed, power must be cycled off and then on to exit the calibration sequence.

7.10 Verifying Thermocouple Input Accuracy

It is necessary to verify the accuracy of a thermocouple input. Verification is accomplished with the use of a precision Thermocouple Simulator.

Verifying Accuracy

1. Ensure that the equipment is properly installed in the cabinet.
2. Connect a reference-grade thermocouple wire between the Thermocouple Simulator and one input of the process control system.
3. Install all equipment covers and close the cabinet doors.
4. Using the applicable configuration form in the **Monitor** tab of Control Builder, disable the Open Thermocouple Detection mode for the control point.
5. Allow the equipment to operate normally for 2 hours while temperature gradients stabilize.
6. Verify the accuracy of the thermocouple using the Thermocouple Simulator.
7. Move the thermocouple reference wire to another thermocouple input from the process control system and repeat the above procedures, starting at step 3.

8 Testing Redundancy

During scheduled plant maintenance, you can improve the Process Manager I/O subsystem's availability by performing specific redundancy tests on Process Manager I/O subsystem hardware. You should notify Operations prior to the tests so that they are prepared for the tests.

Even though fault coverage is high in the process control system during normal operation, periodic redundancy testing provides additional fault coverage by exercising any hardware that is not in use during normal operation.

Related topics

“Testing IOP redundancy” on page 126
“Testing 8-channel AO IOP redundancy” on page 128
“Testing power cable redundancy” on page 130
“Testing power supply module redundancy” on page 131

8.1 Testing IOP redundancy

You can monitor and interact with a redundant PM I/O IOP through its configuration form in the Monitor tab of Control Builder or its Station Detail display. Figure 40 shows a sample **Main** tab of the configuration form for an AO IOP in the **Monitor** tab of Control Builder. Figure 40 is a sample illustration that does not represent actual indications.

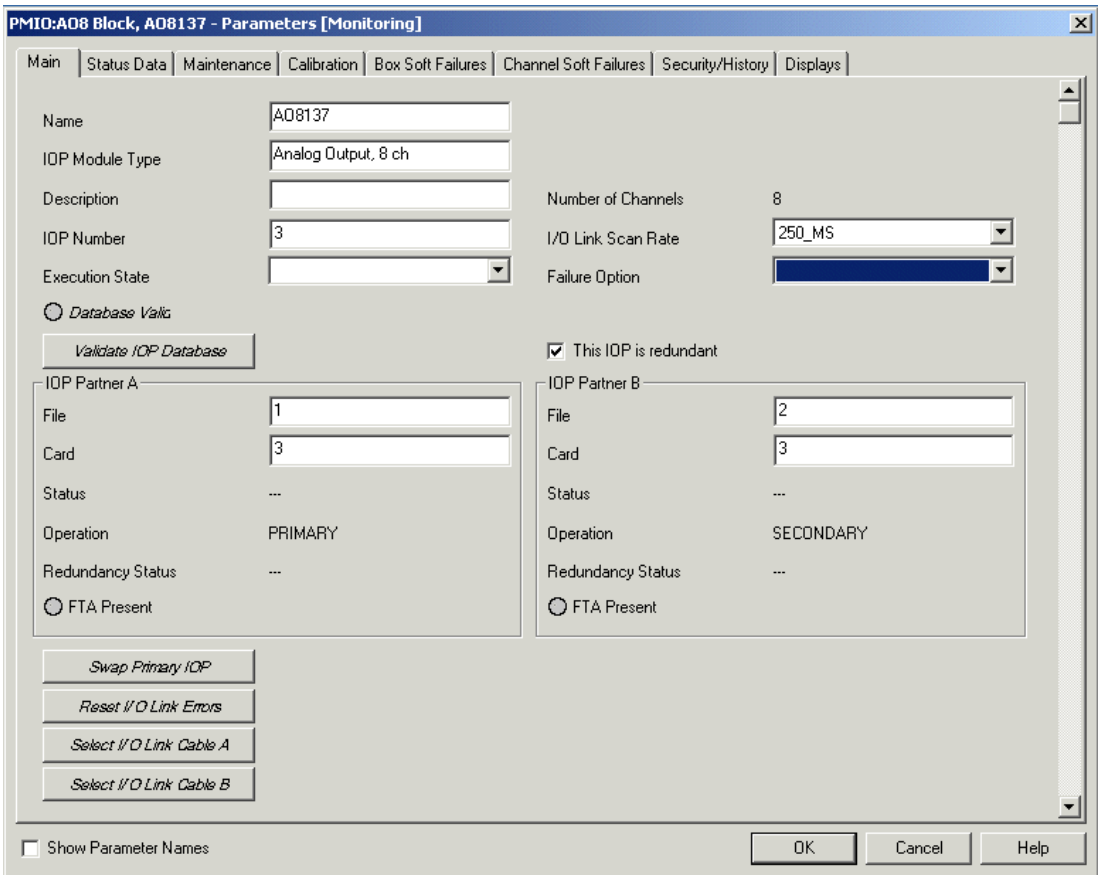


Figure 43: AO IOP configuration form Main tab

8.1.1 Redundancy terminology

Term	Description
IOP-A	IOP-A is the physical primary IOP. It is the IOP that is physically connected by cable to the A-cable connector on a redundant FTA.
IOP-B	IOP-B is the physical primary IOP. It is the IOP that is physically connected by cable to the B-cable connector on a redundant FTA.
Primary IOP	Logical primary IOP that is controlling the FTA's field terminals or providing the process variable. It is the IOP that is physically connected by cable to the A-cable connector on a redundant FTA.
Secondary IOP	Logical secondary IOP that is not controlling the FTA's field terminals or providing the process variable. It is the IOP that is physically connected by cable to the B-cable connector on a redundant FTA.
IOP Swap	The present primary IOP becomes the secondary IOP, and the present secondary IOP becomes the primary IOP. An IOP swap reverses the status of physical IOPs A and B.

Term	Description
IOP Bias	For the 8-channel AO IOP only, the preferred condition is IOP-A as the primary IOP and IOP-B as the secondary IOP, which is with the bias. The non-preferred condition is with the IOP-B as the primary IOP and IOP-A as the secondary IOP because it is against the basis.

Testing redundancy

1. In the **Monitor** tab of Control Builder, double-click applicable IOP icon to open its configuration form.
2. On the **Main** tab, check the current status of IOP-A and its redundant partner IOP-B.
3. Click the **Swap Primary IOP** button.

   Check that the status of IOP-A and IOP-B have changed accordingly.
4. Click the **Swap Primary IOP** button again to restore the status noted in step 2.
5. Repeat this procedure for other redundant pairs of IOPs.

8.2 Testing 8-channel AO IOP redundancy

Redundancy for the 8-channel AO IOPs is biased toward IOP-A to maximize reliability. A hardware bias is used because IOP-A (the physical primary) is connected directly to the FTA circuitry that interfaces the FTA's field wiring output terminals while IOP-B (the physical secondary) is connected to the AO FTA through a switching module on the FTA.

8.2.1 Identifying hardware required

Locate the following components.

- AO IOP-A
- AO IOP-B
- Redundant AO FTA
- Analog Output Standby Manual (AOSM)
- Devices that are being controlled by the FTA analog output
- Control algorithms that are driving the analog outputs

8.2.2 Checking status of AO IOP

Using the IOP configuration form in the **Monitor** tab of Control Builder, check that the IOPs are currently operating normally, as indicated by a status of OK/BKP.

In addition, ensure that the following status conditions exist:

- The outputs are being controlled by IOP-A
- IOP-A and IOP-B are synchronized
- IOP-A is operating normally without Soft failures
- IOP-B is operating normally without Soft failures

Testing 8-channel AO redundancy

1 Notify the Operations Group of the test, and begin the test at a convenient time.
Disrupt power to the AO IOP-B by toggling the IOP's upper extractor.

The status of the IOPs on the **Main** tab of the configuration form in Control Builder should briefly indicate a status of OK/NR [S], and then return to a status of OK/BKP for the IOPs.

Confirm that the field devices are operating properly by observing the operation of the process, or measure the output currents reaching the devices.

2 Disconnect the IOP-to-FTA cable at IOP-B. The AO Main tab should indicate a status of OK/BSF for the IOPs.
Confirm that the field devices are operating properly by observing the operation of the process, or measure the output currents reaching the devices.

3 Reconnect the cable to IOP-B. The AO Main tab should return to an OK/BKP status for the IOPs.

4 Click the **Swap Primary IOP** button so that IOP-B has control of the FTA outputs.
The AO Main tab should indicate a BKP/OK status for the IOPs.

Check that the Main tab continues to indicate BKP/OK status for a period of at least two minutes to allow the Redundancy Diagnostics to finish with IOP-B now controlling the FTA outputs.

Confirm that the output devices are operating properly by observing the operation of the process, or measuring the output currents reaching the field devices before and after executing the swap command.

5 Disrupt power to AO IOP-A by toggling the IOP's upper extractor.
The AO Main tab should indicate a [S] NR/OK status briefly, then return to BKP/OK.

Confirm that the output devices are operating properly by observing the operation of the process, or measuring the output currents reaching the field devices.

6 Disconnect IOP A's IOP-to-FTA cable at the IOP. The AO Main tab should indicate a status of BSF/OK for the IOPs. Confirm that the output devices are operating properly by observing the operation of the process, or measuring the output currents to the field devices.

7 Reconnect the IOP-to-FTA cable at the IOP. The AO Main tab should return to a BKP/OK status for the IOPs.

8 Allow the subsystem to operate against the bias with IOP-B controlling the outputs for a period of time, such as 4 hours. During this period of time, the AO Main tab should continue to indicate a BKP/OK status for the IOPs.

Ensure that no Soft failures are logged into the Station Event Journal.

Continue to monitor the output devices to ensure that they are operating properly by observing the operation of the process, or by measuring the output currents reaching the field devices

9 Initiate a Swap Primary IOP command so that IOP-A has control of the FTA outputs. The AO Main tab should indicate an OK/BKP status for the IOPs. Continue to monitor operation of the output devices with the bias for a period of time, such as 2 hours.

8.3 Testing power cable redundancy

The IOP Card files, the Digital Input Power Distribution assembly, and the Galvanic Isolation Power Distribution assembly are provided with redundant power cables to enhance power distribution reliability within the PM I/O subsystem. You should be able to disconnect either end of one of the two redundant power cables providing power to the IOP card file, Digital Input Power Distribution assembly, or Galvanic Isolation Power Distribution assembly without affecting equipment operation.

CAUTION

Power cable redundancy testing should be performed during a plant shutdown.

Procedure for testing power cable redundancy

1. Disconnect one of the pair of power cables for a card file, Digital Input Power Distribution assembly, or Galvanic Isolation Power Distribution assembly at either the Power System connection or the other end of the cable.

   Determine if the operation of the equipment is impaired by observing the operation of the affected IOP cards.
2. Replace the cable connection and then disconnect the other cable in the pair. Determine if the operation of the equipment is impaired.
3. Repeat steps 1 and 2 for all card files, Digital Input Power Distribution assemblies, and Galvanic Isolation Power Distribution assemblies.

8.4 Testing power supply module redundancy

A power system with redundant Power Supply Modules should continue to provide power to the PM I/O without interruption when one of the power supply modules fails or looses ac power.

CAUTION
Power system redundancy testing should be performed during a plant shutdown.

Procedure for Testing supply module redundancy

1 With both Power Supply Modules of a redundant Power System operating, place the **ON/OFF**switch of the right-side Power Supply Module in the **OFF**position.
Observe that the IOP cards continue to operate normally (Status and Power indicators are illuminated).

2 If operation continues normally, return the **ON/OF**F switch to the **ON**position,
If the IOP cards not continue to operate normally, check cables and/or replace the Power Supply Module.

Attention
When the left-side Power Supply Module's **ON/OFF**switch is placed in the **OFF**position, all LLAI IOPs should report a Soft failure, but they will continue to operate normally.

3 With both Power Supply Modules of a redundant Power System operating, place the **ON/OFF**switch of the left-side Power Supply Module in the **OFF**position.
Observe that the IOP cards continue to operate normally (Status and Power indicators are illuminated).

4 If IOP cards continue to operate normally, return the **ON/OFF**switch to the **ON**position,
If the IOP cards do not operate normally, check power cables and/or replace the Power Supply Module.

9 PM I/O Spare Parts List

The following tables list items that may be required for maintenance during the life of the Process Manager I/O components.

Related topics

“Batteries” on page 134
“Replacement fuses” on page 135
“Cabinet filters” on page 136
“Optimum Replaceable Unit (ORU) Parts” on page 137

9.1 Batteries

Name	Description	Part Number
NiCad Rechargeable Batteries	AA-size NiCad battery, (quantity 1)	51190422-100
	C-size NiCad battery, (quantity 1)	51192060-100
Alkaline Batteries	AA-size Alkaline battery, (quantity 1)	51190467-100

9.2 Replacement fuses

For Assembly… (Assembly No.)	Fuse Description	Qty	Part Number
Left 7-Slot Card File (51401626)	2.0 A Subminiature fuse (F1-8)	8	30754661-021
Right 7-Slot Card File (51401629)	2.0 A Subminiature fuse (F1-8)	8	30754661-021
15-Slot Card File (51401629)	2.0 A Subminiature fuse (F1-16)	16	30754661-021
IOP Card File (51402599)	2.0 A Subminiature fuse (F1-15)	15	30754661-021
	0.5 A Subminiature fuse (F16)	1	30754661-014
3-30 Vdc SS DO FTA (51304423)	5.0 A Time-delay fuse 5 x 20 mm	16	51190584-250
3-30 Vdc SS DO FTA (51304650, 51309153)	2.5 A Time-delay fuse 5 x 20 mm	16	51190584-225
31-200 Vdc SS DO FTA (51304428, 51309154)	1.0 A Time-delay fuse 5 x 20 mm	16	51190584-210
24-240 Vac SS DO FTA (51304408)	3.0 A Time-delay fuse 5 x 20 mm	16	51190584-230
120/240 Vac SS DO FTA (51304648)	2.5 A Time-delay fuse 5 x 20 mm	16	51190584-225
120 Vac Relay DO FTA (51304443, 51309148)	6.0 A Time-delay fuse 5 x 20 mm	16	51190584-260
240 Vac Relay DO FTA (51304427, 51309150)	3.0 A Time-delay fuse 5 x 20 mm	16	51190584-230
24 Vdc Nonisolated DO FTA (51304446)	0.2 A Fast-action fuse 5 x 20 mm (F1-16)	16	51190582-120
	2.0 A Fast-action fuse 5 x 20 mm (F17)	1	51190582-220
24 Vdc Isolated DO FTA (80364013)	1.6 A Fast-action fuse MP16 (F1-4)	4	83957061-004
24 Vdc Isolated DO FTA (80366183)	1.6 A Fast-action fuse MP16 (F1-16)	16	83957061-004
LLAI FTA (51304437, 51309202)	0.5 A Subminiature fuse (F1-4)	4	30754661-014
DI FTA (80364010, 80366180)	0.5 A Fast-action fuse MP05 (F1, F3)	2	83957061-002
DI FTA (80364010, 80366180)	1.0 A Fast-action fuse MP10 (F2)	1	83957061-003
DI Power Distribution Assy (51304425)	1.0 A Fast-action fuse 5 x 20 mm (F1-12)	12	51190582-210
Nonredundant AO FTA (51304476)	1.0 A Fast-action fuse 5 x 20 mm (F1-12)	12	51190582-210
Redundant AO FTA (51304335)	1.0 A Fast-action fuse 5 x 20 mm (F1-3)	3	51190582-210
Redundant AO FTA (80364007, 80366177, 80366481, 80366484)	1.0 A Fast-action fuse MP10 (F1)	1	83957061-003
Pulse Input FTA (51304084)	0.25 A Fast-action fuse 5 x 20 mm (F1-8)	8	51190582-125
Galvanic AO FTA (51304638)	1.0 A Subminiature fuse (F1-3)	3	30754661-019
GI Power Distribution Assy (51304644)	4.0 A Fast-action fuse 5 x 20 mm (F1-8)	8	51190582-240
I/O Link Card	3.0 A Fast-action fuse (F1)	1	30754661-022
Fuse holder Puller	Fuse holder extractor		51190586-100

9.3 Cabinet filters

Name	Description	Part Number
Filter Kit (Rittal cabinet)	Louvered cover and filter, 20 /8 x 20 /8 (cm/in.)	51109488-100
Filter (Rittal cabinet)	Replacement filter only, 20 /8 x 20 /8 (cm/in.)	51109488-200
Filter (Markhon cabinet)	Replacement filter only, 39 /15.5 x 61 /24 (cm/in.)	51109541-100

9.4 Optimum Replaceable Unit (ORU) Parts

The following tables shows information about the Optimum Replacable Unit (ORU) parts.

9.4.1 Cables

Name	Model Number | Length		Part Number
Power Cable - Nonshielded (For internal cabinet use)	Power System to card file cable (Set of two when ordered by model number)		
	MU-KDPR01	1 meter	51201397-001
	MU-KDPR02	1.5 meters	51201397-915
		2 meters	51201397-002
		3 meters	51201397-003
	MU-KDPR04	4 meters	51201397-004
	MU-KDPR05	5 meters	51201397-005
		6 meters	51201397-006
		8 meters	51201397-008
	MU-KDPR10	10 meters	51201397-010
	MU-KDPR15	15 meters	51201397-015
	MU-KDPR20	20 meters	51201397-020
	MU-KDPR25	25 meters	51201397-025
	MU-KDPR30	30 meters	51201397-030
	MU-KDPR35	35 meters	51201397-035
	MU-KDPR40	40 meters	51201397-040
	MU-KDPR45	45 meters	51201397-045
	MU-KDPR50	50 meters	51201397-050
Power Cable - Nonshielded (internal cabinet use)	Power System to card file cable - Set of two (With surge protection network for I/O Link cable)		
		1.0 meter	51204126-001
		1.5 meters	51204126-915
		2 meters	51204126-002
		3 meters	51204126-003
		4 meters	51204126-004
		5 meters	51204126-005
		6 meters	51204126-006
Power Cable Adapter Cable - Nonshielded (internal cabinet use)	Power cable I/O Link protector adapter - Set of two (Provides I/O Link protector for 51201397-xxx cable)		51204127-100
Power and I/O Link Interface Cable	Combination power and I/O link interface cable used to connect the I/O Link Interface Module to the IOP card file and the IOP power system (The cable includes leads for connecting 24 Vdc power to the Process Controller chassis power supply.)		
	TC-KIOL02	2 meters	51202306-100
	TC-KIOL05	5 meters	51202306-200

Name	Model Number | Length		Part Number
	TC-KIOL10	10 meters	51202306-300
Power Cable - Shielded (For external cabinet use)	Power System to Power Distribution Assembly cable (Set of two when ordered by model number)		
	MU-KSPR05	5 meters	51204037-005
	MU-KSPR10	10 meters	51204037-010
	MU-KSPR15	15 meters	51204037-015
	MU-KSPR20	20 meters	51204037-020
	MU-KSPR25	25 meters	
	MU-KSPR30	30 meters	51204037-030
	MU-KSPR35	35 meters	
	MU-KSPR40	40 meters	51204037-040
	MU-KSPR50	50 meters	51204037-050
Power Cable - Shielded (For external cabinet use)	Power System to card file cable - Set of two (With surge protection network for I/O Link cable)		
		1.0 meter	51204138-001
		1.5 meters	51204138-915
		2 meters	51204138-002
		3 meters	51204138-003
		4 meters	51204138-004
		5 meters	51204138-005
		6 meters	51204138-006
Galv Isolation FTA Power Cable (For internal cabinet use)	Power cable I/O Link protector adapter - Set of two (Provides I/O Link protector for 51204037-xxx cable) GI Power Distribution assembly to FTA cable		51204140-100
		0.50 meter	51109620-020
		0.75 meter	51109620-030
		1.00 meter	51109620-040
		1.25 meters	51109620-050
		2 meters	51109620-080
		3 meters	51109620-120
		4 meters	51109620-160
	MU-KGPR05	5 meters	51109620-195
	MU-KGPR10	10 meters	51109620-390
Bridge Cable	Bridge cable for model MU/MC-TDOY23 and MU/MC-TDOY63 FTAs		
		1 meter	80366198-100
		2 meters	80366198-200
Power Adapter Cable (Non-CE Compliant Applications)	Power Adapter to LLMux/SDI/SI FTA cable (External to the cabinet for LLMux/SDI/SI)		
		Special order	51190696-xxx
		76 meters	51190696-076
		152 meters	51190696-152
		305 meters	51190696-305

Name	Model Number | Length		Part Number
Power Adapter Cable (CE Compliant Applications)	Power Adapter to LLMux/RHMUX/SDI/SI FTA cable (External to the cabinet for LLMux/SDI/SI) (Internal to the cabinet for RHMUX)		
		Special order	51192139-104
	MU-KLX076	76 meters	51192139-114
	MU-KLX152	152 meters	51192139-124
	MU-KLX305	305 meters	51192139-134
RHMUX Power Adapter Cable (CE Compliant Applications)	RHMUX Power Adapter to RHMUX FTA cable (External to the cabinet)		
		Special order	51197597-100
	MU-KLO305	305 meters	51197597-305
Power Adapter Cable (Non-CE Compliant Applications)	Power Adapter to LLMux/SDI/SI FTA cable (Internal to the cabinet)		
	MU-KLAM01	30 centimeters	51304465-100
	MU-KLAM02	66 centimeters	51304465-200
	MU-KLAM03	100 centimeters	51304465-300
	MU-KLAM06	200 centimeters	51304465-400
	MU-KLAM09	300 centimeters	51304465-500
I/O Link Interface Cable (Set of two)	IOP card file communication cable		
		Two drop in cabinet	51195479-100
		Three drop in cabinet	51195479-200
		Four drop in cabinet	51195479-300
		Five drop in cabinet	51195479-400
		Six drop in cabinet	51195479-500
I/O Link Interface Cable (Set of two, shielded - for use in Europe)	IOP card file communication cable		
		Two drop in cabinet	51204042-100
		Three drop in cabinet	51204042-200
		Four drop in cabinet	51204042-300
		Five drop in cabinet	51204042-400
		Six drop in cabinet	51204042-500
IOP-to-FTA Cable	IOP-to-FTA cable		
		1 meter	51201420-001
		1.5 meters	51201420-915
	MU-KFTA02	2 meters	51201420-002
	MU-KFTA03	3 meters	51201420-003
	MU-KFTA04	4 meters	51201420-004
	MU-KFTA05	5 meters	51201420-005
		6 meters	51201420-006
	MU-KFTA08	8 meters	51201420-008
	MU-KFTA10	10 meters	51201420-010
	MU-KFTA15	10 meters	51201420-015
	MU-KFTA20	20 meters	51201420-020

Name	Model Number | Length		Part Number
	MU-KFTA25	25 meters	51201420-025
	MU-KFTA30	30 meters	51201420-030
	MU-KFTA35	35 meters	51201420-035
	MU-KFTA40	40 meters	51201420-040
	MU-KFTA45	45 meters	51201420-045
	MU-KFTA50	50 meters	51201420-050
IOP-to-FTA Cable (Shielded - for external cabinet use)	IOP-to-FTA cable		
		1 meter	51204033-001
		1.5 meters	51204033-915
	MU-KFTS02	2 meters	51204033-002
	MU-KFTS03	3 meters	51204033-003
	MU-KFTS04	4 meters	51204033-004
	MU-KFTS05	5 meters	51204033-005
		6 meters	51204033-006
	MU-KFTS08	8 meters	51204033-008
	MU-KFTS10	10 meters	51204033-010
	MU-KFTS15	15 meters	51204033-015
	MU-KFTS20	20 meters	51204033-020
	MU-KFTS25	25 meters	51204033-025
	MU-KFTS30	30 meters	51204033-030
	MU-KFTS35	35 meters	51204033-035
	MU-KFTS40	40 meters	51204033-040
	MU-KFTS45	45 meters	51204033-045
	MU-KFTS50	50 meters	51204033-050

9.4.2 Power system components - non-conformally coated

Name	Description	Part Number
Power Supply Module	Standard 20A Power Supply Module	51109456-200
Power Supply Module	AC-Only 8A Power Supply Module	51190465-100
Power Supply Module	AC-Only 16A Power Supply Module	51190465-200
48 V Battery Backup	48V Battery Pack assembly	51303948-100
AC/DC Distribution Assembly	AC-Only power control and distribution board 115Vac dual power supply modules	51401135-100
AC/DC Distribution Assembly	AC-Only power control and distribution board 115Vac single power supply module	51401135-200
AC/DC Distribution Assembly	AC-Only power control and distribution board 230Vac dual power supply modules	51401135-300
AC/DC Distribution Assembly	AC-Only power control and distribution board 230Vac single power supply module	51401135-400
CMOS Battery Backup Assembly	PS Charger/monitor for CMOS memory	51309206-100

Name	Description	Part Number
Power System Backpanel Assy	Power System backpanel	51404172-100

9.4.3 Power system components - conformally coated

Name	Description	Part Number
Power Supply Module	Standard 20A Power Supply Module	51109456-200
Power Supply Module	AC-Only 8A Power Supply Module	51190465-150
Power Supply Module	AC-Only 16A Power Supply Module	51190465-250
48V Battery Backup	48V Battery Pack assembly	51303948-100
AC/DC Distribution Assembly	AC-Only power control and distribution board 115Vac dual power supply modules	51401135-150
AC/DC Distribution Assembly	AC-Only power control and distribution board 115Vac single power supply module	51401135-250
AC/DC Distribution Assembly	AC-Only power control and distribution board 230Vac dual power supply modules	51401135-350
AC/DC Distribution Assembly	AC-Only power control and distribution board 230 Vac single power supply module	51401135-450
CMOS Battery Backup Assembly	Charger/monitor for CMOS memory	51309206-150
Power System Backpanel Assy	Power System backpanel	51404172-150

9.4.4 IOP cards - non-conformally coated

Name (Model No.)	Description	Part Number
HLAI IOP (MU-PAIH02)	High-Level Analog Input card (Replaced by 51304754-100)	51304489-100
HLAI IOP (MU-PAIH03)	High-Level Analog Input card	51304754-100
LLAI IOP (MU-PAIL02)	Low-Level Analog Input card	51304481-100
LLMux IOP (MU-PLAM02)	Low-Level Multiplexer card	51304362-100
RHMUX(MU-PRHM01)	Remote Hardened Low-Level Multiplexer card	51404109-125
DI IOP (MU-PDIX02)	Digital Input card	51304485-100
DI IOP (MU-PDIY22)	Digital Input card	80363972-100
AO IOP (MU-PAOX02)	Analog Output	51304483-100
AO IOP (MU-PAOX03)	Analog Output card (Replaced by 51309152-175)	51304672-100
AO IOP (MU-PAOX03)	Analog Output card (Conformally Coated)	51309152-175
AO IOP (MU-PAOY22)	Analog Output card	80363969-100
DO IOP (MU-PDOX02)	Digital Output card	51304487-100
DO IOP (MU-PDOY22)	Digital Output card	80363975-100
STI IOP (MU-PSTX02)	Smart Transmitter Interface card (Replaced by 51304516-200)	51304516-100
STI_MV (MU-PSTX03)	Smart Transmitter Interface Multivariable	51304516-200
DISOE IOP (MU-PDIS11)	Digital Input Sequence-Of-Events card (Replaced by 51402625-125)	51304690-100
DISOE IOP (MU-PDIS12)	Digital Input Sequence-Of-Events card	51402625-125

Name (Model No.)	Description	Part Number
Slot Filler	Empty IOP slot filler card	51304260-200

9.4.5 IOP cards - conformally coated

Name (Model No.)	Description	Part Number
HLAI IOP (MC-PAIH02)	High-Level Analog Input card	51304489-150
HLAI IOP (MC-PAIH03)	High-Level Analog Input card	51304754-150
HLAIHART (MC-PHAI01)	HART Analog Input card	51403479-150
LLAI IOP (MC-PAIL02)	Low-Level Analog Input card	51304481-150
LLMux IOP (MC-PLAM02)	Low-Level Multiplexer card	51304362-150
RHMUX (MC-PRHM01)	Remote Hardened Low Level Multiplexer card	51404109-175
DI IOP (MC-PDIX02)	Digital Input card	51304485-150
DI IOP (MC-PDIY22)	Digital Input card	80363972-150
AO IOP (MC-PAOX02)	Analog Output	51304483-150
AO IOP (MC-PAOX03)	Analog Output card (Replaced by 51309152-175)	51304672-150
AO IOP (MC-PAOX03)	Analog Output card	51309152-175
AO IOP (MC-PAOY22)	Analog Output card	80363969-150
AO16HART (MC-PHAO01)	HART 16-Channel Analog Output card	51403476-150
DO IOP (MC-PDOX02)	Digital Output card	51304487-150
DO IOP (MC-PDOY22)	Digital Output card	80363975-150
STI IOP (MC-PSTX02)	Smart Transmitter Interface card (Replaced by 51304516-200)	51304516-150
STI_MVIOP (MC-PSTX03)	Smart Transmitter Interface Multivariable	51304516-250
DISOEIOP (MC-PDIS11)	Digital Input Sequence-Of-Events card (Replaced by 51402625-125)	51304690-150
DISOE IOP (MC-PDIS12)	Digital Input SOE card	51402625-175
Slot Filler	Empty IOP slot filler card	51304260-250

9.4.6 I/O LINK Extender components - non-conformally coated

Name (Model No.)	Description	Part Number
Standard I/O Link Extender (MU-IOLM02)	Standard I/O Link Extender card	51304419-100
	Standard fiber optic Tx/Rx coupler (single interface)	51201557-100
	Standard fiber optic Tx/Rx coupler (triple interface)	51201557-300
Long Distance I/O Link Extender (MU-ILDX02 - Replaced by MU-ILDX03)	Long Distance I/O Link Extender card	51304532-100
	Long Distance fiber optic Tx/Rx coupler (single interface)	51201616-100
Long Distance I/O Link Extender (MU-ILDX03)	Long Distance I/O Link Extender card	51304532-100
	Long Distance fiber optic Tx/Rx coupler (single interface)	51309208-100

Name (Model No.)	Description	Part Number
I/O Link Extender Adapter Kit (MU-ILES01)	I/O Link Extender Adapter kit	51204043-100

9.4.7 I/O LINK Extender components - conformally coated

Name (Model No.)	Description	Part Number
Standard I/O Link Extender (MC-IOLM02)	Standard I/O Link Extender card	51304419-150
	Standard fiber optic Tx/Rx coupler (single interface)	51201557-150
	Standard fiber optic Tx/Rx coupler (triple interface)	51201557-350
Long-Distance I/O Link Extender (MC-ILDX02 - Replaced by MC-ILDX03)	Long-Distance I/O Link Extender card	51304532-150
	Long-Distance fiber optic Tx/Rx coupler (single interface)	51201616-150
Long Distance I/O Link Extender (MC-ILDX03)	Long-Distance I/O Link Extender card	51304532-150
	Long-Distance fiber optic Tx/Rx coupler (single interface)	51309208-150

9.4.8 Standard FTA components - non-conformally coated

Name (Model No.)	Description	Part Number
HLAI/STI FTA (MU-TAIH02)	HLAI/STI with compression terminals	51304453-100
HLAI/STI FTA (MU-TAIH12)	HLAI/STI with compression terminals	51304337-100
HLAIHART FTA (MU-TAIH14)	HLAIHART with compression terminals	
HLAI/STI FTA (MU-TAIH22)	HLAI/STI with compression terminals	80366195-100
	AI Adapter Module for the above FTA	80367163-001
HLAI/STI FTA (MU-TAIH52)	HLAI/STI with screw terminals	51304337-200
HLAI/STI FTA (MU-TAIH62)	HLAI/STI with screw terminals	80366192-100
	AI Adapter Module for the above FTA	80360713-001
HLAI FTA (MU-TAIH03)	HLAI with compression terminals	51309136-125
HLAIHART FTA (MU-TAIH04)	HLAIHART with compression terminals	
HLAI FTA (MU-TAIH13)	HLAI with compression terminals	51309138-125
HLAIHART FTA (MU-TAIH15)	HLAIHART with compression terminals	51305863-125
HLAI FTA (MU-TAIH23)	HLAI with compression terminals	80369165-125

Name (Model No.)	Description	Part Number
AI Adapter Module for the above FTA	80367163-001	
HLAI FTA (MU-TAIH53)	HLAI with screw terminals	51309138-225
HLAIHART FTA (MU-TAIH54)	HLAIHART with screw terminals	51305863-225
STI FTA (MU-TSTX03)	STI with compression terminals	51309140-125
STI FTA (MU-TSTX13)	STI with compression terminals	51309142-125
STI FTA (MU-TSTX53)	STI with screw terminals	51309142-225
LLAI FTA (MU-TAIL02)	LLAI FTA with compression terminals (Replaced by MU-TAIL03)	51304437-100
	Daughter module for above FTA (Replaced by 51309280-100)	51304085-100
LLAI FTA (MU-TAIL03)	LLAI FTA with compression terminals	51309202-125
	Daughter module for above FTA	51309280-100
LLMUX2 TC FTA (MC-TAMT04)	LLMUX2 TC FTA with Local CJR, compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMT02 &MU-TAMT03 and MC-TAMT02 & MC-TAMT03.	51305890-175
	6-pin Connector with compression terminals	51195776-100
	8-pin Connector with compression terminals	51190771-508
LMUX2 FTA (MC-TAMT14)	LLMUX2 TC FTA with Remote CJR, compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMT12 & MU-TAMT13 and MC-TAMT12 & MC-TAMT13.	51305890-175
	Remote CJR	51305902-175
	4-pin Connector with compression terminals	51190771-404
	6-pin Connector with compression terminals	51190776-100
	8-pin Connector with compression terminals	51190771-508
LLMUX2 RTD FTA (MC-TAMT04)	LLMUX2 RTD FTA with compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMR02 & MU-TAMR03 and MC-TAMR02 & MC-TAMR03.	51305907-175
	3-pin Connector with compression terminals	51190771-403
	6-pin Connector with compression terminals	51195776-100
RHMUX GI/IS Power Adapter (MU-GRPA01)	RHMUXGI/IS Power Adapter with compression terminals	51304724-125
RHMUX GI/NI Power Adapter (MU-TRPA01)	RHMUX GI/NI Power Adapter with compression terminals	51304722-125
AO FTA (MU-THAO11)	Analog Output with HART and comp. terminals	51309542-125
AO FTA (MU-TAOX02)	Analog Output FTA with compression terminals	51304476-125

Name (Model No.)	Description	Part Number
AO FTA (MU-TAOX12)	Analog Output FTA with compression terminals	51304335-125
AO FTA (MU-TAOX52)	Analog Output FTA with screw terminals	51304335-225
AO FTA (MU-TAOY22)	Plug-in module for above FTAs	51304338-100
	Analog Output FTA with compression terminals, Stdby Manual	80366481-125
AO FTA (MU-TAOY23)	Analog Output FTA with compression terminals, no Stdby Manual	80366177-200
AO16HART FTA (MU-TAOY24)	HART Analog Output FTA with compression terminals, Stdby Manual	51305865-125
AO16HART FTA (MU-TAOY25)	HART Analog Output with compression terminals, no Stdby Manual	
AO FTA (MU-TAOY52)	Analog Output with screw terminals, Stdby Manual	80366484-125
AO16HART FTA (MU-TAOY54)	HART Analog Output with screw term, Stdby Manual	51305867-125
AO16HART FTA (MU-TAOY55)	HART Analog Output with screw terminals, no Stdby Manual	
DI 120 Vac FTA (MU-TDIA12)	Digital Input 120Vac with compression terminals	51304439-125
DI 120 Vac FTA (MU-TDIA52)	Digital Input 120Vac with fixed-screw terminals	51304439-225
DI 120 Vac FTA (MU-TDIA72)	Plug-in module for above FTAs	51190523-225
	Digital Input 120Vac with removable screw term	51303930-100
DI 240 Vac FTA (MU-TDIA22)	Digital Input 240Vac with compression terminals	51304431-125
DI 240 Vac FTA (MU-TDIA62)	Digital Input 240Vac with fixed-screw terminals	51304431-225
DI 24 Vdc FTA (MU-TDID12)	Plug-in module for above FTAs	51190523-325
	Digital Input 24Vdc with compression terminals	51304441-125
DI 24 Vdc FTA (MU-TDID52)	Digital Input 24Vdc with fixed-screw terminals	51304441-225
DI 24 Vdc FTA (MU-TDID72)	Plug-in module for above FTAs	51190523-125
	Digital Input 24Vdc with removable screw terminals	51303928-100
DI 24 Vdc FTA (MU-TDIY22)	Digital Input 24Vdc with compression terminals	80366180-125
DI 24 Vdc FTA (MU-TDIY62)	Digital Input 24Vdc with screw terminals	80364010-125
DO 120/240 Vac FTA (MU-TDOA12)	Digital Output 120/240Vac (Solid-State) with fixed-compression terminals (Replaced by MU-TDOA13)	51304408-100
DO 120/240 Vac FTA (MU-TDOA52)	Digital Output 120/240Vac (Solid-State) with fixed-screw terminals (Replaced by MU-TDOA53)	51304408-200
DO 120/240 Vac FTA (MU-TDOA13)	Solid-state relay plug-in module for above FTAs	51190516-325

Name (Model No.)	Description	Part Number
	Digital Output 24-240Vac (Solid-State) with removable compression terminals.	51304648-125
DO 120/240Vac FTA (MU-TDOA53)	Digital Output 24-240Vac (Solid-State) with removable screw terminals	51304648-225
DO 3-30Vdc FTA (MU-TDOD12)	Solid-state relay plug-in module for above FTAs	51190516-332
	Digital Output 3-30Vdc (Solid-State) with fixed compression terminals (Replaced by MU-TDOD13)	51304423-100
DO 3-30Vdc FTA (MU-TDOD52)	Digital Output 3-30Vdc (Solid-State) with fixed-screw terminals (Replaced by MU-TDOD53)	51304423-200
DO 3-30Vdc FTA (MU-TDOD13)	Solid-state relay plug-in module for above FTAs	51190516-122
	Digital Output 3-30Vdc (Solid-State) with removable compression terminals	51304650-100
DO 3-30Vdc FTA (MU-TDOD53)	Digital Output 3-30Vdc (Solid-State) with removable screw terminals	51304650-200
DO 3-30Vdc FTA (MU-TDOD14)	Solid-state relay plug-in module for above FTAs	51190516-132
	Digital Output 3-30Vdc (Solid-State) with fixed-compression terminals	51309153-125
DO 3-30Vdc FTA (MU-TDOD54)	Digital Output 3-30Vdc (Solid-State) with fixed-screw terminals	51309153-225
DO 31-200Vac FTA (MU-TDOD22)	Solid-state relay plug-in module for above FTAs	51190516-134
	Digital Output 31-200Vdc (Solid-State) with compression terminals	51304428-100
DO 31-200Vac FTA (MU-TDOD62)	Digital Output 31-200Vdc (Solid-State)with screw terminals	51304428-200
DO 31-200Vac FTA (MU-TDOD23)	Srelay plug-in module for above FTAs	51190516-402
	Digital Output 31-200 Vdc SS with compression terminals	51309154-125
DO 31-200Vac FTA (MU-TDOD63)	Digital Output 31-200Vdc (Solid-State) with screw terminals	51309154-225
DO 24Vdc FTA (MU-TDON12)	Solid-state relay plug-in module for above FTAs	51190516-404
	Digital Output 24Vdc nonisolated with compression terminals	51304446-100
DO 24Vdc FTA (MU-TDON52)	Digital Output 24Vdc nonisolated with screw terminals	51304446-200
DO 24Vdc FTA (MU-TDOY22)	Digital Output 24Vdc isolated with compression terminals	80366183-125
DO 24Vdc FTA (MU-TDOY62)	Digital Output 24Vdc isolated with screw terminals	80364013-125
DO 120Vac Relay (MU-TDOR12)	DO 120Vac/125Vdc with compression terminals (Replaced by 51309148-125)	51304443-150
DO 120Vac Relay (MU-TDOR52)	DO 120Vac/125Vdc with screw terminals (Replaced by 51309148-225)	51304443-250
DO 120Vac Relay	Relay plug-in module for above assemblies	51191945-100

Name (Model No.)	Description	Part Number
(MU-TDOR12)	DO 120 Vac/125Vdc with compression terminals	51309148-125
DO 120Vac Relay (MU-TDOR52)	DO 120 Vac/125Vdc with screw terminals	51309148-225
DO 240Vac Relay (MU-TDOR22)	DO 240Vac/125Vdc with compression terminals (Replaced by 51309150-125)	51304427-100
DO 240Vac Relay (MU-TDOR62)	DO 240Vac/125Vdc with screw terminals (Replaced by 51309150-225)	51304427-200
DO 240Vac Relay (MU-TDOR22)	Relay plug-in module for above assemblies	51191945-100
	DO 240Vac/125Vdc with compression terminals	51309150-125
DO 240Vac Relay (MU-TDOR62)	DO 240Vac/125Vdc with screw terminals	51309150-225
DO 240Vac Relay (MU-TDOY23)	Relay plug-in module for above assemblies	51191945-100
	DO 240Vac/125Vdc with compression terminals	80366189-125
DO 240 Vac Relay (MU-TDOY63)	DO 240Vac/125Vdc with screw terminals	80366186-125
DI Power Dist Assy (MU-TDPR02)	Relay (NT1) for above assemblies	83970001-110
	Jumper for above assemblies	51190610-101
	Digital Input Power Distribution Assembly	51304425-125
DO Standby Manual (MU-SMDC02)	Digital Output Standby Manual Device with case	51304526-100
DO Standby Manual (MU-SMDX02)	Digital Output Standby Manual Device with case and cable	51304527-100
AO Standby Manual (MU-SMAC02)	Analog Output Standby Manual Device Assy with cable	51401277-100
Manual/Auto Station (MU-MASX02)	Honeywell Manual/Auto Station	PC6001-U-2MO-40-A0

9.4.9 Standard FTA components - conformally coated

Name (Model No.)	Description	Part Number
HLAI/STI FTA (MC-TAIH02)	HLAI/STI with compression terminals	51304453-150
HLAI/STI FTA (MC-TAIH12)	HLAI/STI with compression terminals	51304337-150
HLAI-HART FTA (MC-TAIH14)	HLAI-HART with compression terminals	
HLAI/STI FTA (MC-TAIH22)	HLAI/STI with compression terminals	80366195-150
	AI Adapter Module for the above FTA	80367163-001
HLAI/STI FTA (MC-TAIH52)	HLAI/STI with screw terminals	51304337-250
HLAI/STI FTA	HLAI/STI with screw terminals	80366192-150

Name (Model No.)	Description	Part Number
(MC-TAIH62)	AI Adapter Module for the above FTA	80360713-001
HLAI FTA (MC-TAIH03)	HLAI with compression terminals	51309136-175
HLAI-HART FTA (MC-TAIH04)	HLAI-HART with compression terminals	
HLAI FTA (MC-TAIH13)	HLAI with compression terminals	51309138-175
HLAI-HART FTA (MC-TAIH15)	HLAI-HART with compression terminals	51305863-175
HLAI FTA (MC-TAIH23)	HLAI with compression terminals	80369165-175
	AI Adapter Module for the above FTA	80367163-001
HLAI FTA (MC-TAIH53)	HLAI with screw terminals	51309138-275
HLAI-HART FTA (MC-TAIH54)	HLAI-HART with screw terminals	51305863-275
STI FTA (MC-TSTX03)	STI with compression terminals	51309140-175
STI FTA (MC-TSTX13)	STI with compression terminals	51309142-175
STI FTA (MC-TSTX53)	STI with screw terminals	51309142-275
LLAI FTA (MC-TAIL02)	LLAI FTA with compression terminals (Replaced by MC-TAIL03)	51304437-150
	Daughter module for above FTA (Replaced by 51309280-100)	51304085-150
LLAI FTA (MC-TAIL03)	LLAI FTA with compression terminals	51309202-175
	Daughter module for above FTA	51309280-100
LLMUX2 TC FTA (MC-TAMT04)	LLMUX2 TC with Local CJR, compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMT02 & MU-TAMT03 and MC-TAMT02 & MC-TAMT03.	51305890-175
	6-pin Connector with compression terminals	51195776-100
	8-pin Connector with compression terminals	51190771-508
LMUX2 TC FTA (MC-TAMT14)	LLMUX2 TC with Remote CJR, compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMT12 & MU-TAMT13 and MC-TAMT12 & MC-TAMT13.	51305890-175
	Remote CJR	51305902-175
	4-pin Connector with compression terminals	51190771-404
	6-pin Connector with compression terminals	51190776-100
	8-pin Connector with compression terminals	51190771-508

Name (Model No.)	Description	Part Number
LLMUX2 RTD FTA (MC-TAMR04)	LLMUX2 RTD FTA with compression terminals, conformally-coated, CE-compliant. Replaces MU-TAMR02 & MU-TAMR03 and MC-TAMR02 & MC-TAMR03.	51305907-175
	3-pin Connector with compression terminals	51190771-403
	6-pin Connector with compression terminals	51195776-100
RHMUX FTA (MC-GRMT01)	RHMUX TC with screw terminals	51404106-175
RHMUX GI/IS Power Adapter (MC-GRPA01)	RHMUX GI/IS Power Adapter with compression terminals	51304724-175
RHMUX GI/NI Power Adapter (MC-TRPA01)	RHMUX GI/NI Power Adapter with compression terminals	51304722-175
AO FTA (MC-THAO11)	Analog Output with HART and comp. terminals	51309542-175
AO FTA (MC-TAOX02)	Analog Output with compression terminals	51304476-175
AO FTA (MC-TAOX12)	Analog Output with compression terminals	51304335-175
AO FTA (MC-TAOX52)	Analog Output with screw terminals	51304335-275
	Plug-in module for above FTAs	51304338-150
AO FTA (MC-TAOY22)	Analog Output with comp term, Stdby Manual	80366481-175
AO FTA (MC-TAOY23)	Analog Output with comp term, no Stdby Manual	80366177-250
AO16HART FTA (MC-TAOY24)	Analog Output with comp term, Stdby Manual	51305865-175
AO16HART FTA (MC-TAOY25)	Analog Output with comp term, no Stdby Manual	
AO FTA (MC-TAOY52)	Analog Output with screw term, Stdby Manual	80366484-175
AO FTA (MC-TAOY53)	Analog Output with screw term, no Stdby Manual	80364007-250
AO16HART FTA (MC-TAOY54)	HART Analog Output with screw term, Stdby Manual	51305867-175
AO16HART FTA (MC-TAOY55)	HART Analog Output with screw term, no Stdby Manual	
DI 120Vac FTA (MC-TDIA12)	Digital Input 120Vac with compression terminals	51304439-175
DI 120Vac FTA	Digital Input 120Vac with fixed-screw terminals	51304439-275
(MC-TDIA52)	Plug-in module for above FTAs	51190523-225
DI 120Vac FTA (MC-TDIA72)	Digital Input 120Vac with removable screw term	51303930-150
DI 240Vac FTA (MC-TDIA22)	Digital Input 240Vac with compression terminals	51304431-175
DI 240Vac FTA	Digital Input 240Vac with fixed-screw terminals	51304431-275
(MC-TDIA62)	Plug-in module for above FTAs	51190523-325
DI 24Vdc FTA (MC-TDID12)	Digital Input 24Vdc with compression terminals	51304441-175

Name (Model No.)	Description	Part Number
DI 24Vdc FTA (MC-TDID52)	Digital Input 24Vdc with fixed-screw terminals	51304441-275
	Plug-in module for above FTAs	51190523-125
DI 24Vdc FTA (MC-TDID72)	Digital Input 24Vdc with removable screw terminals	51303928-150
DI 24Vdc FTA (MC-TDIY22)	Digital Input 24Vdc with compression terminals	80366180-175
DI 24Vdc FTA (MC-TDIY62)	Digital Input 24Vdc with screw terminals	80364010-175
DO 120/240Vac FTA (MC-TDOA12)	Digital Output 120/240Vac (Solid-State) with fixed-comp term (Replaced by MC-TDOA13)	51304408-150
DO 120/240Vac FTA (MC-TDOA52)	Digital Output 120/240Vac (Solid-State) with fixed-screw term (Replaced by MC-TDOA53)	51304408-250
	Solid-state relay plug-in module for above FTAs	51190516-325
DO 120/240Vac FTA (MC-TDOA13)	Digital Output 24-240Vac (Solid-State) with removable compression terminals.	51304648-175
DO 120/240Vac FTA (MC-TDOA53)	Digital Output 24-240Vac (Solid-State) with removable screw terminals	51304648-275
	Solid-state relay plug-in module for above FTAs	51190516-332
DO 3-30Vdc FTA (MC-TDOD12)	Digital Output 3-30Vdc SS with fixed-compression terminals (Replaced by MC-TDOD13)	51304423-150
DO 3-30 Vdc FTA (MC-TDOD52)	Digital Output 3-30Vdc (Solid-State) with fixed-screw terminals (Replaced by MC-TDOD53)	51304423-250
	Solid-state relay plug-in module for above FTAs	51190516-122
DO 3-30Vdc FTA (MC-TDOD13)	Digital Output 3-30Vdc (Solid-State) with removable compression terminals	51304650-150
DO 3-30Vdc FTA (MC-TDOD53)	Digital Output 3-30Vdc (Solid-State) with removable screw terminals	51304650-250
	Solid-state relay plug-in module for above FTAs	51190516-132
DO 3-30Vdc FTA (MC-TDOD14)	Digital Output 3-30Vdc (Solid-State) with fixed-compression terminals	51309153-175
DO 3-30Vdc FTA (MC-TDOD54)	Digital Output 3-30Vdc (Solid-State) with fixed-screw terminals	51309153-275
	Solid-state relay plug-in module for above FTAs	51190516-134
DO 31-200Vac FTA (MC-TDOD22)	Digital Output 31-200Vdc (Solid-State) with compression terminals	51304428-150
DO 31-200Vac FTA (MC-TDOD62)	Digital Output 31-200Vdc (Solid-State)with screw terminals	51304428-250
	Solid-state relay plug-in module for above FTAs	51190516-402
DO 31-200Vac FTA (MC-TDOD23)	Digital Output 31-200Vdc (Solid-State) with compression terminals	51309154-175
DO 31-200Vac FTA (MC-TDOD63)	Digital Output 31-200Vdc (Solid-State) with screw terminals	51309154-275
	Solid-state relay plug-in module for above FTAs	51190516-404

Name (Model No.)	Description	Part Number
DO 24Vdc FTA (MC-TDON12)	Digital Output 24Vdc nonisolated with compression terminals	51304446-150
DO 24Vdc FTA (MC-TDON52)	Digital Output 24Vdc nonisolated with screw terminals	51304446-250
DO 24Vdc FTA (MC-TDOY22)	Digital Output 24Vdc isolated with compression terminals	80366183-175
DO 24Vdc FTA (MC-TDOY62)	Digital Output 24Vdc isolated with screw terminals	80364013-175
DO 120Vac Relay (MC-TDOR12)	DO 120 Vac/125Vdc with compression terminals (Replaced by 51309148-175)	51304443-150
DO 120Vac Relay (MC-TDOR52)	DO 120 Vac/125Vdc with screw terminals (Replaced by 51309148-275)	51304443-250
	Relay plug-in module for above assemblies	51191945-100
DO 120Vac Relay (MC-TDOR12)	DO 120 Vac/125Vdc with compression terminals	51309148-175
DO 120Vac Relay (MC-TDOR52)	DO 120Vac/125Vdc with screw terminals	51309148-275
	Relay plug-in module for above assemblies	51191945-100
DO 240Vac Relay (MC-TDOR22)	DO 240Vac/125Vdc with compression terminals (Replaced by 51309150-125)	51304427-150
DO 240Vac Relay (MC-TDOR62)	DO 240Vac/125Vdc with screw terminals (Replaced by 51309150-225)	51304427-250
	Relay plug-in module for above assemblies	51191945-100
DO 240Vac Relay (MC-TDOR22)	DO 240Vac/125Vdc with compression terminals	51309150-175
DO 240Vac Relay (MC-TDOR62)	DO 240Vac/125Vdc with screw terminals	51309150-275
	Relay plug-in module for above assemblies	51191945-150
DO 240Vac Relay (MC-TDOY23)	DO 240Vac/125Vdc with compression terminals	80366189-175
DO 240Vac Relay (MC-TDOY63)	DO 240 Vac/125Vdc with screw terminals	80366185-175
	Relay (NT1) for above assemblies	83970001-110
	Jumper for above assemblies	51190610-101
Power Adapter (MC-TLPA02)	Power Adapter (Used with LLMux)	51309204-175
DI Power Dist Assy (MC-TDPR02)	Digital Input Power Distribution Assembly	51304425-175
DO Standby Manual (MC-SMDC02)	Digital Output Standby Manual Device with case	51304526-150
DO Standby Manual (MC-SMDX02)	Digital Output Standby Manual Device with case and cable	51304527-150

Name (Model No.)	Description	Part Number
AO Standby Manual (MC-SMAC02)	Analog Output Standby Manual Device Assy with cable	51401277-150

9.4.10 Galvanically Isolated FTA components - non-conformally coated

Name (Model No.)	Description	Part Number
HLAI FTA (MU-GAIH12)	HLAI FTA with GI Modules (Compression terminals) (Replaced by MU-GAIH13 - 51304718-125)	51304636-100
HLAI FTA (MU-GAIH82)	HLAI FTA with GI Modules (Crimp terminals) (Replaced by MU-GAIH83 - 51304718-325)	51304636-300
	HLAI Galvanic Isolation Module (MTL4041)	51191697-100
HLAI FTA (MU-GAIH13)	HLAI FTA with GI Modules (Compression terminals)	51304718-125
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI FTA (MU-GAIH83)	HLAI FTA with GI Modules (Crimp terminals)	51304718-325
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI FTA (MU-GAIH14)	HLAI FTA with GI Modules (Compress terminals)	51304730-125
	HLAI Galvanic Isolation Module MTL4041P)	51191928-100
HLAI FTA (MU-GAIH84)	HLAI FTA with GI Modules (Crimp terminals)	51304730-325
	HLAI Galvanic Isolation Module MTL4041P)	51191928-100
HLAI FTA (MU-GAIH22)	HLAI FTA with GI Modules (Compress terminals)	51304748-125
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI FTA (MU-GAIH92)	HLAI FTA with GI Modules (Crimp terminals)	51304748-325
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI Calibration Tool	HLAI calibration tool	51201450-100
24Vdc DI FTA (MU-GDID12)	24Vdc DI FTA with GI Modules (Compression Terminals)	51304640-125
24Vdc DI FTA (MU-GDID82)	24Vdc DI FTA with GI Modules (Crimp Terminals)	51304640-325
	24Vdc DI Galvanic Isolation Module (MTL4016)	51191699-100
24Vdc DI FTA (MU-GDID13)	24Vdc DI FTA with GI Modules (Compression Terminals)	51304728-125
24Vdc DI FTA (MU-GDID83)	24Vdc DI FTA with GI Modules (Crimp Terminals)	51304728-325
	24Vdc DI Galvanic Isolation Module (MTL4013)	51191926-100
AO FTA (MU-GHAO11)	AO nonredundant FTA with HART and Compression Terminals	51309540-125
AO16-HART FTA (MU-GHAO21)	AO HART redundant FTA with GI Modules (Compression Terminals)	51305869-125
	AO Galvanic Isolation Module (MTL4046C)	
AO FTA (MU-GAOX02)	AO nonredundant FTA with GI Modules (Compression Terminals)	51304638-125

Name (Model No.)	Description	Part Number
AO FTA (MU-GAOX72)	AO nonredundant FTA with GI Modules (Crimp Terminals)	51304638-325
AO FTA (MU-GAOX12)	AO redundant FTA with GI Modules (Compression Terminals)	51304638-525
AO FTA (MU-GAOX82)	AO redundant FTA with GI Modules (Crimp Terminals)	51304638-725
	AO Galvanic Isolation Module (MTL4045C)	51192097-200
	AO Galvanic Isolation Module (MTL4046P)	51192565-100
	Redundancy Module for FTA	51304338-100
DO FTA (MU-GDOD12)	DO FTA with GI Modules (Compression Terminals)	51304642-125
DO FTA (MU-GDOD82)	DO FTA with GI Modules (Crimp Terminals)	51304642-325
	DO Galvanic Isolation Module (MTL4021)	51191698-100
DO FTA (MU-GDOL12)	DO FTA with GI Modules (Compression Terminals)	51304736-125
DO FTA (MU-GDOL82)	DO FTA with GI Modules (Crimp Terminals)	51304736-325
	DO Galvanic Isolation Module (MTL4023)	51191927-100
LFD Combiner Panel (MU-GLFD02)	Line Fault Detection Combiner Panel	51304732-125
Power Distribution Assembly (MU-GPRD02)	Galvanic Isolation Power Distribution Assembly	51304644-125
Marshalling Panel (MU-GMAR52)	Marshalling Panel	51309156-125
GI Module Connector	Compression-type terminal connector for GI Modules	51191738-100
	Crimp-type terminal connector for GI Modules	51191737-100
	14-20AWG wire crimp pins for above connector	51191737-201

9.4.11 Galvanically Isolated FTA components - conformally coated

Name (Model No.)	Description	Part Number
HLAI FTA (MC-GAIH12)	HLAI FTA with GI Modules (Compression terminals) (Replaced by MU-GAIH13 - 51304718-125)	51304636-150
HLAI FTA (MC-GAIH82)	HLAI FTA with GI Modules (Crimp terminals) (Replaced by MU-GAIH83 - 51304718-325)	51304636-350
	HLAI Galvanic Isolation Module (MTL4041)	51191697-100
HLAI FTA (MC-GAIH13)	HLAI FTA with GI Modules (Compression terminals)	51304718-175
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI FTA (MC-GAIH83)	HLAI FTA with GI Modules (Crimp terminals)	51304718-375
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200

Name (Model No.)	Description	Part Number
HLAI FTA (MC-GAIH14)	HLAI FTA with GI Modules (Compression terminals)	51304730-175
	HLAI Galvanic Isolation Module MTL4041P)	51191928-100
HLAI FTA (MC-GAIH84)	HLAI FTA with GI Modules (Crimp terminals)	51304730-375
	HLAI Galvanic Isolation Module (MTL4041P)	51191928-100
HLAI FTA (MC-GAIH22)	HLAI FTA with GI Modules (Compression terminals)	51304748-175
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI FTA (MC-GAIH92)	HLAI FTA with GI Modules (Crimp terminals)	51304748-375
	HLAI Galvanic Isolation Module (MTL4041B)	51191697-200
HLAI Calibration Tool	HLAI calibration tool	51201450-100
24Vdc DI FTA (MC-GDID12)	24Vdc DI FTA with GI Modules (Compression Terminals)	51304640-175
24Vdc DI FTA (MC-GDID82)	24Vdc DI FTA with GI Modules (Crimp Terminals)	51304640-375
	24Vdc DI Galvanic Isolation Module (MTL4016)	51191699-100
24Vdc DI FTA (MC-GDID13)	24Vdc DI FTA with GI Modules (Compress Terminals)	51304728-175
24Vdc DI FTA (MC-GDID83)	24Vdc DI FTA with GI Modules (Crimp Terminals)	51304728-375
	24Vdc DI Galvanic Isolation Module (MTL4013)	51191926-100
AO FTA (MC-GHAO11)	AO nonredun FTA with HART and (Compression Terminals)	51309540-175
AO16-HART FTA (MC-GHAO21)	AO HART redundant FTA with GI Modules (Compression Terminals)	51305869-175
	AO Galvanic Isolation Module (MTL4046C)	
AO FTA (MC-GAOX02)	AO nonredun FTA with GI Modules (Compression Terminals)	51304638-175
AO FTA (MC-GAOX72)	AO nonredun FTA with GI Modules (Crimp Terminals)	51304638-375
AO FTA (MC-GAOX12)	AO redundant FTA with GI Modules (Compression Terminals)	51304638-575
AO FTA (MC-GAOX82)	AO redundant FTA with GI Modules (Crimp Terminals)	51304638-775
	AO Galvanic Isolation Module (MTL4045C)	51192097-200
	AO Galvanic Isolation Module (MTL4046P)	51192565-100
	Redundancy Module for FTA	51304338-100
DO FTA (MC-GDOD12)	DO FTA with GI Modules (Compression Terminals)	51304642-175
DO FTA (MC-GDOD82)	DO FTA with GI Modules (Crimp Terminals)	51304642-375
	DO Galvanic Isolation Module (MTL4021)	51191698-100
DO FTA (MC-GDOL12)	DO FTA with GI Modules (Compression Terminals)	51304736-175
DO FTA	DO FTA with GI Modules (Crimp Terminals)	51304736-375

Name (Model No.)	Description	Part Number
(MC-GDOL82)	DO Galvanic Isolation Module (MTL4023)	51191927-100
LFD Combiner Panel (MC-GLFD02)	Line Fault Detection Combiner Panel	51304732-175
Power Distribution Assembly (MC-GPRD02)	Galvanic Isolation Power Distribution Assembly	51304644-175
Marshalling Panel (MC-GMAR52)	Marshalling Panel	51309156-175
GI Module Connector	Compression-type terminal connector for GI Modules	51191738-100
	Crimp-type terminal connector for GI Modules	51191737-100
	14-20 AWG wire crimp pins for above connector	51191737-201

9.4.12 Miscellaneous components - non-conformally coated

Name (Model No.)	Description	Part Number
Card Case	Plastic case for IOP card	51304072-100
Card Label	Label - Plain blue for IOP filler card	51109474-100
	Label for Low Level Analog Input IOP	51109475-100
	Label for High Level Analog Input IOP	51109476-100
	Label for Analog Output IOP	51109477-100
	Label for Digital Input IOP	51109478-100
	Label for Digital Output IOP	51109479-100
	Label for I/O Link Extender	51109480-100
	Label for Low Level Multiplexer IOP	51109486-100
	Label for Smart Transmitter Interface IOP	51109494-100
FTA Plug-in Terminal Block	8 Point terminal block	51190694-108
	12 Point terminal block	51190694-112
	8 Point terminal block, labeled 1-8, gold contacts, for LLAI	51190787-408
	8 Point terminal block, labeled 9-16, gold contacts, for LLAI	51190787-508
	11 Point terminal block, labeled 9-19, gold contacts, for LLAI	51190787-411
Terminal Block Cover	Cover for terminals on 8-channel LLAI FTA	51201569-100
Cabinet Fan Assembly	Cabinet fan assembly, 115Vac without alarm	51304074-100
	Cabinet fan assembly, 230Vac without alarm	51304074-200
Cabinet Fan	Fan, 115Vac (replacement for 51304074-100)	68A8976P1
	Fan, 230Vac (replacement for 51304074-200)	68A8976P2
Cabinet Fan Assembly	Cabinet fan assembly, 115Vac with alarm	51303940-100
	Cabinet fan assembly, 230Vac with alarm	51303940-200
Cabinet Fan Assembly PWB	PWB, 115Vac (replacement for 51303940-100)	51201475-100
	PWB, 230Vac (replacement for 51303940-200)	51201475-200

Name (Model No.)	Description	Part Number
Left 7- Slot Card File (MU-HPFH01)	Left 7-Slot IOP card file assy (slots 1-7)	51404125-100
Left 7- Slot Card File (MU-HPFI03)	Left 7-Slot IOP card file assy (slots 1-7)	51404191-225
Left 7- Slot Card File Backpanel	Left 7-Slot card file backpanel assy (slots 1-7)	51401626-100
Right 7- Slot Card File (MU-HPFH11)	Right 7- Slot IOP card file assy (9-15)	51404126-100
Right 7- Slot Card File (MU-HPFI13)	Right 7- Slot IOP card file assy (slots 9-15)	51404192-225
Right 7- Slot Card File Backpanel	Right 7- Slot card file backpanel assy (slots 9-15)	51401629-100
IOP-Only Card File (MU-IOFX02)	15 IOP-Only card file assembly	51401546-100
IOP-Only Card File Backpanel	15 IOP-Only card file backpanel assembly	51402599-100
IOP-Only Card File (MU-IOFX03)	15 IOP-Only card file assembly	51404210-125
IOP-Only Card File Backpanel	15 IOP-Only card file backpanel assembly	51402599-125
Filler Plate	Filler plate between 7-Slot card files	51304720-100
Opto-Isolator	Solid-state opto-isolator for card files	51190516-202
Fuse Holder/Puller	Fuse holder/puller (15 IOP card file)	51190586-100
Range Resistor	100-ohm range resistor	51190102-100
	250-ohm range resistor	51190102-200
Zero Ohm Resistor	Zero-ohm resistor for Power System backpanel when adding Battery Pack assembly	51190101-100

9.4.13 components - conformally coated

Name (Model No.)	Description	Part Number
Cabinet Fan Assembly	Cabinet fan assembly, 115Vac without alarm	51304074-150
	Cabinet fan assembly, 230Vac without alarm	51304074-250
Cabinet Fan	Fan, 115Vac (replacement for 51304074-100)	68A8976P1
	Fan, 230Vac (replacement for 51304074-200)	68A8976P2
Cabinet Fan Assembly	Cabinet fan assembly, 115Vac with alarm	51303940-150
	Cabinet fan assembly, 230Vac with alarm	51303940-250
Cabinet Fan Assembly PWB	PWB, 115Vac (replacement for 51303940-100)	51201475-150
	PWB, 230Vac (replacement for 51303940-200)	51201475-250
Left 7- Slot Card File (MC-HPFH01)	Left 7-Slot IOP card file assy (slots 1-7)	51404125-150
Left 7- Slot Card File (MC-HPFI03)	Left 7-Slot IOP card file assy (slots 1-7)	51404191-275
Left 7- Slot Card File Backpanel	Left 7-Slot card file backpanel assy (slots 1-7)	51401626-150
Right 7- Slot Card File (MC-HPFH11)	Right 7- Slot IOP card file assy (9-15)	51404126-150

Name (Model No.)	Description	Part Number
Right 7- Slot Card File (MC-HPFI13)	Right 7- Slot IOP card file assy (slots 9-15)	51404192-275
Right 7- Slot Card File Backpanel	Right 7- Slot card file backpanel assy (slots 9-15)	51401629-150
IOP-Only Card File (MC-IOFX02)	15 IOP-Only card file assembly	51401546-150
IOP-Only Card File Backpanel	15 IOP-Only card file backpanel assembly	51402599-150
IOP-Only Card File (MC-IOFX03)	15 IOP-Only card file assembly	51404210-175
IOP-Only Card File Backpanel	15 IOP-Only card file backpanel assembly	51402599-175
Filler Plate	Filler plate between 7-Slot card files	51304720-150

10 Notices

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