

maxPAC Hardware Reference Guide

277596 Rev. C1

Refer to this publication for complete and accurate information that helps you better operate and service Metso Automation MAX Controls equipment. Your comments and suggestions are welcome.

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Preface

This publication, which describes the installation and operation of maxPAC, assumes familiarity with the DPU and its configuration. For additional information on related topics, refer to the following publications:

Book No.	Book Title
277522	Model PDP DPU Preparation and Adjustment
277590	Model 200 Series maxDPU4E Hardware Guide
277561	System Power and Grounding

Chapter 1

maxPAC **Input/Output Subsystem**

Overview

The maxPAC Input/Output System links the maxDNA Distributed Control System to real world process control inputs and outputs. The Input/Output system uses a compact design to provide the system with greatly enhanced I/O capacity in relatively little space. A close relationship exists, in turn, between this I/O system and the maxDNA Distributed Processing Unit (DPU) which it serves.

The DPU and the I/O modules mount in an I/O chassis assembly. The backplane in the chassis assembly provides the I/O bus connection between the DPU and the I/O modules. It also provides the system power and field power connections to the modules. Multiple I/O chassis that share the I/O bus can be installed in a cabinet.

Model IOP I/O Subsystem

Cabinet

Two standard cabinet types are available for the mounting of I/O system hardware. The cabinet is available as either a NEMA (National Electrical Manufacturers Association) type 1 or 12 and consists of the following:

- Welded steel construction
- Front and Rear access
 - I/O mounted in front and rear of cabinet (standard)
 - I/O mounted in front and terminations in rear of cabinet (option)
 - Other mounting arrangement options are also available
- Removable doors
- 19" rack mount rails with standard E.I.A. hole spacing
- Top or bottom Cable access
- Size 85 7/8" h x 24 3/4" w x 38 7/8" d

Optional Cabinet styles and sizes are also available.

The following figure shows a typical cabinet arrangement with I/O in both the front and rear of the cabinet.

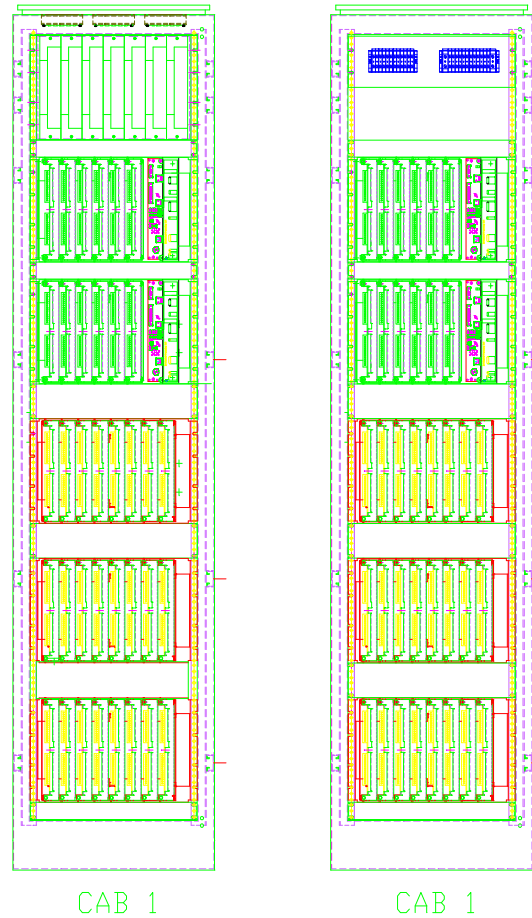


Figure 1-1. Typical Cabinet Arrangement, Front and Rear Views

Chassis Assembly

Three chassis assembly types are available for the installation of the I/O module as follows:

- ❑ IOP382 Eight-pack assembly to accommodate up to eight maxPAC I/O modules.
- ❑ IOP383 Six-pack assembly to accommodate a DPU or a Model 564 I/O module in the right most position along with six maxPAC I/O modules; the DPU takes up the equivalent of two maxPAC I/O module positions.
- ❑ IOP381 Four-pack assembly to accommodate four maxPAC or Model 564 I/O modules.

The rack assemblies contain an I/O backplane featuring edge connectors for I/O modules and connectors for 24V system supply and 24V and 48V loop power supplies. Input/Output modules connect to the I/O bus through four to eight connectors on the backplane, depending on chassis style.

The backplane also contains ribbon cable connectors to interconnect chassis assemblies and extend the I/O bus to the maximum number of modules supported by the DPU.

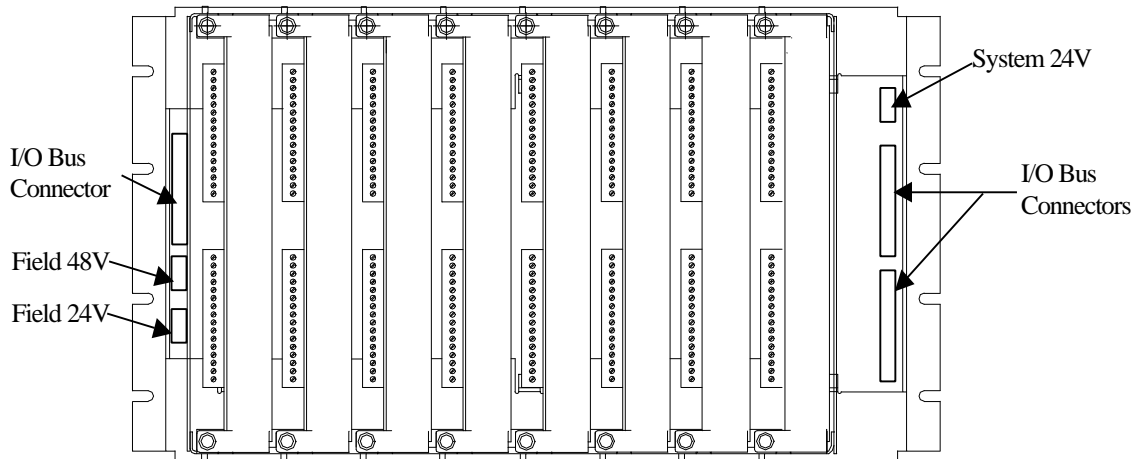


Figure 1-2. Eight-Pack Rack

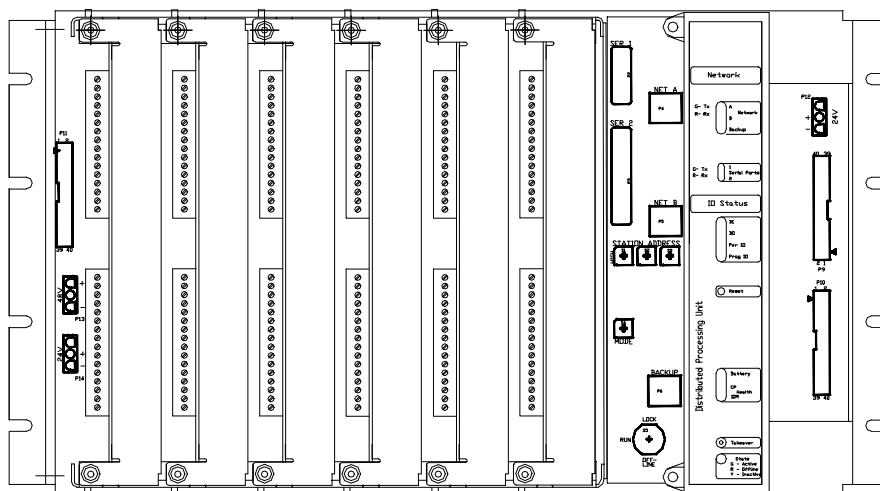


Figure 1-3. Six Wide Rack with DPU

Model Number	Description
IOP381	4-wide frame assembly
IOP382	8-wide rack assembly
IOP383	6-wide rack assembly
IOP015	maxPAC Chassis used with IOP381
IOP011,012	Model 564 Chassis used with IOP381

DPU Mounting

DPU4E mounts in the right most position of the six-pack chassis assembly. It occupies the equivalent of two I/O modules. Refer to Publication 277590 for DPU4E information.

I/O Modules

The I/O modules are rugged enclosed printed circuit board assemblies. The edge connection at the rear of each module provides the interface to the backplane and the I/O bus. System power and field power, when applicable, is also available through this connection.

While I/O modules vary by type, they may include one or more of the following:

- ❑ A color bar on the module faceplate identifies the module type. Each module type has a unique color.
- ❑ Euro-style terminal connector blocks for field wiring; each block contains 16 connectors;
- ❑ Rotary address switch;
- ❑ Light Emitting Diodes (LED) for module status indication;
- ❑ All the modules that require field power include a front mounted fuse disconnect and a LED fuse status indication;
- ❑ All discrete modules include front mounted LEDs for input/output logic state;
- ❑ The TC module includes front-end connectors with thermistors to measure the junction temperature for cold junction compensation.

The I/O modules may be inserted and withdrawn safely with 24 Vdc and field power applied.

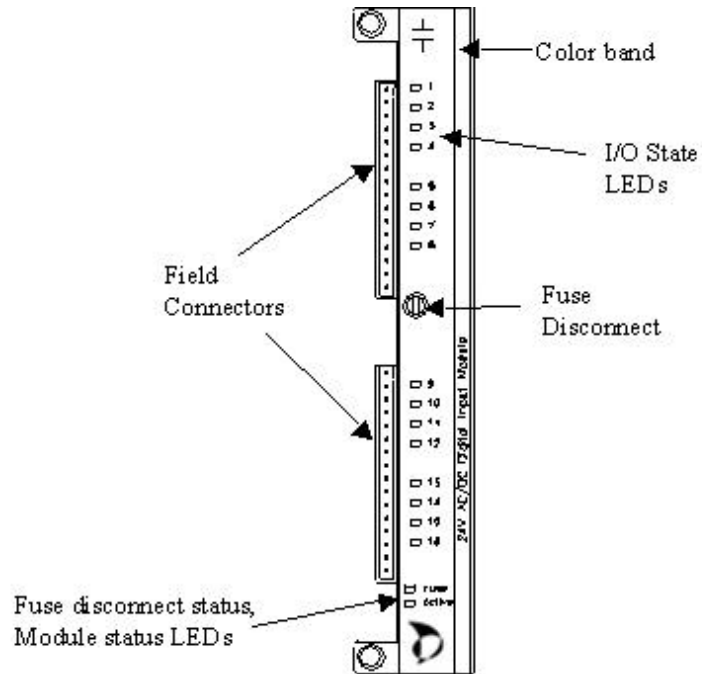


Figure 1-4. Typical I/O Module Front Panel

I/O Module Types

Because of the variety of input and output ranges needed in distributed control applications, the Model IOP I/O offers many types of easily configurable discrete and analog I/O modules. For a list of modules, along with their ranges and number of points per module, refer to the following tables.

Digital Input (AC/DC)*

Part Number	Description
IOP330	24 Vdc common input; 16 channels
IOP334	24 Vdc isolated input; 16 channels
IOP331	48 Vdc common input; 16 channels
IOP332	120 Vac/dc isolated input; 16 channels
IOP333	240 Vac/Vdc isolated input; 16 channels
IOP350	Form C relay; 10 channels
IOP351	Form A/B relay; 16 channels

*ac Voltages/currents are RMS

Analog Input

Part Number	Description
IOP301	Isolated analog input; 16 channels
IOP302	4-20mA common input; 16 channels
IOP303	3-wire RTD input; 8 channels
IOP304	Thermocouple/emf input; 16 channels
IOP305	Voltage common input; 16 channels
IOP306	Kit with sixteen 100 Ohm resistors

Analog Output

Part Number	Description
IOP320	4-20 mA common output, 8 channels

Bus Extender

Part Number	Description
IOP371	Optical bus extender

Power Supply

The maxDNA Input/Output System uses the Model APS Power Supply Assembly, which provides 24V dc power for Distributing Processing Units and I/O. This Power Supply Assembly consists of a 19-inch rack mount or flush mount chassis accommodating up to six independent 10 amp power supply modules. Metso Automation MAX Controls typically installs the power supply modules in an N + 1 redundancy configuration. Because each module is individually isolated, the chassis can be split to provide both system power and loop power.

Power supply features consists of the following:

- Redundant AC power inputs
- 250 Watt power supply modules
- Hot replaceable
- Current Sharing
- Power factor correction
- Front panel indicators on each module
- AC input
- Output voltage status
- Output current level
- External status signals

Field Termination Options

A maxPAC system uses two field cable termination approaches:

- | | |
|---------------------|--|
| Local Terminations | Field cables terminate directly on the I/O module. |
| Remote Terminations | Field cables terminate on terminal blocks remotely to the I/O module with an interconnecting cable back to the I/O module. |

Local Terminations (standard)

Each I/O module is supplied with two 16 point, "Euro-Style" screw clamp plugs that mate to the Printed Circuit Board Header on the module. Field cables would be routed directly to these Euro-Style plugs which can accept up to a #12awg conductor.

Remote Terminations (option)

Many remote field cable termination options are possible. Listed below are a few examples:

- I/O in front of cabinet, terminations in the rear of cabinet.
- Termination cabinet mounted adjacent to I/O cabinet.
- Termination cabinet located remotely from I/O cabinet.

The types of terminal blocks installed in the termination facility are too numerous to list; typically these terminations are DIN rail style. The cabling back to the I/O module is typically made using two multi-conductor cables, one to each of the 16 point Euro-Style plugs supplied with the individual I/O module.

Installing Model IOP I/O Equipment

This section covers the physical mounting and installation of the Model IOP I/O equipment. See "Module Mounting Considerations," before mounting any equipment.

The following tools and hardware are required:

- Screwdriver
- Hex Key Wrench, MAX Part No. 064598
- Mounting Screws, MAX Part No. 030162 (8 per unit supplied)
- Nut Retainers, MAX Part No. 003530 (8 per unit supplied)
- Crimp Tool for field connectors, Weidmuller Part No. 906480
- Crimp Contact Removal Tool, Weidmuller Part No. 906481

Before mounting any hardware, see "Cabling, Power, and Ground Wiring."

Sequence of Mounting Operations

Mounting the parts of the Model IOP I/O in proper order can save time and duplication of effort.

Follow this sequence as closely as possible for best results:

1. Refer to field wiring instructions that can influence mounting locations for chassis assemblies and chassis assembly/module replacement.
2. Mount the chassis assemblies; see "Mounting I/O Chassis Assemblies."
3. Perform all steps as outlined in "Cabling, Power, and Ground Wiring."
5. Complete field wiring.
6. Refer to "Module Addressing" for switch settings and jumper selections.
7. Install I/O modules.

If your field wiring enters through the bottom of the cabinet, mount the Model IOP I/O units from top to bottom. This will make wiring of future units easier, since you will not have to pull wires from the bottom of the cabinet past existing Model IOP I/O units. This same reasoning applies to field wiring entering the top of the cabinet. Here you mount the Model IOP units from bottom to top.

Mounting I/O Chassis Assemblies

The Model IOP I/O chassis assembly attaches to the rear mounting rails in standard 19-inch maxDNA I/O cabinets. Three chassis styles are available. See "Chassis Assembly." Up to seven chassis assemblies may be installed in a standard cabinets.

Usually, the Model IOP I/O units are supplied already mounted in cabinets, but if you are mounting them yourself, follow this procedure.

Note: before you mount an I/O chassis, it should contain the I/O backplane.

To attach the chassis assembly:

1. At the desired chassis assembly mounting location in the cabinet, place eight 10-32 nut retainers (MAX Part No. 003530) in the rear mounting rail holes that correspond to the eight screw slots on the Model IOP chassis assembly.
2. The holes in the maxDNA cabinet rear mounting rails are arranged in a repeating pattern of two holes close together separated by a single hole.

To make sure all chassis assembly mounting screw cutouts line up to corresponding mounting rail holes, you must align the top mounting screw cutouts (left and right) of the chassis assembly with the top holes (left and right) of two hole pair.

3. Position the chassis assembly (two ribbon connectors to the right) so that the screw slots align with the nut retainers. Insert eight 10-32 mounting screws (MAX Part No. 030162) and tighten securely.

Cabling, power wiring, and chassis assembly to cabinet frame grounding should be completed before mounting the I/O modules. See next section.

Cabling, Power, and Ground Wiring

This section describes power wiring, Model IOP I/O connection, and connection to other Model IOP I/O units. The connections covered in this section should be done after the chassis assemblies are in place and before the I/O modules are mounted. Some cabling can be done when the I/O modules are mounted, but the job is easier when they are removed. (See also Interconnecting Adjacent I/O Chassis).

Cables used in the maxDNA Distributed Control Systems are labeled at both ends with the device and connector number. Interconnecting ribbon cables are designed for specific orientation, however, the connectors still prohibit wrong electrical connection.

Refer to Publication 277561, *System Power and Grounding*, for a discussion of cabinet grounding.

Supplying 24V Power to the I/O Modules

The I/O system requires a 24 Vdc ± 4.0 Vdc power supply. Normally, this is a maxDNA power supply mounted in the cabinet holding the DPU; to ensure reliability, Metso Automation MAX Controls recommends using a maxDNA power supply exclusively. If another 24 Vdc power supply is used, it must meet the same specification requirements as the maxDNA supply. All modules are individually fused. The CMOS technology in the Model IOP I/O design results in low module power consumption.

Whether the power source is the standard maxDNA supply or another supply, the +24 Volts connector plugs into the 24V connector on the right side of the I/O backplane.

Caution: The +24 Vdc power supply used to power any maxDNA hardware should never be used for external relay contact wetting or to power any other field equipment. Use a separate supply for contact wetting to provide noise and interference protection for the maxDNA hardware.

Interconnecting Adjacent I/O Chassis

Use a ribbon cable to interconnect in daisy chain style two or more adjacent I/O chassis assemblies in the same maxDNA I/O cabinet group. One end of the ribbon cable plugs into P10 of the first I/O in the string. The other end of the ribbon cable connects to P9 of the next I/O in the string. Continue this P10 to P9 sequence until the last I/O in the string is reached. See Figure 1-5.

If the I/O bus connection continues to the rear of the cabinet, or to an adjacent cabinet in the same cabinet group, the ribbon cable connection can be made to the connectors located on either side of the backplane to minimize the cable length. The ribbon cable connectors are keyed. The red line in the ribbon cable should match the pin 1 marking in the connector.

Depending on the spacing between maxPAC chassis, the following ribbon cable lengths are available:

Part Number	Description
--------------------	--------------------

CPO301	10 inches - 0 rack units between racks
CPO303	12 inches - 1 rack unit between racks
CPO304	14 inches - 2 rack units between racks
CPO305	26 inches - 10 rack units between racks

For I/O bus connections to a cabinet outside the cabinet group, use a 7-foot cable (CPO307), a 15-foot cable (CPO315), or a special length cable.

The maximum number of modules supported by the DPU4E within a cabinet or cabinet pairs is 60 maxPAC modules. This number of modules is reduced when the I/O bus is extended to other cabinets. A bus terminator (CPO402) must be installed at the end of the I/O bus connection.

For applications that require I/O bus connections between Model 564 I/O racks and maxPAC racks, the following cables are available:

Part Number	Description
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CPO504	13 inches - 2 rack units between racks
CPO507	7 feet
CPO515	15 feet

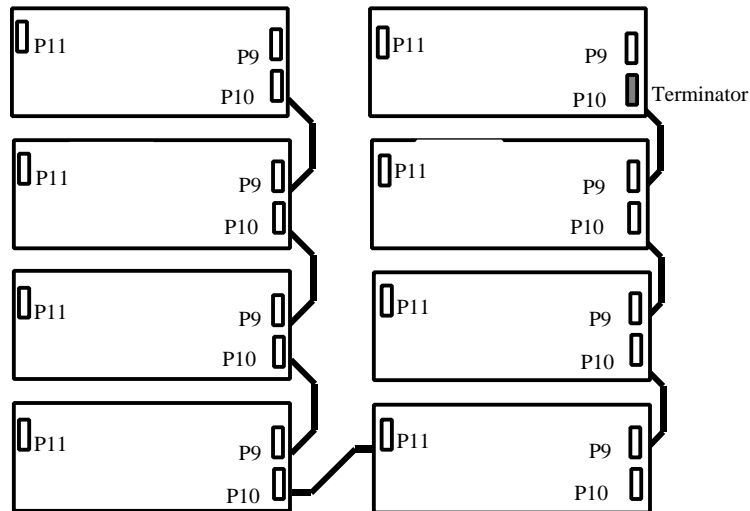


Figure 1-5. Interconnecting Adjacent I/O Cabinets

Module Mounting Considerations

I/O Modules

As you determine how modules are positioned in a cabinet, give some thought to the signal levels that are to be wired to the modules. High and low signal levels and AC and DC wiring should be kept separate. In general, wherever possible, modules receiving the same type and level of signals should be grouped together, with similar signal types arranged in vertical columns.

DPU Modules

The DPU must be mounted in its own special six-wide I/O chassis in the right most position since the DPU is wider than the I/O cards and requires good air flow. Likewise, when using a second DPU for backup, it must be inserted in the same six-wide chassis style mounted beneath the primary DPU.

Before mounting I/O modules, you should complete power and grounding and field wiring and any I/O module preparation and adjustment. See appropriate chapters in this publication to check correct addressing and jumper selection on the modules.

Before installing an I/O module in the right-most position of a chassis assembly, make sure the +24 Vdc is connected to the chassis assembly as well as the I/O bus cable. Additionally, connect the cabinet frame ground to the Model IOP I/O chassis assembly before installing an I/O module in the extreme left position of a chassis assembly. Refer to "Cabling, Power, and Ground Wiring."

Before installing any modules, complete all field wiring.

Model IOP I/O is designed to allow module installation and removal with the +24 Vdc power supply ON.

To mount modules:

1. With chassis assembly in place and all wiring completed, position module into top and bottom card guides of the chassis. Gently slide module forward, verifying that the connector pins on the side of the module board engage the corresponding contact guides on the chassis assembly.
2. When the contacts are engaged and resistance is felt, firmly press on the front panel of the module front plate to make the simultaneous connections at the front and rear. Apply pressure to the left of the LEDs to place the force directly in line with the printed circuit card of the module.
3. Secure module to chassis assembly with the top and bottom lock-down screws on the front of the module.

Module Addressing

You must set addresses for each I/O module using rotary switches mounted in the lower or upper right corner of the printed circuit board of the module, depending on module type. These hexadecimal switches permit 256 logical addresses. The lower switch is the low order address and the upper switch is the high order address.

maxPAC modules use one, two or eight addresses. The address set on the module is its base address. For the eight-address module the base address is the address of channel 1. The module will automatically occupy an address for each of its channels, starting with its base address.

To convert the hexadecimal address to the equivalent logical (decimal) address:

1. Multiply the low order switch setting by 1 to get the decimal equivalent, where switch positions A to F correspond to 10 to 15, respectively.
2. Multiply the high order switch setting by 16 to get the decimal equivalent, where switch positions A to F correspond to 10 to 15, respectively.
3. Add the two decimal equivalents for logical (decimal) module address.

For example, a 2 setting of S2 ($2 \times 16 = 32$) and an A setting of S1 (10) gives a module a logical (decimal) address of 42, the decimal equivalent of the hexadecimal word 2A formed by the switch setting.

Module addressing is completely independent of module physical locations. Each module address must be different from all other module addresses in the system. Addresses are determined by the system designer during system planning.

Backup Configuration Options

Three input/output configuration options are available: shared, redundant, and mixed.

Shared Configuration

A shared I/O configuration uses a primary DPU, a secondary DPU, and one set of Model IOP parallel modules. See Figure 1-6. Both DPUs share the I/O bus but only the active DPU (primary or secondary) receives data from and sends data to, the set of common I/O modules.

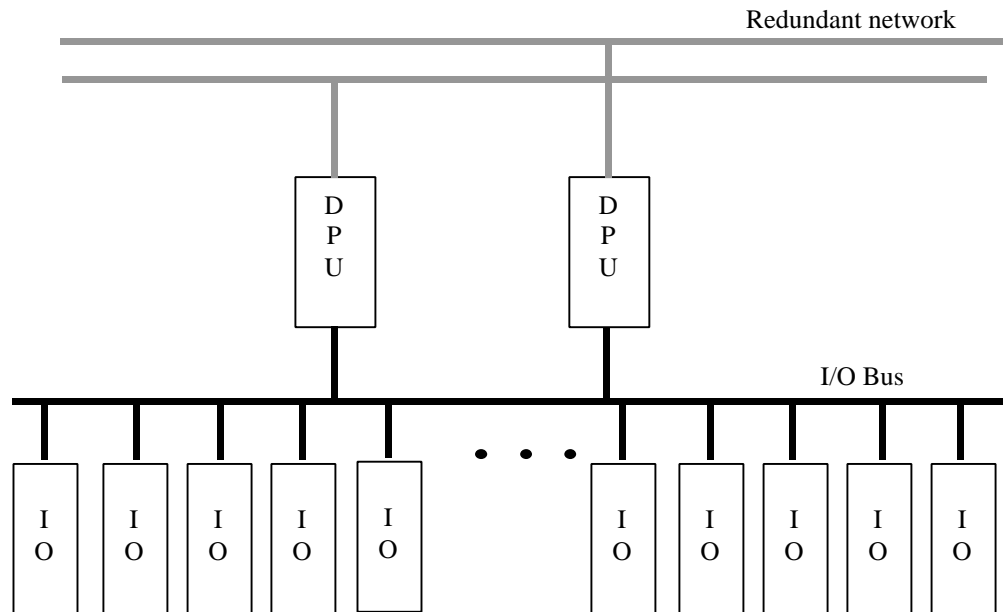


Figure 1-6. Shared Configuration

Redundant Configuration

A redundant I/O configuration uses a primary DPU, a secondary DPU, and two identical sets of Model IOP parallel modules. See Figure 1-7. The primary and secondary DPUs receive data from, and send data to, their set of I/O modules. Outputs from the inactive string of modules are inhibited until they become active. It is necessary to install a Part No. CPO309 cable between the two I/O strings as shown; this cable inverts the output-enable signal so that outputs of the inactive I/O string are disabled.

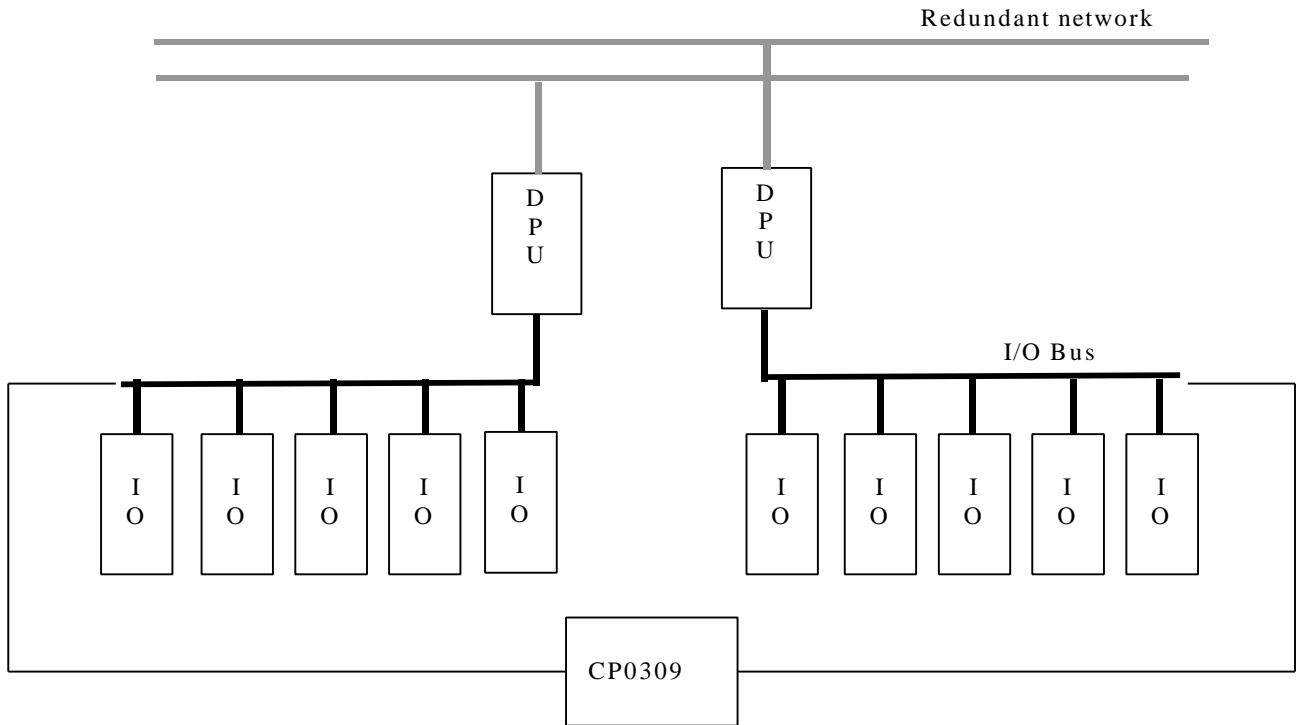


Figure 1-7. Redundant Configuration

Mixed Configuration

A mixed configuration uses a primary DPU, a secondary DPU, a Y adapter, two identical sets of redundant Model IOP parallel modules, and various other common Model IOP modules. See Figure 1-8. The primary and secondary DPUs receive data from, and send data to, the redundant modules. The active DPU (primary or secondary) also receives data from, and sends data to, the common set of I/O modules.

The output-enable signal to the modules is handled internally by the mixed backup adapter; Part No. CP0101.

In redundant or mixed configurations, the inactive DPU polls its redundant modules for hardware failures when it is not performing control actions. No transfer of control will occur if a failure is detected by the inactive DPU. The

inactive DPU also continuously updates its analog output modules with current values so that bumpless transfer occurs when the inactive DPU becomes active.

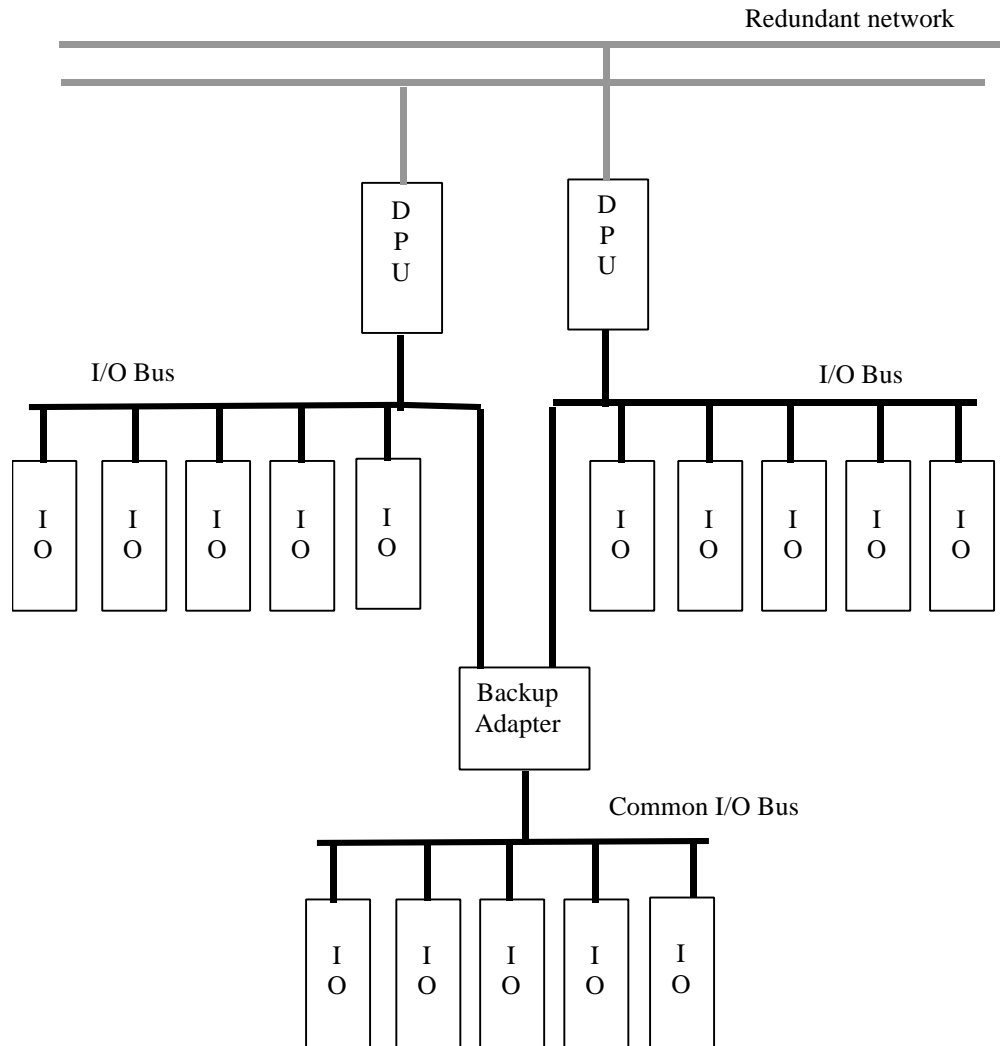


Figure 1-8. Mixed Configuration

Remote I/O

A Bus Expander Module (BEM) permits the I/O bus to be extended up to 2,000 meters using highly reliable and noise immune fiber optic cables.

BEMs, configured in pairs, support both locally and remotely mounted I/O cards. In a typical configuration using redundant Distributed Processing Units (DPUs), an I/O cabinet installed locally in a control room contains I/O modules, a DPU pair, and a BEM pair. This is connected via I/O optical cable to a ruggedized remote cabinet containing I/O modules, and a second BEM pair. The optical link is established between the local and remote

expander modules. Any DPU or redundant pair of DPUs, can communicate with I/O that are locally and/or remotely mounted. See Figure 1-9.

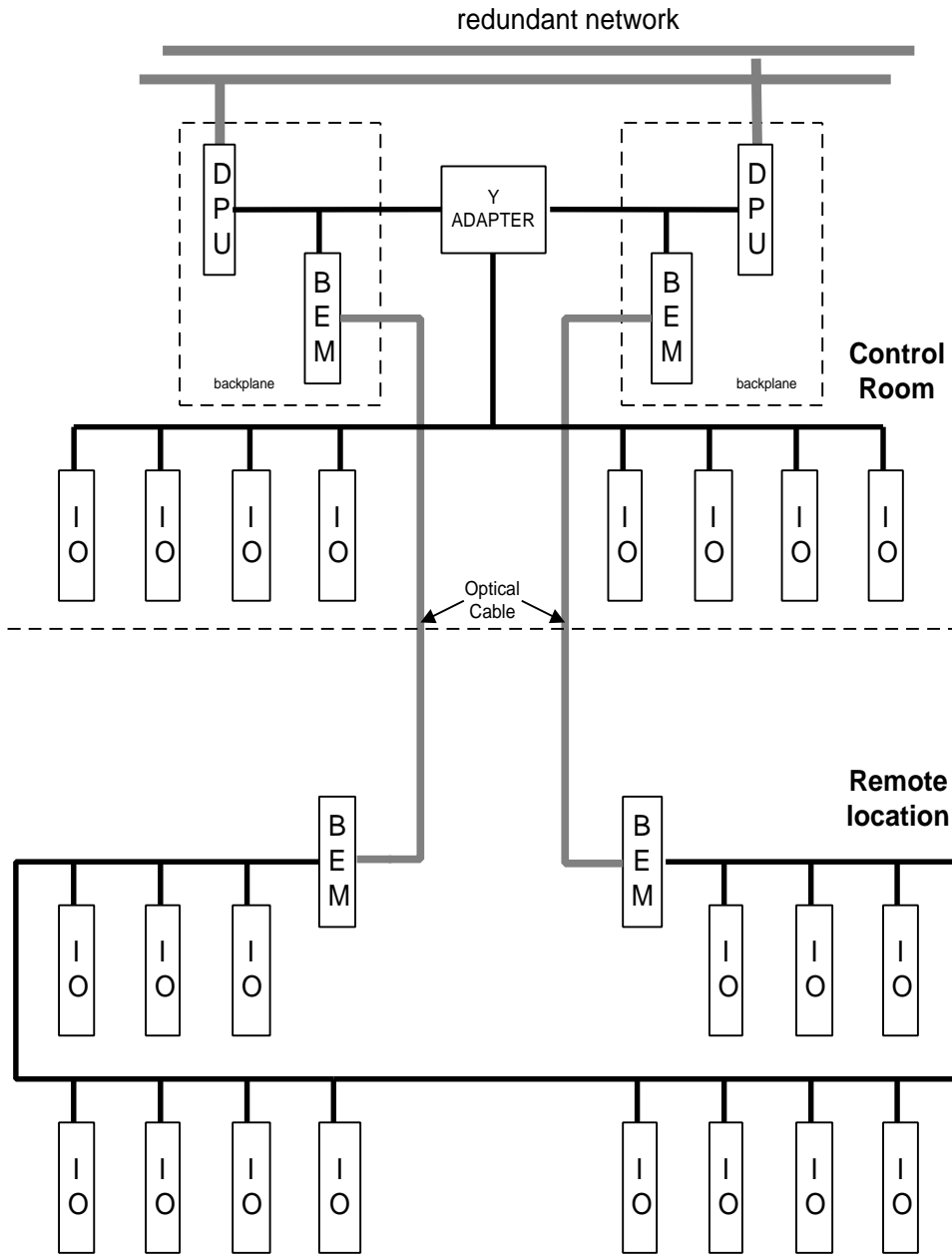


Figure 1-9. Typical Bus Expander Module Configuration

Specifications

Environment

The Model IOP I/O operates in the temperature range of 0°C to 60°C at a relative humidity range of 0 to 90%, noncondensing.

I/O Bus

The Model IOP I/O uses an 8-bit parallel asynchronous I/O bus, capable of 10 microsecond transfers. The I/O bus interface uses LSI circuitry for better reliability. Parity checks are performed on all inputs and outputs, with additional security provided for outputs using a check-before-execute control strategy.

To further enhance reliability, I/O incorporates module address verification and multiple module detection checks. Bus fault detection is also performed by automatic confirmation of input data on every module.

Inputs/Outputs

All modules, both analog and digital types, withstand the normal or common mode connection (IEEE-472, ANSI c37.90) and still maintain correct operation. Common mode transients are bypassed to chassis metal work. All points are optically or transformer isolated from the maxDNA I/O bus. Channel to channel isolation allows series or parallel connection between channels or external relay systems. All digital modules have logic state indication on the front panel, one indication per point.

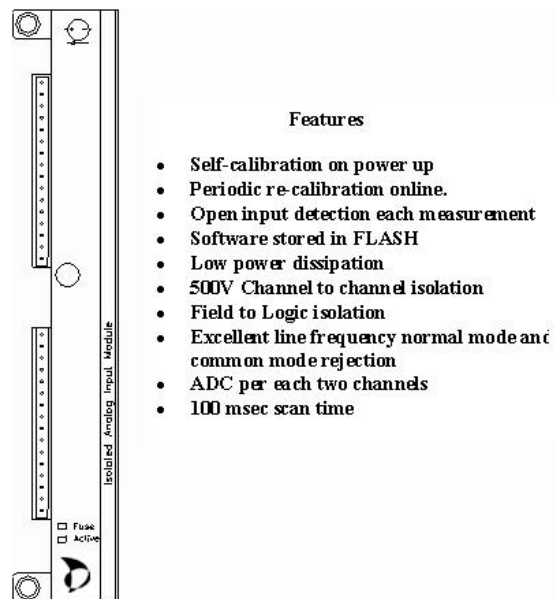
In addition to logic state indication, digital output modules contain fused outputs and a front-panel blown fuse indicator. Each output also has a deadman timer (approximately 1 second) that can be optionally used to freeze or drop out all outputs if the module is not updated by the DPU.

Chapter 2

Analog Input Modules **Isolated Input Module IOP301**

Overview

This module, featuring 16 isolated input channels, can be configured for any mix of voltage or current inputs. The current loop can be powered from a field supply or from a system loop supply provided via the backplane edge connector. For current inputs, this module is pin and function compatible with the IOP302 input module.



LED Indication

A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the

DPU. This LED blinks on and off when the module is not being scanned by the DPU.

Bus Address

This module supports two modes of operation selected by jumper setting. For use with DPU4A/B this module requires 16 addresses and provides 15 channels.

When used with DPU4E, the module only requires two addresses and provides 16 channels.

Jumper Configuration

The module contains two jumpers, located near the address switches. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W1	50 Hz	60Hz
W6	DPU4A/B	DPU4E

In addition, five jumpers per channel determine the type of input connected to the channel.

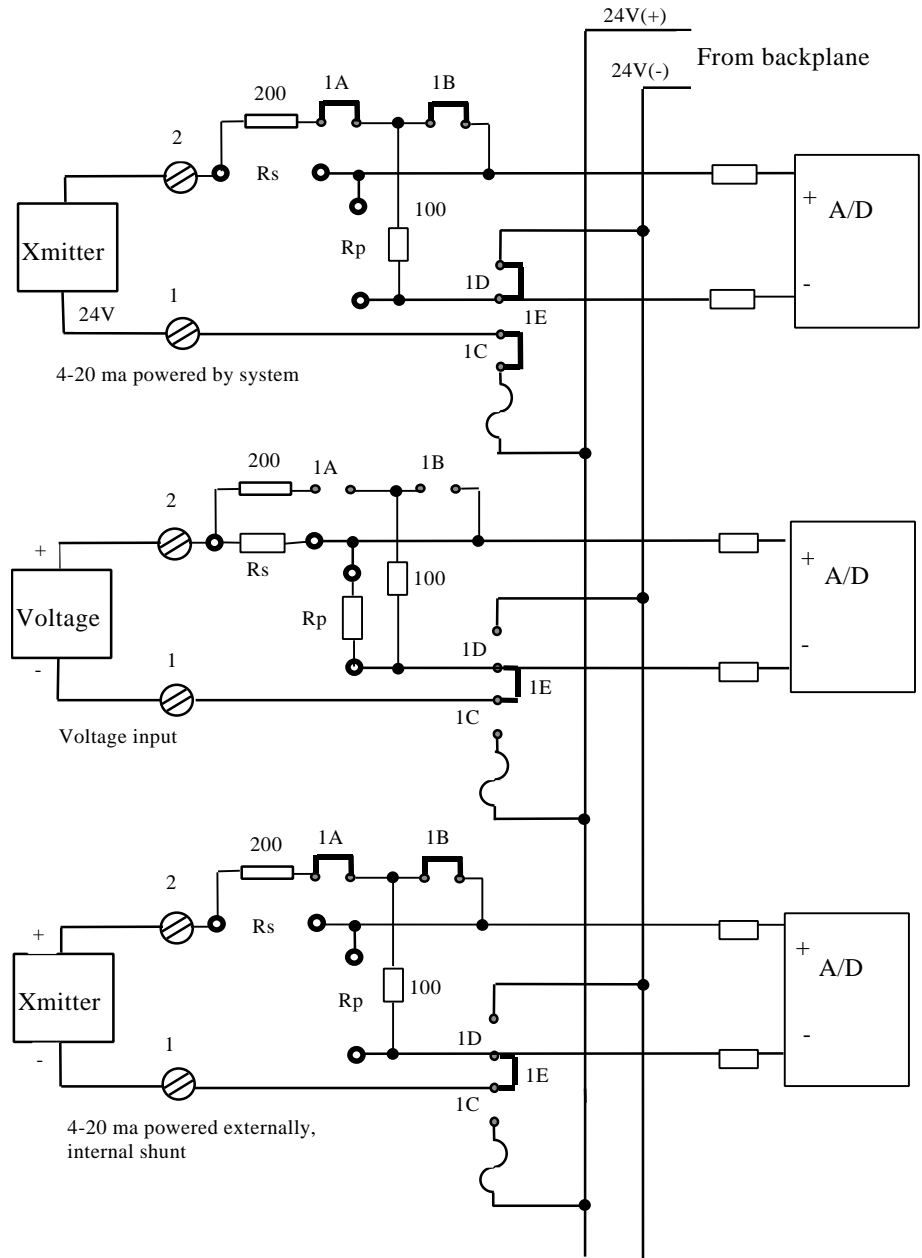
Input Type	A	B	C	D	E
4-20 mA powered by Metso Automation MAX Controls	IN	IN	IN	IN	OUT
4-20 mA powered by user	IN	IN	OUT	OUT	IN
Voltage input	OUT	OUT	OUT	OUT	IN

Program Resistors

Jacks are provided at the front of the module for the installation of a pair of resistors per channel. These resistors can be used to scale a voltage input to the 2.4V span of the A/D measurement. These resistors are identified as follows:

Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Series R	1	7	26	32	51	57	78	85	113	120	142	148	175	193	211	233
Shunt R	3	10	29	35	53	60	80	88	115	123	144	151	177	196	215	234

The input circuit configuration for each type of input is shown in the following sketch. An electronic fuse protects the 24-volt loop power to the transmitter. A 200-Ohm thermistor in series with the 4-20 mA input provides current limiting for voltages up to 100 Volts. The 24-volt loop supply is available to the module from the backplane. For current inputs with external shunt the channel is configured for voltage input and $R_s = 0$.



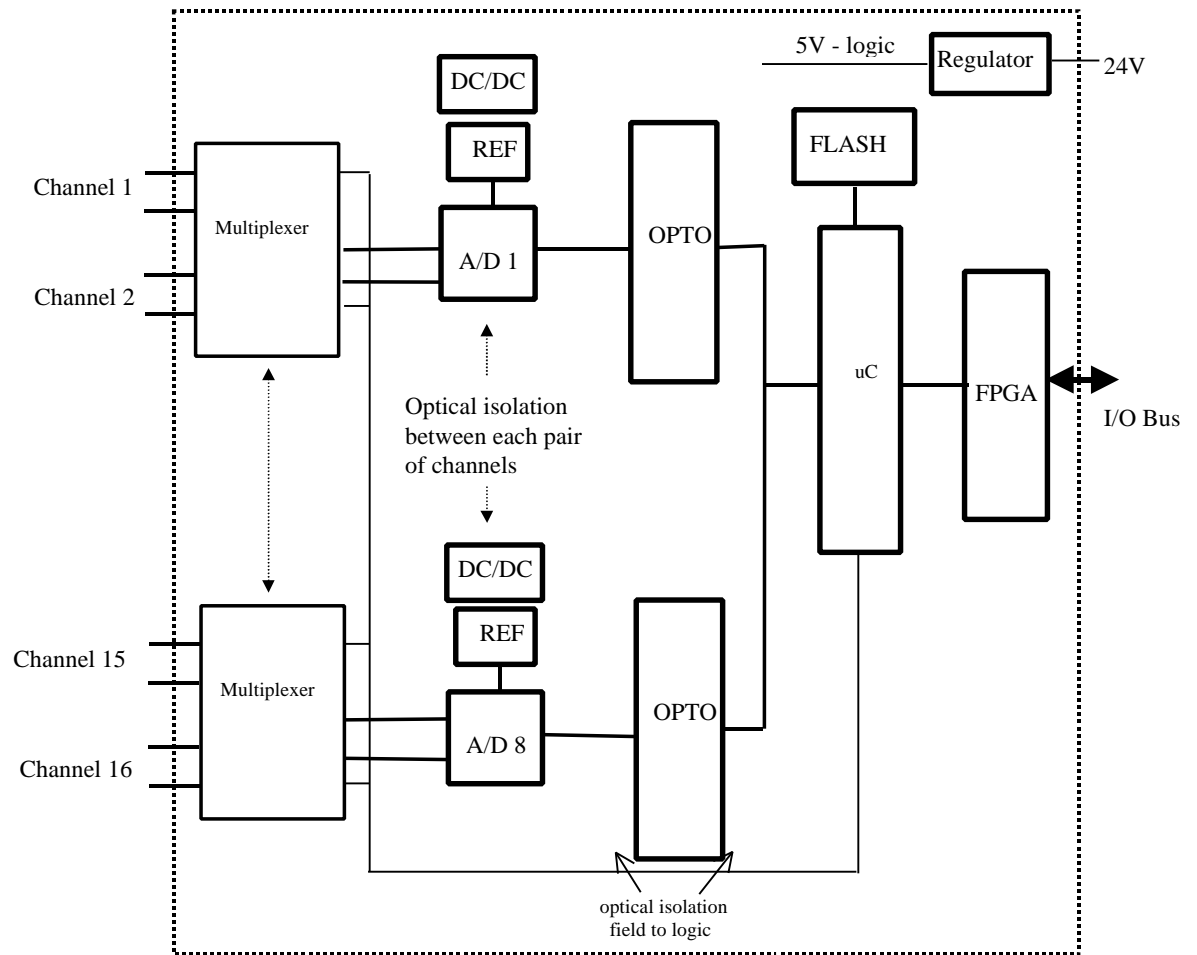
Module Operation

This microprocessor-based module supports up to 16 isolated high level inputs. A sigma delta A/D and precision reference is provided for each pair of inputs. The A/D reads the voltage generated by the selected input and converts the differential measurement to a 15-bit plus sign binary value representing the voltage input, which is read by the microcontroller. The microcontroller initiates the conversion and waits for the conversion to complete.

The digital filter in the oversampling A/D provides excellent 50/60 Hz normal mode rejection. Prior to starting each conversion, the microcontroller selects one of the two input channels by means of two solid-state, optically coupled relays. The two inputs are multiplexed with optical relays to provide channel to channel isolation. Immediately following each measurement, open input and over range conditions are checked.

A separate DC/DC converter provides isolated power to each A/D converter measuring circuit. Communication between the microcontroller and each A/D is serial at 100kHz. A separate group of optical isolators provide the isolation between each A/D and the serial logic circuits. The microprocessor provides the input data to the DPU on demand via the bus FPGA. The FPGA provides the I/O bus interface logic; its program is loaded from the FLASH on power up.

Module calibration is done automatically at power up following startup diagnostics. Calibration is repeated periodically online to compensate for temperature effects.



Diagnostics

The module executes diagnostics on power up. When an error is detected on power-up or during online operation, the front-panel green LED, labeled Active, blinks the first digit at a slower rate and the second digit at a faster rate. During normal operation the active LED is on continuously or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

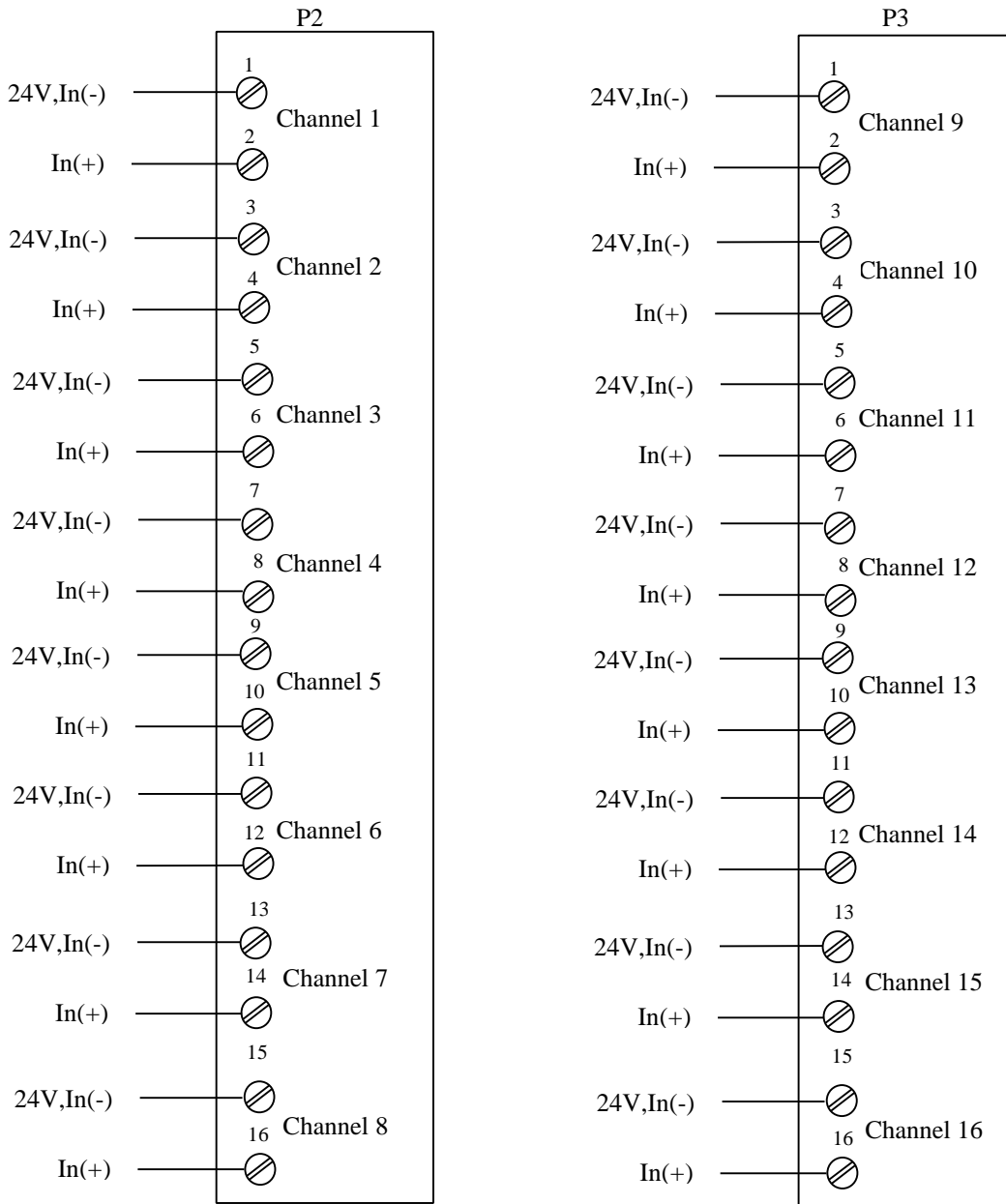
Error Condition	Code
A/D send fault	0x12
A/D receive fault	0x13
A/D self calibration failure	0x14
Bad A/D communication	0x15
A/D does not complete conversion	0x16
RAM Test Failure (power-on)	0x22

CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power-on)	0x32

Module specifications

Resolution	15 bits plus sign
Scan Rate	100 msec.
Temperature Sensitivity	$\pm 0.004\%$ of reading/ $^{\circ}\text{C}$ $\pm 1.5\mu\text{v}/^{\circ}\text{C}$ RTI
Accuracy	$\pm 0.1\%$ of reading at 25°C
Source Impedance Effect	10 MOhm operational, 20K Ohms on loss of power
Conversion method	Sigma Delta oversampling. Single A/D per channel
Span	4 to 20 mA, 0-2.4V
Calibration	Self-calibration on power up. Periodically on line to compensate for temperature effects
Input Impedance - 4-20 mA input	300 Ohms
- voltage input	1 Mohm
Normal Mode Voltage	50 Volts
Normal Mode Rejection	60db @ 50/60 Hz
Common Mode Voltage	500 Volts ac or peak ac
Common Mode Rejection	120db @ 50/60 Hz, 100 Ohm imbalance
Isolation	1500 Vac (field to logic) 500 Vac (channel to channel)
Input Power (from 24V system supply)	400 mA

Field Wiring

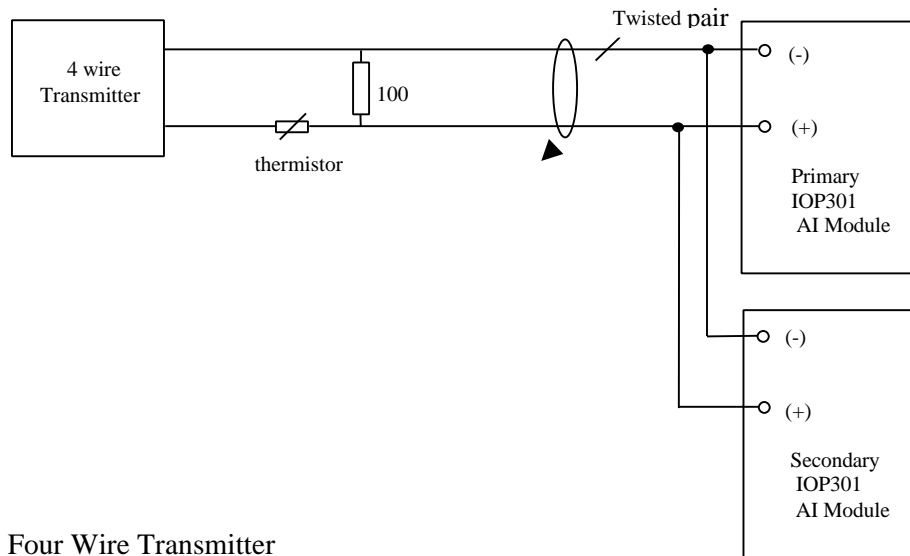


Field Wiring for Redundant Modules with Common Transmitter

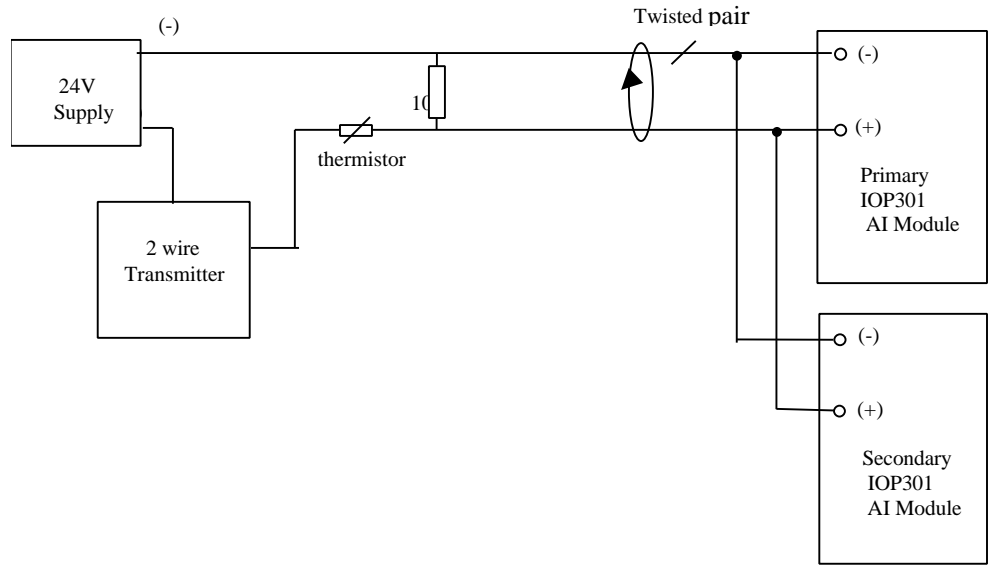
The following figure shows the recommended wiring for two redundant IOP301 analog input modules that share a common two-wire or four-wire transmitter.

Redundant inputs must be configured as voltage inputs with an external 100-Ohm shunt resistor. The recommended maximum distance between the shunt and the I/O module is 10 meters. The +24V connection should be independently fused to each transmitter.

The connection to the (-) terminal of the 24v supply must be made at the (-) side of the shunt resistor. The voltage that is developed across each 100-Ohm shunt by the 4-20 mA signal from the transmitter is wired to the AI module using twisted pair cables. A PTC thermistor is recommended between the transmitter output and the 100-Ohm shunt. This protects the 100-Ohm shunt against over voltage and provides additional resistance to increase the transmitter load to 250 Ohms. Kit IOP306 supplies 16 pairs of 100-Ohm shunts and thermistors to support two IOP301 analog input modules.



Four Wire Transmitter



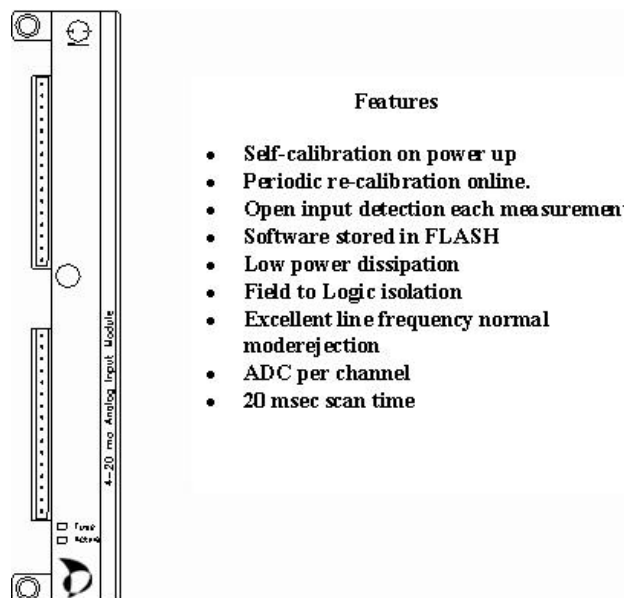
Two Wire Transmitter

Chapter 3

Analog Input Modules **4-20 mA Input Module IOP302** **Voltage Input Module IOP305**

Overview

The IOP302 module features sixteen 4-20 mA common input channels. The IOP305 module features 16 voltage input (not current input) channels. Transmitter loop power is available to the module via the backplane, providing individually fused 24V transmitter power for each channel.



LED Indication

A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the

DPU. This LED blinks on and off at a constant rate when the module is not being scanned by the DPU.

Bus Address

This module supports two modes of operation selected by jumper setting. For use with DPU4A/B this module requires 16 addresses and provides 15 channels.

When used with DPU4E, the module only requires two addresses and provides 16 channels.

Jumper Configuration

The module contains two jumpers. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W1	50 Hz	60Hz
W6	DPU4A/B	DPU4E

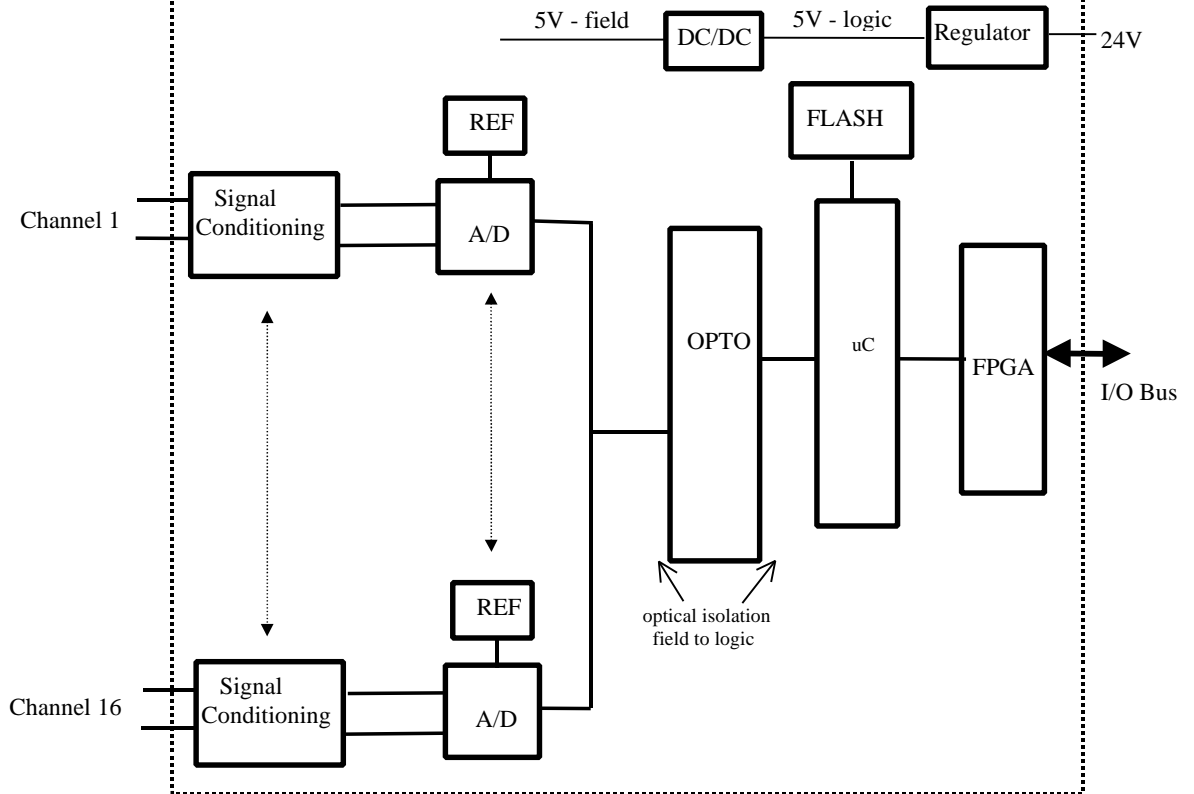
Module Operation

This microprocessor-based module supports up to 16 4-20 mA inputs, all powered from a local 24V loop supply. A sigma delta A/D and reference are provided for each input. Each A/D constantly reads the voltage generated by the input and converts the differential measurement to a 15-bit plus sign binary value, which is read by the microcontroller.

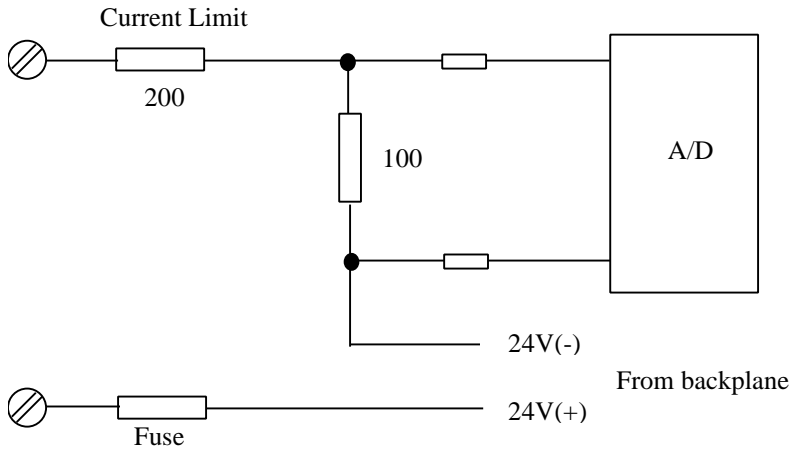
The digital filter in the oversampling A/D provides excellent 50/60 Hz normal mode rejection. Immediately following each measurement, open input and over range conditions are checked. A DC/DC converter provides isolated power to the A/D measuring circuit. Communication between the microcontroller and the A/D is serial at 100kHz. Optical isolators provide the isolation between the A/D and the serial logic circuits.

The microprocessor provides the input data to the DPU on demand via the bus FPGA. The FPGA provides the I/O bus interface logic; its program is loaded from the FLASH on power up. Module calibration is done automatically at power up following startup diagnostics. Calibration is repeated periodically online to compensate for temperature effects.

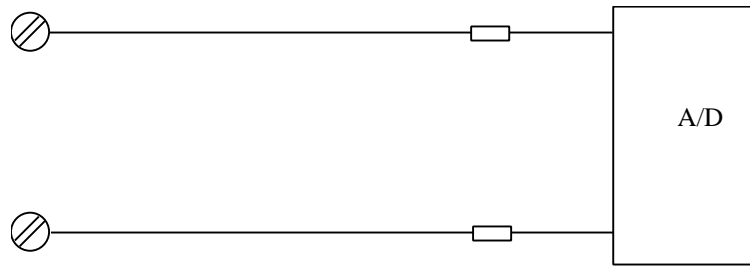
Analog Input Modules
4-20mA Input Module IOP302
Voltage Input Module IOP305



The input circuit for each channel of the 4-20 mA input module is shown in the following sketch. An electronic fuse protects the 24V loop power to the transmitter. A 200-Ohm thermistor in series with the input provides current limiting for overvoltage conditions up to 100 Volts. The 24-volt supply is available to the module from the backplane.



The following sketch shows the input circuit for the voltage-input module.



Voltage Input Module

Diagnostics

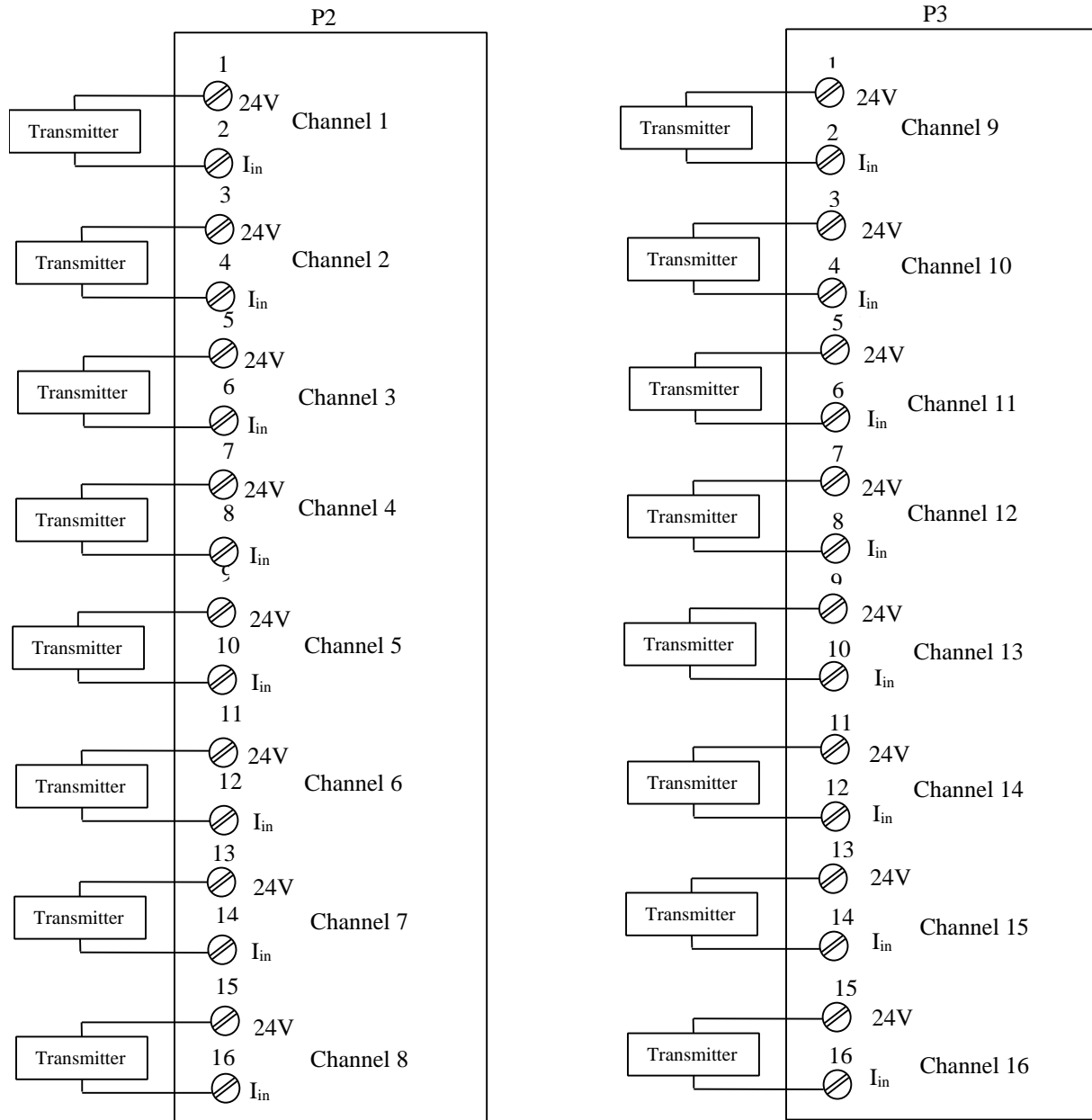
The module executes diagnostics on power up. When an error is detected on power-up or during online operation, the front-panel green LED, labeled Active, blinks the first digit at a slower rate and the second digit at a faster rate. During normal operation the active LED is on continuously or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

Error Condition	Code
A/D send fault	0x12
A/D receive fault	0x13
A/D self calibration failure	0x14
Bad A/D communication	0x15
A/D does not complete conversion	0x16
RAM Test Failure (power-on)	0x22
CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power -on)	0x32

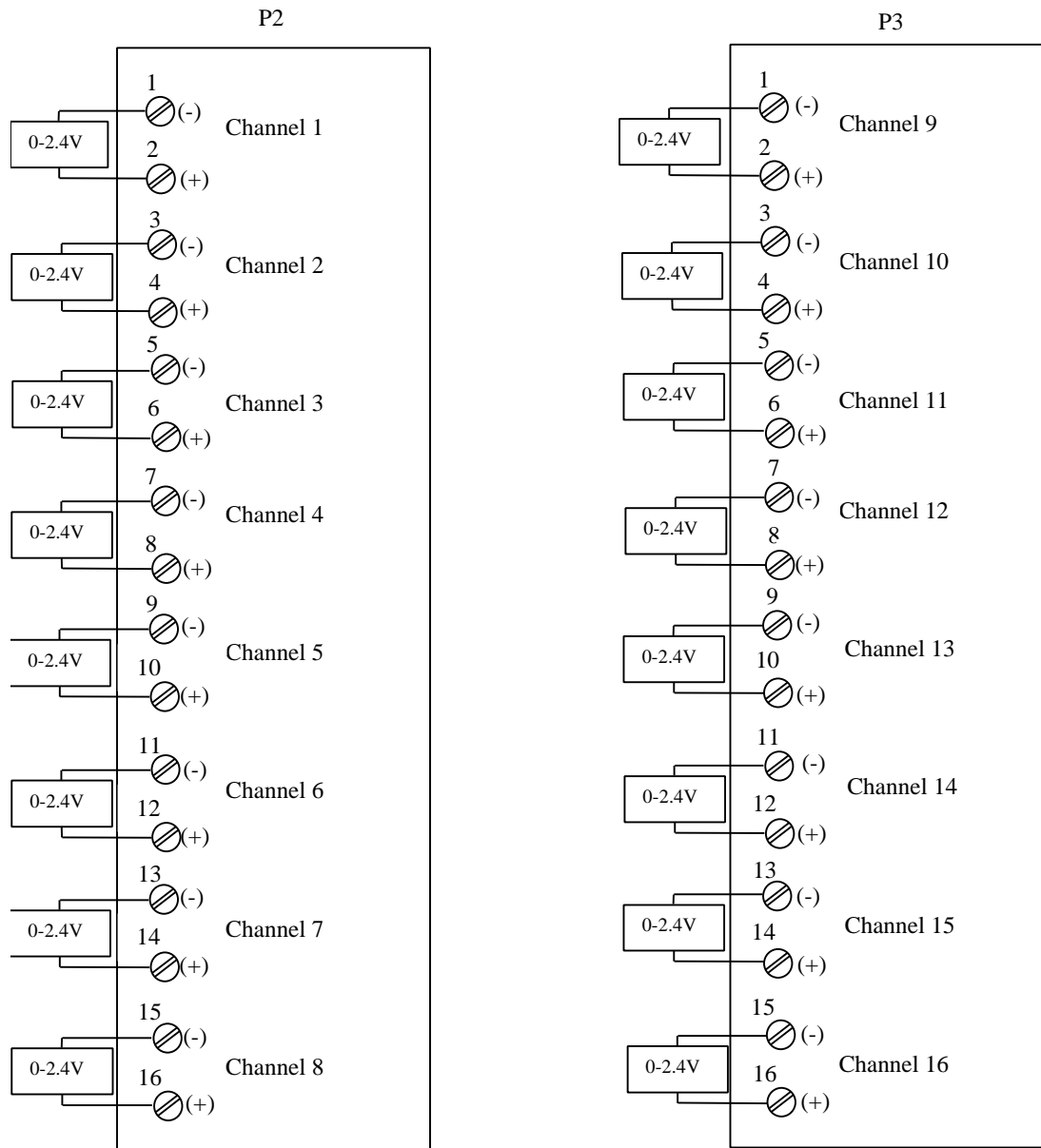
Module Specifications

Resolution	15 bits plus sign
Scan Rate	20 msec.
Temperature Sensitivity	$\pm 0.004\%$ of reading/ $^{\circ}\text{C}$ $\pm 1.5\mu\text{v}/^{\circ}\text{C}$ RTI
Accuracy	$\pm 0.1\%$ of reading at 25°C
Source Impedance Effect	10 Mohm operational, 20K Ohms on loss of power
Conversion method	Sigma Delta oversampling. Single A/D per channel
Span	4 to 20 mA, 1-2.4V.
Calibration	Self-calibration on power up. Periodically on line to compensate for temperature effects
Input Impedance	IOP302, 300 Ohms; IOP305, 1mOhm
Normal Mode Voltage	IOP302, 50 Volts; IOP305, 24 Volts
Normal Mode Rejection	60db @ 50/60 Hz
Input Power (from 24V system supply)	125 mA

Field Wiring for IOP302



Field Wiring – IOP 305 Analog Input Module

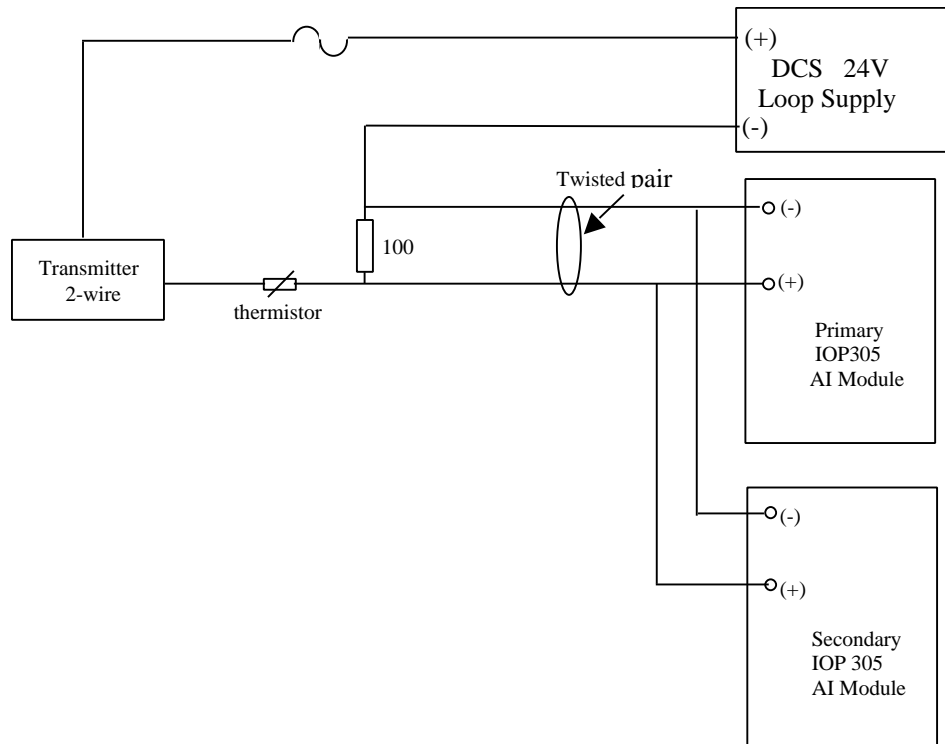


Field Wiring For Redundant Modules with Common Transmitter

The following figure shows the recommended wiring for two redundant IOP305 analog input channels that share a common transmitter.

The recommended maximum distance between the shunt resistor and the I/O module is 10 meters. The +24V connection is independently fused to each transmitter. The voltage that is developed across each 100-Ohm shunt by the 4-20 mA signal from the transmitter is wired to the AI module using twisted pair cables.

The (-) terminal of the loop supply is connected to the (-) side of the shunt resistors so that the 4-20 mA current does not flow through the twisted pairs wires. A PTC thermistor is recommended between the transmitter output and the 100-Ohm shunt. This protects the 100-Ohm shunt against over voltage and provides additional resistance to increase the transmitter load to 250 Ohms. Kit IOP306 supplies 16 pairs of 100-Ohm shunts and thermistors to support two IOP305 analog input modules.

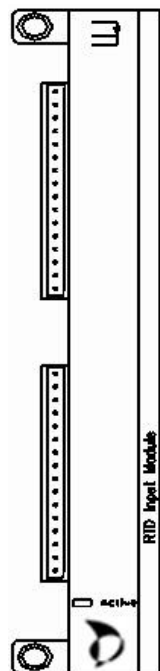


Chapter 4

Analog Input Modules **3 Wire RTD Module IOP303**

Overview

This module features 8 isolated 3-wire RTD input channels.



Features

- Self-calibration on power up
Periodic re-calibration online.
- Open RTD detection each measurement
- Software stored in FLASH
- Low power dissipation
- Supports different configuration for each channel.
- Excellent line frequency normal mode and common mode rejection
- Channel to channel and field to logic isolation

LED Indication

A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being scanned by the DPU. It is also used to display errors detected by diagnostics.

Bus Address

This module supports two modes of operation selected by jumper setting. For use with DPU4A/B this module requires eight addresses and provides seven channels.

When used with DPU4E, the module only requires two addresses and provides eight channels.

Jumper Configuration

The module contains three jumpers. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W2	Common I/O	Redundant I/O
W3	50 Hz	60 Hz
W4	Not used	
W6	DPU4A/B**	DPU4E

** For version B or earlier, W7 must be installed for DPU4A/B operation

Module Operation

This microprocessor-based module supports up to 8 RTD inputs, which can be independently configured. A reference excitation current is provided for each input. A sigma delta A/D reads the voltage generated by one of the eight inputs and converts the differential measurement to a 15-bit plus sign binary value representing the millivolt input, which is read by the microcontroller.

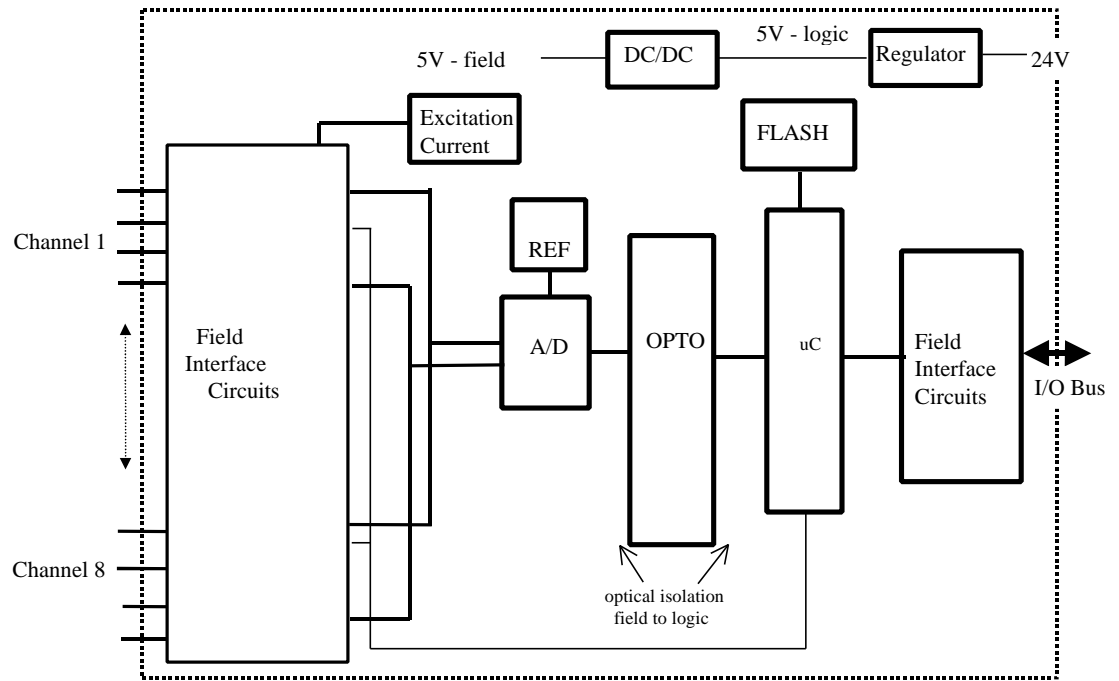
Multiple readings are done for each channel to compensate for the error introduced by the field wiring in 3-wire RTDs. The microcontroller initiates the conversion and waits for the conversion to complete. The digital filter in the oversampling A/D provides excellent 50/60 Hz normal mode rejection. The A/D also provides a variable gain amplifier function. Prior to starting each conversion, the microcontroller sets the gain required in the A/D and selects the RTD excitation current based on the configuration for that input. It also selects the input channel by means of four solid-state optically coupled relays.

The inputs are multiplexed with optical relays to provide channel to channel isolation. Immediately following each measurement, open RTD and over range conditions are checked. A DC/DC converter provides isolated power to the field side of the measuring circuit. Communication between the microcontroller and the A/D is serial at 100kHz.

Optical isolators provide the isolation between the A/D and the serial logic circuits. The microprocessor provides the input data to the DPU on demand

via the bus FPGA. The FPGA provides the I/O bus interface logic; its program is loaded from the FLASH on power up.

Module calibration is done automatically at power up following startup diagnostics. Calibration is repeated periodically online to compensate for temperature effects.



Diagnostics

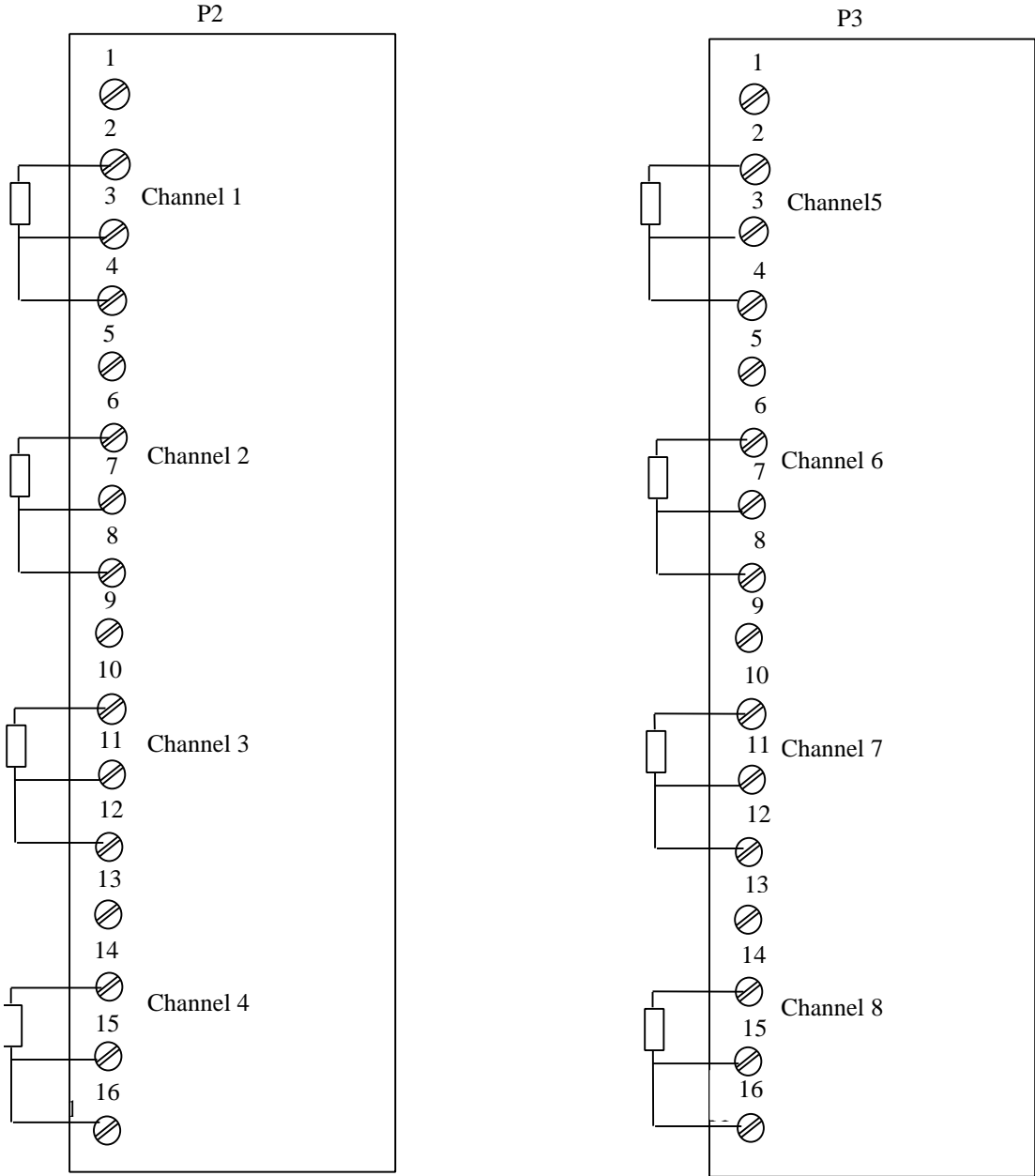
The module executes diagnostics on power up. When an error is detected on power-up or during online operation, the front-panel green LED, labeled Active, blinks the first digit at a slower rate and the second digit at a faster rate. During normal operation the active LED is on continuously or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

Error Condition	Code
A/D send fault	0x12
A/D receive fault	0x13
A/D self calibration failure	0x14
Bad A/D communication	0x15
A/D does not complete conversion	0x16
RAM Test Failure (power-on)	0x22
CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power -on)	0x32

Module Specifications

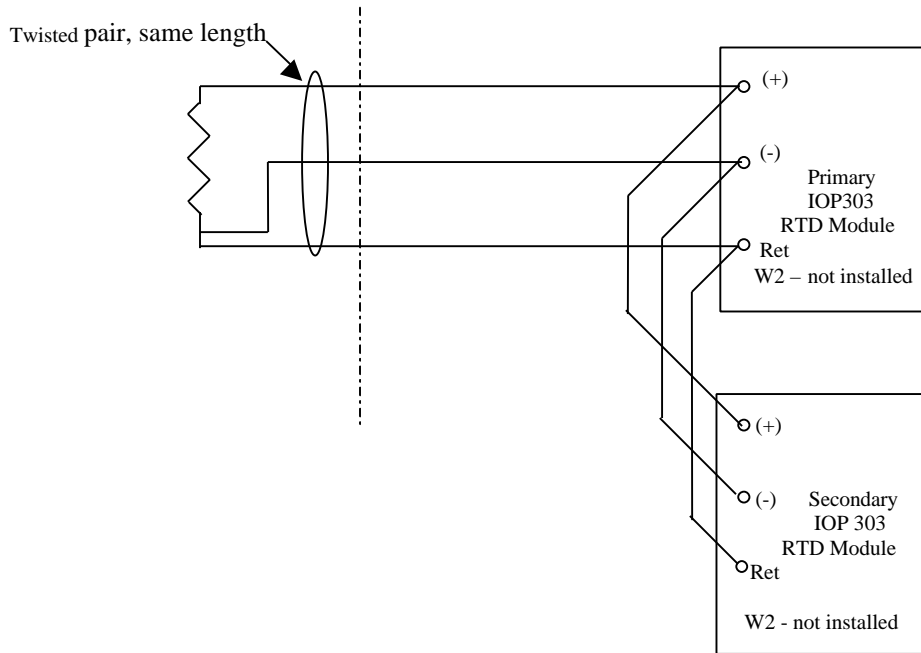
Resolution	15 bits plus sign
Scan Rate	8 points converted in 1.6 seconds
Temperature Sensitivity	$\pm 0.004\%$ of reading/ $^{\circ}\text{C}$ $\pm 1.5\mu\text{v}/^{\circ}\text{C}$ RTI
Accuracy	$\pm 0.15\%$ of reading $\pm 0.5^{\circ}\text{C}$
Input Multiplexer	Solid-state FET, optical isolation
Conversion method	Sigma Delta oversampling
Linearization	Digital in DPU. RTD ranges may be randomly mixed.
Calibration	Self-calibration on power up. Periodically on line to compensate for temperature effects.
Maximum Lead Resistance Compensation	5 Ohms each lead
Backup	Conversions disabled if common RTD is connected to redundant modules.
Conformity Error	$\pm 0. \pm 0.3^{\circ}\text{C}$, $\pm 0.5^{\circ}\text{F}$
Normal Mode Rejection	60db @ 50/60 Hz
Common Mode Rejection	120db @ 50/60Hz, 100 Ohm imbalance
Common Mode Voltage	240V rms, 350V dc peak
Input Power (from 24V system supply)	125 mA

Field Wiring



Note: Field wires must be of equal length

Field Wiring For Redundant Modules with Common RTD

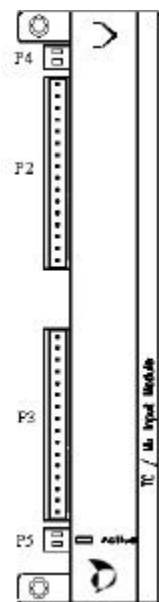


Chapter 5

Analog Input Modules *TC Module IOP304*

Overview

This module features 16 isolated thermocouple or emf input channels



Features

- Self-calibration on power up
- Periodic re-calibration online
- Open TC detection each measurement
- Software stored in FLASH
- Low power dissipation
- Supports different configuration for each channel
- Cold junction compensation
- Channel to channel and field to logic isolation
- Excellent line frequency normal mode and common mode rejection

LED Indication

A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off at a constant rate when the module is not being scanned by the DPU.

Bus Address

This module supports two modes of operation selected by the jumper setting. For use with DPU4A/B this module requires 16 addresses and provides 15 channels. W7 installed

When used with DPU4E, the module only requires two addresses and provides 16 channels. W7 not installed

Jumper Configuration

The module contains three jumpers. These jumpers are located at the rear of the module above the edge connector. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W3	50 Hz	60Hz
W2	Common I/O	Redundant I/O
W6	DPU4A/B	DPU4E

Cold Junction Compensation

If this module is configured by the DPU to perform cold junction compensation, a thermistor (MAX Part No. 074566) must be installed in connectors P4 and P5 at the front of the module, above and below the input connectors.

Module Operation

This microprocessor-based module supports up to 16 TC or emf inputs, which may be independently configured. A sigma delta A/D reads the voltage generated by one of the 16 TC or emf inputs and converts the differential measurement into a 15 bit plus sign binary value representing the millivolt input which is read by the microcontroller. The microcontroller initiates the conversion and waits for the conversion to complete.

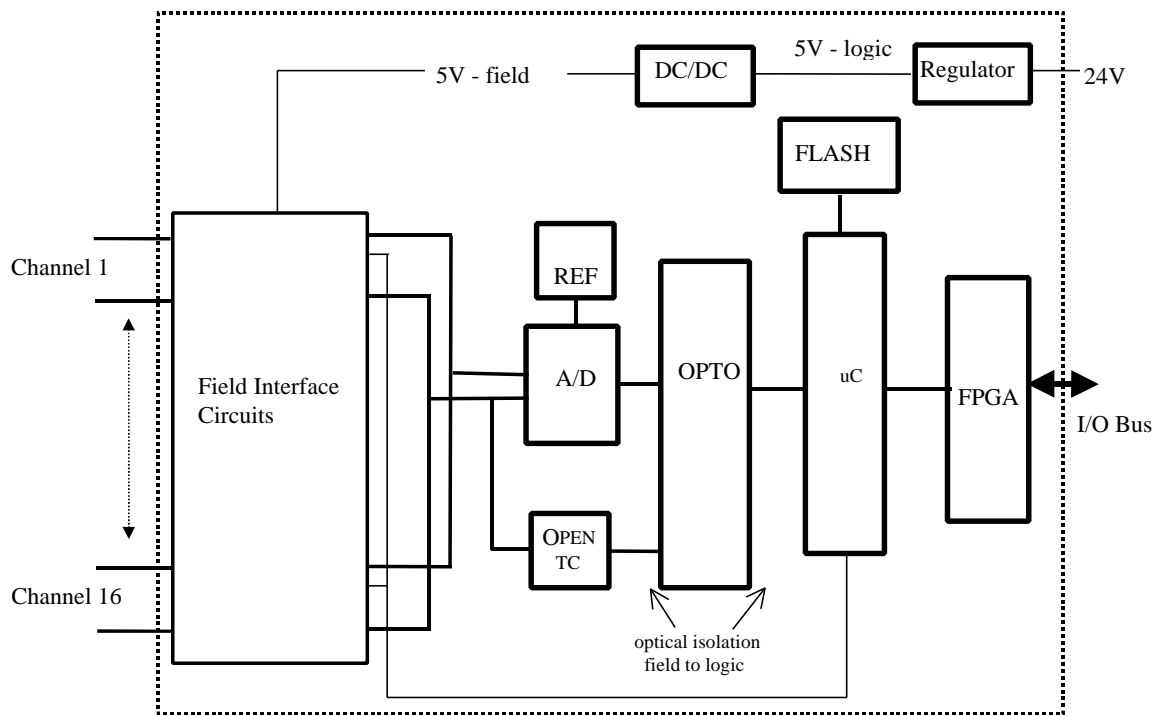
The digital filter in the oversampling A/D provides excellent 50/60 Hz normal mode rejection. The A/D also provides a variable gain amplifier function. Prior to starting each conversion, the microcontroller sets the gain required in the A/D for each configured input measurement, and selects the input channel by means of two solid state, optically coupled relays.

The inputs are multiplexed with optical relays to provide channel to channel isolation. Immediately following each measurement, open TC and over range conditions are checked. A DC/DC converter circuit provides isolated power

to the field side of the measuring circuit. Communication between the microcontroller and the A/D is serial at 100kHz. Optical isolators provide the isolation between the field side and the serial logic circuits. The microprocessor provides the input data to the DPU on demand via the bus FPGA. The FPGA provides the I/O bus interface logic; its program is loaded from the FLASH on power up.

Module calibration is done automatically at power up following startup diagnostics. Calibration is repeated periodically online to compensate for temperature effects.

When thermocouples are measured, the module monitors the TC cold junction temperature and the input value read is compensated for the cold junction temperature. Thermistors, installed at the terminal blocks provided above and below the field connectors, are used to measure the TC cold junction temperature. When remote terminations are used, these thermistors must be removed from the module and moved to the wiring connections at the remote terminations. The microcontroller schedules periodic measurements of the thermistors and uses these measurements to calculate a cold junction temperature for each channel.



Diagnostics

The module executes diagnostics on power up. When an error is detected on power-up or during online operation, the front-panel green LED, labeled Active, blinks the first digit at a slower rate and the second digit at a faster

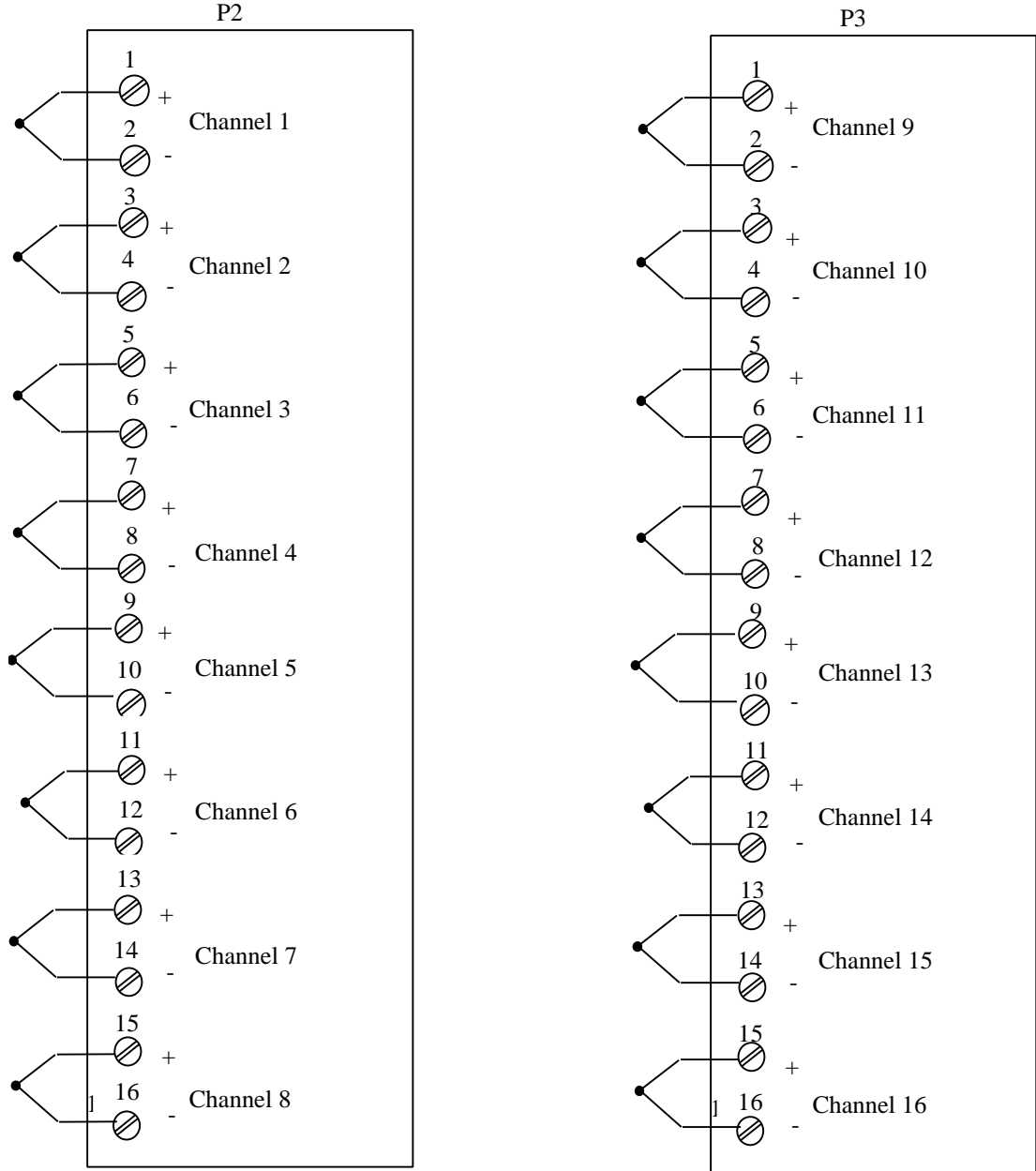
rate. During normal operation the active LED is on continuously or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

Error Condition	Code
A/D send fault	0x12
A/D receive fault	0x13
A/D self calibration failure	0x14
Bad A/D communication	0x15
A/D does not complete conversion	0x16
RAM Test Failure (power-on)	0x22
CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power-on)	0x32

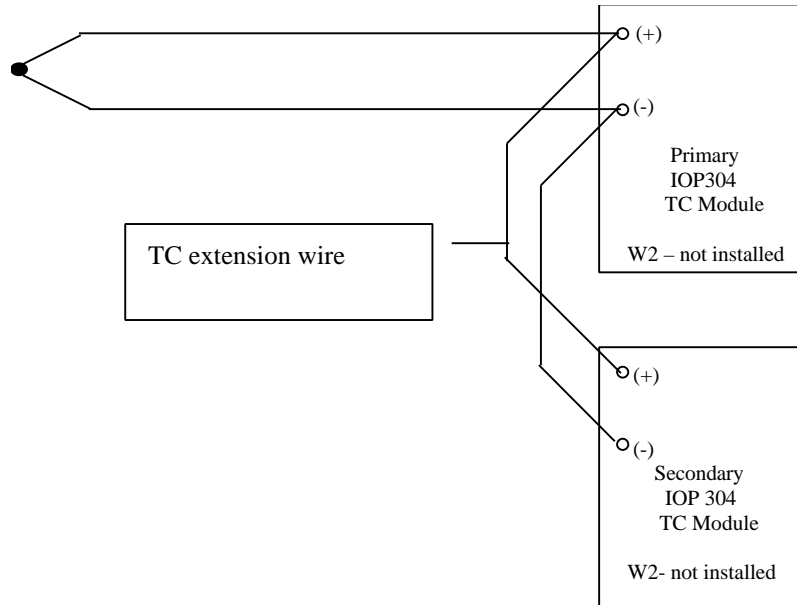
Module Specifications

Resolution	15 bits plus sign
Scan Rate	16 points converted in 1 seconds
Temperature Sensitivity	$\pm 0.004\%$ of reading $^{\circ}\text{C}$ $\pm 1.5\mu\text{v}/^{\circ}\text{C}$ RTI
Accuracy	$\pm 0.15\%$ of reading $\pm 0.05^{\circ}\text{C}$
Input Multiplexer	Solid-state FET, optical isolation
Conversion method	Sigma Delta oversampling
Linearization	Digital in DPU. RTD ranges may be randomly mixed.
Calibration	Self-calibration on power up. Periodically on line to compensate for temperature effects
RJ Compensation	Digital in module
Open TC Detection	Performed each reading (1,000 Ohm threshold)
Backup	Conversions disabled if common TC is connected to redundant modules
Conformity Error	$\pm 0.3^{\circ}\text{C}$, $\pm 0.5^{\circ}\text{F}$
Reference Junction Error	$\pm 0.25^{\circ}\text{C}$
Normal Mode Rejection	60db @ 50/60 Hz
Common Mode Rejection	120db @ 50/60 Hz, 100 Ohm imbalance
Common Mode Voltage	240V rms, 350V dc peak
Input Power (from 24V system supply)	125 mA

Field Wiring



Field Wiring For Redundant Modules with Common TC



Note: Thermistors must be installed in both modules.

Chapter 6

Analog Output Modules ***4-20 mA Output Module IOP320***

This module, featuring eight 4-20 mA output channels, receives power from the 24V-system supply via the backplane edge connector. Loop power is also available to the module via the backplane and is individually fused 24V for each channel.



Features

- Self-calibration on power up.
- Open output detection
- Software stored in FLASH
- Low power dissipation
- DAC per channel

LED Indication

A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being scanned by the DPU. A second green LED provides the status of the loop power fuse disconnect.

Bus Address

This module supports two- or eight-address mode of operation selected by jumper W6. When used with DPU4A/B this module requires eight addresses, one per channel. When used with DPU4E, the module currently requires eight addresses.

Jumper Configuration

The module contains four jumpers. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W1	Run Mode	Calibrate Mode
W2	Hold Output	Reset Output
W3	Secondary	Primary
W4	Common I/O	Redundant I/O
W6	8 addresses	2 addresses*

*future use.

Note: the W6 switch setting shown in the above table applies to modules with two rotary switches installed. For modules with only one rotary switch, use the following definition:

W6 base address = x8 (hexadecimal)

W7 base address = x0 (hexadecimal)

Where x is the rotary switch setting. Refer to the following table:

S1 Setting	W6 Setting	W7 Setting	Base Address
1	out	In	16
1	in	Out	24
2	out	In	32
2	in	Out	40
3	out	In	48
3	in	Out	56
4	out	In	64
4	in	Out	72
5	out	In	80
5	in	Out	88
6	out	In	96
6	in	Out	104
7	out	In	112
7	in	Out	120
8	out	In	128
8	in	Out	136
9	out	In	144
9	in	Out	152
A	out	In	160
A	in	Out	168
B	out	In	176
B	in	Out	184
C	out	In	192
C	in	Out	200
D	out	In	208
D	in	Out	216
E	out	In	224
E	in	Out	232

Module Operation

This microprocessor-based module supports up to eight 4-20 mA output channels. Communication between the microcontroller and each output is serial. The output request received from the I/O bus is translated by the microcontroller into a pulse width modulated signal, which is transmitted to each output circuit via a high-speed optical isolator. This optical isolator provides the isolation between the logic and the field.

The duty cycle of the serialized output is proportional to the output level. The output circuit converts this signal into 4-20 mA. Open load is detected and reported to the DPU.

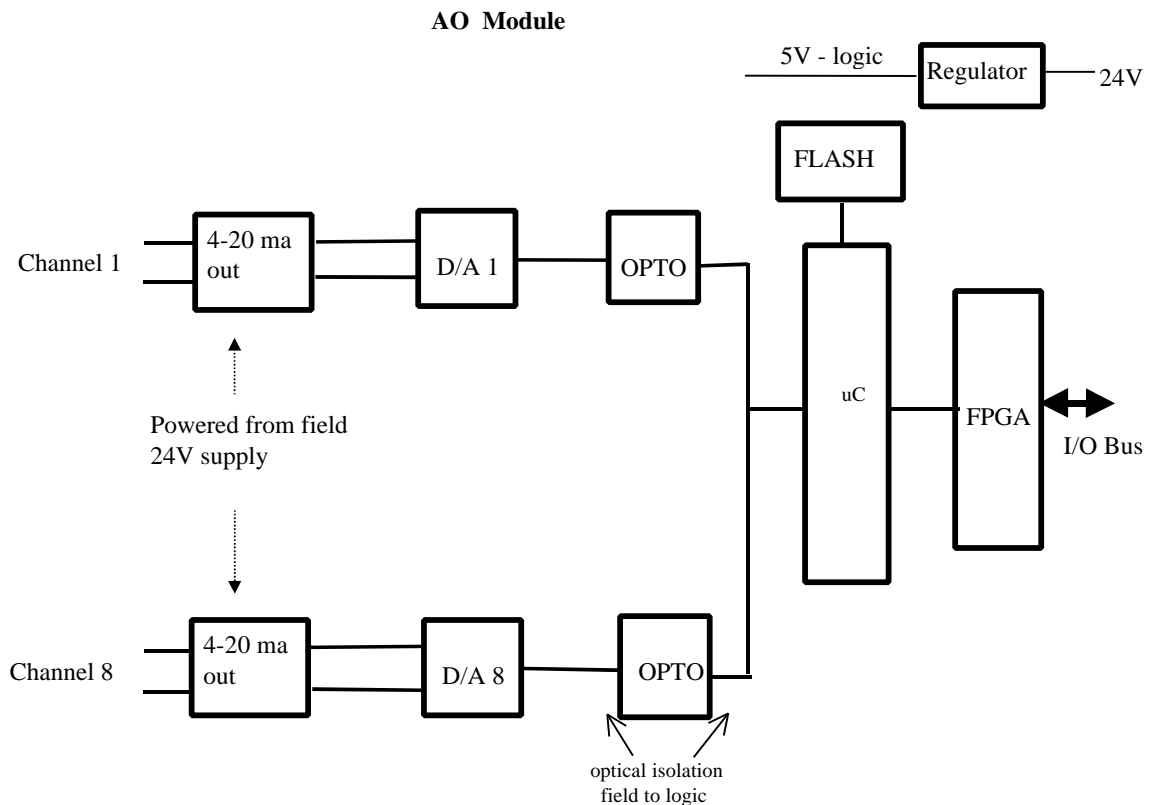
The FPGA provides the I/O bus interface logic; its program is loaded from the FLASH on power up.

A watchdog timer function is included to monitor communications on the I/O bus. The watchdog timers will timeout if there is no communications on the I/O bus for longer than 0.7 seconds. When this occurs, the outputs will

either reset or remain in their last state depending on the position of the onboard program jumper.

Module calibration is done automatically at power up following startup diagnostics.

The 24-Volt loop supply is available to the module from the backplane. All the outputs are connected to the loop supply.



Diagnostics

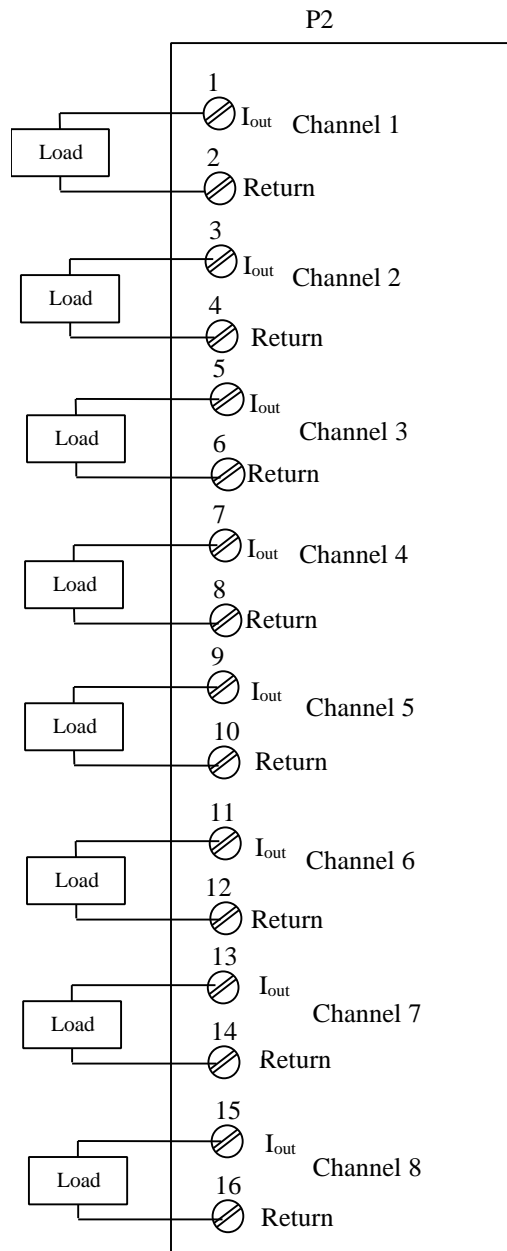
The module executes diagnostics on power up. When an error is detected on power-up or during online operation, the front-panel green LED, labeled Active, blinks the first digit at a slower rate and the second digit at a faster rate. During normal operation the active LED is on continuously or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

Error Condition	Code
RAM Test Failure (power-on)	0x22
CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power-on)	0x32
Calibration Error (channel 1 to 8)	0x41 – 0x48

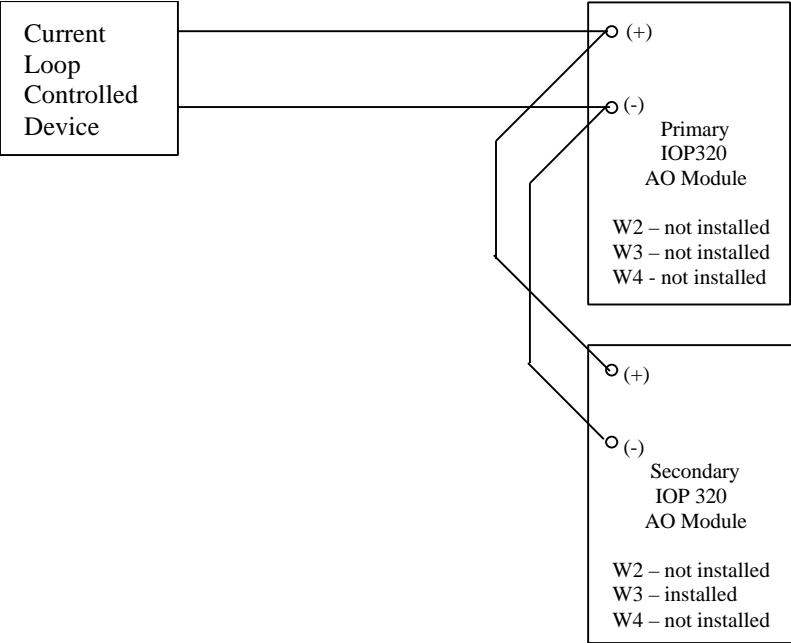
Module Specifications

Resolution	12 bits
Scan Rate	8 msec.
Temperature Sensitivity	$\pm 0.004\%$ of reading/ $^{\circ}\text{C}$ $\pm 1.5\mu\text{v}/^{\circ}\text{C}$ RTI
Accuracy	$\pm 0.1\%$ of reading $\pm .05\%$ of span at 25°C
Span	4 to 20 mA.
Calibration	Self-calibration on power up with calibration jumper set
Load Impedance	0 – 800 Ohms
Input Power (from 24V system supply)	175 mA

Field Wiring



Field wiring for redundant modules with common end element



Chapter 7

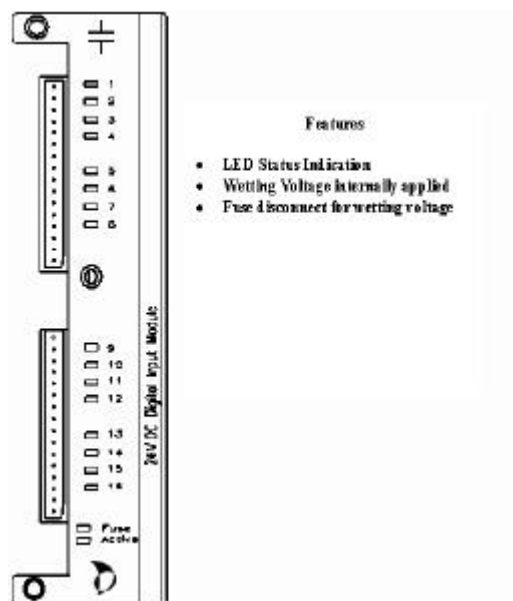
Digital Input Modules

24V Common Input Module IOP330

48V Common Input Module IOP331

Overview

These modules feature 16 digital common inputs.



LED Indication

Individual red front-panel LEDs provide the input status indication for each channel. A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being

scanned by the DPU. A second green LED provides the status of the loop power fuse disconnect.

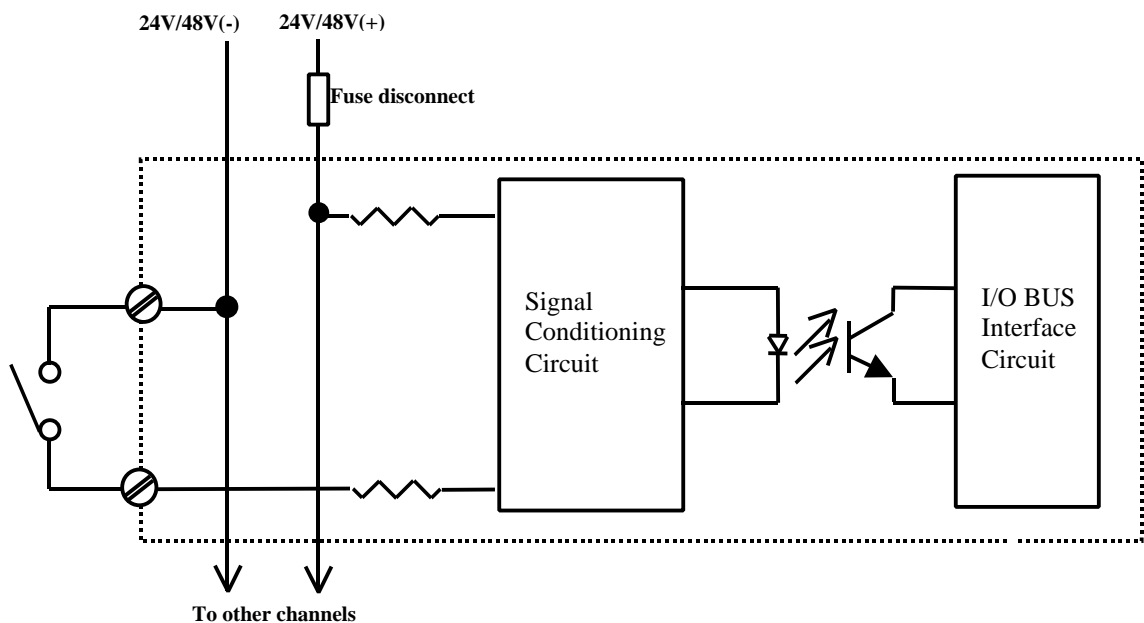
Bus Address

This module requires one I/O one bus address. The address range for digital input modules is 0 – 1F (0-31).

Module Operation

The following is a simplified sketch of the circuit for one channel. The signal-conditioning block provides filtering, current limiting circuit, and an input threshold. It also includes the input status LED. The optical isolator provides isolation between the field circuits and the logic circuits. The input status is buffered and latched in the I/O bus interface circuit. The data is presented to the I/O bus as a 16-bit word when the module is scanned by the DPU. A watchdog timer in the I/O bus interface circuit controls the operation of the active LED, causing it to blink when the module is not scanned for 0.7 seconds.

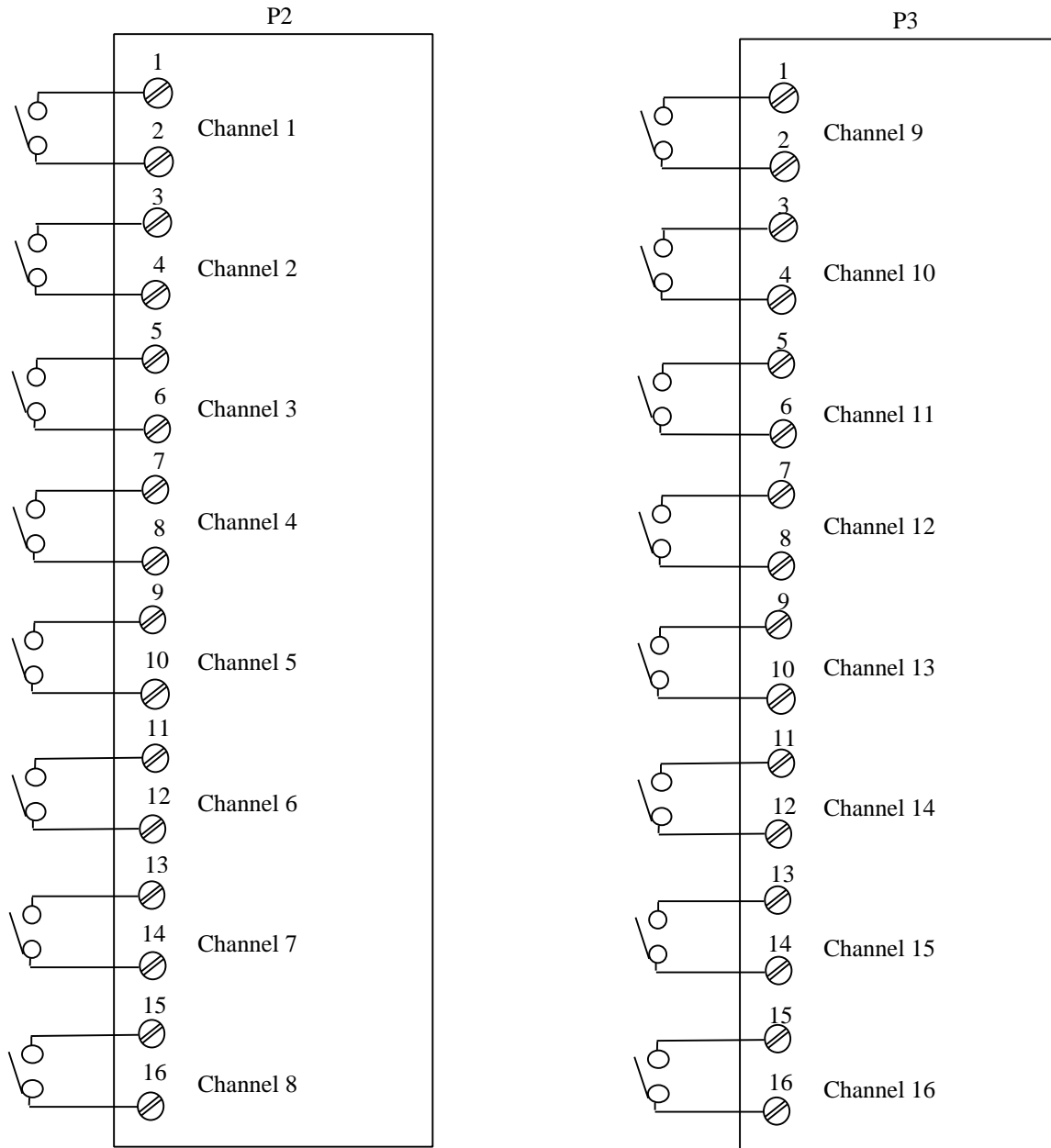
The 24V/48V(+) and 24V/48V(-) loop power signals are connected to all the channels. They are routed to the module from the backplane via a fuse is accessible from the front of the module.



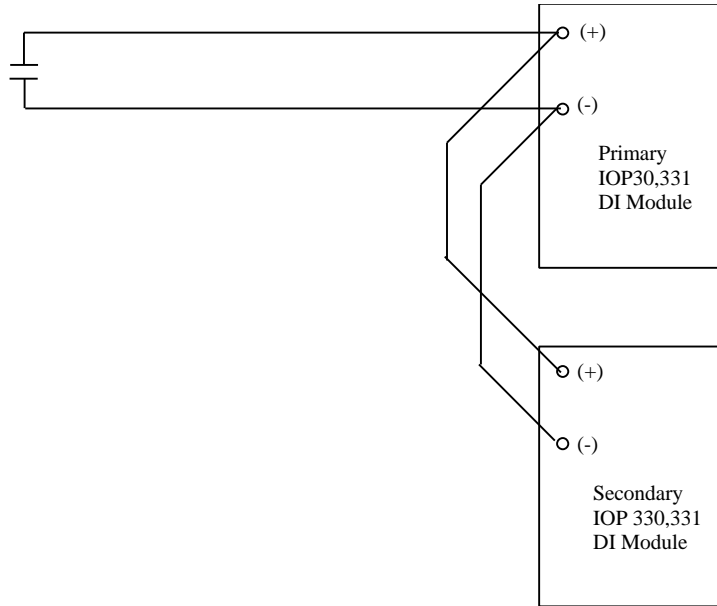
Module specifications

	IOP 330 – 24V	IOP331 – 48V
Rated Input Voltage	24 Volts nominal, 40 Volts maximum	48 Volts nominal, 60 Volts maximum
Input current per point	5 mA @ 24 Volts	5 mA @ 48 Volts
On-State Voltage	8.5 Volts	22 Volts
Isolation User input to logic	250 VAC continuous, 1,500 VAC for 1 minute	
Indicators	1 LED per point provides status indication. LED provides power and communication indication. LED provides loop power disconnect status	
I/O Bus Address	One address	
Input Power (from 24V system supply)	50 mA	

Field Wiring



Field Wiring For Redundant Modules with Common DI



Chapter 8

Digital Input Modules

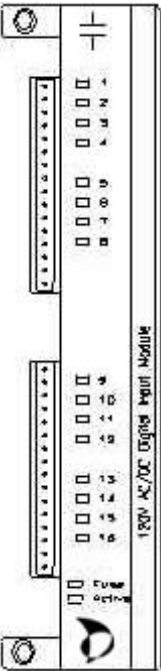
24V DC Isolated Input Module IOP334

120V AC/DC Isolated Input Module IOP332

240V AC/DC Isolated Input Module IOP333

Overview

These modules provide 16 isolated digital inputs



Features

- LED status indication
- Channel to channel and field to logic isolation
- High common mode rejection

LED Indication

Individual red front-panel LEDs provide the input status indication for each channel. A green LED, labeled Active at the bottom of the module front

panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being scanned by the DPU.

Bus Address

This module requires one I/O one bus address. The address range for digital input modules is 0 – 1F (0-31)

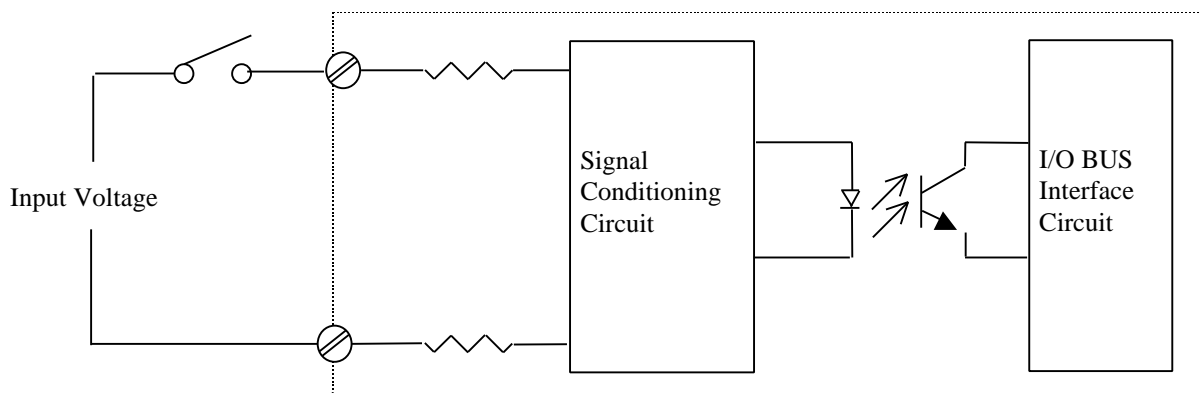
Jumper Configuration

For IOP332 and IOP333, jumpers (W1—W16) must be installed for AC inputs.

Note: IOP334 does not include jumpers.

Module Operation

The following is a simplified sketch of the circuit for one channel. The signal-conditioning block provides filtering, current limiting circuit, and an input threshold. It also includes the LED. The optical isolator provides isolation between the field circuits and the logic circuits. The input status is buffered and latched in the I/O bus interface circuit. The data is presented to the I/O bus as a 16-bit word when the module is scanned by the DPU. A watchdog timer in the interface circuit controls the operation of the active LED, causing it to blink when the module is not scanned for 0.7 seconds.

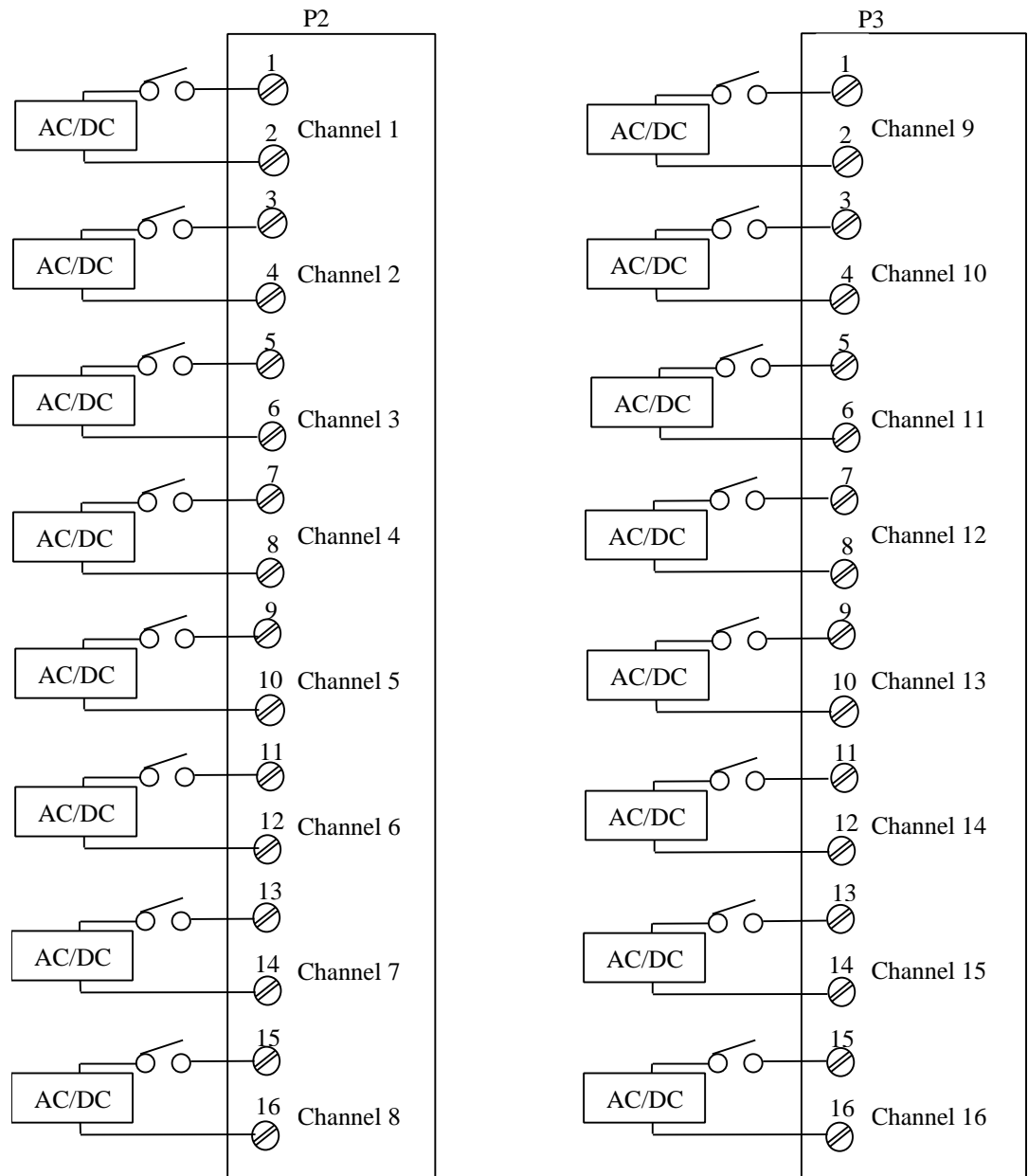


Digital Input Modules
24V DC Isolated Input Module IOP334
120V AC/DC Isolated Input Module IOP332
240V AC/DC Isolated Input Module IOP333

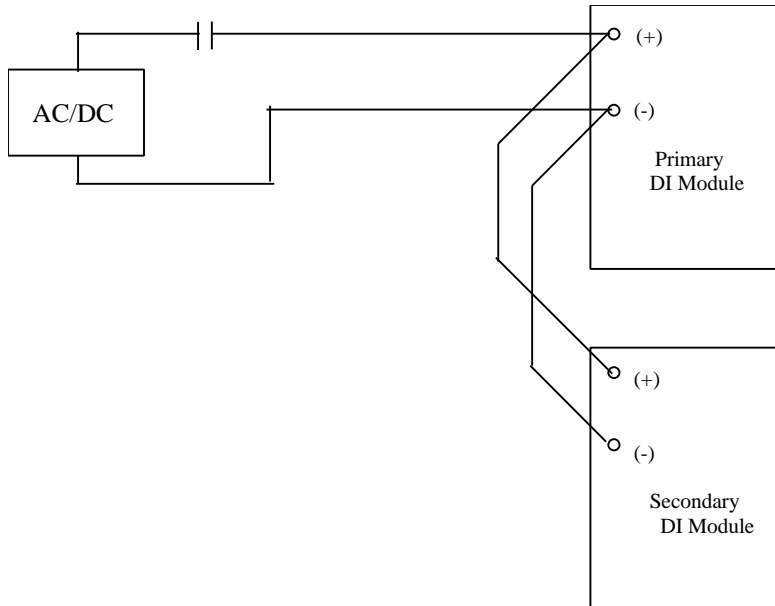
Module Specifications

	IOP 332 – 120V	IOP333 – 240V	IOP334 – 24V
Rated Input Voltage	120 Volts ac/dc nom. 180 Volts max	240 Volts ac/dc nom. 280 Volts max	24 Volts ac/dc nom. 40 Volts max
Input current per point	5 mA @ 120 Volts	5 mA @ 240 Volts	5 mA @ 24Volts
On-State Voltage	48 Volts dc	70 Volts dc 100 Volts ac	8.5 Volts dc
Isolation User input to logic	60 VAC; 250 VAC continuous, 125 VAC; 1500 VAC for 1 minute		
Isolation Channel to channel	350 VAC continuous		
Indicators	1 LED per point provides status indication LED provides power and communication indication LED provides the status of the loop power fuse disconnect		
I/O Bus Address	One address		
Input Power (from 24V system supply)	50 mA		

Field Wiring



Field Wiring For Redundant Modules with Isolated DI



Chapter 9

Digital Input Modules ***Pulse I/O Module IOP335***

This module provides eight isolated Pulse I/O digital input channels. Each channel provides a pair of digital inputs which can be individually programmed to support 24 or 48 Volt inputs. The module features the following:

- Software stored in FLASH
- Low power dissipation
- Different configuration for each channel.

Picture

LED Indication

A red status LED is provided for each input. A green LED, labeled Active on the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being scanned by the DPU.

Bus Address

This module only requires two addresses. It is compatible with DPU4E only.

Jumper Configuration

A two-position jumper is used to select the input voltage for each input. The input number identifies the jumpers. The two positions are A and B as follows:

Jumper	Installed	Not Installed
W1A - 16A	24 V	48V

This microprocessor-based module supports up to eight pulse input channels. Each channel can be independently configured for both function type and debounce time. The functions supported are:

Mode 1 – Frequency Input

Frequency in counts per second in input1. Input 2 is not used. The Pulse I/O Buffer in DPU4E supports the following timebase mode selections for frequency measurement: 20 msec, 50 msec, 100 msec, 250 msec, 500 msec, and 1 second. For the selected timebase, the Pulse I/O module measures frequency for the specified duration and normalizes each measurement to cycles per second. The measurement is updated at the end of each interval and the counts read by the DPU when the module is scanned represent the average of the last four measurements in cycles/second. The scan rate of the DPU is asynchronous from the scan rate by the module. The accuracy of the frequency measurement is +/-1 count for the one-second timebase. The accuracy for the other timebases is approximately the normalizing multiplier divided by 4. Thus for the shortest timebase (20 msec), the accuracy is reduced to approximately +/-12 counts.

In applications requiring fast frequency measurements, a period measurement (mode 7) can also be used to measure frequency. Since each count in the period measurement corresponds to 0.5 microseconds, the inverse of the period will yield a fast frequency measurement with an accuracy of 0.1% for a 2000Hz input and 0.25% for a 5000Hz.

Mode 2– Simple Event Counter (default configuration)

32 bit accumulation of OFF-to-ON transitions in input1. Input2 provides an external accumulator reset.

Mode 3 – Up/Down Event Counter

Net counts of OFF to ON transitions in input1 and input2. Input1 counts up and input2 counts down.

Mode 4 – On-Time Timer

The timebase frequency (0.5 usec/count) is counted while input1 = ON. Input 2 provides an external reset.

Mode 5 – Up/Down Pulse Timer

Counts corresponding to the on-time difference in input1 and input2. The timebase frequency (0.5 usec/count) is counted up while input1 = ON and counted down while input2 is ON.

Mode 6 – Pulse Width

ON time of last detected pulse in input1, based on the timebase frequency (0.5 usec/count). Input2 is not used. The measurement is updated at the end of each detected pulse (ON to OFF transition). Counts read by DPU represent the average of the last four measurements.

Mode 7 – Period

Time duration between the last onset of input1 and the previous onset of input1. The timebase frequency (0.5 usec/count) is counted during this time. Input2 is not used. The measurement is updated at the end of each detected period. Counts read by DPU represent the average of the last four measurements.

Module Operation

This microprocessor based module supports up to 16 digital inputs. As shown in the functional block diagram, the field circuits are used to detect and optically isolate the digital inputs. High-speed optical isolators support higher frequency inputs. The processor circuits implement the configured timing functions and provide the interface to the I/O bus FPGA. The Time Processor Unit (TPU) included in the 68332 processor is used to process the timing functions. The TPU operates from microcode masked in 68332 ROM. The 16 DI inputs are debounced in an FPGA and are available individually to the processor TPU inputs.

Diagnostics

The module executes diagnostics on power up. To indicate any errors detected during power-up or on-line operation the LED labeled active blinks the first digit at a slower rate and the second digit at a faster rate.

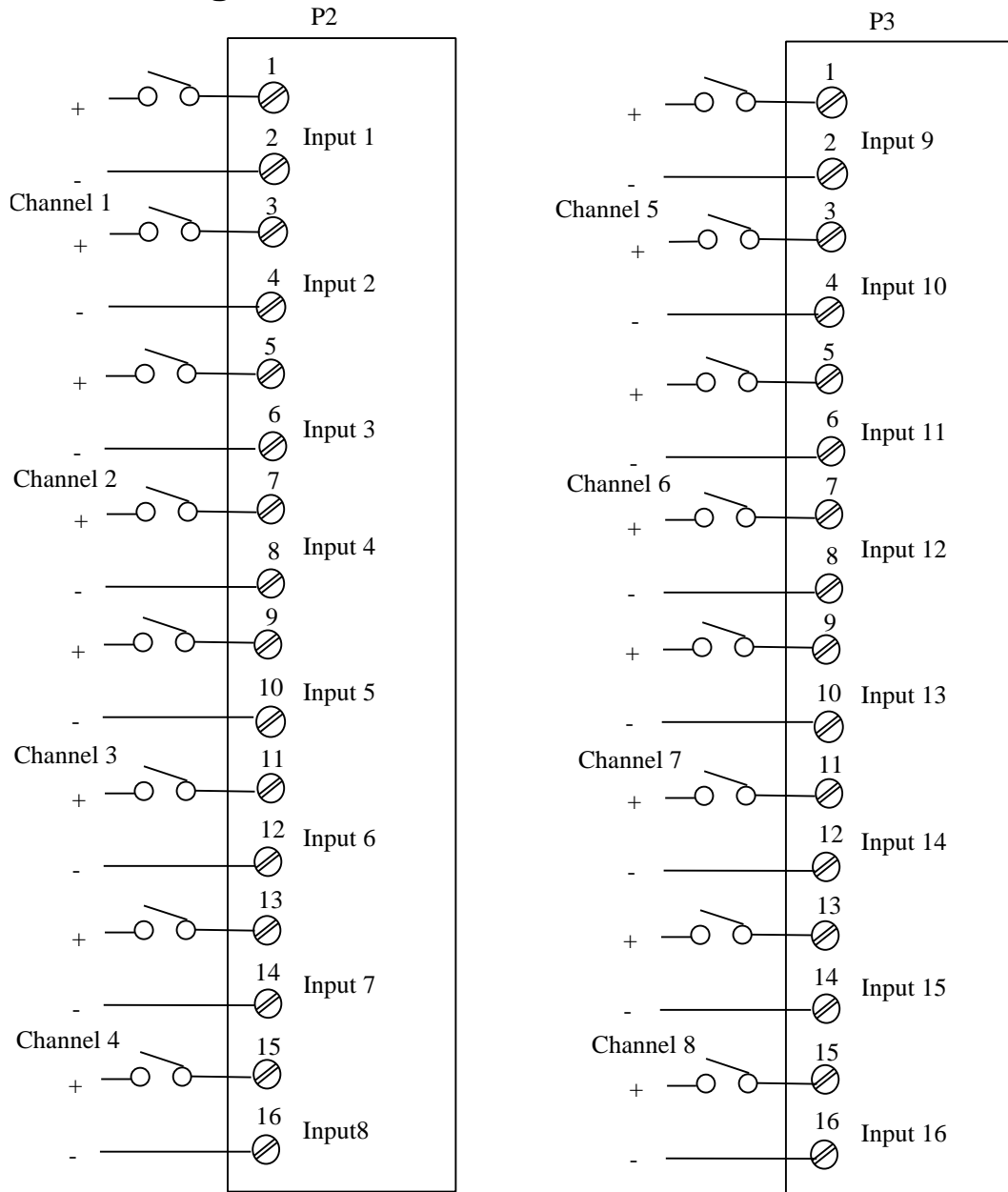
During normal operation this LED stays on or flashes at a steady one-second rate when the module is not being scanned. The diagnostic codes are as follows:

Error Condition	Code
RAM Test Failure (power-on)	0x22
CPU Stack Error (power-on)	0x23
CPU Error (power-on)	0x24
Checksum Error (power-on)	0x25
Interrupt Error (power-on)	0x26
FPGA Download Error (power -on)	0x32

Module specifications

Input voltage	24V, 48V jumper selectable
Input thresholds	24V – 10 Volts 48V – 20 Volts
Debounce	0-255 msec dynamically configured per channel
Accuracy	1 cycle or $\pm 0.15\%$, whichever is greater
Maximum frequency	32KHz
Minimum Pulse Width	10 usecs
Common Mode Voltage	240Vac rms, 350V dc peak
Input Power (from 24V system supply)	150 mA

Field Wiring



Chapter 10

Digital Output Modules ***Form A/B Relay Module IOP351*** ***Form C Relay Module IOP350***

Overview

These modules provide 16 Form A relays or 10 form C relays. The form A outputs can be converted to form B via on-board jumpers.



Features

- LED status Indication
- Channel to channel and field to logic isolation

LED Indication

Individual red front-panel LEDs provide the output status indication for each channel. A green LED, labeled Active at the bottom of the module front panel, is on when system power is present and the module is communicating with the DPU. This LED blinks on and off when the module is not being scanned by the DPU.

Bus Address

This module requires one I/O one bus address.

Jumper Configuration

Jumper W1 configures all the outputs to either reset or fail in place when there is no communications in the I/O Bus for more than 0.7 seconds. Configuration is as follows:

Jumper	Position 2-2	Position 1-2
W1	Reset Output	Hold Output

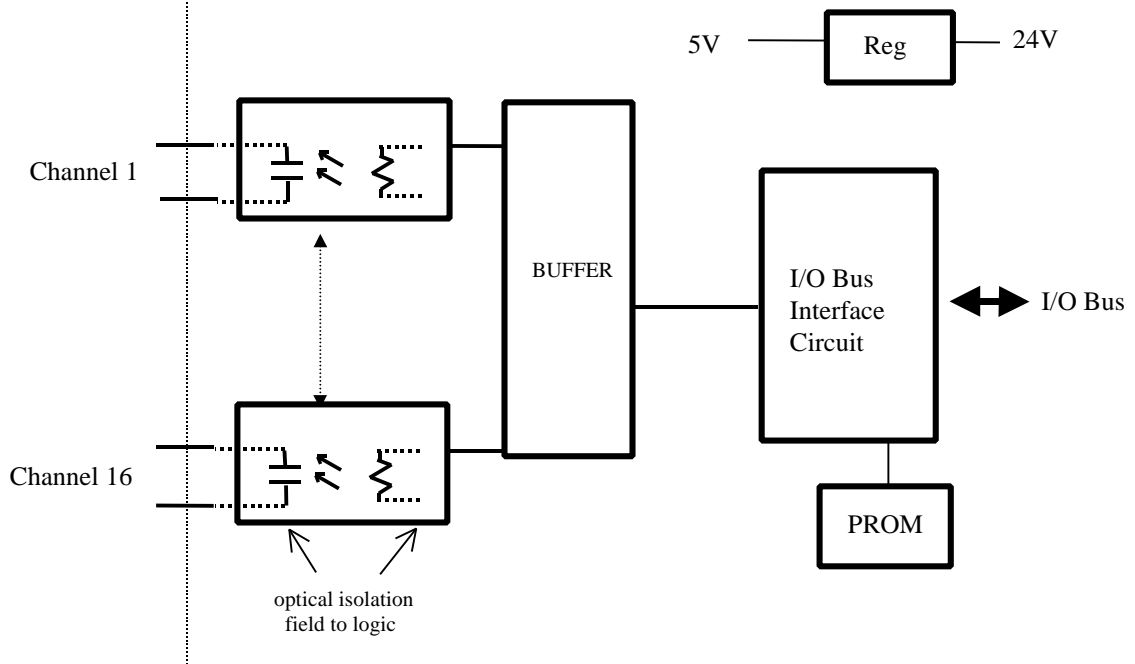
For the IOP351 module, each channel can be strapped in the printed circuit assembly for form A or form B operation per the following table. The default configuration is form A for all channels.

Channel Number	Form A	Form B
1	R100	R101
2	R103	R104
3	R106	R107
4	R108	R109
5	R111	R112
6	R114	R115
7	R116	R117
8	R119	R120
9	R122	R123
10	R124	R125
11	R127	R128
12	R130	R131
13	R132	R133
14	R135	R136
15	R138	R139
16	R140	R141

Module Operation

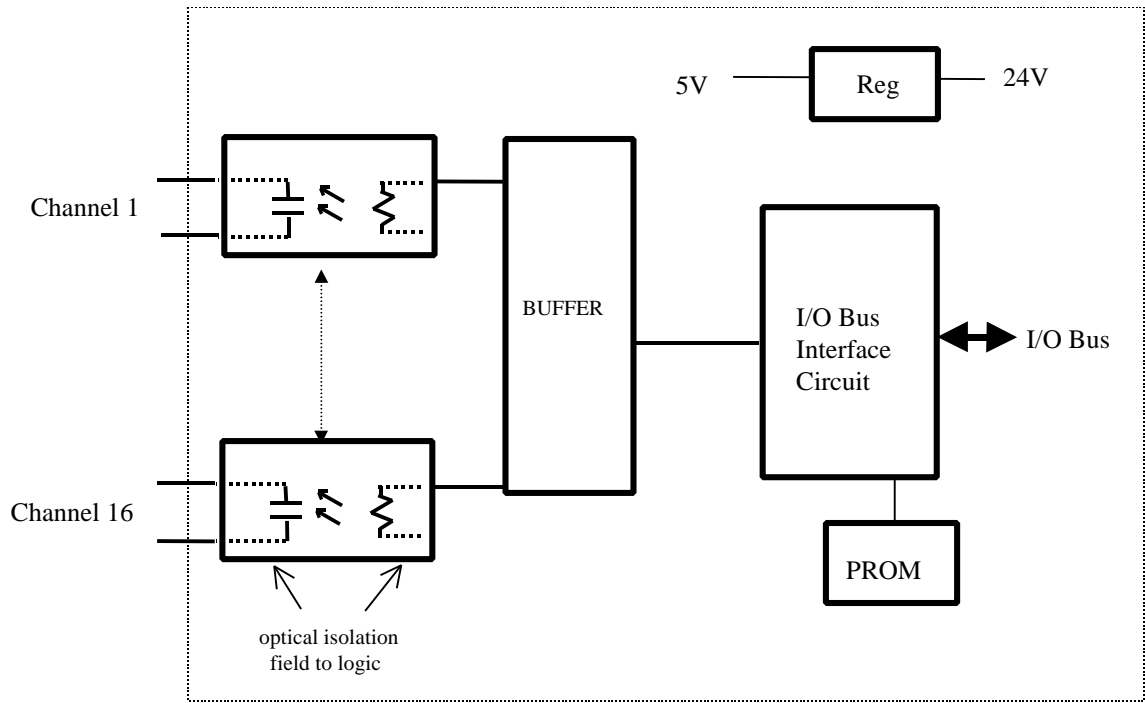
The following is a simplified sketch of the circuit for one channel. The relay drivers energize the relay coils and control the operation of the output LEDs to correspond to the data in the I/O bus interface circuit. A watchdog timer in the interface circuit controls the operation of the active LED, causing it to blink when the module is not scanned for 0.7 seconds. It also controls the state of the outputs on loss of communications.

Digital Output Modules
Form A/B of Relay Module IOP351
Form C Relay Module IOP350

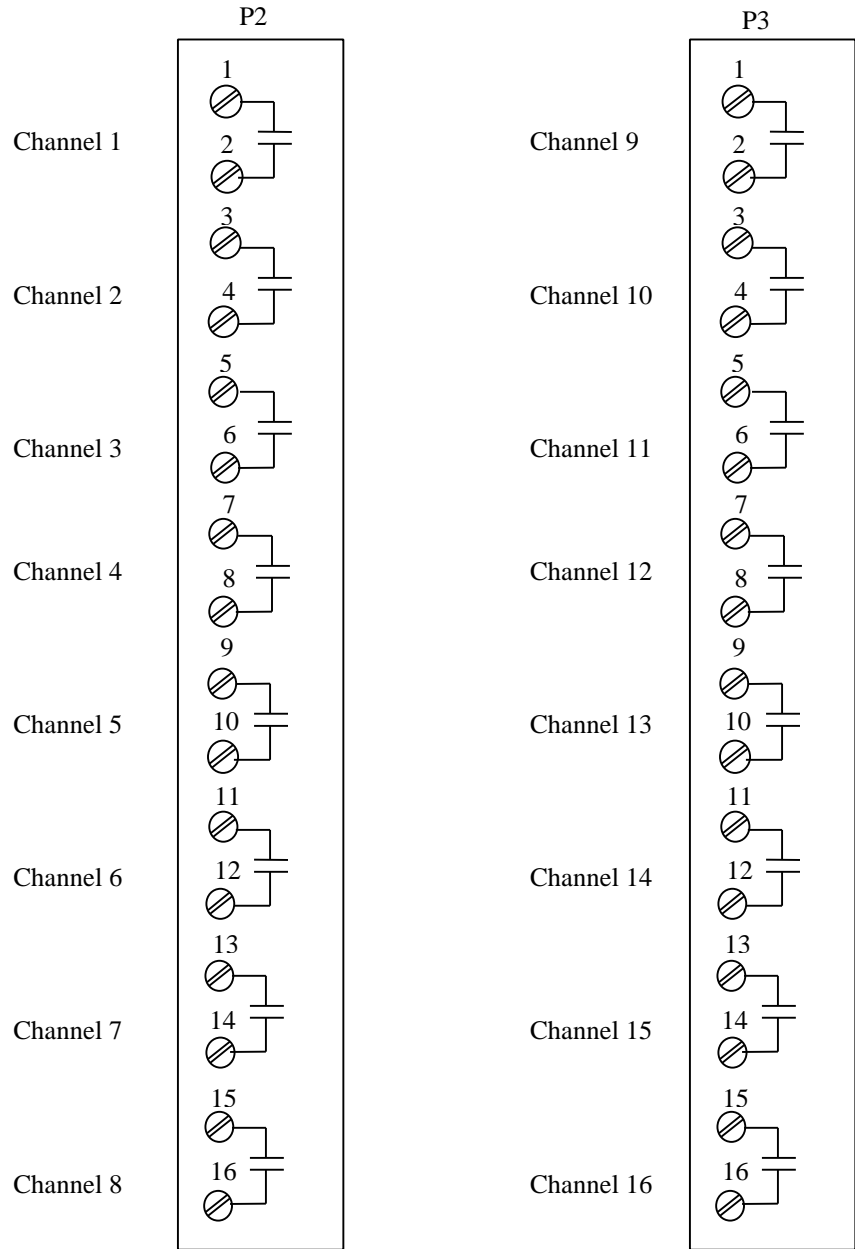


Module Specifications

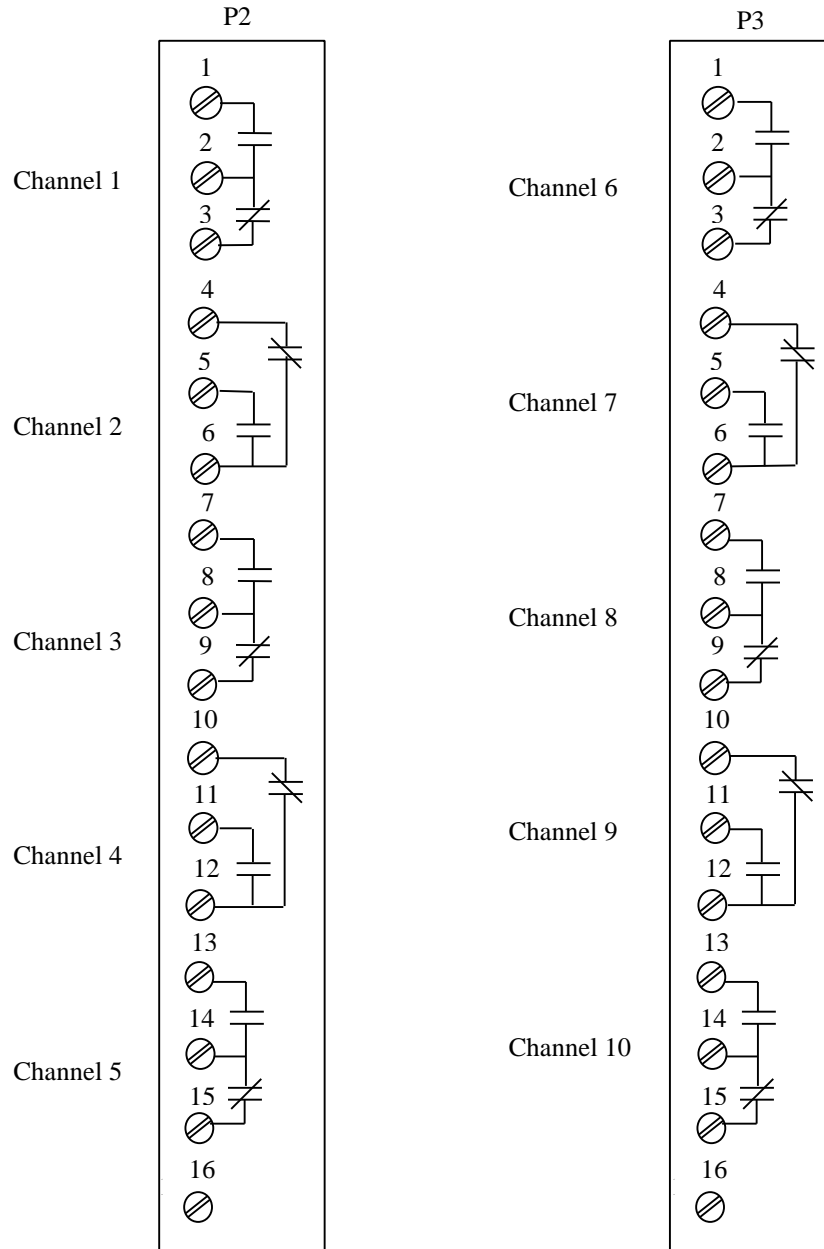
	IOP 350 – Form C	IOP351 – Form A/B
Maximum Switching Capacity	5 amps @ 250 VAC 3 amps @ 30 VDC 0.3 amps @ 110 VDC	
Number of Channels	10	16
Expected Relay Life	Mechanical @ 180cpm - 5×10^6 Electrical @ 20cpm (resistive load) – 10^5	
Maximum Operating Speed	20cpm	
Operating Time	15 msec. Maximum (excluding bounce)	
Release Time	5 msec. Maximum (excluding bounce)	
LED Indication	1 LED per point provides output status indication active LED provides power and communication indication	
I/O Bus Address	One address	
Input Power (from 24V system supply)	400 mA	



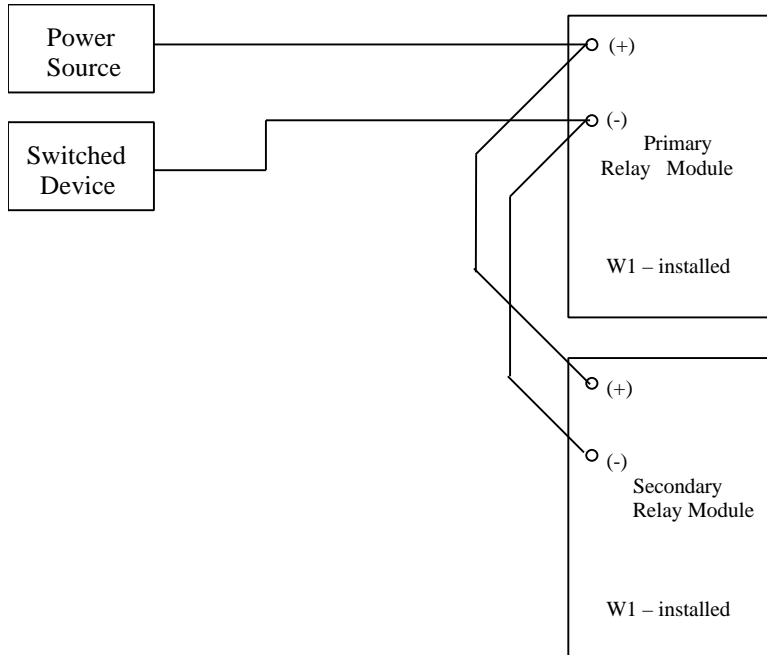
Field Wiring – IOP 351



Wiring – IOP350



Field Wiring For Redundant Modules with Common End Element



Chapter 11

Bus Extender Unit Module IOP371

Overview

The Bus Extender Unit (BEM) provides a flexible way to distribute the system throughout the plant, resulting in reduced cabling costs and installation time. Placing I/O in remote cabinets closer to a given process typically reduces tray loading and the number of required junction boxes since remote I/O cabinets are substituted. It also shortens wiring distances to field devices, such as thermocouples and RTDs.



Features

- Geographic distribution of I/O
- Distance up to 2000 meters
- Real time I/O bus expansion
- Redundant high speed optical links
- Digital output indication of optical link failover

BEM Front Panel

The BEM front panel contains a pair of optical connectors (optical transceivers), LEDs to report the status of the two optical links, a push button for link testing, and an output contact, used to detect and report the failure of either optical cable when redundant cables are provided (optional).

LED Indication

Individual green front-panel LEDs provide status indication for each channel. The lower LED, labeled Active at the bottom of the module front panel, is on when the BEM and its associated DPU are active. The LEDs labeled “link1” and “link2” indicate which optical link is operational.

Link Test

A link test pushbutton is provided to switch operation between the two optical links. This can be used to verify that the two links are operational.

Bus Address

This module does not require a bus address.

Jumper Configuration

The module contains two jumpers located in the bottom right corner of the board. Refer to the following table for jumper setting information.

Jumper	Installed	Not Installed
W1	Remote	Local
W3	Redundant	Common

Bus Extender Modules, configured in pairs, support both locally and remotely mounted I/O cards. The local BEM installed with the DPU, plugs into the I/O backplane to access the DPU's parallel I/O bus. Locally mounted I/O can share the I/O bus with the BEM. The remote BEM receives the bus data over the optical link and establishes the I/O bus at the remote location.

A single DPU, or redundant pair of DPUs, can communicate with I/O modules that are locally and/or remotely mounted. In a typical configuration

using redundant Distributed Processing Units (DPUs), an I/O cabinet installed locally in a control room contains I/O modules, a DPU pair, and a BEM pair. This is connected via I/O optical cables to a ruggedized remote cabinet containing I/O modules, and a second BEM pair. The optical link is established between the local and remote Extender modules as shown in figure 10-1.

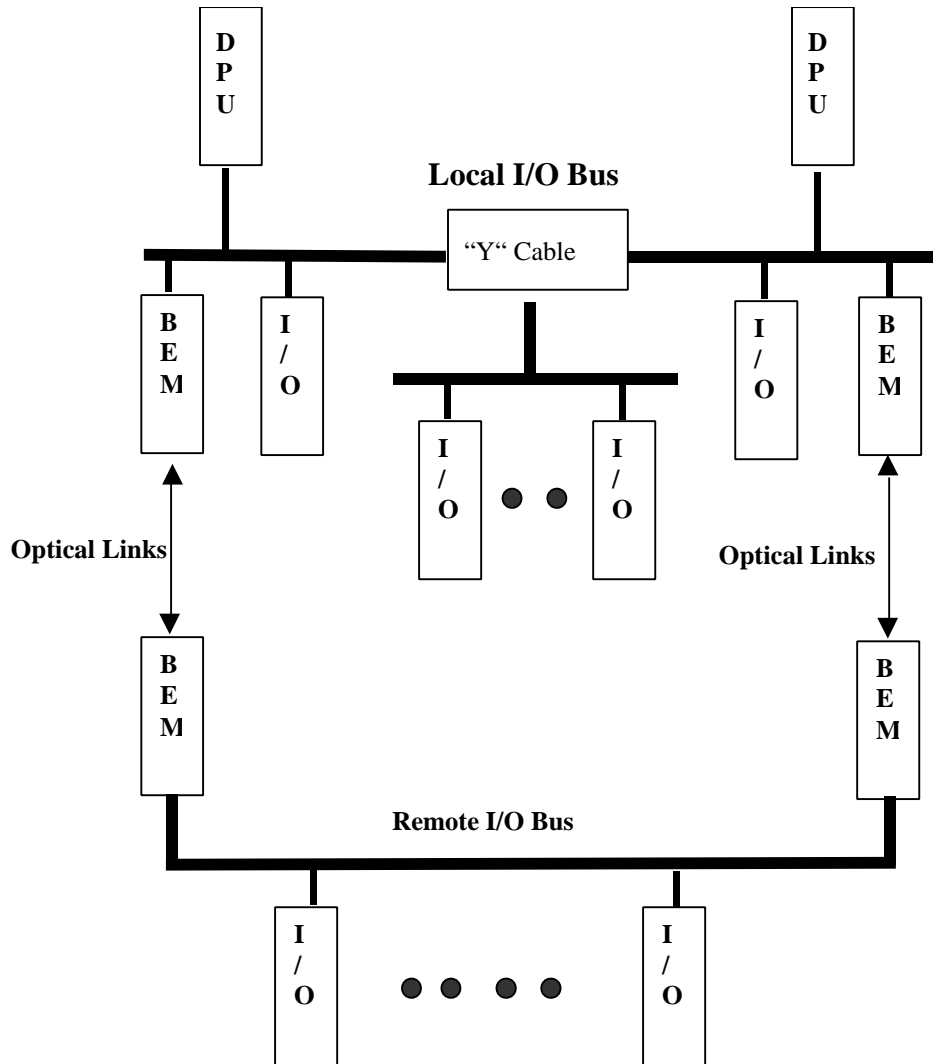


Figure 10-1. Optical Link between Local and Remote Extender Modules

Multiple BEMs can be connected to the I/O bus to allow multiple remote locations for I/O. When multiple BEM modules are connected to different parts of the system, all BEMs connected to a DPU must share the same I/O bus as the DPU, as shown in figure 10-2. See also, "Redundant Configuration Approaches."

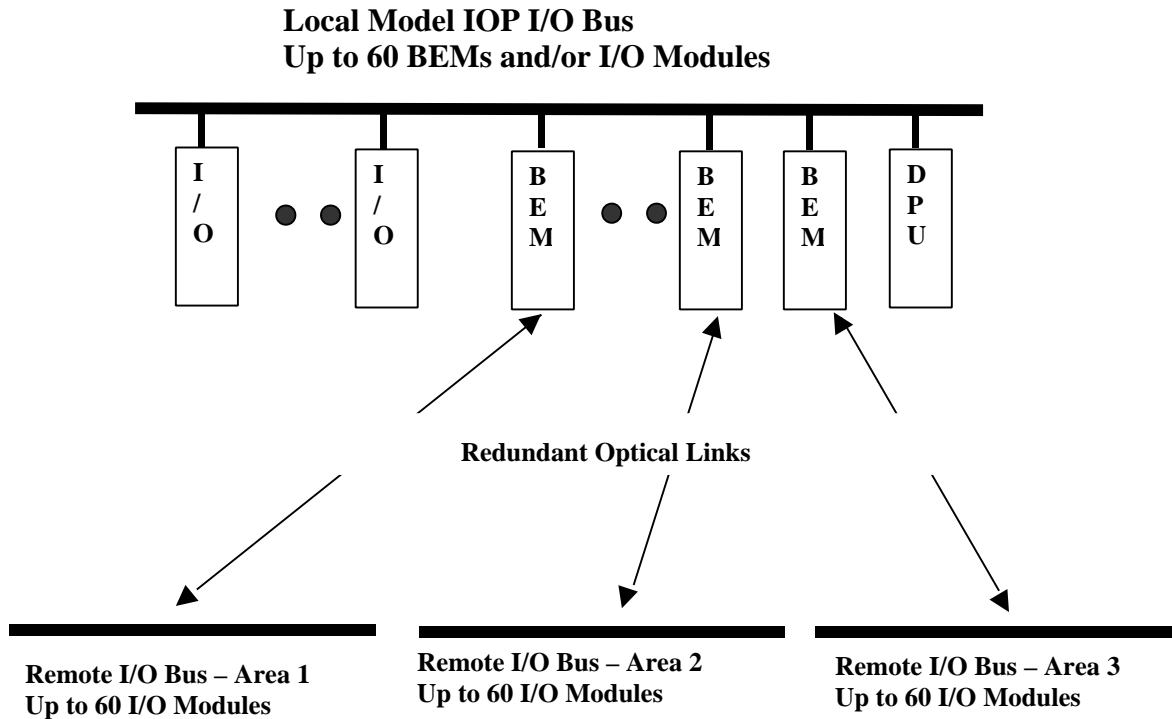


Figure 10-2. The DPU Supports up to 60 Modules per Location, the locally, remotely, or both.

In addition to the configuration described in Figure 10-1, BEMs may be non-redundant, and configured with redundant or non-redundant DPUs. All options are possible. See "Redundant Configuration Approaches."

DPU Compatibility

The Extender is compatible with 4A, 4B and 4E DPUs, but is not compatible with the earlier DPU3, DPU4 or controller file models. To use a bus Extender with DPU 4A and 4B, firmware EPLD may need to be updated. Contact Metso Automation MAX Controls Customer Care for assistance.

I/O Bus Loading

BEMs may also be used to expand the number of I/O modules that may be configured locally. The local BEM represents the same bus loading as one I/O module, regardless of the number of I/O modules attached to the remote I/O bus. Without the use of BEMs, a single DPU supports up to 60 modules. When BEMs are used, a DPU could support up to 60 modules per location (locally, remotely, or both), and up to 255 addresses total for the DPU.

Important: Remember other factors continue to limit the number of modules you may configure, such as I/O mix, DPU loading, application requirements, etc. Such sizing factors need to be considered when planning I/O configurations. See also "BEM Configuration Considerations."

BEM Operation

Each Extender module is packaged in a Model IOP I/O style printed circuit board. Each board contains a chipset that includes a transmitter, receiver and an optical transceiver. The transmitter converts the parallel data into serial data, appends encoded error checking bits and sends the data serially over a very fast fiber optic link (160 MBaud). The receiver decodes the serial data, does error checking and converts the data back to the original parallel form.

The Extender also includes the buffers/darlington's associated with the Model IOP bus, bosfet switches to disconnect the backup DPU Extender from the bus, and a CPLD to provide some small additional logic required to support the operation of the chip set. The MACK condition (multiple modules on the bus) is detected by the remote Extender transmitted over the link and simulated locally for interpretation by the DPU.

Figure 10-3 shows a functional block diagram of the Bus Extender Module. Operation is as follows:

I/O Bus Interface – Buffers to duplicate both the DPU and I/O module bus interface. The ACK signal from the module is detected at the remote end transmitted by the link and simulated at the DPU end.

CPLD –provides all the logic resources required by the link. This includes latching and synchronizing the bus data to the frame clock, error detection and link failover.

Transmitter (Serializer) – Converts a snapshot of the parallel bus data into 160Mb TTL level serial stream.

Receiver (Serializer) – Converts the received TTL level serial stream into parallel data.

Frame Clock – 8 MHz clock initiates the serial conversion of the I/O bus data. Thus a snapshot of the Model IOP bus is sent every 125 nsecs. This corresponds to a serial speed of 160Mb of the optical transceivers.

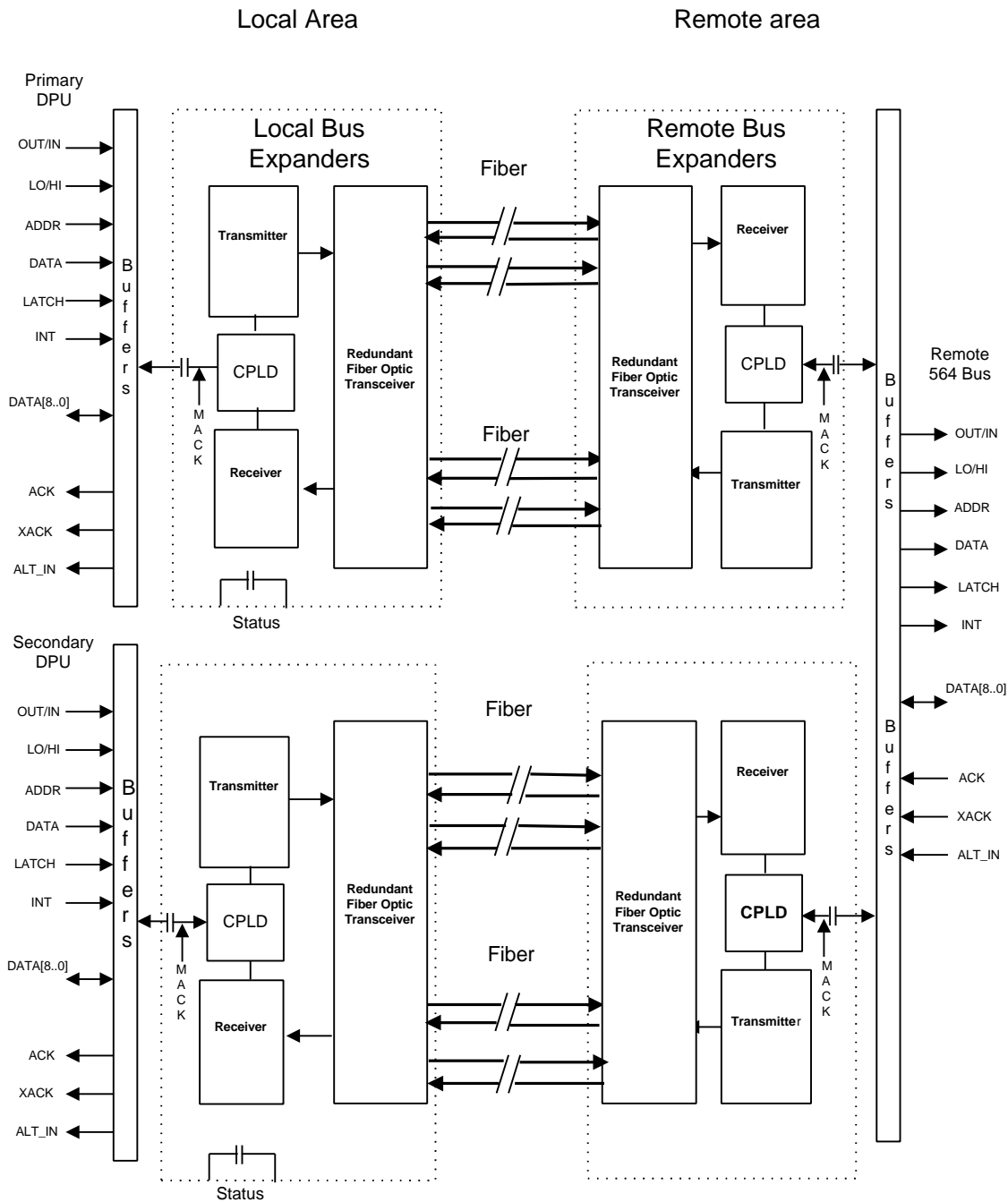


Figure 10-3. BEM Functional Block Diagram

Optical Transceivers – Convert the TTL level transmit serial data into an optical signal and the received optical signal into a TTL level serial data. A second transceiver supports redundant links for single DPU applications. The transmitter/receiver chip pair detects the operational state of the active link.

On power-up transceiver 1 is selected. If a failure is detected, the circuit will switch the link to transceiver 2, a digital output will be set and an LED will identify which link is operational. If the link cannot be established using transceiver 2 the circuit will go back to transceiver 1 and the sequence will repeat indefinitely until the link is established.

Power on reset – The power on reset circuit includes a watchdog timer to monitor the operation of the CPLD.

Optical Cabling

The two front-accessible optical transceivers, designated Link 1 (top link) and Link 2 (bottom link), each have two ST type connectors, one to transmit (Tx) and the other to receive (Rx). The fiber optic cable connects the transmit output of one BEM to the receive input of the other BEM.

Multimode 62.5-micron cable is used to connect the local and remote Extender modules. Cable is run between the redundant optical transceivers to support redundant optical cable pairs. If redundant cables are provided, one cable pair is always active while the second pair serves as a hot standby link. See "Ensuring Link Availability."

Model 564 and maxPAC I/O Compatibility

Because the Extender module has the same form factor as the Model IOP I/O modules, it can be used in either Model 564 or maxPAC applications. The module installs in an IOP015 4-pack I/O Chassis or any of the maxPAC chassis described in chapter 1.

Termination Requirements

In an I/O configuration using BEMs, an additional terminator is required at the remote BEM I/O bus location. This is in addition to the terminator assembly usually installed at the end of the I/O bus. For model 564 I/O installations, use CP0102 terminator assembly. For maxPAC applications, use CP0402 terminator assembly.

Redundant Configuration Approaches

In a redundant configuration, I/O may be configured only at the remote end or both locally and remotely. A redundant configuration consists of a primary and secondary DPU, each with its own associated BEM.

Four Configuration Approaches

Redundant DPUs and redundant BEMs may be employed in any of the following configuration schemes:

1. Remote I/O only (redundant, common or mixed).
2. Remote I/O and local redundant I/O.
3. Remote I/O and local common I/O.
4. Remote I/O and mixed local I/O consisting of common and redundant configurations.

Configuring Remote I/O only

In a redundant configuration using only remote I/O (configuration scheme No. 1), the local DPUs and associated BEMs are placed in one rack. The IOP381 4-wide rack is used for this application. The DPU4E chassis are mounted at either end of the rack. The BEMs are installed next to each DPU using the IOP015 Chassis. Resistor R1 located in the center of the backplane must be removed to isolate the “active” DPU control line.

Configuring Local Common I/O

In a redundant DPU configuration using local common I/O (configuration scheme No. 3), the I/O bus “active” control signal from each DPU must be connected to its associated BEM only. A special cable (Part No. 047374) must be used to connect the local I/O bus between the racks housing each DPU. When this cable is used, jumpers in the following module types must be set up for common I/O as follows:

- Analog Output – W4 installed
- Thermocouple – W2 installed
- RTD – W2 installed

Configuring Mixed Common and Redundant I/O

Configurations with mixed redundant and common I/O can be used at either the local or remote end. The I/O bus from each DPU at the local end or each BEM at the remote end is connected separately to the redundant modules. A mixed backup adapter, (Part No. 080441) is used to combine the redundant I/O buses into a common I/O bus. See Figure 10-4.

At the remote location, the I/O bus connections to the BEMs end must be isolated only for redundant I/O applications. For common I/O applications the two remote BEM modules, connected to primary and secondary DPUs, are connected to the same Parallel I/O backplane or daisy chained Parallel I/O backplanes.

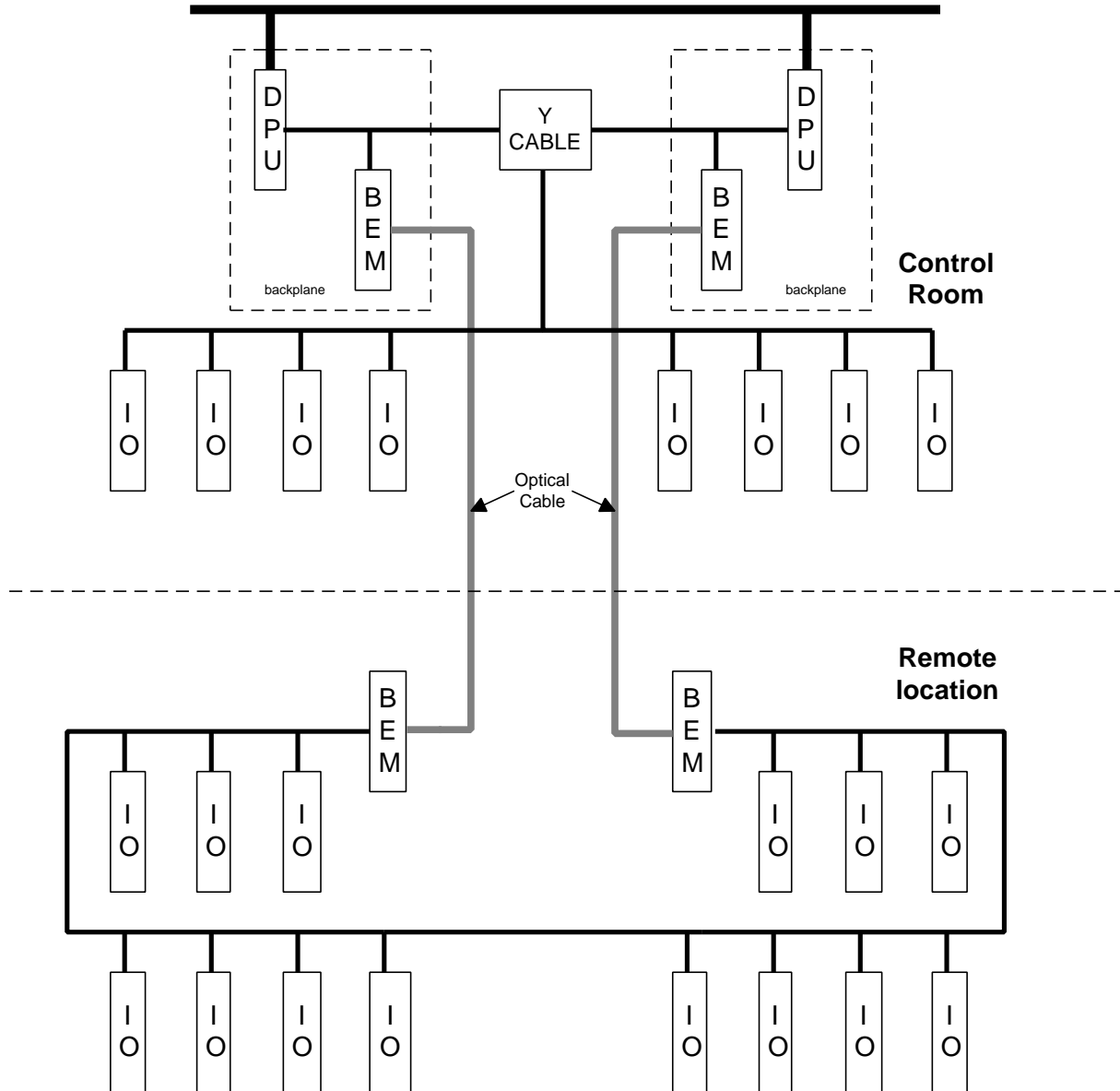


Figure 10-4. Redundant DPUs with local common and remote common I/O configuration using Y cable.

Single DPU Configurations

For configurations using a single DPU, setup schemes as described in "Four Configuration Approaches" still apply. However, the special cabling used in redundant configurations is of course not needed. This applies to Part No. 04374 and the mix cable adapter. Additionally, special jumper considerations as listed in "Configuring Local Common I/O" do not apply. See Figure 10-5.

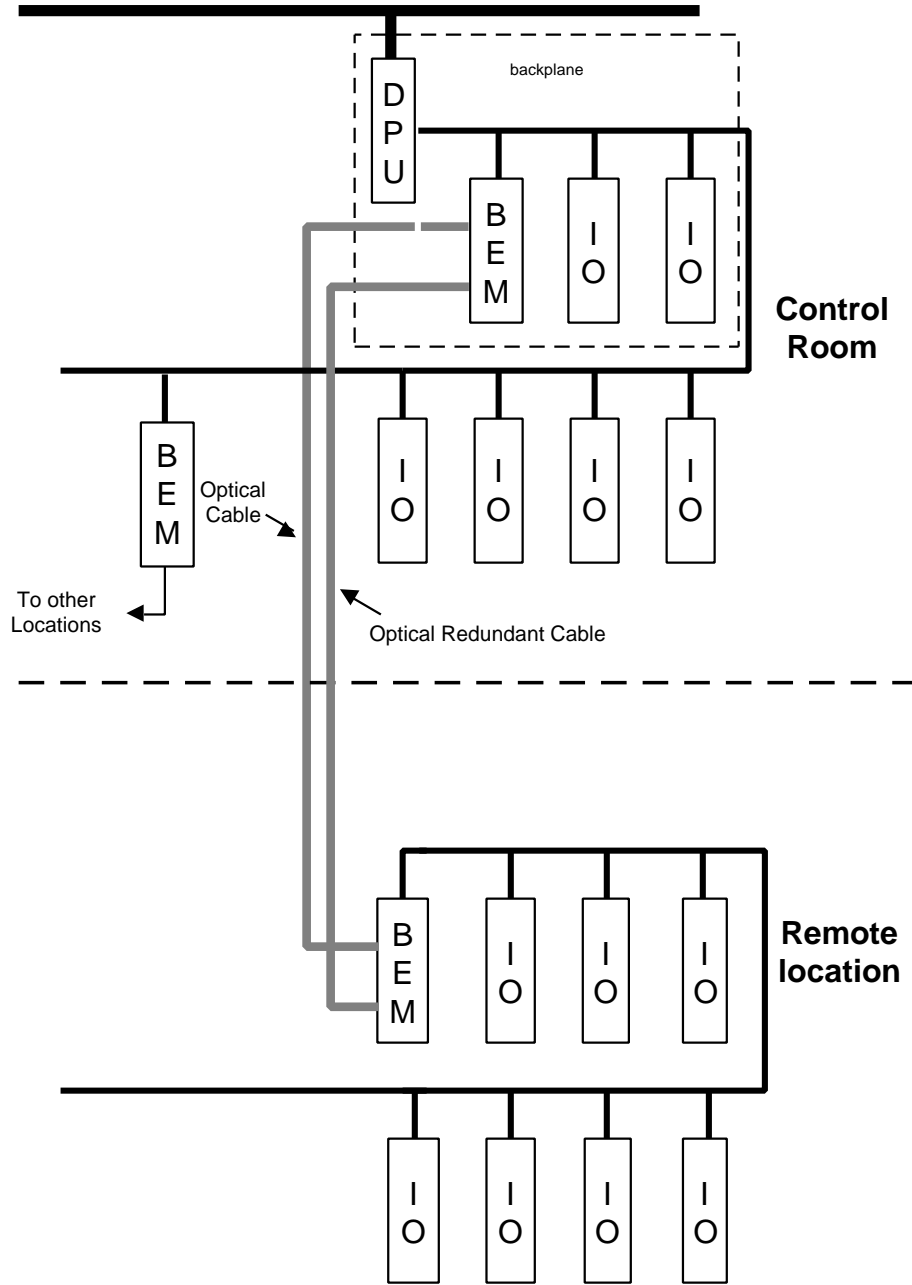


Figure 10-6. Single DPU with common and remote I/O configuration. The redundant optical cables shown in this illustration are optional but recommended.

BEM Configuration Considerations

Communication between the DPU and the remote I/O occurs in real time using the existing Model IOP protocol. The remote I/O modules communicate with the DPU, as if they were local I/O. Extenders are transparent to the bus.

Although the BEM extends the Model IOP I/O bus up to 2000 meters, a time delay factor reduces the maximum number of I/O modules that may be installed beyond 400 meters. The time delay in the Extender circuit is minimal; however there is a delay in the optical cable, introduced by the speed of light, which is proportional to distance (approximately 1×10^{-9} sec/ft).

In configurations using a cable link no more than 400 meters in length, I/O module reduction is minimal. See "Calculating Link Capacities."

Calculating Link Capacities

While as noted, a DPU supports up to 60 I/O per location, a link delay exists proportional to distance. The Extender circuits themselves introduce very little delay.

The distance factor primarily impacts Digital Input modules set for SOE operation. The following table shows the maximum number of DI modules, which can be handled at various cable distances. This is caused by the need to scan all SOE cards every 1 ms.

For example, at 2,500 feet a DPU 4E can have 14 DI modules set for SOE. No other restrictions limiting the number of cards exist. For instance, the number of thermocouple or analog cards does not decrease because of distance.

Of course, the 60 cards on an electrical DPU Bus still apply.

The microsecond numbers reflect the total amount of time, including the speed of light for the signal to be sent and to return, for each card's transactions.

Table 2. Number of Modules Supported by Distance

Meters	Feet	DPU 4A/4B maximum SOE cards	DPU4E maximum SOE cards
0	0	22	32
8	25	22	32
61	200	20	28
152	500	18	24

229	750	16	22
305	1000	14	20
457	1500	12	17
610	2000	10	15
762	2500	9	14
914	3000	8	13
1067	3500	7	12
1219	4000	6	11
1372	4500	6	10
1524	5000	5	9
1676	5500	4	9
1829	6000	4	8
2000	6500	4	8

Links can be in series or in parallel, the preferred configuration approach. In a parallel link, a star approach, each remote location's BEM is connected to a BEM located on the electrical bus with the DPU.

In a series link, the links can be configured such that one BEM and DPU connects to a remote's BEM and its rack. This rack then contains another BEM, which is then connected to a second remote's rack with its BEM. This configuration approach introduces time delays, which will limit the number of supported modules. Consult the factory if more than two links are on one DPU.

Ensuring Link Availability

To ensure link availability, installations may include multiple levels of redundancy. In configurations using only a single DPU, redundant cables ensure availability. The loss of either cable pair will automatically route the signal to the alternate cable pair. Only a momentary loss of the remote I/O, (milliseconds), will occur while the Extender switches over to the inactive cable.

To ensure optimal availability, each cable pair should be routed separately to minimize the probability of damage to both cables. With separate cables, in the event a cable should break or fail, a second cable is still available.

In configurations using redundant DPUs, each DPU can have its own bus Extender to the remote location. Any single failure of the Extender or cable will not result in loss of operation, and the replacement of the failed component can occur without loss of service.

A failure in the remote location will only affect the remote I/O modules associated with the remote Extender.

Refer to the front-panel LEDs and a digital output to identify fault conditions detected by the link, specifically loss of lock and receive error.

Detecting Failover Conditions

A Form C relay is provided to indicate a link failure. When a BEM experiences a failover between the redundant links, a momentary relay closure occurs. Attach the DI Contact on module front panel to a Digital Input Module to monitor this logic output. The module produces a logic output to indicate and report the occurrence of an optical link failover or link failure.

Use a front panel pushbutton to test the redundant links. The pushbutton initiates a failover between the two links.

Cabling Recommendations

To augment cable reliability, Metso Automation MAX Controls recommends the following cabling practices:

For configurations using either single or redundant pairs of BEMs, use two separate, four-fiber optical cables (Part No. CON064-LLLL). Attach one cable to Link 1 and the other cable to Link 2. As noted, route cables separately to minimize the possibility of damage to both cables.

For each link connect two of the four available connector ends to the optical transceiver connectors. The two extra, unused fibers in each cable serve as spares in the event that the active fibers are cut or damaged.

Specifications

Model:

IOP371 Bus Extender Module (Part No. 181500)

Distance:

Up to 2000 meters

Speed:

Maintain Model IOP I/O bus communications

I/O addresses:

Up to 255 unique I/O addresses per DPU

Link bus loading:

One of up to 60 I/O nodes

Approval Bodies and Standards

The product meets SAMA PMC33.1 EMI/RFI specs at three different frequencies, and is designed to meet IEC 801-2 static specification (8,000 Volts).

Power Requirements

24 Volts @0.5 amps

Environment

The module operates in the temperature range of 0°C to 60°C at a relative humidity range of 0 to 90%, noncondensing.

Optical cable

62.5/125 µm multimode fiber optic cable

CON062-LLLL Two- fiber optical cable

CON064-LLLL Four-fiber optical cable

Operating wavelength l

1300 nm.