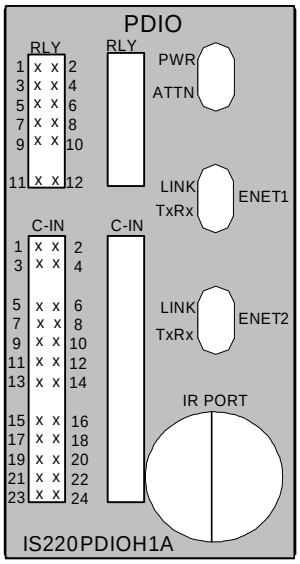
PDIO Discrete Input/Output Module

Discrete Input/Output (PDIO)

Functional Description

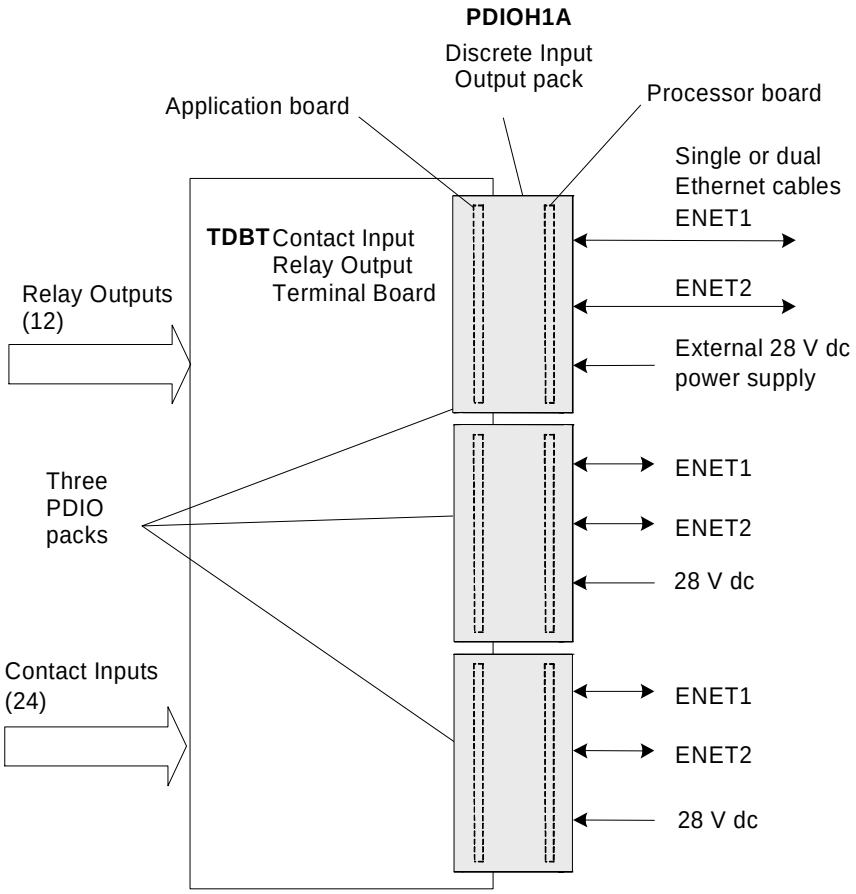


The Discrete Input/Output (PDIO) pack provides the electrical interface between one or two I/O Ethernet networks and a discrete input/output terminal board. The pack contains a processor board common to all Mark* VIe distributed I/O packs and an acquisition board specific to the discrete input/output function. The pack accepts up to 24 contact inputs, controls up to 12 relay outputs, and receives terminal board specific feedback signals. The associated terminal board determines voltage capability of PDIO. System input to the pack is through dual RJ45 Ethernet connectors and a three-pin power input. Discrete signal input/output is through a DC-62 connector that connects directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.

Note The infrared port is not used.

PDIO is the functional equivalent of a PDIA and PDOA I/O pack combined into a single assembly. For simplex applications, it goes on a TDBS terminal board that is the equivalent of a SRLY relay terminal board combined with a STCI contact input terminal board. For TMR applications, it goes on a TDBT terminal board that, with the WROB option, provides the equivalent of a terminal board combined with a TBCI contact input terminal board.

The following illustration shows the connections when three PDIO packs are mounted on a TDBT terminal board.



Compatibility

PDIOH1A is compatible with two types of discrete contact input/output terminal boards: TDBS for single PDIO applications and TDBT for TMR PDIO applications. The relay output portion of the terminal board accepts option cards as described later in this document. The following table gives details of the compatibility:

Terminal Board	Control Mode	DI Voltage	DO Option Cards
TDBSH2	Simplex	24 V dc	WROB, WROF, WROG
TDBSH4	Simplex	48 V dc	WROB, WROF, WROG
TDBSH6	Simplex	125 V dc	WROB, WROF, WROG
TDBTH2	TMR	24 V dc	WROB
TDBTH4	TMR	48 V dc	WROB
TDBTH6	TMR	125 V dc	WROB

Control mode refers to the number of I/O packs used in a signal path:

- Simplex uses one I/O pack with one or two network connections.
- TMR uses three I/O packs with one network connection on each.

Installation

➢ To install the PDIO pack

1. Securely mount the desired terminal board.
2. Directly plug the PDIO I/O pack into the terminal board connectors.
3. Mechanically secure the packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-62 pin connector between the pack and the terminal board. The adjustment should only be required once in the life of the product.

Note The PDIO mounts directly on a Mark VIe terminal board. Simplex terminal boards have a single DC-62 pin connector that receives the PDIO. TMR-capable terminal boards have three DC-62 pin connectors, one used for simplex operation, two for dual operation, and three for TMR operation. PDIO directly supports all of these connections.

4. Plug in one or two Ethernet cables depending on the system configuration. The pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. Apply power to the pack by plugging in the connector on the side of the pack. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.
6. Use the ToolboxST* application to configure the I/O pack as necessary. See also the *Auto-Reconfiguration* section.

Attention

If the configuration being downloaded contains I/O packs with different module IDs than the configuration currently running, the download may install incorrect firmware to some I/O packs. If this occurs, make sure the controller is running the new configuration, restart the entire system, and then start the ToolboxST Download Wizard again.

Operation

Processor

The processor board is common to all Mark VIe Ethernet I/O packs or modules. It contains the following:

- High-speed processor with RAM and flash memory
- Two fully independent 10/100 Ethernet ports with connectors
- Hardware watchdog timer and reset circuit
- Internal temperature sensor
- Status-indication LEDs
- Electronic ID and the ability to read IDs on other boards
- Input power connector with soft start/current limiter
- Local power supplies, including sequencing and monitoring

The processor board connects to an acquisition board specific to the I/O pack or module function. Upon application of input power, the soft-start circuit ramps up the voltage available on the processor board. The local power supplies are sequenced on, and the processor reset is removed. The processor completes self-test routines and then loads application code specific to the I/O pack or module type from flash memory. The application code reads board ID information to ensure the correct matching of application code, acquisition board, and terminal board. With a good match, the processor attempts to establish Ethernet communications, starting with request of a network address. The address request uses the industry standard dynamic host configuration protocol (DHCP) and the unique identification read from the terminal board. After Ethernet initialization, the processor programs the on-board logic, runs the application, and enables the acquisition board to begin operation.

The processor application code contains all the logic necessary to allow the I/O pack to operate from one or two Ethernet inputs. When operated from two Ethernet inputs, both network paths are active all the time. A failure of either network will not result in any disturbance to the I/O pack or module operation, and the failure will be indicated through the working network connection. This arrangement is more tolerant of faults than a classic hot-backup system where the second port is only used after a primary port failure is detected. The Ethernet ports on the processor auto-negotiate between 10 MB/s and 100 MB/s speed, and between half-duplex and full-duplex operation.

Auto-Reconfiguration

The Auto-Reconfiguration feature first became available with the ControlST V03.05 software release.*

The Auto-Reconfiguration feature allows I/O packs to be replaced without the operator having to manually reconfigure each pack or module. If the Auto-Reconfiguration feature is enabled, when the controller detects an I/O pack booting with a different configuration, a reconfiguration file is automatically downloaded from the controller to the I/O pack. This reconfiguration includes the bootload, baseload, firmware, and parameters. Each I/O pack is updated with the current configuration that matches the configuration used by the controller, unless it already contains the latest version.

Refer to GEI-100694, ControlST Upgrade Instructions for more information.

While an Auto-Reconfiguration is in progress, the controller will not allow a reboot until after the Auto-Reconfiguration has finished. Other downloads to the I/O pack cannot be initiated while it is being Auto-Reconfigured. If an I/O pack is already running, Auto-Reconfiguration only performs diagnostics.

Auto-Reconfiguration is enabled or disabled in the ToolboxST application through the Component Editor. This allows the operator to manually reconfigure each pack or module if necessary. The Auto-reconfiguration of terminal boards and controllers is not supported. If a terminal board is replaced, the I/O pack must be manually reconfigured.

Refer to GEH-6700, ToolboxST for Mark* VIe Control for more information.*

Install or replace the I/O pack in accordance with the procedure in the *Installation* section. When power is applied, the I/O pack boots up and the Auto-Reconfiguration process starts. It generates a signal to the controller to indicate it needs an IP address and configuration. The controller queries the I/O pack to identify existing files to determine if a reconfiguration is needed. The controller then starts to download the IP address and reconfiguration files. The controller signals the I/O pack when the download is complete. The I/O pack reboots, performs a self-diagnostic test, and goes online.

Note When replacing an I/O pack with a new one that has a similar file structure (a current revision with another current revision) the Auto-Reconfiguration process takes a relatively short amount of time. When the file structure of the replacement I/O pack varies from the one being replaced (a current revision with an older revision), the Auto-Reconfiguration process takes a longer time to complete.

Status LEDs

Processor LEDs

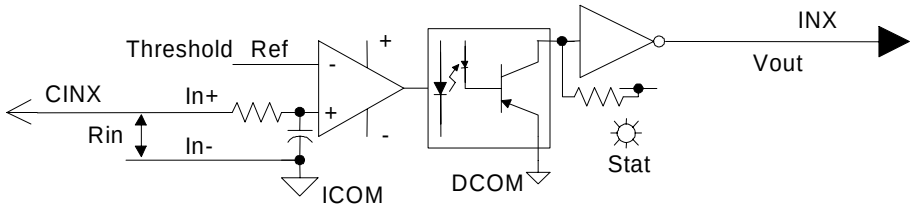
Color	Label	Description
Green	PWR	Shows the presence of control power
Green	LINK	Provided for each Ethernet port to indicate if a valid Ethernet connection is present
Yellow	TxRx	Provided for each Ethernet port to indicate when the pack or module is transmitting or receiving data over the port
Red / Green	ATTN	Shows I/O pack or module status

LED Status

LED	Flashing Pattern	Description	Software Version
Red ATTN	LED out	There are no detectable problems with the I/O pack or module.	All
	LED solid on	A critical fault is present that prevents the I/O pack or module from operating. There could be hardware failures on the processor or acquisition boards, or there is not any application code loaded.	3.04 or earlier
	4 Hz 50%	An alarm condition is present in the pack or module. These alarms include wrong processor / terminal board combination, terminal board is missing, or errors in loading the application code.	
	1.5 Hz 50%	The I/O pack or module is not online.	
	0.5 Hz 50%	This is used during factory testing to draw attention to the pack or module.	
Red ATTN	Solid	Booting - prior to reading Dallas ID	3.05 or later
	4 Hz 50%	Diagnostic present	
	2 Hz 50%	Awaiting an IP address	
	1 Hz 50%	No Firmware to load (Program mode)	
	0.5 Hz 50%	Application not loaded	
Green ATTN	Solid	BIOS (at power on), but if it remains in this state, the I/O pack or module Is not functioning properly and should be replaced.	
	2 Hz 50%	Awaiting Auto-Reconfiguration release	
	1 Hz 50%	In WAIT or STANDBY mode	
	Two 4 Hz flashes every 4 sec	Application online	

Contact Input Signals

The discrete input/output acquisition board provides the second stage of signal conditioning and level shifting to interface the terminal board inputs to the control logic. Initial signal conditioning is provided on the terminal board. The discrete input acquisition input circuit is a comparator with a variable threshold. Each input is isolated from the control logic through an opto-coupler and an isolated power supply. The inputs are not isolated from each other. Each of the twenty-four inputs has filtering, hysteresis, and a yellow status LED, that indicates when an input is picked up. The LED will be OFF when the input is dropped-out. The LEDs are grouped at the bottom left of the PDIO pack.

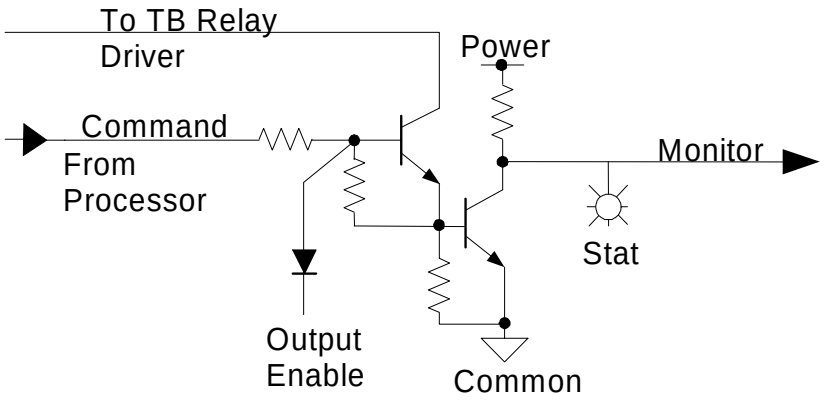


Variable Input Threshold

The input threshold is derived from the contact wetting voltage input terminal. In most applications this voltage is scaled to provide a 50% input threshold. This threshold is clamped to 13% to prevent an indeterminate state if the contact wetting voltage drops to zero. If the contact wetting voltage drops below 40% of the nominal voltage, the under-voltage detector annunciates this condition to the control. A special test mode is provided to force the inputs from the control pack. Every four seconds, the threshold is pulsed high and then low and the response of the opto-couplers is checked. Non-responding inputs are alarmed.

Relay Command Signals

The PDIO relay command signals are the first stage of signal conditioning and level shifting to interface the terminal board outputs to the control logic. Each output is an open collector transistor circuit with a current monitor to sense when the output is picked up and connected to a load. The status LEDs and monitor outputs indicate when an output is picked up and connected to the terminal board. If an output is commanded to be picked up and the correct load is not sensed, the status LED will be off and the monitor line will be false. The LEDs are grouped at the top left of the PDIO pack.



Relay Command Signals

Output Enable

All of the outputs are disabled during power application until a variety of internal self-tests are completed. An enable line reflects the status of all required conditions for operation. This function provides a path independent of the command to ensure relays stay dropped-out during power-up and initialization.

Monitor Inputs/Control

There are 15 inverting level shifting monitor input circuits. On a typical terminal board 12 of these circuits are used as relay contact feedbacks and the other three are used for fuse status. An inverting level shifting line is also provided from the control to the terminal board for status feedback multiplexing control allowing the pack to receive two sets of 15 signals from a terminal board.

Sequence Of Events

All of the inputs and outputs may be individually configured to generate SOE records when the signal changes. Input hardware is scanned at a 1000 Hz rate for SOE time stamping while output commands are captured when a change of command is received through Ethernet from the controller.

ID Line

The processor board and acquisition board within the I/O pack contain electronic ID parts that are read during power initialization. A similar part located with each terminal board DC-62 pin connector allows the processor to confirm correct matching of I/O pack to terminal board and report board revision status to the system level control.

Power Management

The I/O pack includes power management in the 28 V input circuit. The management function provides soft start to control current inrush during power application. After applying power, the circuit provides a fast current limit function to prevent a pack or terminal board failure from propagating back onto the 28 V power system. When power is present and working properly, the green PWR LED indicator will be lit. After the current limit function operates, PWR LED will remain unlit until the problem is resolved.

Connectors

The pack contains the following connectors:

- A DC-62 pin connector on the underside of the PDIO pack connects directly to the discrete input terminal board. The connector contains the 24 input signals, ID signal, relay coil power, and feedback multiplex command.
- An RJ45 Ethernet connector named ENET1 on the side of the pack is the primary system interface.
- A second RJ45 Ethernet connector named ENET2 on the side of the pack is the redundant or secondary system interface.
- A 3-pin power connector on the side of the pack is for 28 V dc power for the pack and terminal board.

Specifications

Item	Specification
Number of input channels	24 DI and 12 form C contact DO
Input isolation in pack	Optical isolation to 1500 V on all inputs (group isolation)
Input Filter	Hardware filter, 4 ms
Ac voltage rejection	60 V rms at 50/60 Hz at 125 V dc wetting voltage
Number of relay command channels	12 relays
Relay and coil monitoring	15 pack inputs. The selection of monitor feedbacks depends on the type of terminal board used, based on ID chip
I/O pack response time	From Ethernet command to output is typically 4 ms.
SOE reporting	Each relay may be configured to report operation in the sequence of events (SOE) record.
Frame rate	System dependent scan rate for control purposes 1,000 Hz scan rate for sequence of events monitoring
Fault detection	Loss of contact input wetting voltage Non-responding contact input in test mode Incorrect terminal board Relay position feedback using contact pair separate from load contacts

Diagnostics

The pack performs the following self-diagnostic tests:

- A powerup self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware.
- Continuous monitoring of the internal power supplies for correct operation.
- A powerup check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set.
- Monitoring for loss of contact input wetting voltage on the terminal board takes place at the selected system frame rate.
- Detecting a non-responding contact input during diagnostic test. In this test, the threshold is pulsed high and low and the response of the opto-couplers is checked. The test typically runs once every four seconds, and can be observed as a very brief period when all twenty-four contact input lights turn on.
- A frame rate comparison is made between the commanded state of each relay drive and the feedback from the command output circuit.
- Relay board specific feedback is read by the pack and processed every frame. The information varies depending on the relay board type. Refer to relay terminal board documentation for feedback specifics.

Configuration

Note The following information is extracted from the ToolboxST application and represents a sample of the configuration information for this board. Refer to the actual configuration file within the ToolboxST application for specific information.

Parameter	Description	Choices
PDIO_Mod_Configuration		
Redundancy	Redundancy mode of the pack	Simplex, TMR
PDIO_Input	Terminal board connected to PDIO	Connected, not connected
Relay Feedback	Selection will enable Relay feedback inputs	Used, Unused
Contact Input	Selection will enable Contact Input feedbacks	Used, Unused
Signal Invert	Inversion makes signal true if contact is open	Normal, Invert
Sequence of Events	Record contact transitions in sequence of events	Enable, disable
Diag Vote Enable	Enable voting disagreement diagnostic	Enable, disable
Signal Filter	Contact input digital filter in msec (in addition to 4 ms hardware filter)	0, 10, 20, 50, 100
PDIO_Output		
Relay Output	Selection will enable use of the relay	Used, Unused
Signal Invert	Invertion makes relay closed if signal is false	Normal, Invert
SeqOfEvents	Record relay command transitions in sequence of events	Enable, Disable
FuseDiag	Enable fuse diagnostic - Will appear as configuration item for use with Fuse daughterboard	Enable, Disable
Output_State	Select the state of the Relay condition based on IOPack going offline with controller	PwrDownMode, HoldLastValue, Output_Value