



Instruction
Harmony Series

Distributed I/O System Harmony DCU



Preface



This instruction describes the operation, installation, and configuration of the distributed I/O (DIO) system that interfaces to a Harmony Distributed Control Unit. It is intended for use with the SR4.0 release of Symphony software.



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Safety Summary



Electrostatic Sensitive Device

Devices labeled with this symbol require special handling precautions as described in the installation section.

GENERAL WARNINGS

Equipment Environment

All components, whether in transportation, operation or storage, must be in a noncorrosive environment.

Electrical Shock Hazard During Maintenance

Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIFIC WARNINGS

The TransNet bus provides both communication capability and 24 VDC power to the DIO hardware modules. Installation of the optional attenuator requires severing the TransNet bus. Be sure that power is removed from the TransNet bus before proceeding with installation of the attenuator. (p. D-2)



Support Services

ABB will provide assistance in the operation and repair of its products. Requests for sales or application services should be made to your nearest sales or service office. ABB can also provide installation, repair and maintenance contract services.

When ordering parts, use nomenclature or part numbers and part descriptions from equipment manuals. Parts without a description must be ordered from the nearest sales or service office. Recommended spare parts lists, including prices are available through the nearest sales or service office.

ABB has modern training facilities available for training your personnel. On-site training is also available. Contact your nearest ABB sales office for specific information and scheduling.

Additional copies of this instruction, or other instructions, can be obtained from the nearest ABB sales office at a reasonable charge.

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Safety Summary



Electrostatic Sensitive Device

Devices labeled with this symbol require special handling precautions as described in the installation section.

GENERAL WARNINGS

Equipment Environment

All components, whether in transportation, operation or storage, must be in a noncorrosive environment.

Electrical Shock Hazard During Maintenance

Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIFIC WARNINGS

The TransNet bus provides both communication capability and 24 VDC power to the DIO hardware modules. Installation of the optional attenuator requires severing the TransNet bus. Be sure that power is removed from the TransNet bus before proceeding with installation of the attenuator. (p. D-2)



Support Services

ABB will provide assistance in the operation and repair of its products. Requests for sales or application services should be made to your nearest sales or service office. ABB can also provide installation, repair and maintenance contract services.

When ordering parts, use nomenclature or part numbers and part descriptions from equipment manuals. Parts without a description must be ordered from the nearest sales or service office. Recommended spare parts lists, including prices are available through the nearest sales or service office.

ABB has modern training facilities available for training your personnel. On-site training is also available. Contact your nearest ABB sales office for specific information and scheduling.

Additional copies of this instruction, or other instructions, can be obtained from the nearest ABB sales office at a reasonable charge.

Preface



This instruction describes the operation, installation, and configuration of the distributed I/O (DIO) system that interfaces to a Harmony Distributed Control Unit. It is intended for use with the SR4.0 release of Symphony software.



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Safety Summary



Electrostatic Sensitive Device

Devices labeled with this symbol require special handling precautions as described in the installation section.

GENERAL WARNINGS

Equipment Environment

All components, whether in transportation, operation or storage, must be in a noncorrosive environment.

Electrical Shock Hazard During Maintenance

Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIFIC WARNINGS

The TransNet bus provides both communication capability and 24 VDC power to the DIO hardware modules. Installation of the optional attenuator requires severing the TransNet bus. Be sure that power is removed from the TransNet bus before proceeding with installation of the attenuator. (p. D-2)



Support Services

ABB will provide assistance in the operation and repair of its products. Requests for sales or application services should be made to your nearest sales or service office. ABB can also provide installation, repair and maintenance contract services.

When ordering parts, use nomenclature or part numbers and part descriptions from equipment manuals. Parts without a description must be ordered from the nearest sales or service office. Recommended spare parts lists, including prices are available through the nearest sales or service office.

ABB has modern training facilities available for training your personnel. On-site training is also available. Contact your nearest ABB sales office for specific information and scheduling.

Additional copies of this instruction, or other instructions, can be obtained from the nearest ABB sales office at a reasonable charge.

Preface



This instruction describes the operation, installation, and configuration of the distributed I/O (DIO) system that interfaces to a Harmony Distributed Control Unit. It is intended for use with the SR4.0 release of Symphony software.



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Safety Summary



Electrostatic Sensitive Device

Devices labeled with this symbol require special handling precautions as described in the installation section.

GENERAL WARNINGS

Equipment Environment

All components, whether in transportation, operation or storage, must be in a noncorrosive environment.

Electrical Shock Hazard During Maintenance

Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIFIC WARNINGS

The TransNet bus provides both communication capability and 24 VDC power to the DIO hardware modules. Installation of the optional attenuator requires severing the TransNet bus. Be sure that power is removed from the TransNet bus before proceeding with installation of the attenuator. (p. D-2)



Support Services

ABB will provide assistance in the operation and repair of its products. Requests for sales or application services should be made to your nearest sales or service office. ABB can also provide installation, repair and maintenance contract services.

When ordering parts, use nomenclature or part numbers and part descriptions from equipment manuals. Parts without a description must be ordered from the nearest sales or service office. Recommended spare parts lists, including prices are available through the nearest sales or service office.

ABB has modern training facilities available for training your personnel. On-site training is also available. Contact your nearest ABB sales office for specific information and scheduling.

Additional copies of this instruction, or other instructions, can be obtained from the nearest ABB sales office at a reasonable charge.



Purpose

This instruction describes the operation, installation, and configuration of the Distributed I/O (DIO) System that interfaces to a Harmony Distributed Control Unit or Harmony DCU (HDCU). It is intended for use with the SR4.0 release of Symphony software and Controlware II.

Application

One reason for using distributed I/O instead of local I/O is usually financial since the additional cost of using the distributed I/O hardware is less than the cost of installing the field wiring between the Harmony DCU and the process field equipment (e.g., sensors, actuators, motors). In general, the distributed I/O system should be considered when the process field equipment is located more than 100 meters (300 feet) from the Harmony DCU. Refer to **Hardware Components** in Section 2 for a description of the various hardware components that combine to create the distributed I/O system.

Software Licensing

In order to run DIO application software, a valid CIO (Communications Input/Output) software license must be installed in the system. The purpose of the software license is to permit running the DIO data collection program. Without the license the CIO database modules and the DIO hardware modules will not communicate with each other.

To find out if a license is installed, access the DIO board configuration from the HSI interface (refer to **Remote I/O Module Configuration** in Section 4). If the license is not available in the system, the message *DIO NOT LICENSED TO RUN!* will display on the HSI screen.

NOTE: DIO configuration, downloading of the DIO software, and uploading and downloading of the DIO database can still occur without the proper software licenses.



Intended User

This instruction is intended for technical personnel responsible for installation, operation, maintenance, and repair of the distributed I/O system. System engineers and technicians with a background in process control systems should read this instruction thoroughly before installing and using the distributed I/O system.

Experience with Harmony DCU is also required including a good working knowledge of the Harmony DCU hardware, the HSI interface (i.e., Conductor Series software), and Controlware II.

Instruction Content

Introduction	Gives a brief overview of the distributed I/O system and describes the content and intended user of this instruction. It also highlights I/O system features, lists reference documents, and contains system and general block specification information.
Description and Operation	Provides a hardware and software overview for the distributed I/O system and provides general instructions on the design and startup of a system.
Installation	Provides detailed information on the layout and wiring of the DIO system hardware which is located remotely from the Harmony DCU. This includes the DIO modules, termination bases, power supplies, the TransNet bus cable and its termination. Detailed information about the DIO board and ITB/CIO board can be found in the <i>Distributed Control Unit</i> instruction.
System Configuration	Provides instructions for programming addresses in the DIO termination bases, and for configuring the individual DIO module parameters and linkage to CIO database modules in the DIO database.
Controlware CIO Database Module	Provides information for the CIO database modules and their applications.
DIO Board Utilities	Describes DIO application software loading from a human system interface, the loading and dumping of DIO databases to and from the HSI interface, and utilities which support DIO operations.

Data Dictionary Configuration	Provides instructions for configuring the DIO data dictionary.
Database Configuration	Provides instructions for configuring the DIO database directly.
Appendix A	Provides instructions for connecting the copper TransNet wire to a fiber optic cable using the CI-FIBER converter.
Appendix B	Provides information about the use of Controlware II SIM (simulation) modules to test the configuration of modules in the CIO database.
Appendix C	Provides information on updates to the DIO system to meet the Electromagnetic Compatibility (CE) and Low Voltage Directive compliance standards.
Appendix D	Provides information on an optional attenuator for noise reduction on the TransNet bus.

Reference Documents

Table 1-1 lists additional documents that relate to the DIO system and are referenced in this instruction.

Table 1-1. Reference Documents

Number	Document Title
Not assigned	Controlware II, Configuration
Not assigned	Controlware II, Module Reference
WFPEEU1210002??	Distributed Control Unit (P-HC-DCU)

Document Conventions

This document uses standard text conventions to represent keys, display items, and user data inputs:

Display item	Any item displayed on a screen appears as italic text. Example: <i>Running</i>
User data input	Bold - Identifies any part of a command line that is not optional or variable and must be entered exactly as shown. <i>Italic</i> - Identifies a variable parameter entered in a command line.



[] - Indicates an optional parameter; text within the brackets follows the previously described conventions.

Example:

CUP [port] [baud] [file_name.CSP]

SPECIAL KEYS - Identifies a specific key that is not alphabetic, numeric or punctuation. Examples:

Press **ENTER**.

Press **ESC V M**. (Press and release each key in sequence.)

Press **CTRL-ALT-SHIFT-DEL**. (Press all keys in sequence without releasing any one key until you have pressed them all.)

File names **Name** - Indicates a file or directory name. Example:

file1.exe
c:\new

Revision variable A ? indicates a value that may change depending on the version of an item. Example:

Part number: 1234567?0

Part number: 1234567??

Glossary of Terms and Abbreviations

Table 1-2 is a glossary of terms and abbreviations used in the instruction. It contains those terms and abbreviations that are unique to ABB Automation or have a definition that is different from standard industry usage.

Table 1-2. Glossary of Terms and Abbreviations

Term	Definition
Analog input board (A-input)	Process I/O board providing 24, 0 to 5 VDC AI channels.
Analog loop board (A-loop)	Process I/O board providing 8 AI, 4 AO, 16 DI, and 8 DO channels. Additionally provided are 4 AI which monitor AO current, and 8 DI which monitor DO current.
Base programmer	A device that is used to program the station address into a termination base.
Card frame	A mounting rack enclosure which houses intelligent I/O boards, DCP board, and a power supply.

Table 1-2. Glossary of Terms and Abbreviations *(continued)*

Term	Definition
CIO database module	Generic name for a Controlware II module that resides in the dual-port memory of the DIO board. CIO database modules are used to transfer data between the DIO hardware modules and the DCP board through the DIO board. The DIO software provides a default data dictionary definition which contains five standard CIO database module types. Only three module types are applicable to the distributed I/O application: AIO, AIOB, and DIOB.
CIO module	A type of Controlware II module that resides in the dual-port memory of the DCP board. One CIO module is used for each DIO board in the Harmony DCU. The CIO module has the same relationship to the DIO board as the IOB module has to the A-loop and D-loop boards. The CIO module (described in the Controlware II, Module Reference instruction) contains information about the DIO board, such as which slot in the card frame it occupies.
Communication input/output board (CIO)	An intelligent serial communications board that communicates with the DCP board through a dual-port memory interface. It supports communication activity with a variety of external serial communication devices.
Control Network (Cnet)	A dual Ethernet communication network used for internodal communication. This network is primarily used for global database transactions between nodes.
Controlware command language (CCL)	The interpretive language for sequence control and configurable modes.
Controlware II	The Harmony DCU resident software application that performs the control function.
Data dictionary	The DIO data dictionary resides in the dual-port memory of the DIO board. The data dictionary is generated by the DIO software, not by the Controlware II software running in the DCP board.
DIO module	I/O hardware module connected to a DIO board via communication lines. Examples of the hardware modules are DO0016M, AI0016, etc.
DIO software	Software that exists in the dual-port memory of the DIO board.
Discrete loop board (D-loop)	Process I/O board providing 32 DI and 16 DO channels. Additionally provided are 16 DI which monitor DO current.
Distributed control processor board (DCP)	The Harmony DCU processor board with or without IOB boards.
Distributed input/output board (DIO)	An intelligent serial communications board that communicates with the DCP board through a dual-port memory interface. It supports communication activity with DIO modules over the TransNet bus. This is basically a CIO board with a TransNet processor.

**Table 1-2. Glossary of Terms and Abbreviations** *(continued)*

Term	Definition
Dual-port memory	Memory that is accessible to both the DIO board and the DCP board. Under shared rules of communication protocol and data structure organization, dual-port memory is used to exchange information between the two devices.
Ethernet communications coprocessor board (ECCD)	The Ethernet coprocessor of the DCP board that interfaces to the Cnet network.
Global database	The set of all databases which are accessible by system products. A foreign database joins the system global database through the mechanisms of global DBA.
Global DBA	The ABB Automation convention for providing access to system database atoms.
Harmony DCU (HDCU)	The overall name of the multiloop controller. Includes CPU board, power supply, racks, process I/O boards, etc.
HSI interface	A Windows NT [®] based system which supports the Conductor NT software.
I/O board (IOB)	Generic term for all Harmony DCU intelligent process input/output boards.
Interface terminal board (ITB)	A circuit board assembly that provides a terminal block for connection of field process signals. Additionally, some ITB boards may contain signal conditioning components. Connection between the ITB board and Harmony DCU is via pre manufactured, standardized cable.
ITB/CIO board	ITB board for the CIO and DIO boards.
Module	A block of dual-port memory (DIO or DCP memory) consisting of a sequence of atoms. A module is referenced externally by a tag name. It is considered to be a functional unit and to perform a single or related group of functions or to store single or related blocks of values.
Module descriptor	A part of the data dictionary. One module descriptor exists for each module type. Among its contents are module name, number of modules of this type in the database, the number of atoms in the module type's atom descriptor list, and the module's memory size.
Module type	A grouping of modules which all share a common type name and common characteristics. A module type is defined by a module descriptor and a list of atom descriptors in the data dictionary.
Termination base	DIO hardware modules are mounted to termination bases. Faulty modules can be swapped without disconnecting power, communications, and field wiring. The station address and I/O configuration data for the modules are programmed into the termination base for permanent storage.
TransNet bus	A twinaxial or fiber cable used for communications between the DIO and the DIO hardware modules.



Introduction

This section provides a hardware and software overview for the distributed I/O (DIO) system and provides general instructions on startup of a system.

Hardware Components

The DIO system is composed of the following hardware components:

DIO Board	Input/output board which includes the TransNet bus processor.
ITB/CIO Board	Interface terminal board for the DIO board.
TransNet Bus	Twinaxial cable serial bus used for communications between the DIO board (via the ITB/CIO board) and various DIO modules (via termination bases) in the DIO system. The bus also distributes 24 VDC power to the DIO modules. Refer to Appendix A for information about using fiber optic converters to interface with the TransNet bus.
TransNet Bus Terminator	Small electronic devices placed on both ends of the TransNet bus to reduce electrical noise.
DIO Module	Electronic I/O module that connects to the process being controlled or monitored by the DIO system. The DIO modules provide analog input (AI), analog output (AO), discrete input (DI), or discrete output (DO) capabilities.
Termination Base	Hardware used for mounting a DIO module.
Power Supplies	DIO modules use 24 VDC power (nominal) from the TransNet bus. For small systems, a PS-01 power supply (20 watt) is available to power the TransNet bus and the DIO modules. For large systems, a PSC-24 power supply adaptor (100 watt) is available for interfacing to conventional power supplies that provide DIO module power. Multiple PSC-24 adapters can be used.



Field Wiring	Wiring that connects between the field devices and the DIO module bases.
Base Programmer (Optional)	Device used for programming the station address into a termination base. A base programmer is recommended for large numbers of DIO termination bases.

The TransNet bus, TransNet bus terminator, PS-01 power supply, PSC-24 power supply adapter, DIO hardware modules, DIO termination bases, and base programmer are manufactured for ABB Automation by MTL Incorporated. The DIO modules, termination bases, power supply, power supply adapter, base programmer, and TransNet bus terminator should be obtained from your local ABB system supplier. TransNet bus cable can be obtained from ABB Automation or any electronic supply outlet that can supply a twinaxial type wire (refer to **Selecting Cable Type** in Section 3).

Refer to **Section 3** for hardware installation information. Figure 2-1 shows a typical distributed I/O system installation.

DIO Board and ITB/CIO Board

Each DIO system requires one DIO board, one ITB/CIO board, and one ITB interface cable. The length of the cable is limited to three meters (10 feet). The DIO board and ITB/CIO board are manufactured by ABB Automation. Detailed information on these items can be found in the **Distributed Control Unit** instruction.

DIO Module and Termination Base

DIO hardware modules are available in different signal values and types to meet the requirements of most applications (Table 3-1). The DIO modules are available in eight, 16, and 32 channel configurations.

Input modules convert the field signals into digital values, which are sent to the DIO board via the ITB/CIO board. Output modules receive data from the DIO board via the ITB/CIO board and convert the data to signals to drive field devices.

Each DIO module plugs into a termination base where the field wiring and communication wiring are connected. The DIO modules can be removed from or plugged into the termination bases without disconnecting or disturbing the power, commu-

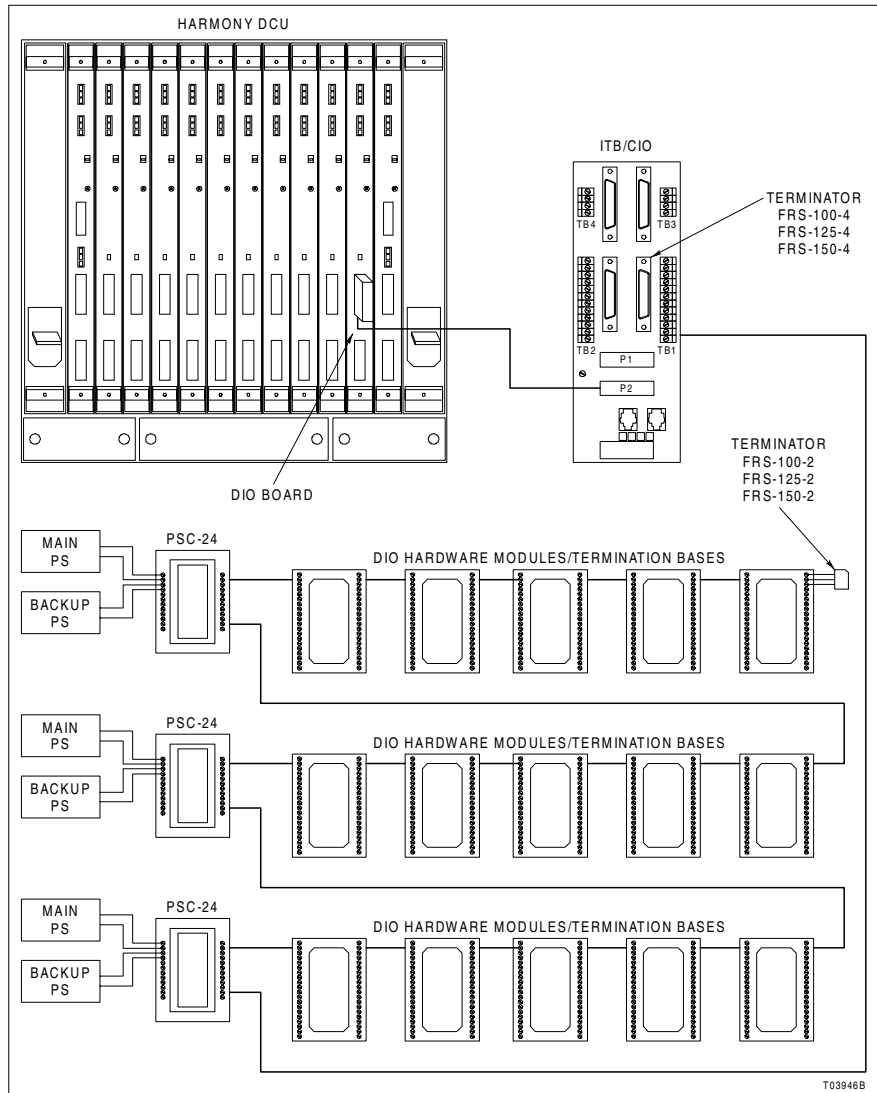


Figure 2-1. Typical Distributed I/O System Installation



nications, and field wiring (i.e., hot swapped). Modules can be hot swapped without affecting other modules on the bus. To permit hot swapping, the station address and I/O configuration data for a DIO module are programmed into and permanently stored in the termination base.

Module Tasks

Each DIO module contains its own CPU for performing the following tasks:

Communications Task	This task is responsible for communications with the DIO board. DIO modules are I/O devices on the TransNet bus that respond to queries from the DIO board, which is a TransNet bus master. The DIO board sends a command to a selected DIO module to perform a selected function. The selected DIO module then performs that command and responds to the DIO board with data and status information corresponding to the DIO board issued command. The DIO board will abort this cycle if the DIO module fails to respond to the query within a certain configurable time-out period.
I/O Channel Read and Write (Primary Task)	This task is responsible for mapping logical data (DIO module digital data representation of actual physical data) to physical data (actual field wiring conditions), and vice versa. For example, this task is responsible for converting the 1 to 5 VDC inputs of an FAI-15-08 module to their respective digital representations (generating an integer between 6,552 and 32,760). This task is executed continuously and asynchronously for communications with the DIO board and the other modules.
Process Inputs and Outputs	This task is responsible for filtering and latching input data, and linearization and scaling analog data. For output modules, this task writes the output states or values to the output channels, monitors the outputs (i.e., monitoring modules only) while in the correct state, and controls the channel LED indicators.
Diagnostics	After each I/O scan, the CPU runs a portion of its diagnostic routine to verify the integrity of the hardware and software.

Discrete Input Module

The discrete input module converts the voltage signals generated by factory sensors such as pushbuttons, pressure switches, etc. into usable data for the Harmony DCU. The con-

version process requires that the input voltage be above the threshold voltage of the particular module and that the input voltage be applied for a time period longer than the filtering time specified when the DIO hardware module is configured.

Filters: The DIO software filters out the electrical noise generated by the site environment allowing the true state of the input to be determined. When the state has stabilized for the filtering time specified, that value is stored in the memory of the DIO module and retrieved by the interface.

Filter times: Filter times tell the DIO module how long an input signal must be stable before the signal is accepted. The impact of the filter time is equivalent to a resistor/capacitor network in electronics. The setup and configuration software allows creating custom time constants for each channel. The setting of the filtering times are described in [Section 4](#).

Counters: Counter DIO modules are identified with a C suffix in the product name, for example, DI2432C. These modules have the ability to record the number of times an input changes state for the first four inputs. The user can select whether the count will be incremented on the rising (positive transition) or falling (negative transition) edge of the signal. Each time the input changes state in the configured direction, the count for that input will be incremented. The maximum count rate is 450 hertz with a minimum on time of 400 microseconds and minimum off time of 400 microseconds. The channel counter will count up to 65,533, then reset.

The operation of the counters is independent of the latches. If one of the first four inputs is configured for latching operations and the input cycles while the latch state is on, the counter will record those transitions.

Analog Input Module

The analog input modules convert an analog field signal to a 16-bit value. For example, 1 to 5 VDC inputs are represented by 6,552 to 32,760. Examples of field devices that generate analog signals are thermocouples, pressure transmitters, flow transmitters, potentiometers, etc. The signals accepted by the analog input module are common plant floor signals such as millivolts, 0 to 5 VDC, 1 to 5 VDC, 4 to 20 milliamperes, and several different types of thermocouples and RTDs.



Inputs are filtered using software filters with user-configured filtering times.

Thermocouple signals are linearized to present temperature. The setup and configuration software (refer to [Section 4](#)) can be used to configure the following analog input related parameters:

Input filter on a channel by channel basis: Each channel in an analog input DIO module has a programmable software filter. The purpose of the filter is to attenuate noise that can occur at the input. In factory environments, it is normal to have a wide variety of sources of electrical noise. Some of this noise can appear at the input of the analog input DIO module. The software filter is provided to suppress this noise. This filter responds in a similar manner as a simple RC low pass filter.

Range and thermocouple type on a channel by channel basis:

Range The numbers that are returned to the DIO board from the analog input DIO modules are floating point numbers expressed in engineering units. This depends on the DIO module being used and the function and format selected. In order to convert scaled signals (± 5 VDC or 1 to 5 VDC) into engineering values (temperature, pressure, and flow) it is necessary to assign engineering unit numbers to the maximum full scale and minimum full scale positive numbers returned from the module. The setup and configuration software uses these numbers to generate a multiplier and zero offset ($y = mx + b$) necessary to create engineering units.

Thermocouple Type This programs the analog-to-digital converter to read a particular type of thermocouple. This also sets up the DIO module to perform the necessary cold junction compensation and linearization for this thermocouple. The functions are as follows:

J, J DIN, K1, K2, K DIN, T, E, C, S, R, B, and N

TC/burn-out upscale and downscale: On analog input DIO modules with RTD or thermocouple functions, the analog module checks the electrical continuity of the input sensor. Should this input sensor open, the module drives the input value for that channel either full scale positive (upscale) or full scale negative (downscale).

Discrete Output Module

Discrete output DIO modules are available with 16 channels which are capable of driving two amperes each with a maximum of 20 amperes per DIO module. In addition, each output channel is protected against current surges and voltage spikes generated by turning inductive loads on and off. The discrete output modules convert the digital data which is generated by the applications program and transmitted by the DIO board into voltage levels for use by field devices. For example, these signals can be used to:

- Directly drive solenoids and lights.
- Indirectly drive (through power contactors or interposing relays) high power devices such as heaters.

The following features are set by the user in the system setup and configuration software (refer to [Section 4](#)).

Power-up defaults: Set the power-up defaults to be either on or off (off is the default setting). When a DIO module has completed a power-up cycle (module power not field power) each output channel is set to the power-up default state.

Communications fault defaults: Set the communications defaults to either on, off, or hold last state (off is the default setting). When an output module has had either a communications time-out (no communications) or detected five consecutive communications errors, the FAULT and COMM ERROR LEDs will turn on. The DIO module will set its outputs to the configured communication fault default states.

Filter times: For output modules with monitoring capabilities (i.e., DO0216M) the filter time can be set for each channel. The filter time is used for monitoring to determine the time in which the output should have changed state. If the output has not changed to the correct state within this time, an output mismatch error is declared. Under this condition, an error is reported to the DIO board and the FAULT LED and the appropriate channel LED will flash in unison.

Monitoring: The monitoring of outputs is accomplished by detecting the presence or absence of current flow. If the current flow is greater than four milliamperes, then the output is detected as on, less than four milliamperes the output is off.



This detected state is compared against the state the output was set to. The differences between the two (after the filter time has elapsed) results in the declaration of a mismatch. Typically, outputs fail off (open circuit), for example, when fuses blow, wires break or actuators fail. In the rare event that an output fails on (short circuit), the DIO module would have to be replaced.

Analog Output Module

The analog output DIO module converts a 12-bit number (setup as 15 bits) to an analog signal used to control field devices. Examples of field devices that can be controlled are valves, dampers, speed controllers or any device that accepts a 0 to 20 milliampere signal or 4 to 20 milliampere signal.

The following features can be set by the user via system setup and configuration software (refer to [Section 4](#)):

Power up percent: This field is used to specify the analog output value between the time the analog output DIO module is powered up until communications with the DIO board has been regained.

Communications failure percent: This field is used to specify the analog output value of the analog output DIO module when the module has determined that communications with the DIO board has been lost.

Power Supply

The sources of power for the DIO modules are:

- PS-01 power supply and the TE-04 power supply base.
- PSC-24 power supply adaptor.

The PS-01 power supply (Fig. [2-2](#)) is capable of providing approximately 20 watts of power. Each PS-01 power supply requires a TE-04 termination base. Multiple PS-01/TE-04 power supplies are required if the module power requirement is greater than 20 watts.

The PSC-24 power supply adaptor (Fig. [2-3](#)) allows for the use of any commercial power supply that delivers between 24 VDC to 35 VDC to power the system. The PSC-24 power supply adaptor is capable of delivering up to 100 watts of power when used with any conventional 33.5 VDC power supply. It is only

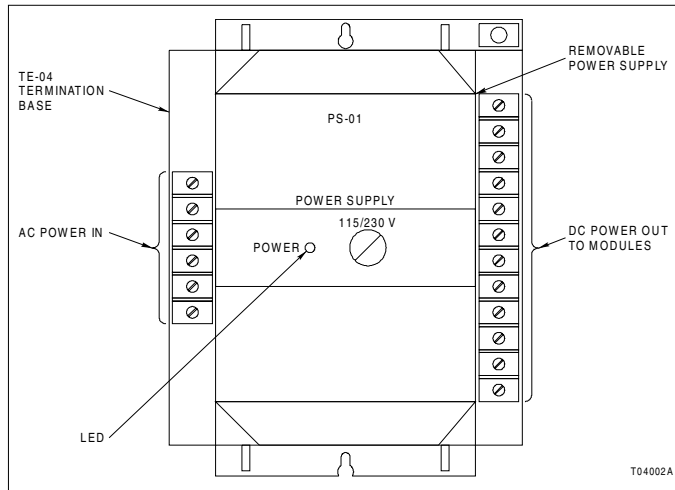


Figure 2-2. PS-01/TE-04 Power Supply

capable of delivering 72 watts of power when used with conventional 24 VDC power supplies because of a 3.0 ampere current limiting fuse within the PSC-24 adapter. Multiple PSC-24 power supplies are required if the DIO module power requirement is greater than 100 watts. PSC-24 power supply adaptors also provide a diode-ORing function so that backup power supply systems can be implemented. The PSC-24 also provides both normally open and normally closed relay contacts which can be used to signal an alarm when the primary power supply fails.

Refer to **System Power Requirements** in Section 3 for procedures to determine the total power requirements of the DIO modules.

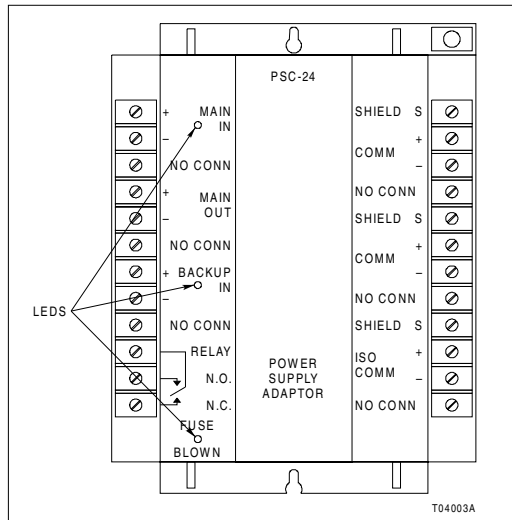


Figure 2-3. PSC-24 Power Supply Adaptor

Redundancy

A redundant DIO system provides backup support to the primary DIO board in case there is a system failure in any part of the DIO interface (i.e., from the interconnection of the Harmony DCU to the TransNet bus interface). The selection of the primary DIO board is carried out by the Harmony DCU based on conditions presented by the DIO board through the back-plane interface, by the operational readiness of the DIO back-plane interface, and by any manual conditions forced by a system operator.

- Primary DIO Board The DIO board that will control all DIO applications.
- Backup DIO Board A DIO board with the same logical address as the primary DIO board which could take over application control in the event of a primary DIO board failure.
- Backup Ready State A state in which the backup DIO board is functionally ready and not in suspend mode.

Switchover Transfer of control from the primary DIO board to the backup DIO board.

The Harmony DCU (i.e., DCP board) controls the DIO mode and switchover handling. A DIO board informs the Harmony DCU that a switchover is necessary, but the Harmony DCU performs the actual switchover.

In addition to the hardware items listed in **Hardware Components** in this section, a redundant network coupler and a redundant network selector are required for a redundant DIO system.

Redundant Network Coupler

One redundant network coupler is required for each redundant DIO board pair. The redundant network coupler is used in redundant DIO configurations to allow the backup DIO board to monitor commands being transmitted by the primary DIO board over the TransNet bus by electrically coupling these commands onto a secondary TransNet bus connected to the backup DIO board. Figure 2-4 is an example of a typical redundant DIO board configuration using the redundant network coupler. Also shown in Figure 2-4 is the wiring of a redundant network coupler to a redundant DIO board pair.

Redundant Network Selector

A redundant network selector is required for each DIO module cluster. Generally, a DIO module cluster is a group of DIO hardware modules which share a common equipment cabinet. The redundant network selector receives commands originating from the online DIO board over the primary TransNet bus and passes these commands to its DIO module cluster over a nonredundant local TransNet bus. If the command was directed to one of the DIO modules in the cluster, the module will receive the command and generate a response. The response is passed back to the redundant network coupler over the nonredundant local TransNet bus. The redundant network coupler then passes the response to both the primary and secondary TransNet busses. Figure 2-5 is an example of the typical placement and wiring of the redundant network coupler in DIO module clusters.

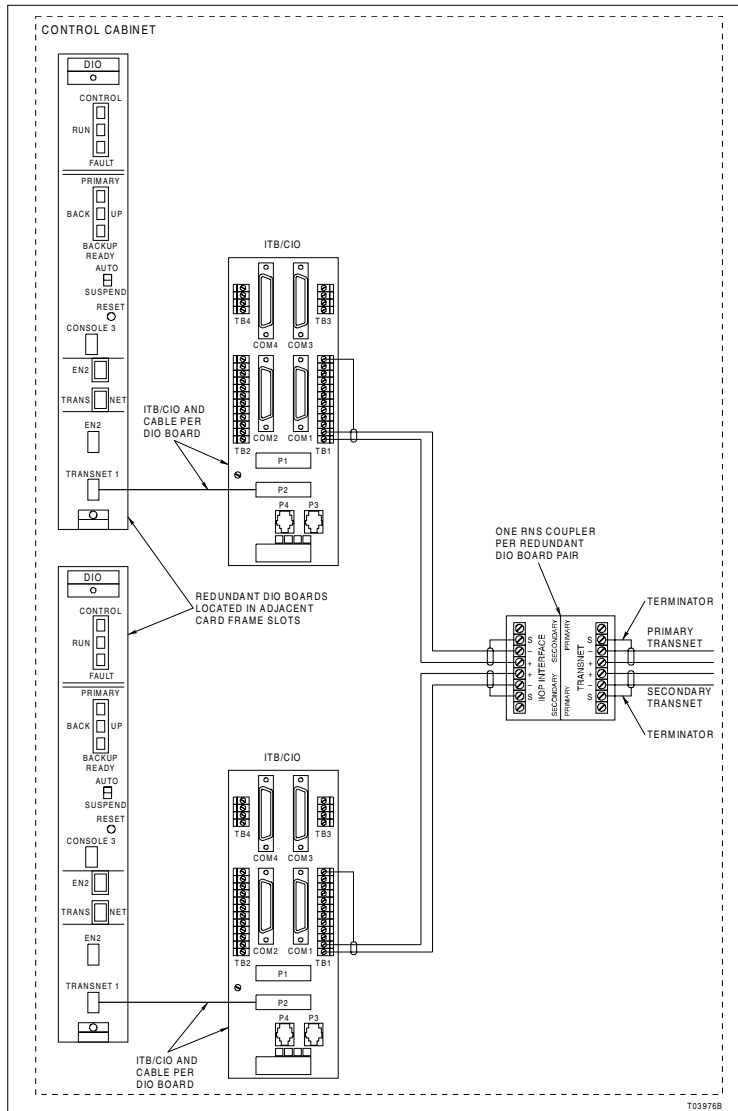


Figure 2-4. Redundant DIO Boards in Adjacent Harmony DCU Frame Slots

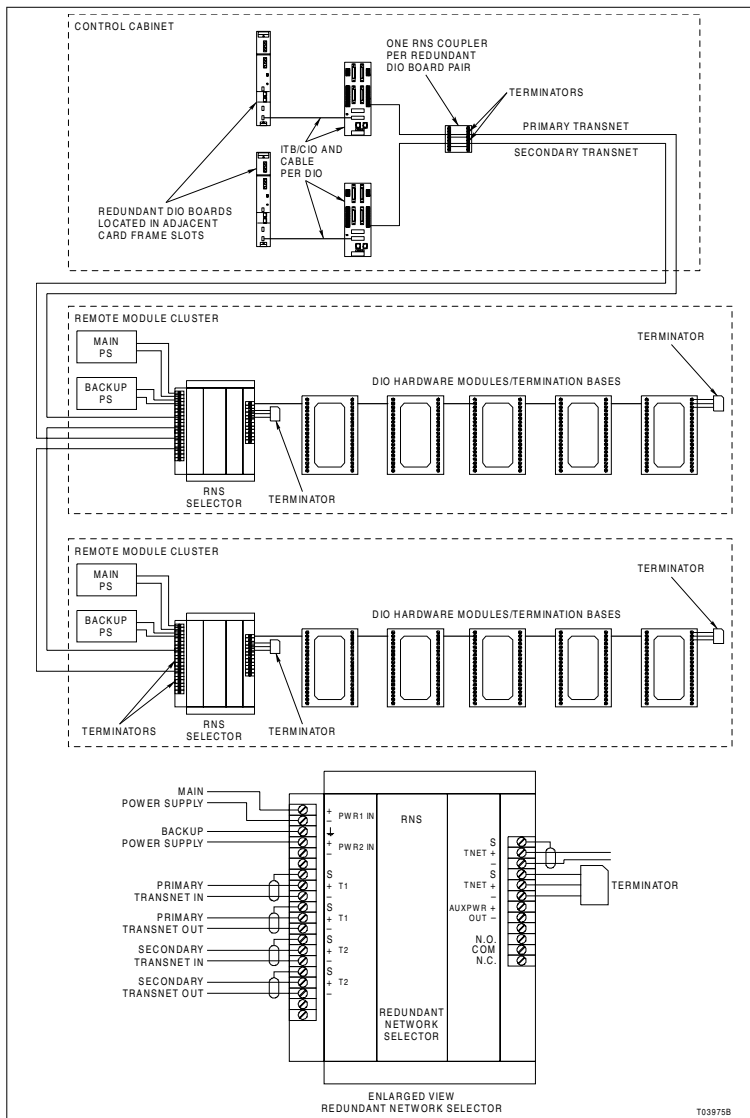


Figure 2-5. Typical Redundant Distributed I/O System Installation



Redundancy Implementation

Because the DIO modules and termination bases were not designed to operate with redundant TransNet busses, only one communication port for interfacing to the TransNet bus is provided. This prevents a true redundant implementation, where every system element is duplicated. However, a robust, reliable redundant implementation is still possible.

Typical distributed I/O system installations usually involve one or more clusters of DIO modules. Each of these DIO module clusters are mounted within a metal enclosure. There is a low probability of severing the nonredundant TransNet cable that is daisy-chained between the DIO modules of a cluster within the enclosure. The possibility of severing the TransNet cables running between the DIO board (located in the HDCU cabinet) and the cluster enclosures is much higher. Therefore, the redundant DIO implementation described here is intended to safeguard against the most probable system failures. This includes failure of a DIO board or the severing of one of the TransNet cables running between the DIO board (located in the HDCU cabinet) and the cluster enclosures.

The DIO redundancy implementation described here uses redundant TransNet cables between the HDCU cabinet and the cluster enclosures. Using additional hardware, it is also possible to run redundant fiber optic cables between the HDCU cabinet and the cluster enclosures. To protect against lightning strikes, the use of fiber optic cable is recommended whenever TransNet bus is run between buildings.

To protect against a DIO failure, a pair of DIO boards is used. Each DIO board controls one of the redundant TransNet busses that run between the HDCU cabinet and the cluster enclosures. Each DIO board interfaces to its own ITB/CIO termination board. Before each of the two TransNet cables exit the HDCU cabinet, they pass through a common device called the TransNet network coupler (RNSC-01). The coupler is required to couple commands originating from the primary DIO board to the backup DIO board. This permits the backup DIO board to monitor communication activity (commands sent and received) by the primary DIO board as it operates (although the backup DIO board does not monitor the content of the communications).

At each cluster enclosure, a device called the redundant network selector (RNS-01) is used to convert the redundant TransNet bus originating from the HDCU cabinet to the nonredundant TransNet bus that is daisy-chained between the DIO modules resident in that enclosure. The RNS selector has two inputs for the redundant TransNet cables coming in from the HDCU cabinet and one output for the nonredundant TransNet bus that is daisy-chained between the DIO modules resident in that enclosure. A command received from either of the redundant TransNet cables coming in from the HDCU cabinet is relayed onto the nonredundant TransNet bus that is daisy-chained between the DIO modules. The RNS selector also routes the DIO module responses onto both of the redundant TransNet cables going back to the HDCU cabinet. Again, this is done to allow the backup DIO board to monitor communications between the primary DIO board and the DIO modules.

A typical redundant DIO board transaction includes (Fig. 2-6):

1. The online DIO board transmits a command packet onto the primary TransNet bus.

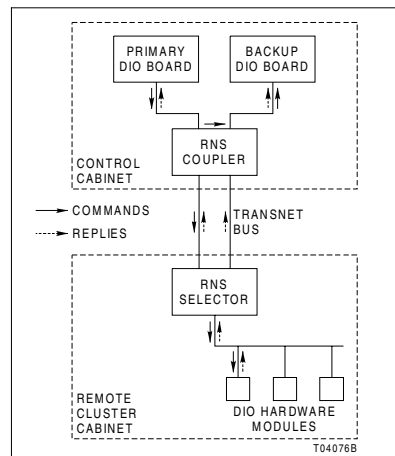


Figure 2-6. Typical Redundant DIO Board Transactions

2. The command packet is electrically relayed to the backup DIO board via the coupler. The backup DIO board is now aware of the command being executed.



3. The command packet that was sent by the primary DIO board over the primary TransNet bus is received by the redundant network couplers.
4. The redundant network couplers relay the command packet to the DIO modules in its cluster over the local TransNet bus.
5. The selected DIO module receives the command packet from the local TransNet bus.
6. The selected DIO module decodes commands, executes commands, and formulates a response packet which is sent back over the local TransNet bus to the redundant network coupler through the selector.
7. The redundant network coupler relays the response packet to both the primary and backup DIO boards over both TransNet busses.

The DIO application software allows each DIO module to be assigned to one of twenty-one groups (0 to 20). A DIO switchover will occur when the DIO application software senses that it has lost communication with all the DIO modules in a group. To protect against loss of communication with a remote module cluster if one of the connections to the redundant network selector fails, assign all the DIO modules in the remote cluster to the same group. Node group assignment is described in **Create, Edit, Modify, or Delete** in Section 4.

DIO Board Firmware Requirements

For redundant DIO boards, the firmware must be version 2.8 (on the firmware chip itself, this will read V.2.08) or later. To determine this, go to the system status display of the HSI interface and locate the icon for the Harmony DCU which contains the DIO boards to be checked.

1. Click on the icon for the Harmony DCU containing the DIO boards to be checked.
2. Click on *Services* in the resulting pull-down menu.
3. Click on *Configure CIO*.
4. Select the DIO board to be checked by clicking on its associated radio button, then click *OK*.

5. In the resulting window, enter **2** (remote I/O configuration) in response to the *Function=* prompt.
6. The remote I/O module configuration window will be displayed which should contain the words *COMMREV 2.8* in the upper right corner.

If the board does not have version 2.8 firmware:

- The status field will contain an error message; it will **not** say *IOM Communicating OK*.
- After a switchover, backup ready cannot be restored anymore.

If the board contains firmware of a revision level prior to 2.8, return it to ABB Automation for an upgrade.

Switchover Conditions

In order for a switchover to occur, the backup DIO board must be considered backup ready by the Harmony DCU and by the primary DIO board. The backup DIO board cannot be in suspend mode and must be functioning properly. Table 2-1 lists the conditions or system failures that can cause the Harmony DCU to perform a DIO switchover.

The state of both the primary and backup DIO boards is stored in the dual-port memory interface which is accessible through the HDCU I/O backplane. The Harmony DCU monitors each interface every 500 milliseconds.

If the Harmony DCU software determines that the primary DIO board has detected a failure, control is transferred to the backup DIO board. After the new primary DIO board shuts down its backup monitoring functions and starts its online tasks, communication is established with the DIO modules and control functions are resumed. The elapsed time between the external event causing the DIO board failure, and the resumption of control by the new primary DIO board typically



Table 2-1. Causes for Redundant DIO Board Switchover

Type of Failure	Description
Primary communication coprocessor failure	The DIO board uses a daughter board coprocessor which plugs into the motherboard. The coprocessor is responsible for handling the communication interface to the TransNet bus. The DIO communication to the motherboard is through a DMA channel. If the interface to the DMA fails, then this status is indicated to the Harmony DCU and will result in a switchover condition. The DIO board provides an indicator to the Harmony DCU which determines whether the communication card exists. The DIO board also provides an indicator which presents the state of the coprocessor. If a coprocessor exists, and the state indicator presents a failed status, a switchover condition will occur. If no board is detected, then the DIO board cannot become an online unit.
Primary DIO board watchdog timer failure	The DIO board contains a watchdog timer which must be periodically reset by DIO application software in order to prevent a system suspend condition from occurring. If the DIO board goes into suspend due to a watchdog failure the Harmony DCU will consider this a switchover condition and start the backup board.
Primary DIO to DCP interface failure	The HDCU I/O backplane interface includes checks for bus errors and bad hardware modes. A bus error can occur, for example, if the DIO board is pulled out. If the Harmony DCU can no longer effectively communicate to the primary DIO board through the I/O backplane, a switchover condition occurs. The detection of this is done by the Harmony DCU and forces a switchover.
Manual switchover	The DIO board can be placed into suspend mode through the DIO board front panel suspend switch or through the DIO point display of the HSI interface. If the DIO board is placed into suspend by an operator, a condition for switchover will be presented to the Harmony DCU. The Harmony DCU will perform the switchover. After a switchover the backup unit must be rearmed in order to allow another switchover operation. The backup is rearmed through the use of the DIO point display of the HSI interface or by cycling the auto/suspend switch on the front panel of the backup DIO board.
ITB cable related failures	The DIO board can monitor the status of the ITB cable connected between the DIO board front panel and the ITB board. A hardware signal is sent to the DIO board if the connection fails. This signal means that a DIO board has lost communication with all remote modules. If the DIO board determines that the ITB cable is disconnected, a status flag will be indicated to the Harmony DCU which will force a switchover to the backup board.
TransNet bus failure	The DIO application software will monitor the communication status of each module on the TransNet bus. If the DIO board can no longer access all modules assigned to the same node group, a switchover condition will be forced in redundant installations.

does not exceed three seconds for a moderately sized system (e.g., 50 Controlware CIO module).

NOTE: For block mode operation there is one CIO database module per DIO hardware module; and for single mode operation there could be as many as 32 CIO database modules per DIO hardware module. The transfer time could be somewhat extended for larger systems, and also extended according to the configured Controlware module scan period, the external tag scan period, and the DIO module scan period.

Redundant DIO Considerations

Hardware Installation

The ***Distributed Control Unit*** instruction describes IOB board redundant hardware installation. For a redundant DIO board configuration, two DIO boards are required, the primary DIO board and the backup DIO (or redundant) board. The boards must be mounted in adjacent slots in the Harmony DCU, the left board mounted in an odd-numbered slot. In addition, for DIO boards to be redundant, they must be logically paired by having the same logical address assigned to both boards.

Backup Ready Functionality

For redundant functionality (i.e., a switchover to be able to occur if necessary) both DIO boards in the redundant pair must contain the same program load. Instructions for loading the DIO program to both boards are provided in [Section 6](#).

Also, both DIO boards in the redundant pair must contain the same database configuration. Any time the primary DIO board database is changed through system configuration, the backup DIO board database must be made to match that of the primary. Configuration changes are not passed automatically from the primary to the backup DIO board. Configuration changes are not made directly to the backup DIO board. Instead, the database of the primary DIO board is dumped to the HSI interface hard drive, then loaded to the backup DIO board.

The Harmony DCU automatically validates the DIO board primary and backup DIO databases. When the backup DIO database does not match the primary DIO database, the backup DIO board is considered backup not ready. This condition will generate a backup not ready state message on the HSI inter-



face and a visible indication on the DIO board and point display for the CIO database module associated with the DIO board.

System Operation

The DIO module converts analog or discrete inputs from the field into digital form for transmission to the DIO board, or the modules convert digital data received from the DIO board into analog or discrete output signals which can be used for controlling valves, motors, etc.

The DIO board is responsible for data movement between the DIO hardware modules and the CIO database modules. Refer to **DIO Database** in this section for more information on CIO database modules. All communications between the DIO board and the DIO modules occurs over the TransNet bus.

Controlware is responsible for data movement between the CIO database modules and the Controlware II database. All data transfers between the Controlware II database and the CIO database modules occurs over the HDCU I/O bus via dual-port memory on the DIO board.

DIO Database

The DIO board maintains a local database for the storage and retrieval of the analog or discrete input or output points contained within the distributed I/O system. The DIO database has the same structure as the Controlware II database. The DIO database is composed of CIO database modules. Both the CIO database modules and the DIO data dictionary are included in all DIO database load and dump operations.

CIO Database Modules

The DIO database contains the default module mix listed in Table 2-2.

Table 2-2. DIO Database Module Mix

Quantity	Module Type
250	AIO

Table 2-2. DIO Database Module Mix *(continued)*

Quantity	Module Type
120	AIOB
350	DIOB

DIO hardware modules are available for handling analog inputs, analog outputs, discrete inputs, and discrete outputs. The number of channels available on the various DIO modules differs. For example, DIO analog input hardware modules are available in both eight channel and 16 channel versions.

The CIO database module types were designed to be general purpose. For example, the AIOB module has been designed to work with both eight channel and 16 channel analog input and analog output DIO hardware modules.

AIO/AIOB - Analog Input/Output Modules

The AIO and AIOB modules were designed to handle both analog input and analog output data. The user may choose which DIO database module to use for storing or retrieving analog data by selecting the appropriate mode (single or block) during DIO configuration (refer to [Section 4](#)). Before making this choice, review the following considerations (reference [Advantages and Disadvantages of Single and Block Modes](#) in Section 4 and [Special Considerations](#) in Section 5 for more information):

1. Data packing is approximately six times more efficient when using AIOB modules (block mode).
2. To configure Controlware II modules to an AIO module output, the format of the pointer would be AIOTAGNAME.OUT. To configure Controlware II modules to an AIOB module output, the format of the pointer would be AIOBTAGNAME.OUT[N], where $0 \leq N \leq 7$ or $0 \leq N \leq 15$, depending on the AIOB channel size.
3. Both the AIO module OUT atom and the AIOB module OUT[N] atoms can be addressed by any analog pointer (such as XIN, PIN, SIN) residing in the Controlware II database or by the module export tag in the CIO database module.
4. The HSI interface standard hierarchical display for an AIO module displays the output data (one channel) as a bar graph.



The standard hierarchical display for an AIOB module displays the output data (eight or 16 channels) in numeric format.

AIO - Analog Input/Output Module Atoms

An AIO module is used for the storage of a single analog value for either input or output purposes. An AIO module is automatically used by DIO configuration software whenever single analog input or output mode is configured.

AIOB - Analog Input/Output Block Module Atoms

An AIOB module is used to store a group of analog values and the module can be used for either input or output purposes. The size of the storage group is set by the module's FIX and corresponds to the number of channels supported by the associated analog DIO hardware module. An AIOB module is automatically selected by DIO configuration software whenever a block analog input or output transfer is configured.

DIOB - Discrete Input/Output Block Module Atoms

A DIOB module is used to store a discrete value or a group of discrete values. The module can be used for either input or output purposes. The size of the group is set by the module's FIX and corresponds to the number of channels supported by the associated discrete input/output DIO hardware module. A DIOB module is automatically selected by DIO configuration software whenever a discrete input/output module is configured.

Controlware Functions

CIO Module

The CIO module (i.e., Controlware module) supplies the interface information and the software interface information concerning the DIO board to the Harmony DCU.

The CIO module:

- Specifies the location of the DIO board. When a new board is detected, the board's information and tags are added to the CIO module. If a board was present and then removed,

the information and tags for that board are removed from the CIO module.

- Is used to specify one CIO or DIO board. Up to ten CIO and DIO boards can be installed in the Harmony DCU.
- Contains the board's hardware and software status as well as information about the currently loaded applications and database.

If DCP board and DIO board communication has been established, the slot, LCIO (CIO logical address), and tag name fields of the CIO module will be automatically configured. If there is more than one DIO board, each board must have a unique logical address. If the same logical number has been assigned to more than one board, the logical number must be changed (refer to **DIO Utilities** in Section 6).

Inhibiting Bad Hardware State

When the ANO module, DO module, and DOB module have a null IOB pointer or an unlinked IOB pointer, the modules are set to the bad hardware state. When the module is set to this state, the module output is not transferred to the DIO module. Since the DIO application does not use the IOB pointer, the module is set to this mode.

If those output modules are used as the interface between Controlware and the DIO modules, BOIH (bad output inhibit flag) in the module must be set in order for the bad hardware state to be reset.

Export Scan Period

The export scan period can be configured with the SCAN atom in the CIO module. The default condition, one, is the equivalent to 100 milliseconds. If more than 50 export tags have been configured, the export scan period must be adjusted using the information listed in Table 2-3.

Table 2-3. Export Scan Periods

Number of Export Tags	Scan Period
1 to 50	100 msec
51 to 100	200 msec

**Table 2-3. Export Scan Periods** *(continued)*

Number of Export Tags	Scan Period
101 to 200	400 msec
201 to 300	600 msec
301 to 400	800 msec
401 to 500	1 sec

Restart the DIO software after the export tags have been configured. The DIO software is restarted by toggling the auto/suspend switch on the DIO board.

CIO Pointers

The DIO board stores the process data it receives from input DIO hardware modules in AIO, AIOB, or DIOB modules. The Controlware software expects to see analog input data presented through the ANI module. Similarly, the Controlware software expects to see discrete input data presented through the DI module. A CIO pointer is used to move analog data from the AIO/AIOB modules to ANI modules and discrete data from the DIOB module to DI modules via the DIB module (for example, the CIO atom of the ANI module).

The following ANI and DIB FIXes are intended for use with DI modules. The CIO pointer provided by the ANI module FIXes should be pointed to the AIO or AIOB output atoms (OUT or OUT[] respectively). The CIO pointer provided by the DIB FIX 1 module should be pointed to the DIOB output word (OWD1).

Module Type	FIX	Description
ANI	4	0-100% in float (raw input from CIO pointer) into the instrument range
ANI	5	Square root of 0-100% in float (raw input from CIO pointer) into the instrument range
ANI	6	Engineering unit data input from CIO pointer DIB 1
DIB	1	Raw input from CIO pointer

The BLIM atom should be configured to zero to eliminate unnecessary status change during the startup scan delay

period. The application examples of the CIO pointer are described in **Configuration Examples** in Section 4.

DIO Operation

Release SR2.0 or newer Harmony DCU software is required for DIO operation. An appropriate release of Conductor series software is also required to support DIO configuration, and DIO application program and database uploads and downloads.

1. Before applying power to the Harmony DCU, ensure that the DIO board auto/suspend switch is in the auto position.
2. When shipped from the factory, the DIO board needs to be loaded with the latest version of DIO application (configuration) software. Refer to **Section 6** for DIO application program loading.
3. When the DIO application program is loaded, the CONTROL and RUN LEDs of the DIO board should follow the CONTROL and RUN LEDs of the online DCP board.
4. Check that Controlware is communicating with the DIO board by reviewing the next available CIO module of the database. If DCP and DIO board communication has been established, the slot, LCIO (CIO logical address), and tag name fields of the CIO module should be automatically configured. Refer to **CIO Module** in this section.

If configuring for redundancy, two DIO boards with the same logical address are required. The format for the tag field is ddCIOM_ss where dd represents the HDCU address, m represents the DIO module number, and ss represents the card frame slot address. The LEG, MSET, AREA, PRIO, etc. CIO module fields can now be configured.

5. If the previous check does indicate that the DCP board has identified the newly installed DIO board, proceed with DIO configuration. DIO configuration can be performed at the HSI interface or locally through the EN3 port of the DIO board. **Section 4** describes the operation of DIO configuration software.





Introduction

Hardware Components in Section 2 lists the distributed I/O (DIO) system hardware components. This section discusses DIO system hardware installation.

NOTE: DIO system components manufactured by MTL Incorporated include features not available with the standard MTL Incorporated product line. To ensure compatibility with the Harmony DCU, purchase distributed I/O system components through your local ABB sales representative.

DIO Modules

Table 3-1 lists the current MTL Incorporated module offerings supported by the DIO board. As Table 3-1 indicates, each DIO module also requires a termination base.

Table 3-1. Available DIO Modules

Hardware Module Type	Available Module Offerings	Associated Termination Base	Power Requirements ¹	General Information
Analog Inputs	AI1508	TE-08	7 W	Carried on: Twinaxial Cable Voltage Level: 15 to 35 VDC Ripple: The voltage may vary between 16 VDC and 35 VDC without regulation, but must not produce more than 10 mV rms noise in the 1.0 to 2.5 MHz communications band
	AI1516	TE-08	12 W	
	AI0008	TE-07	7 W	
	AI0016	TE-07	12 W	
	AI0108	TE-06	7 W	
	AI0116	TE-06	12 W	
	AI0108-3W	TE-06	7 W	
	AI0116-3W	TE-06	12 W	
Analog Output	AO42008	TE-03	12 W	Carried on: Twinaxial Cable Voltage Level: 16 to 35 VDC Ripple: The voltage may vary between 16 VDC and 35 VDC without regulation, but must not produce more than 10 mV rms noise in the 1.0 to 2.5 MHz communications band
	AO42016	TE-03	20 W	

**Table 3-1. Available DIO Modules** *(continued)*

Hardware Module Type	Available Module Offerings	Associated Termination Base	Power Requirements ¹	General Information
Discrete Inputs	DI11516	TE-01 or TE-02	3 W	Carried on: Twinaxial Cable Voltage Level: 16 to 35 VDC Ripple: The voltage may vary between 16 VDC and 35 VDC without regulation, but must not produce more than 10 mV rms noise in the 1.0 to 2.5 MHz communications band
	DI11532	TE-01	3 W	
	DI23016	TE-01 or TE-02	3 W	
	DI23032	TE-01	3 W	
	DI2416	TE-01 or TE-02	3 W	
	DI2416-C	TE-01 or TE-02	3 W	
	DI2432	TE-01	3 W	
	DI2432-C	TE-01	3 W	
	DI0516	TE-01 or TE-02	3 W	
	DI0516-C	TE-01 or TE-02	3 W	
	DI0532	TE-01	3 W	
	DI0532-C	TE-01	3 W	
Discrete Outputs	DO0016	TEF09-3 or TEF09-5	3.7 W	Carried on: Twinaxial Cable Voltage Level: 15 to 35 VDC Ripple: The voltage may vary between 16 VDC and 35 VDC without regulation, but must not produce more than 10 mV rms noise in the 1.0 to 2.5 MHz communications band
	DO0016-M	^	3.7 W	
	DO0116	^	3.7 W	
	DO0116-M	^	3.7 W	
	DO0216	^	3.7 W	
Power Supplies	PS-01	TE-04	N/A	Input: 115 VAC, 60 Hz; 230 VAC, 50 Hz Output: 17.5 to 28 VDC Power Supply: 20 W
	PSC-24	Not Required	N/A	

NOTE:1. Refer to [Appendix A](#) for power requirements of fiber optic network converters.

System Power Requirements

Power is applied to the DIO modules from the power supplies connected to the TransNet bus. Due to DC resistance of the cable, the cable itself consumes some power and produces a voltage drop which reduces the voltage supplied to the DIO modules. This voltage drop must be factored in when calculat-

ing power requirements for the system. The location and quantity of power supplies can be calculated exactly or can be estimated.

Once the DIO module complement is chosen, the type and quantity of power supplies required needs to be calculated.

1. The first step in defining power supply requirements is to divide the DIO modules into clusters based on their physical location.
2. Use the module power requirement column in Table 3-1 to determine the power supply requirements for each cluster. Refer to **Module Clusters** in this section.
3. All DIO modules require a minimum of 15 VDC power to operate. The TransNet bus cable itself consumes power and produces a voltage drop which reduces the voltage supplied to the DIO modules in the group. Refer to **Maintaining Minimal DIO Module Operating Voltage** in Section 3 for calculations used to insure DIO module operating voltages are maintained. Skip this step if the maximum distance between the PS-01 supply or PSC-24 adapter and the farthest DIO module in the group is under 12.2 meters (40 feet). This assumes 24 VDC nominal power supplies derated to 19 VDC and 0.32 square-millimeter (22 AWG) TransNet bus cable.

NOTE: Voltage drops in the TransNet bus are dependent on the TransNet bus cable type used. To minimize TransNet bus voltage drop choose a cable type with low loop resistance (refer to Table 3-13 for cable data).

Module Clusters

For small module clusters, a PS-01 power supply is available which is capable of delivering 20 watts of 24 VDC (nominal) power. If the power requirements for a cluster exceed 20 watts, multiple PS-01 power supplies can be used to power DIO module groups within the cluster.

For larger module clusters, a PSC-24 power supply adapter is available which is capable of delivering up to 100 watts of power when used with any conventional 33.5 VDC power supply. The PSC-24 adapter is only capable of delivering 72 watts of power when used with conventional 24 VDC power supplies because of a 3.0 ampere current limiting fuse within the PSC-24 adapter. If the power requirements for the cluster



exceed the 72 or 100 watt limit, multiple PSC-24 power supply adapters can be used to power DIO module groups within the cluster.

Refer to **Power Supply** in Section 2 for additional information.

Estimating the Number of Power Modules

For most applications, the DIO modules tend to be located together in groups (i.e., one group of six DIO modules in one location, another group of eight DIO modules in another location, etc.). For the purpose of calculations, each group can be treated as a separate entity with one or more power supplies located at each group. A group of DIO modules would consist of the modules located within 6.1 meters (20 feet) of cable length. For each group, use the total power consumed by the modules in that group (refer to Table 3-2) to calculate the approximate number of power modules required. For example, if the power consumed by a group of modules adds up to 39 watts, two power supplies (PS-01) would be required.

Table 3-2. DIO Module Power Requirements

Module Type	Channels	Watts Consumed ¹
Discrete Output	16	3.7
Discrete Input	16	3.0
Discrete Input	32	3.0
Analog Output	8	12.5
Analog Output	16	20.0
Analog Input	8	7.0
Analog Input	16	12.5

NOTE:

1. Refer to **Appendix A** for power requirements of fiber optic network converters.

Maintaining Minimal DIO Module Operating Voltage

In systems where one or more DIO modules in a group are distant from their respective power supply, the system designer should verify the voltage drops in the bus cable in order to not jeopardize the minimum DIO module voltage source requirements. DIO modules require a minimum source voltage of 15 VDC. The nominal voltage for bus power supplies is

24 VDC, but this can drop during low AC line conditions. To minimize voltage drops in the bus cable, choose a cable type with a low loop resistance. Table 3-3 shows loop resistances for approved bus cable types.

Table 3-3. DC Loop Resistance for Wire Gauges

Copper Wire Size	Loop Resistance	Loop Resistance
2.1 mm ² (14 AWG)	0.0052 Ω/ft.	0.0170 Ω/m
1.3 mm ² (16 AWG)	0.0083 Ω/ft. (Belden 9860)	0.0272 Ω/m
0.83 mm ² (18 AWG)	0.0133 Ω/ft.	0.0436 Ω/m
0.52 mm ² (20 AWG)	0.021 Ω/ft.	0.0689 Ω/m
0.32 mm ² (22 AWG)	0.030 Ω/ft. (Belden 9182)	0.0984 Ω/m

The example that follows shows a simple method for determining if minimum DIO module source voltage specifications will be met. A more exact method is described in **Power Supply Calculations** in this section.

NOTE: Both examples only consider one DIO module in a group, as the calculations are complex for groups containing multiple DIO modules.

Example: A 20 watt supply is powering a 16 channel analog input module. The supply delivers 19 VDC output, with a minimum input line voltage of 80 VAC. It supplies the power over 350 feet of 9860 Belden cable (Table 3-3) with a loop resistance of 0.0083 ohms per foot. The total resistance of the wire is about 2.9 ohms (0.0083×350). The analog input requires 12.5 watts of power and at least 15 VDC to run.

15 VDC at 12.5 watts

Equation:

$$V_s - (R)(i) > 15 \text{ VDC minimum (enough power)}$$

$$V_s - (R)(i) < 15 \text{ VDC minimum (not enough power)}$$

Variables:

$$i = \frac{12.5 \text{ W}}{15 \text{ VDC}} = 0.83 \text{ A}$$

$$R = 350 \text{ ft.} \times 0.0083 \text{ Ω/ft.} = 2.9 \text{ Ω}$$

Check:



$$V_s - (R)(i) > 15 \text{ VDC minimum}$$

$$19 - (0.83 \times 2.9) > 15$$

The check indicates that the minimum source voltage requirement will be met.

Power Supply Calculations

The following equation will calculate the exact power requirement per module (the same example as previously described in *Maintaining Minimal DIO Module Operating Voltage* will be used).

$$V_s - V_r - V_l = 0$$

$$V_s - (R_l \times i) - \frac{W}{i} = 0$$

where:

V_s	Voltage source
V_r	Voltage resistance (cable voltage drop)
V_l	Voltage load at module
i	Amperes of current
W	Power in watts
V	DC volts
R	Ohms of resistance

Solve for i :

$$V_s - (R_l \times i) - \frac{W}{i} = 0$$

$$19 - (2.9 \times i) - \frac{12.5}{i} = 0$$

$$i = 0.743 \text{ A}$$

Solve for V_l :

$$V_l = \frac{12.5 \text{ W}}{0.743 \text{ A}} = 16.82 \text{ VDC}$$

The calculation indicates a minimum supply voltage to the DIO module of 16.82 VDC, which meets the minimum source voltage specification of 15 VDC.

Installation Sequence

The following steps provide a summary of installation procedures:

1. Mount the termination bases (refer to **Mounting and Wiring Procedure** in this section for mounting details).
2. Mount the PS-01 power supplies or the PSC-24 power supply adapters (refer to **Mounting and Wiring Procedure** in this section for mounting details).

NOTE: The PSC-24 power supply mounts similar to a module termination base.

3. Mount the ITB/CIO board. Locate the ITB/CIO board within three meters (10 feet) of the DIO board. Mounting information for the ITB/CIO board can be found in the **Distributed Control Unit** instruction.

4. Connect each PS-01 power supply to an AC power source. **PS-01 Power Supply** in this section provides instructions for jumpering the PS-01 for 115 VAC or 230 VAC operation.

-or-

Connect the PSC-24 power supply adapters to their DC supplies. **PSC-24 Power Supply Adaptor** in this section provides connection information.

5. Connect the process field wiring (refer to **Field Wiring** in this section).
6. Connect the TransNet bus cable (refer to **TransNet Bus** in this section). Insure that terminators are installed at both ends of the TransNet bus.
7. Apply AC power to the PS-01 power supplies or the power supplies used to drive the PSC-24 power supply adapters. Check that the POWER LED on the PS-01 power supply or the MAIN IN LED on each PSC-24 power supply adapter is lit. Check the voltage between the positive (+) and negative (-) terminals of the COMM BUS port at each DIO module termination base for the presence of 24 VDC (nominal).
8. If a base programmer is available, use it to program TransNet bus station addresses into each individual DIO module ter-



mination base. This will allow using the auto configure feature in the DIO configuration software. Install the DIO modules onto their respective termination bases after the station addresses have been assigned.

If a base programmer is not available, do not install the DIO hardware modules at this time. Termination bases come shipped from the factory with a default station address of 121. Instead, the DIO modules should be installed one at a time changing the station address with the DIO configuration software (refer to ***DIO Module Bus Addressing*** in Section 4) and repeating this cycle until all addresses have been assigned.

9. Install the DIO board into the Harmony DCU card frame and connect the IOB cable between the DIO board and the ITB/CIO board. After successfully running DIO diagnostics, the system should be ready for operation. DIO board information can be found in the ***Distributed Control Unit*** instruction.

Module Termination Bases

Table 3-4 summarizes termination base information.

Table 3-4. Termination Base Information

Base	Channels	Module
TE-01	32 in	Discrete input
TE-02	16 in	Discrete input
TE-03	16/8 out	Analog output
TE-04	N/A	Power ¹ - PS-01
TE-06	16/8 in	RTD
TE-07	16/8 in	Analog input Thermocouple input Universal input
TE-08	16/8 in	High level input Analog input
TE-09-3 ² TE-09-5 ²	16/8 out	Discrete output

NOTES:

1. The TE-04 termination base is used only for mounting PS-01 power supply modules.

2. 3 = 3 A fuse; 5 = 5 A fuse

Each input/output channel screw terminal can accept up to two 2.1 square-millimeter (14 AWG) wire. Each terminal base stores input/output configuration data in electrically alterable read only memory (EAROM, nonvolatile memory), allowing the hot swapping of modules without the need to reconfigure.

Figures 3-1 through 3-8 are the termination bases. Figure 3-9 is the termination base mounting template. Figure 3-10 shows the typical mounting dimensions.

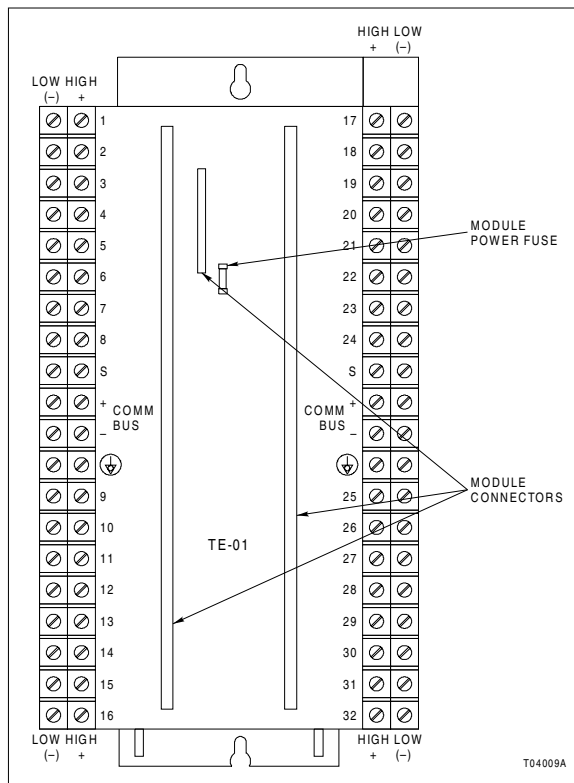


Figure 3-1. TE-01 Termination Base - Discrete Input (32 Channels)

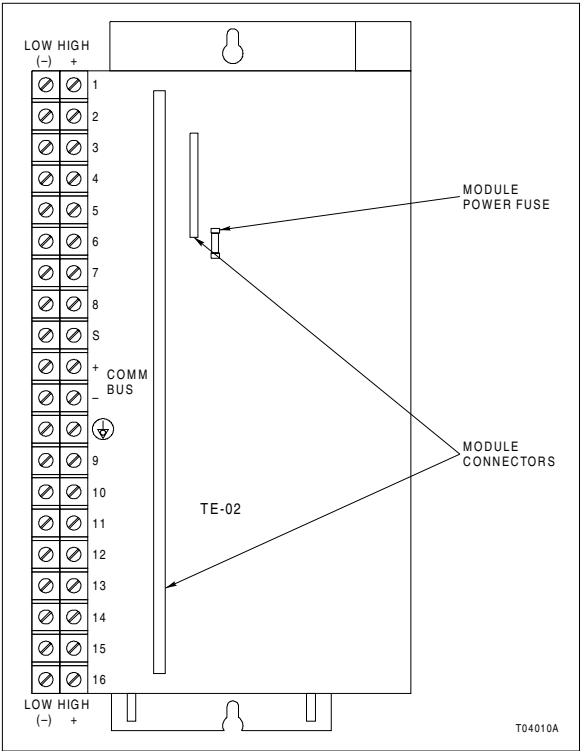


Figure 3-2. TE-02 Termination Base - Discrete Input (16 Channels)

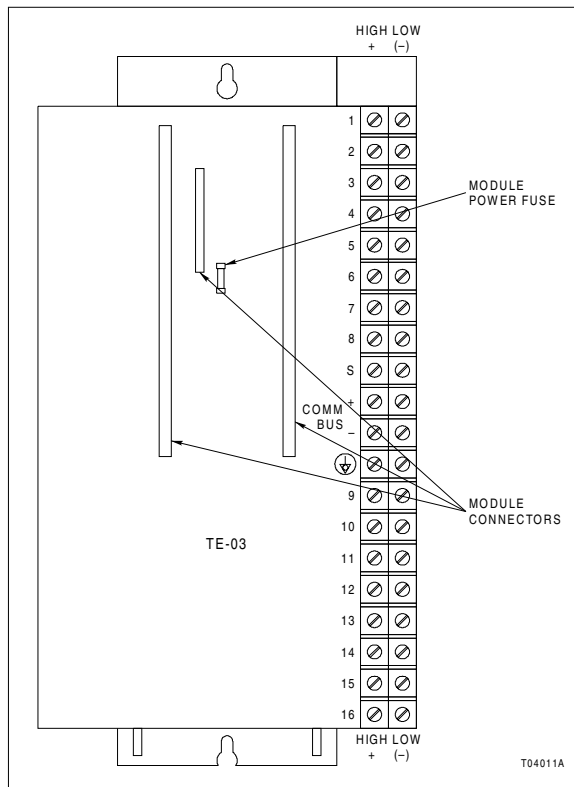


Figure 3-3. TE-03 Termination Base - Analog Outputs (8 or 16 Channels)

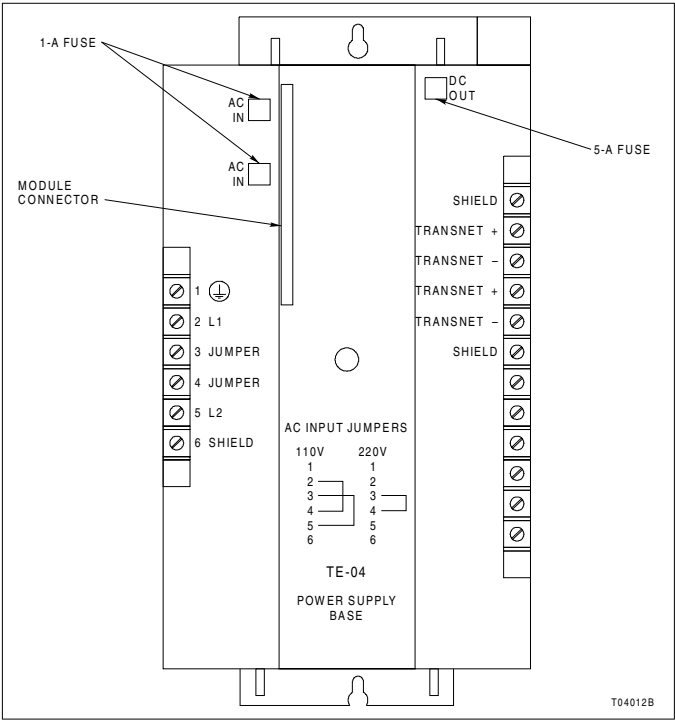


Figure 3-4. TE-04 Termination Base - PS-1 Power Supply

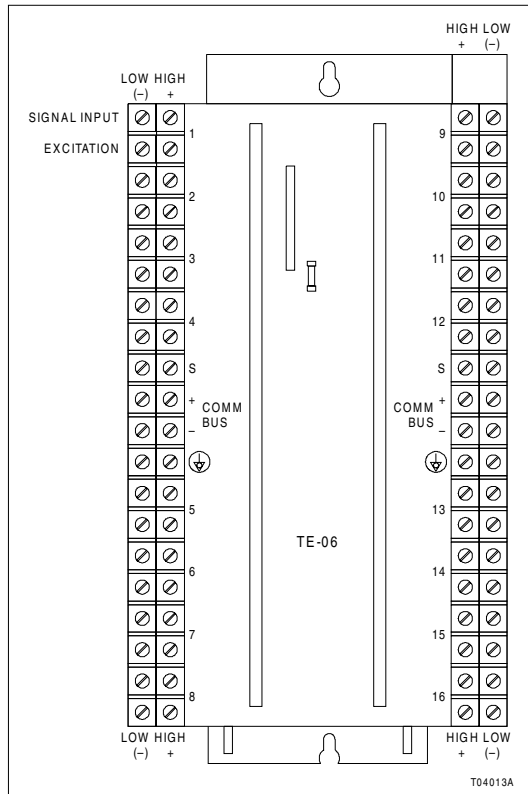


Figure 3-5. TE-06 Termination Base - RTD (8 or 16 Channels)

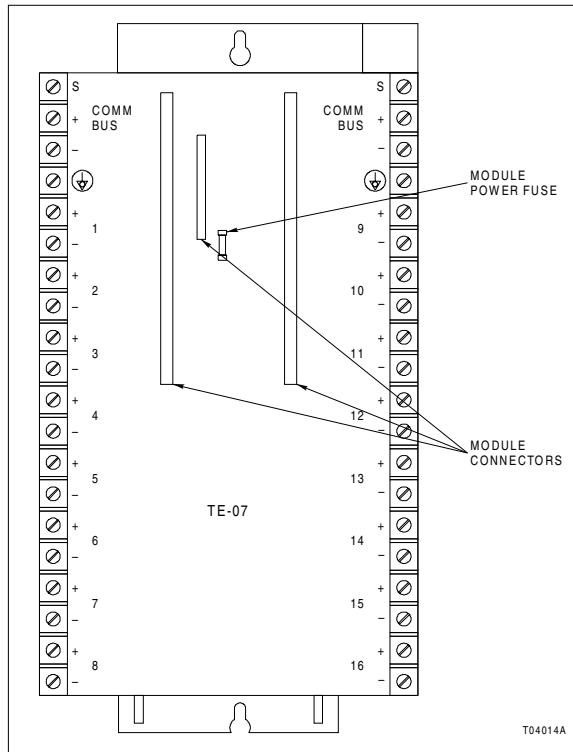


Figure 3-6. TE-07 Termination Base - Low Level Analog Input (8 or 16 Channels)

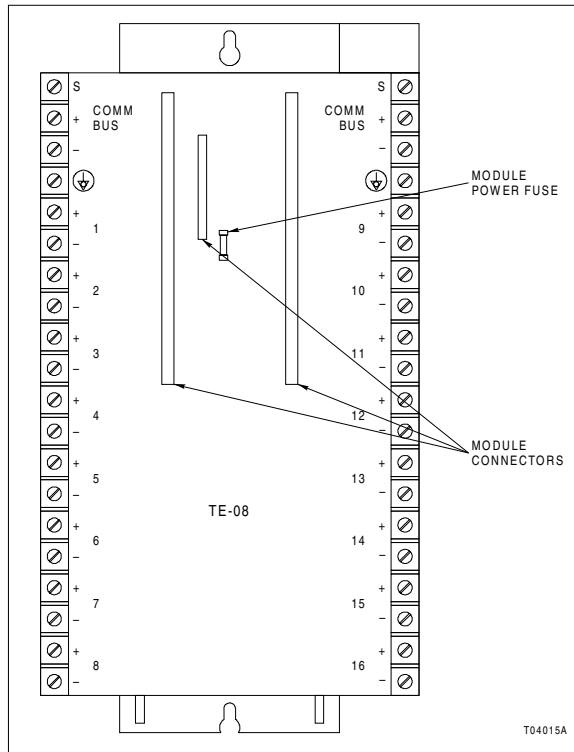


Figure 3-7. TE-08 Termination Base - High Level Analog Input (8 or 16 Channels)

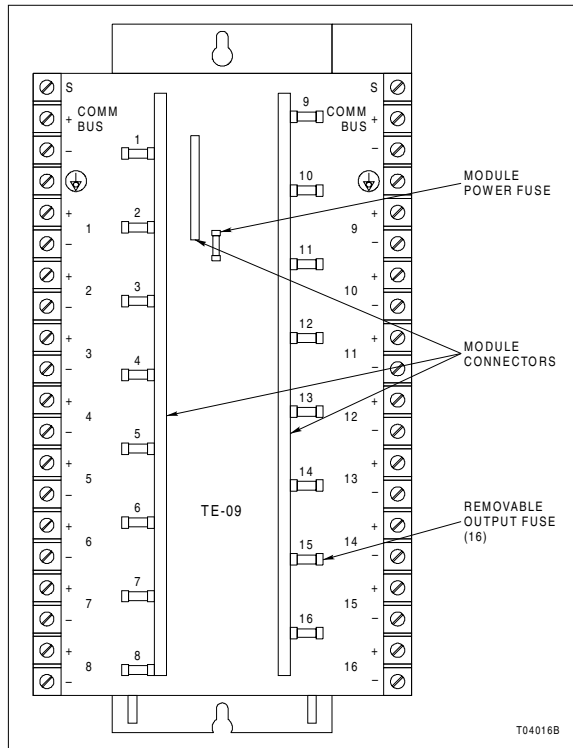


Figure 3-8. TE-09-5 or TE-09-3 Termination Base - Discrete Output (8 or 16 Channels)

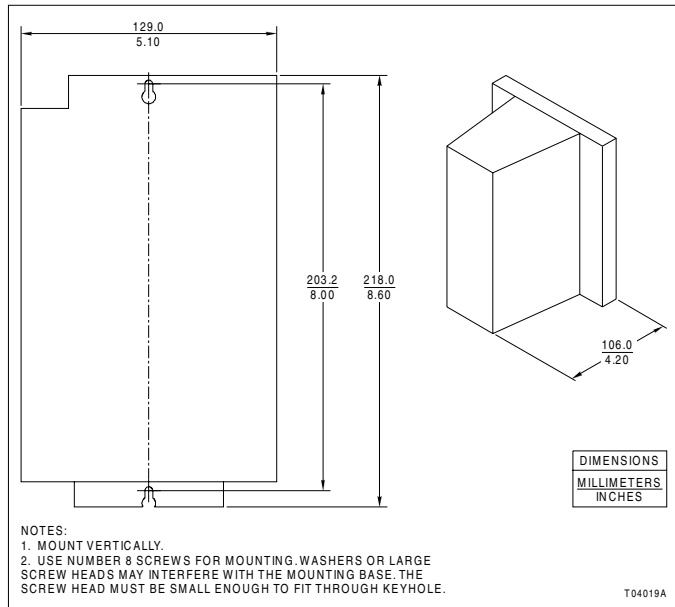


Figure 3-9. Termination Base Mounting Template

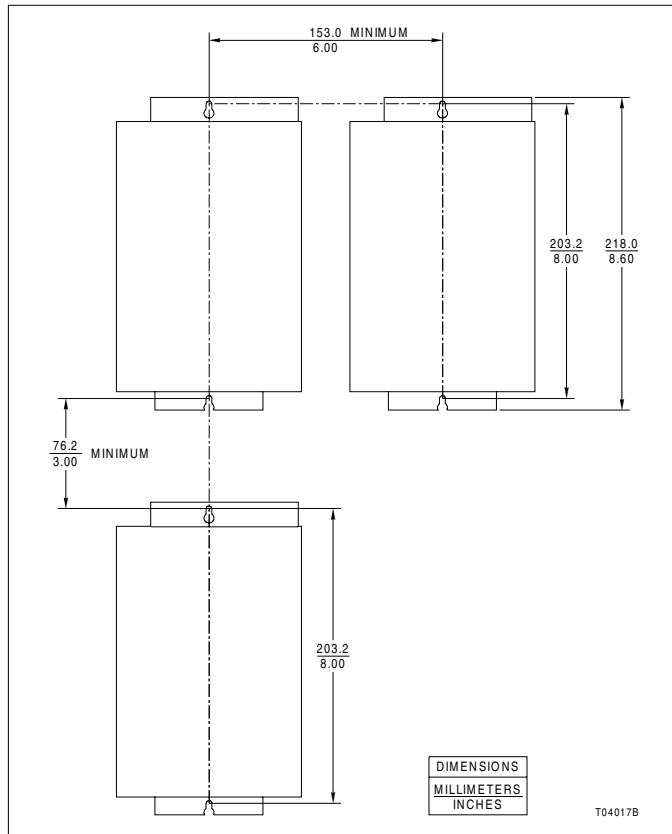


Figure 3-10. Termination Base - Typical Mounting Dimensions

Mounting and Wiring Guidelines

Avoid installing the DIO modules in locations with excessive vibrations. Do not mount modules where the ambient temperatures are higher than 60° C (140° F). Do not mount modules where any type of corrosive chemicals or fluids can come in contact with the modules.

Modules must be mounted vertically for power dissipation at the specified temperatures and current ratings.

All electrical wiring must be installed according to local electrical codes and requirements.

The following information is needed prior to mounting DIO modules:

- Termination base location.
- Number and type of modules needed for each configuration.
- Wiring diagrams (refer to **Field Wiring** in this section).

Mounting and Wiring Procedure

Refer to Figures 3-9 and 3-10 for mounting dimensions.

1. Install two M5 (no. 8), panhead screws (user supplied), leaving approximately 10-millimeters (3/8-inch) clearance between the head of the screw and the mounting surface for the module termination base.
2. While holding the termination base in the upright position, place the termination base over the mounting screws aligning the wider portion of the cutouts on the termination base over the mounting screws.
3. Push the termination base towards the mounting surface and slide the termination base downward.
4. Tighten the mounting screws so that the bolt heads just contact the termination base.
5. If necessary, replace jumpers with fuses. Refer to the wiring diagrams for optional fuse locations. Wire the module termination bases according to the diagrams in **Field Wiring** in this section.
6. Cover wiring connections with terminal strip covers.

PS-01 Power Supply

Figure 3-11 is the PS-01 power supply. Jumpers are required to configure the use of the power supply for 115 VAC or 230 VAC.

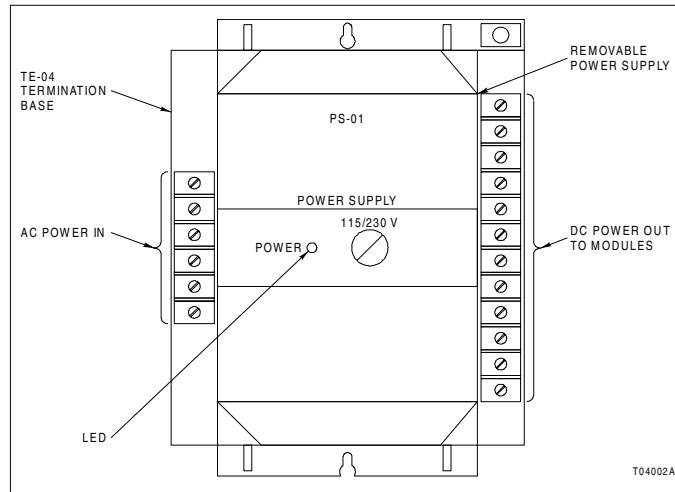


Figure 3-11. PS-01/TE-04 Power Supply

115 VAC Jumpers
(Fig. 3-12)

- Connect terminals 2 to 4 with a jumper.
- Connect terminals 3 to 5 with a jumper.
- Connect the 115 VAC source to terminals 2 and 5.
- Use 1.5 square-millimeter (16 AWG) wire.

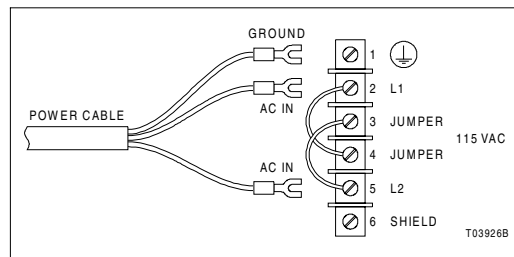


Figure 3-12. 115 VAC Jumper

230 VAC Jumpers
(Fig. 3-13)

- Connect Terminals 3 to 4 with a jumper.
- Connect the 230 VAC source to Terminals 2 and 5
- Use 1.5 square-millimeter (16 AWG) wire.

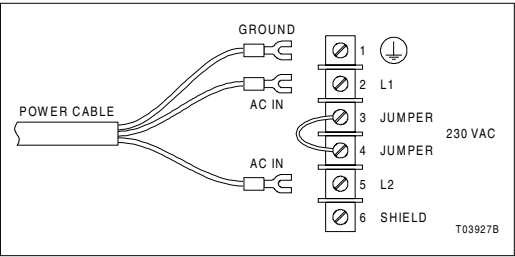


Figure 3-13. 230 VAC Jumper

PSC-24 Power Supply Adaptor

Figure 3-14 is the PSC-24 power supply adaptor. The PSC-24 power supply adaptor allows using any commercial power supply that delivers between 24 VDC to 35 VDC to power the system.

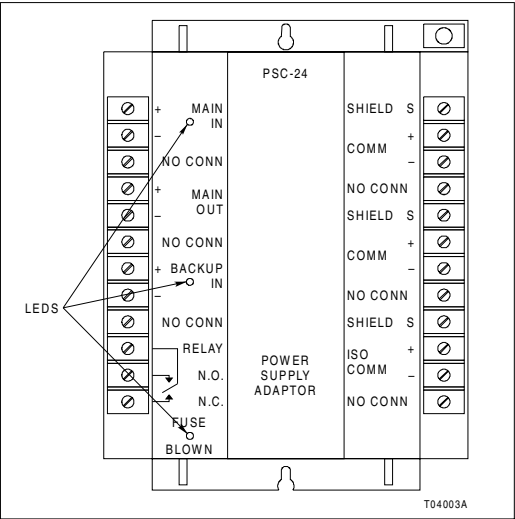


Figure 3-14. PSC-24 Power Supply Adaptor

MAIN IN DC power supply:



- The terminal marked (+) is the connection for the positive leg of the power supply.
- The terminal marked (-) is the connection of the negative leg of the power supply.
- The terminal marked NO CONN should **not** be connected.

MAIN OUT Parallel connections to the MAIN IN power input terminals:

- The terminal marked (+) is the connection for the positive leg of the power supply.
- The terminal marked (-) is the connection of the negative leg of the power supply.
- The terminal marked NO CONN should **not** be connected.

BACKUP IN Backup power supply that will switch automatically when the main power supply fails:

- The terminal marked (+) is the connection for the positive leg of the power supply.
- The terminal marked (-) is the connection of the negative leg of the power supply.
- The terminal marked NO CONN should **not** be connected.

The voltage for the BACKUP power supply should be set to 0.5 VDC below the MAIN IN power supply voltage, so that most of the power is supplied by the MAIN IN power supply.

The connections marked RELAY, N.O., N.C. are for the main supply indicating relay. These terminals are connected to the normally open, normally closed, and common terminals of a relay that are actuated when the loss of DC power occurs at the MAIN IN connection.

Field Wiring

NOTE: All connections are external to the module.

The DIO module termination bases easily attach on or near field devices. All field wiring are directly connected to the terminal blocks located on the termination bases. The DIO modules are mounted directly onto the termination bases.

This section describes wiring for the following module types:

- Discrete input.
- Discrete output.
- Analog input.
- Analog output.
- Power supplies.

Discrete Input Module

A discrete input DIO module converts an on or off field signal into an intelligible signal that is sent to the Harmony DCU. A discrete input module can be used to monitor on or off field devices such as a limit switch, a flow switch, or motor status, etc.

Channel isolation: Each channel is totally isolated from every other and from the ground. Each channel can use a different power source and does not need to be grounded.

- Channel to channel isolation: 1,500 V_{RMS}.
- Channel to ground isolation: 1,500 V_{RMS}.
- Channel to communications isolation: 1,500 V_{RMS}.
- Meets IEEE 472 surge withstand test: 3,000 VAC peak.
- UL listed at 300 VAC continuous.

Table 3-5 lists and describes the currently available discrete input DIO modules.

Table 3-5. Discrete Input DIO Modules

Module	Off Voltage	On Voltage	Switch Voltage	Input Impedance (On)	Mounting Base
DI11516	0 - 30 VAC	90 - 130 VAC	65 VAC	25 k	TE-01 or TE-02
DI11532	0 - 30 VAC	90 - 130 VAC	65 VAC	25 k	TE-01
DI23016	0 - 60 VAC	180 - 260 VAC	130 VAC	90 k	TE-01 or TE-02
DI23032	0 - 60 VAC	180 - 260 VAC	130 VAC	90 k	TE-01
DI2416	0 - 5 VDC	18 - 35 VDC	11.5 VDC	2.3 k	TE-01 or TE-02
DI2416C	0 - 5 VDC	18 - 35 VDC	11.5 VDC	2.3 k	TE-01 or TE-02
DI2432	0 - 5 VDC	18 - 35 VDC	11.5 VDC	2.3 k	TE-01
DI2432C	0 - 5 VDC	18 - 35 VDC	11.5 VDC	2.3 k	TE-01
DI4816	0 - 10 VDC	36 - 70 VDC	23 VDC	11 k	TE-01 or TE-02
DI4832	0 - 10 VDC	36 - 70 VDC	23 VDC	11 k	TE-01

**Table 3-5. Discrete Input DIO Modules** *(continued)*

Module	Off Voltage	On Voltage	Switch Voltage	Input Impedance (On)	Mounting Base
DI0516	0 - 1 VDC	2.4 - 15 VDC	2.2 VDC	0.73 k	TE-01 or TE-02
DI0516C	0 - 1 VDC	2.4 - 15 VDC	2.2 VDC	0.73 k	TE-01 or TE-02
DI0532	0 - 1 VDC	2.4 - 15 VDC	2.2 VDC	0.73 k	TE-01
DI0532C	0 - 1 VDC	2.4 - 15 VDC	2.2 VDC	0.73 k	TE-01

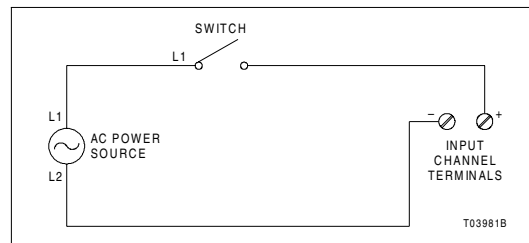
Discrete Input Module with Counters

A discrete input DIO module with counters is a discrete input module with counting capability for the first four channels. The maximum count frequency is 400 hertz square. The accumulated counts can be read by the Harmony DCU. DIO module numbers ending in C are counter modules, for example DI2416C.

Discrete Input Channels

Figures 3-15 and 3-16 show discrete input channel wiring.

In Figure 3-16 if the polarity at the input terminals is reversed, inputs will not be sensed.

**Figure 3-15. DI11516, DI11532, DI23016, and DI23032 AC Input Channels**

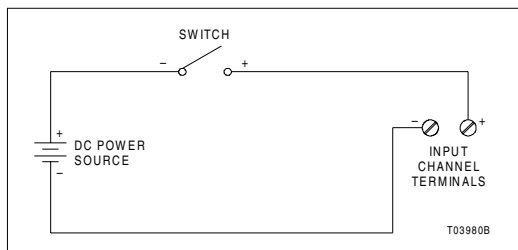


Figure 3-16. DI05XX, DI05XX, and DI24XX DC Input Channels

Discrete Output Module

A discrete output is a solid-state relay contact or a switch that is controlled by the Harmony DCU. A discrete output can be used to control motor starters, relays, indicator lights, etc. The maximum current output per each DIO module is 20 amperes.

Channel Isolation: All channels are isolated from one another. Each channel can use a different power source and does not need to be grounded.

NOTE: Certain versions of the DC output module, models D00016, D00016-M, D00116, and D00116-M are isolated in groups of four channels.

- Channel to channel isolation: 1,500 V_{RMS} .
- Channel to ground isolation: 1,500 V_{RMS} .
- Channel to communications isolation: 1,500 V_{RMS} .
- Meets ANSI/IEEE C37.90-1978 surge withstand capability.
- UL listed at 300 VAC continuous.

Table 3-6 lists and describes the currently available discrete output DIO modules, which are approved for Class 1 Division 2 Groups A, B, C, and D equipment.

Table 3-6. Discrete Output DIO Modules

Module	Chan	Output Voltage	Range	Off Leakage	Voltage Drop (On)	Output Current
DO0116	16	20 to 250 VAC	20 to 250 VAC	<2.50 mA	<1.2 at 2 A	2 A
DO0116-M	16	20 to 250 VAC	20 to 250 VAC	<2.50 mA	<1.2 at 2 A	2 A
DO0016	16	5 to 50 VDC	5 to 50 VDC	<.250 mA	<1.0 at 2 A	2 A
DO0016-M	16	5 to 50 VDC	5 to 50 VDC	<.250 mA	<1.0 at 2 A	2 A

**Table 3-6. Discrete Output DIO Modules** *(continued)*

Module	Chan	Output Voltage	Range	Off Leakage	Voltage Drop (On)	Output Current
DO0216-M	16	5 to 50 VDC	5 to 50 VDC	<.250 mA	<1.0 at 2 A	2 A
DO0216	16	5 to 50 VDC	5 to 50 VDC	<.250 mA	<1.0 at 2 A	2 A

Discrete Output Module with Monitoring

A discrete output DIO module with monitoring has the capability to verify the status of the output channel. DIO module numbers ending in M include the monitoring feature. The monitor turns on if the current in the output circuit is greater than 40 milliamperes and is off if the output circuit is less than 20 milliamperes. If the monitored status does not agree with the written value, (i.e., the Harmony DCU turns on an output in a module but the module does not actually turn on, or the Harmony DCU turns the output of the module off but the module does not actually turn off) an error condition is shown as a flashing channel LED and a flashing FAULT LED.

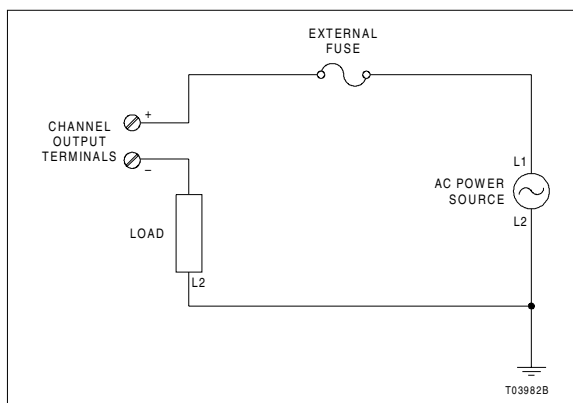
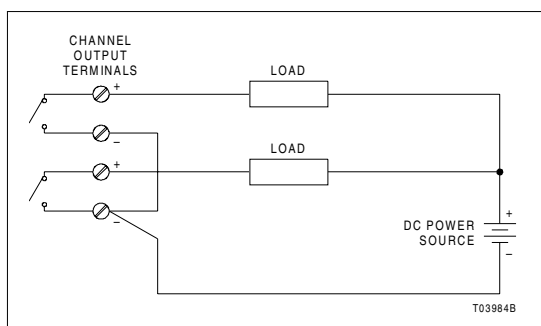
The on/off status of the current flow in the output circuit is sent back to the Harmony DCU. This feature allows the host computer to detect field wiring problems such as open circuits, blown fuses, faulty field devices, or a faulty output channel.

Discrete Output Channels

Figures 3-17 through 3-19 show discrete output channel wiring.

In Figures 3-18 and 3-19 if the polarity is reversed, the output will be biased to the on condition.

In Figures 3-18 and 3-19, output channels are individually isolated; two channels are shown in this figures.

**Figure 3-17. DO0116 and DO0116-M Output Channels****Figure 3-18. DO0216 and DO0216-M Output Channels - Low Side Switching**

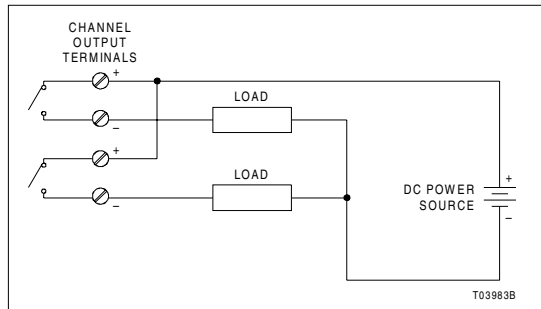


Figure 3-19. DO0216 and DO0216-M Output Channels - High Side Switching

Analog Input Module

An analog input DIO module converts a variable field signal into a numerical value that is sent to the host computer. Each analog input channel can be configured with software to accept various signals such as a voltage, current, or thermocouple type signal. Figure 3-20 shows analog input channel wiring.

Channel isolation: Each channel is totally isolated from each other and from the ground. Each channel can use a different power source and does not need to be grounded.

- Channel to Channel isolation: 1,500 V_{RMS}.
- Channel to Ground isolation: 1,500 V_{RMS}.
- Channel to Communications isolation: 1,500 V_{RMS}.
- Meets ANSI/IEEE C37.90-1978 surge withstand capability.
- UL designed at 300 VAC continuous.

NOTE: Maximum differential input voltage is 30 VDC.

Table 3-7 lists and describes the currently available analog input DIO modules, which are approved for Class 1 Division 2 Groups A, B, C, and D equipment.

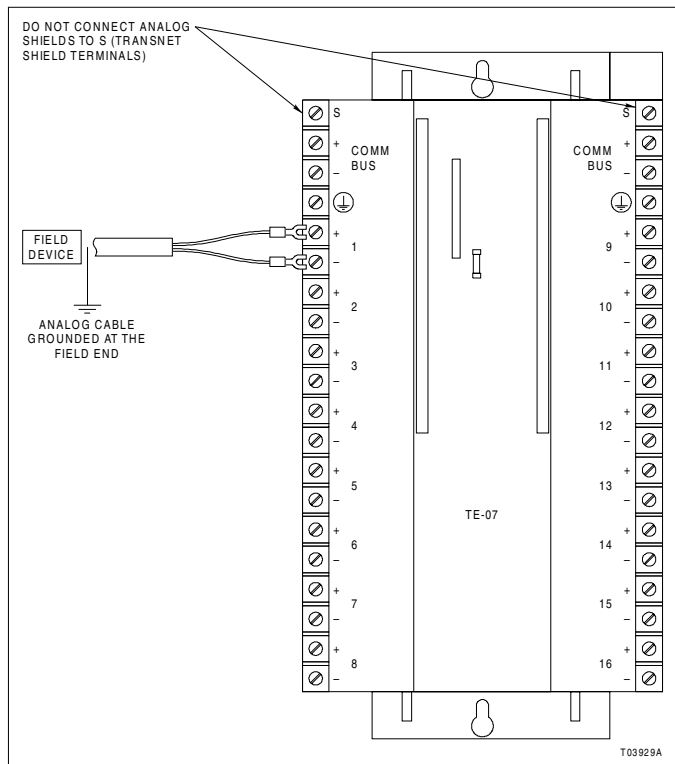


Figure 3-20. Analog Input Channel Wiring

Table 3-7. Analog Input DIO Modules

Model	Chan	Input Voltage
AI0008	8	Software selectable per channel
AI0016	16	Signal values: 1 - 5.0 VDC ± 5.0 VDC ± 12.5 mVDC ± 25 mVDC ± 50 mVDC ± 100 mVDC Thermocouple types: J, J DIN, K1, K2, K DIN, T, E, C, S, R, B, N



Table 3-7. Analog Input DIO Modules (continued)

Model	Chan	Input Voltage
AI0108	8	Software selectable per channel
AI0116	16	Signal values: 1 - 5.0 VDC 0 - 5.0 VDC 0 - 12.5 mVDC 0 - 25 mVDC 0 - 50 mVDC 0 - 100 mVDC Pt/Ni RTD types: Pt 385: 60 C, 400 C, 879 C Pt 391: 60 C, 400 C, 879 C Pt 392: 60 C, 400 C, 879 C Ni 120: 7 C, 150 C, 320 C Slide wire resistance: 100 Ω 125 Ω 250 Ω 500 Ω 10 K Ω NOTE: This module does not compensate for field lead resistance when used with 3-wire RTDs.
AI0108-3W	8	3-wire RTDs and slide wires only
AI0116-3W	16	
AI1508	8	1 - 5.0 VDC; ± 5.0 VDC
AI1516	16	

Analog Input Channel - Voltage or Millivolt Source

In Figure 3-21, the shield must be connected to ground in one place only.

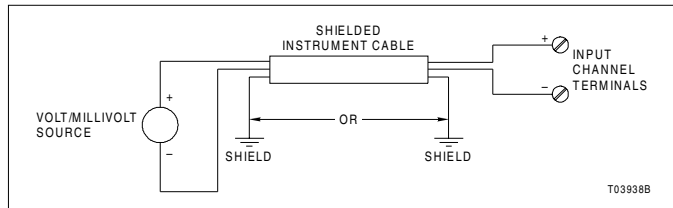


Figure 3-21. Analog Input Channels with Voltage or Millivolt Sources

Analog Input Channel - Externally Powered Current Source

In Figure 3-22, the polarities must be as shown for this circuit to work.

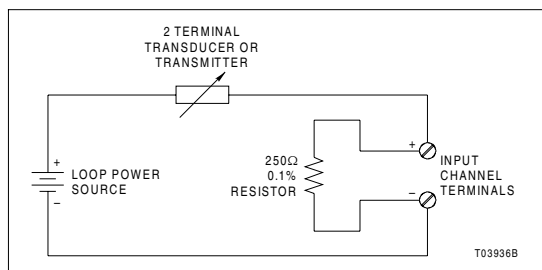


Figure 3-22. Analog Input Channels with Externally Powered Current Source

Analog Input Channel - Internally Powered Transducer and Transmitter

In Figure 3-23, the polarities must be as shown for this circuit to work.

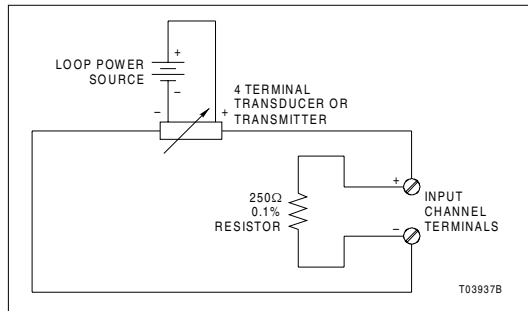


Figure 3-23. Analog Input Channels with Internally Powered Transducer and Transmitter

Analog Input Channel - Thermocouple

In Figure 3-24 if the polarity of the thermocouple wire is reversed, the temperature measurement will have a large error.

In Figure 3-24 if a thermocouple extension wire is being used, make sure that the proper polarity is observed. If the polarity of the extension wire is reversed, an error to the thermocouple signal will be induced.

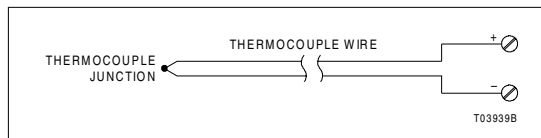


Figure 3-24. Analog Input Channels with Thermocouple

Analog Input Channel - Voltage or Millivolt Source (AI0108 or AI0116)

In Figure 3-25, connect the shield to ground in one place.

In Figure 3-25, each channel has four terminals, two for excitation and two for signal input. The module measures the voltage level at the input terminals. The excitation terminals are connected to an isolated 0.2 milliamperes constant current source. The excitation (-) and input (-) **must** be connected for proper calibration operation.

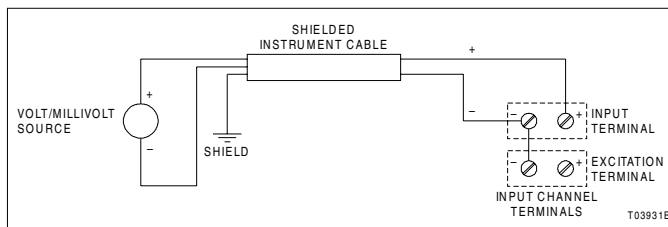


Figure 3-25. AI0108 or AI0116 Input Channels with Voltage or Millivolt Source

Analog Input Channel - Externally Powered Current Source (AI0108 or AI0116)

In Figure 3-26, the polarities must be as shown for this circuit to work.

In Figure 3-26, each channel has four terminals, two for excitation and two for signal input. The module measures the voltage level at the input terminals. The excitation terminals are connected to an isolated 0.2 milliamperes constant current source. The excitation (-) and input (-) **must** be connected for proper calibration operation.

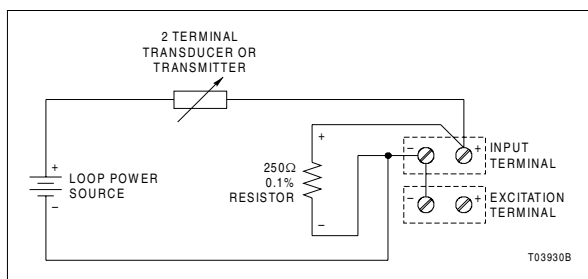


Figure 3-26. AI0108 or AI0116 Input Channels with Externally Powered Current Source

Analog Input Channel - Internally Powered Transducer and Transmitter (AI0108 or AI0116)

In Figure 3-27, the polarities must be as shown for this circuit to work.



In Figures 3-27, each channel has four terminals, two for excitation and two for signal input. The module measures the voltage level at the input terminals. The excitation terminals are connected to an isolated 0.2 milliamperes constant current source. The excitation (-) and input (-) **must** be connected for proper calibration operation.

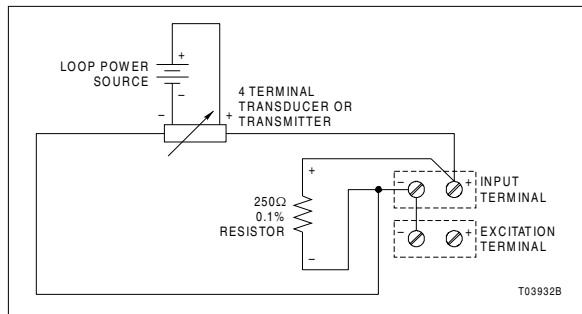


Figure 3-27. AI0108 or AI0116 Input Channels with Internally Powered Transducers or Transmitters

Analog Input Channel - 2-Wire RTD (AI0108 or AI0116)

In Figure 3-28, the polarities must be as shown for the circuit to work. Excitation is a constant 0.2 milliamperes nominal current source.

In Figure 3-28, this module does not compensate for the lead resistance of the excitation wire. Significant errors will be introduced into the measurement proportional to the lead resistance. This effect becomes worse with distance.

In Figure 3-28, the AI01XX and AI02XX modules have four terminals. Two of the terminals are for signal input. The module measures signal level at these terminals. The other two terminals are for excitation. These excitation terminals are connected to an isolated (constant) 0.2 milliamperes nominal current source.

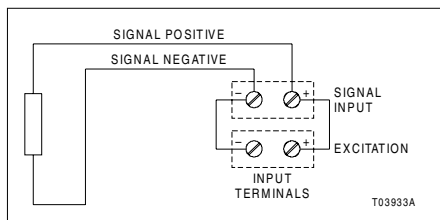


Figure 3-28. AI0108 and AI0116 Input Channels with 2-Wire RTD

Analog Input Channel - 3-Wire RTD (AI0108 or AI0116)

In Figure 3-29, the polarities must be as shown for this circuit to work.

In Figure 3-29, this module does not compensate for the lead resistance of the excitation wire. Significant errors will be introduced into the measurement proportional to the lead resistance. This effect becomes worse with distance.

In Figure 3-29, the AI01XX and AI02XX modules have four terminals. Two of the terminals are for signal input. The module measures signal level at these terminals. The other two terminals are for excitation. These excitation terminals are connected to an isolated (constant) 0.2 milliamperes nominal current source.

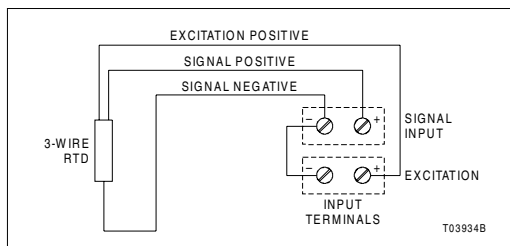


Figure 3-29. AI0108 and AI0116 Input Channels with 3-Wire RTD

Analog Input Channel - 4-Wire RTD/Slide Wire (AI0108 or AI0116)

In Figures 3-30, the polarities must be as shown for this circuit to work.



In Figure 3-30, the AI01XX and AI02XX modules have four terminals. Two of the terminals are for signal input. The module measures signal level at these terminals. The other two terminals are for excitation. (Excitation is a constant 0.2 milliamperes nominal current source.) These excitation terminals are connected to an isolated (constant) 0.2 milliamperes nominal current source.

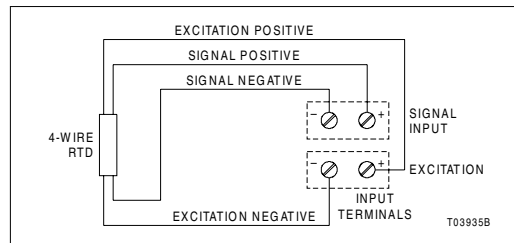


Figure 3-30. AI0108 & AI0116 Input Channels with 4-Wire RTD/Slide Wire

Analog Input Channel - 3-Wire RTD (AI0108-3W and AI0116-3W)

In Figure 3-31, the polarities must be as shown for this circuit to work.

In Figure 3-31, the AI01XX-3W modules each have four terminals. Two of the terminals are for signal input. The module measures signal levels at these terminals. The other two terminals are for excitation. These excitation terminals are connected to an isolated (constant) 0.2 milliamperes nominal current source.

In Figure 3-31, the AI01XX-3W module contains special firmware for compensating for the lead resistance of the field wires between the module and a three wire RTD. To minimize error, the field wire connected from the positive (signal and excitation) terminals to the RTD, and the field wire connected from the negative excitation terminal to the RTD must be of the same length, gauge, and type.

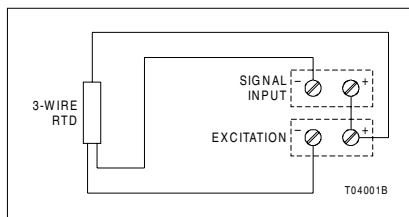


Figure 3-31. AI0108-3W and AI0116-3W Input Channels with 3-Wire RTD

Analog Output Module

An analog output DIO module converts numerical values from the Harmony DCU into signals used to control field devices. For example, such a field device can be a 4 to 20 milliamperes actuator.

Channel isolation: Each channel is totally isolated from each other and from the ground. Each channel can use a different power source and does not need to be grounded.

- Channel to Channel isolation: 1,500 V_{RMS}.
- Channel to Ground isolation: 1,500 V_{RMS}.
- Channel to Communications isolation: 1,500 V_{RMS}.
- Meets ANSI/IEEE C37.90-1978 surge withstand capability.
- UL designed at 300 VAC continuous.

Table 3-8 lists and describes the currently available analog output DIO modules, which are approved for Class 1 Division 2 Groups A, B, C, and D equipment.

Table 3-8. Analog Output DIO Modules

Model	Chan	Output Range
AO42016	16	0 - 20 mA 4 - 20 mA
AO42008	8	0 - 20 mA 4 - 20 mA

Analog Output Channels

Figures 3-32 and 3-33 show analog output channel wiring.



In Figure 3-32, the loop power source is in the module. Each channel is capable of driving a 600 ohm maximum load.

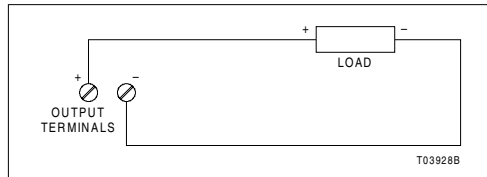


Figure 3-32. Analog Output Channels

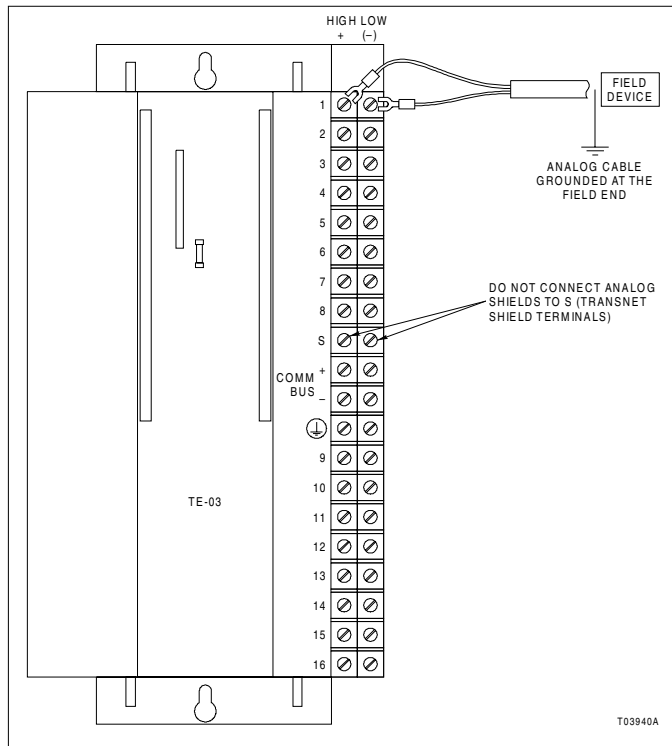


Figure 3-33. Analog Output Wiring

Analog Module - Channel Shielding

All analog input and output shields must be grounded to minimize the effects of noise on the field signals. The shield on a cable must be grounded at one end or the other, but not both ends. Grounding a cable at both ends will create a ground loop which can introduce noise into the system. It is recommended that grounds be connected to the ground at the termination base.

TransNet Bus

The TransNet bus is used for all communications between the DIO board (through the ITB/CIO board) and the DIO modules. The TransNet bus operates at 375 kilobaud with frequency shift keying between 1.5 megahertz and 2.0 megahertz. The protocol is a command/response protocol which allows the DIO board to communicate with every DIO module. Each DIO module is identified by a unique station address (1 to 120), which is assigned during system installation.

The signals transmitted on the TransNet bus are attenuated by the bus cable and DIO module loading. For example, the greater the attenuation, the greater the loss of the signal. When a signal is transmitted through the TransNet bus, a certain percentage of the signal is lost. The DIO system designer must verify that the TransNet bus AC communications signal is not over attenuated as a result of loading by the bus cable, DIO modules, and power supplies. Refer to ***Determining Cable Loss Attenuation***, ***Determining Reflection Loss Attenuation (Module)***, and ***Determining Reflection Loss Attenuation (Power Supply)*** in this section for information on calculating communication signal attenuation.

The communication signal attenuation does not need to be considered, however, if the maximum length of the TransNet bus is under 610 meters (2,000 feet) and the number of hardware modules is less than 75.

NOTE: Communication signal attenuation in the TransNet bus is dependent on the TransNet bus cable type used. To minimize TransNet bus voltage drops, choose a cable type with low loss at 2 MHz (refer to Table 3-13 for cable data).



TransNet Terminator

TransNet bus terminators are required for the DIO system. The TransNet bus needs terminators at both ends of the network. Failure to properly terminate the bus result in noise on the bus, which could cause the system to not functioning properly. The terminating resistors must be selected to match the nominal characteristic impedance of the network cable type selected.

Two different TransNet bus termination packages are available from ABB Automation; each package contains two bus terminators. ABB part number FRS-xxx-2 (where xxx is 100, 125, or 150 to satisfy different TransNet bus cable impedances) should be ordered when connecting the DIO board somewhere in the middle of the TransNet bus. ABB part number FRS-xxx-4 (where xxx is 100, 125, or 150 to satisfy different TransNet bus cable impedances) should be ordered when one side of the TransNet bus terminates at the ITB/CIO board.

ITB/CIO Board Location

The ITB/CIO board can be connected anywhere on the on the main line of the TransNet bus. A terminator is placed at each end of the TransNet bus (to reduce electrical noise). The most direct path between the TransNet terminator resistors represents the main trunk of the TransNet bus. Depending on the configuration desired, the ITB/CIO board may or may not have a terminator plugged into it.

If the DIO board is not located at one end of the TransNet main trunk and a cable drop is used to connect the ITB/CIO board to the TransNet bus, the maximum allowable drop length is determined by the stub rule described in ***Determining the Maximum Allowable Length of Drops*** in this section. (Refer to the ***Distributed Control Unit*** instruction for the ABB part numbers for ITB/CIO cables of various lengths.)

Power Supply Location

The TransNet bus power supplies can be connected anywhere on the main line. If necessary, multiple power supplies can be used to power the electronics of the DIO modules.

TransNet Bus Topologies

The TransNet cable can connect between the DIO modules and the ITB/CIO board using various network topologies:

- Direct connect topology which has the least attenuation (the best configuration).
- Multidrop topology which has some attenuation (the second best configuration).
- Cluster topology which has the highest attenuation (the least desirable configuration).

Direct Connect

In a direct connect topology (Fig. 3-34), the DIO board is cable connected to the ITB/CIO board. A terminator is mounted on the ITB/CIO board. The length of the cable between the DIO board and the ITB/CIO board **must** be less than or equal to the maximum determined by the rule in *Determining the Maximum Allowable Length of Drops* in this section.

Multidrop

In a multidrop topology (Fig. 3-35), the DIO board is cable connected to the main trunk of the TransNet bus, passing through the ITB/CIO board. No terminator is mounted on the ITB/CIO board. The length of the cable between the DIO board and the junction box on the main trunk of the TransNet bus **must** be less than or equal to the maximum determined by the rule in *Determining the Maximum Allowable Length of Drops* in this section.

Cluster

In a cluster topology (Fig. 3-36), the DIO board is cable connected to the main trunk of the TransNet bus, passing through the ITB/CIO board, through a junction box to the main trunk of the TransNet bus. No terminator is mounted on the ITB/CIO board. The length of the cable between the DIO board and the junction box on the main trunk of the TransNet bus **must** be less than or equal to the maximum determined by the rule in *Determining the Maximum Allowable Length of Drops* in this section.

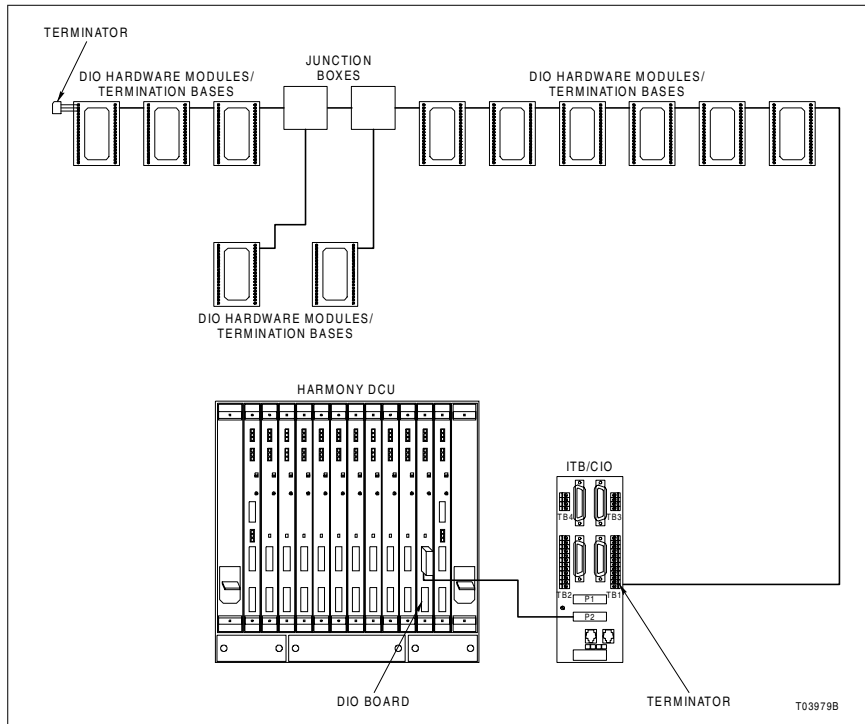


Figure 3-34. Direct Connect Configuration Topology

Communication Distance

The length of the TransNet bus is limited by attenuation due to line loss and reflections. The maximum length, away from the ITB/CIO board in either direction, of the main line must be less than 1.65 kilometers (one mile). Refer to [Appendix A](#) for information about use of fiber optic converters and fiber optic cable to extend the TransNet bus.

Determining Signal Attenuation

Each module on the TransNet bus must receive a signal from the interface that is greater than 1.0 volt, peak-to-peak. The signal attenuation is determined by the following formula:

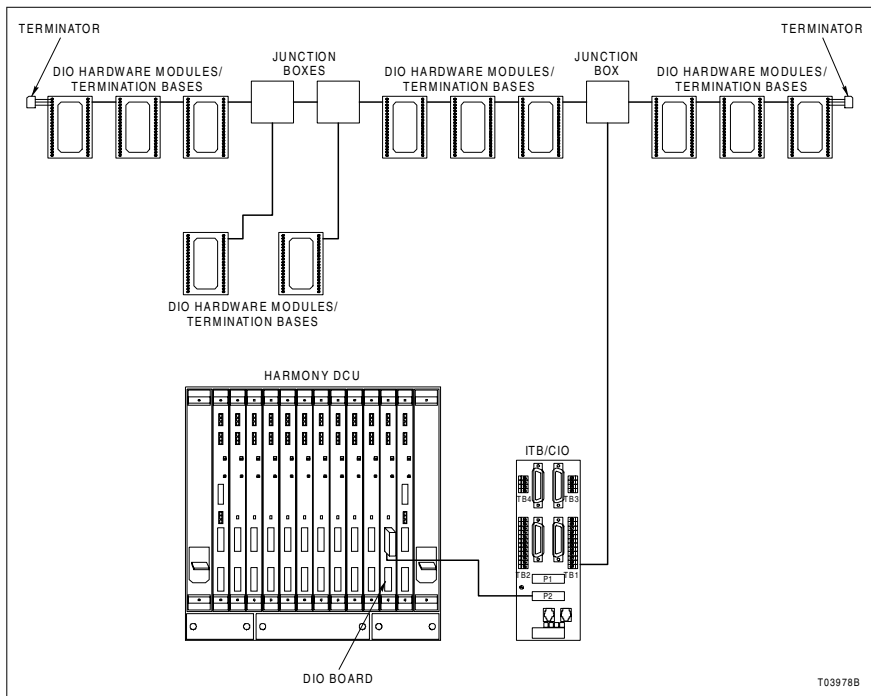


Figure 3-35. Multidrop Configuration Topology

$$\text{Cable Loss} + \text{Reflection Loss (Modules)} + \text{Reflection Loss (Power Supplies)} = \text{Signal Attenuation}$$

where:

The sum of the signal attenuation must be **less** than that shown in Table 3-9.

NOTE: If an optional network attenuator is installed on the TransNet bus, it must also be considered when calculating signal attenuation. A network attenuator will cause 3 dB or 5 dB attenuation, depending on the model installed. Refer to [Appendix D](#) for additional information on the network attenuator.

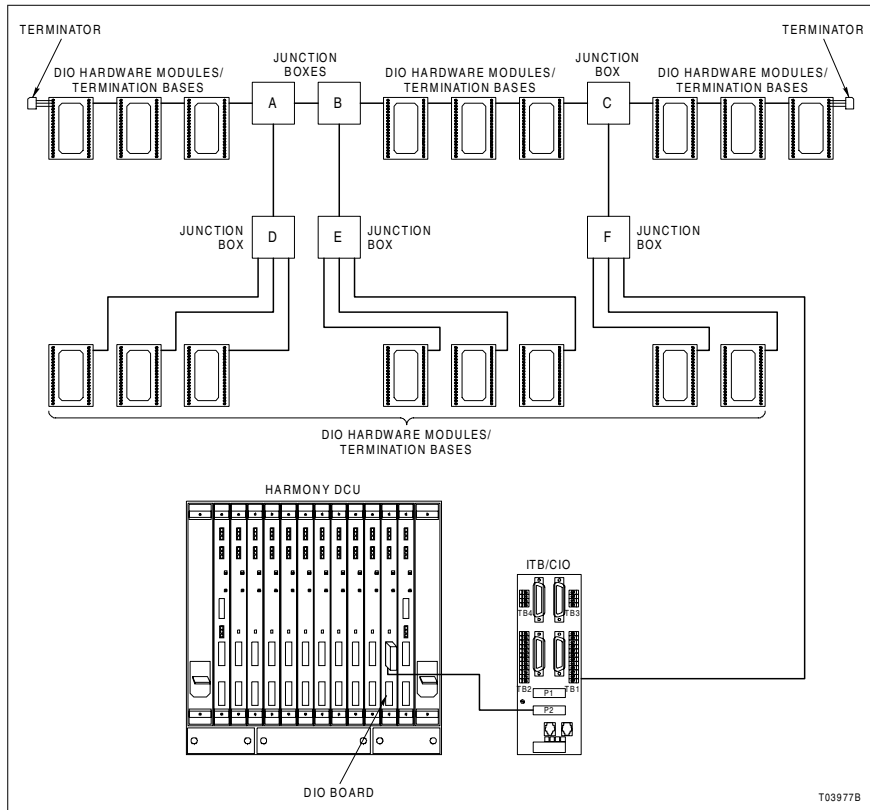


Figure 3-36. Cluster Configuration Topology

<i>Cable Loss</i>	Affected by the cable type and length.
<i>Reflection Loss (Modules)</i>	Affected by the number of modules.
<i>Reflection Loss (Power Supplies)</i>	Affected by the number of Power Supplies

Table 3-9. Signal Attenuation

Cable Type	150 Ω	125 Ω	100 Ω
Allowed Attenuation	24.0 dB	23.5 dB	22.7 dB

Determining Cable Loss Attenuation

1. Determine the nominal attenuation. Attenuation is usually expressed in dB per 100 feet and depends upon the operating frequency. The maximum frequency of the TransNet bus is 2 megahertz. For example, nominal attenuation for Belden 9182 is shown in Table 3-10.

Table 3-10. Nominal Attenuation for Belden 9182

Frequency (Mhz)	Nominal Attenuation (dB/100 ft.)
1	0.40 Belden catalog
2	0.56 interpolation determination
10	1.20 Belden catalog

NOTE: Interpolation was required because the Belden cable specification does not give the nominal attenuation at the 2 MHz operating frequency.

- Determine the length of the signal path along the cable between the interface and the DIO module.
- Calculate the cable loss attenuation as follows:

$$\text{Cable Distance} \times \text{Nominal Attenuation} = \text{Cable Loss Attenuation}$$

Determining Reflection Loss Attenuation (Module)

The signal arriving at a DIO module is attenuated by reflections at each connection on the main trunk along the path of transmission. If there are four connections between the interface and a DIO module; then that DIO module is attenuated by five reflection attenuations.

Use Table 3-11 to determine reflection attenuation for one DIO module connected to the main line. Because DIO modules are connected directly to the TransNet bus a drop length of zero feet is used.

**Table 3-11. Module Reflection/Drop Attenuation**

Cable Ω	Attenuation
100	0.11 dB
125	0.14 dB
150	0.17 dB

Determining Reflection Loss Attenuation (Power Supply)

The signal arriving at a power supply is attenuated by reflections at each connection on the main trunk along the path of transmission. If there are four connections between the interface and a power supply; then that power supply is attenuated by five reflection attenuations.

Use Table 3-12 to determine reflection attenuation for one power supply connected to the main line. Because power supplies are connected directly to the bus a drop length of zero feet is used.

Table 3-12. PS-01 and PSC-24 Power Supplies Reflection/Drop Attenuation

Cable Ω	Attenuation
100	0.20 dB
125	0.25 dB
150	0.31 dB

Selecting Cable Type

The bus requires a cable that consists of twinaxial type wire with the following characteristics:

- Wire size or gauge.
- Nominal impedance.
- Nominal attenuation.

A larger size wire reduces DC power loss and allows more flexibility when locating the power supplies. In addition, a lower nominal impedance reduces signal attenuation caused by reflectance. The low nominal attenuation reduces AC signal attenuation caused by cable capacitance.

The recommended cables for use are:

- Belden 9182.

- Alpha 9823.
- Belden 9860.

Table 3-13 lists specific information about each of these cables.

Table 3-13. Recommended TransNet Cables

Cable	Wire Gauge	Wire Loop Resistance (Ω /ft.)	Nominal Impedance (Ω /ft.)	Nominal Attenuation at 2 MHz (dB/ft.)	Nominal Attenuation at 2 MHz (dB/m)
Belden 9182	0.32 mm ² (22 AWG)	0.030	150	0.0056	0.0182
Alpha 9823	0.32 mm ² (22 AWG)	0.030	150	0.0056	0.0182
Belden 9860	1.3 mm ² (16 AWG)	0.008	125	0.0028	0.0091

NOTE: For other cables, refer to the manufacturer's specifications of wire gauge, nominal impedance, and nominal attenuation.

Example In a system that contains:

1,200 feet of Alpha 9823 cable (150 ohm)
 2 MHz frequency
 23 modules
 3 PSC-24 power supply adaptors

Cable loss attenuation:

$$1200 \text{ ft.} \times 0.0056 \text{ dB/ft.} = 6.72 \text{ dB}$$

Reflection loss attenuation (modules):

$$23 \text{ modules} \times 0.17 \text{ dB} = 3.91 \text{ dB}$$

Reflection loss attenuation (power supplies):

$$3 \text{ power supplies} \times 0.31 \text{ dB} = 0.93 \text{ dB}$$

Determining signal attenuation:

$$6.72 \text{ dB} + 3.91 \text{ dB} + 0.93 \text{ dB} < 24 \text{ dB}$$

The calculation indicates an acceptable signal attenuation, which is below 24 dB.



Grounding Information

Before connecting the TranNet bus, it is important that the following items are verified:

- Do **not** connect the shield of the interface cable to the computer chassis.
- The network shield **must** be grounded at only one point to prevent ground loops.
- Make certain the shield is connected at every module.

Physical Bus Connections

Cable Connections and **Terminator Connections** in this section describe how to:

- Wire the interface to a module.
- Install the terminating resistor to a module.

Cable Connections

Figure 3-37 shows the TransNet bus cable connection. The shields should be connected to chassis ground only in one location. Connecting the shields to chassis ground in multiple locations may cause communication problems.

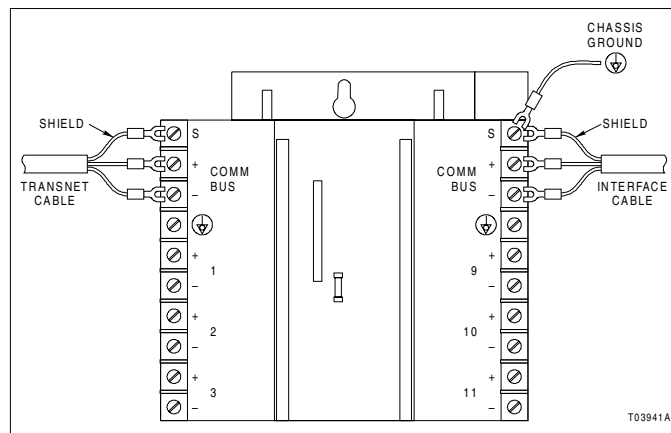


Figure 3-37. Cable Connections

Terminator Connections

One TransNet bus terminator is supplied with FRS-100-4, FRS-125-4, or FRS-150-4. The TransNet bus terminator is mounted at the COM1 connector of the ITB/CIO board when the TransNet bus terminates at the ITB/CIO board.

Figure 3-38 shows the terminator connections to a module. Terminating resistors are attached at the last module on the bus.

NOTE: In Figure 3-38, the chassis terminal on the base is connected to the internal ground of the CPU in the module. Under normal circumstances it is not necessary to ground this terminal.

The terminating resistors have polarity, and should not be installed upside down (Fig. 3-38). The termination circuits for the positive (+) and negative (-) pins of the terminator are identical, and can therefore be used interchangeably. The shield (S) pin of the terminating resistor is **not** interchangeable; always connect it to a shield (S) connection.

Figure 3-39 shows the different terminators available. The value of the terminating resistor is determined by how many corners have been snipped off. Typically, the correct resistor is shipped from the factory. However, it is important to be able to recognize the rating of each terminating resistor.

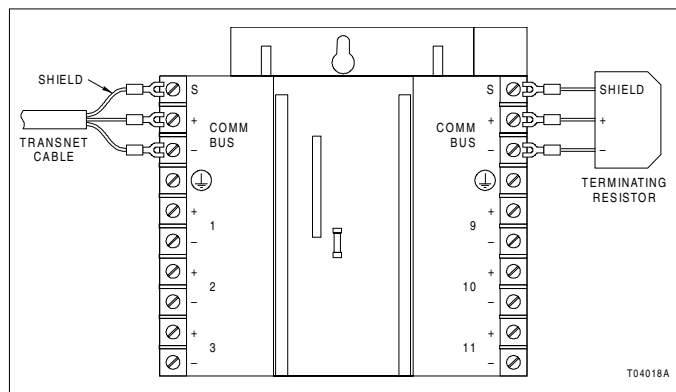


Figure 3-38. Module Terminating Resistors

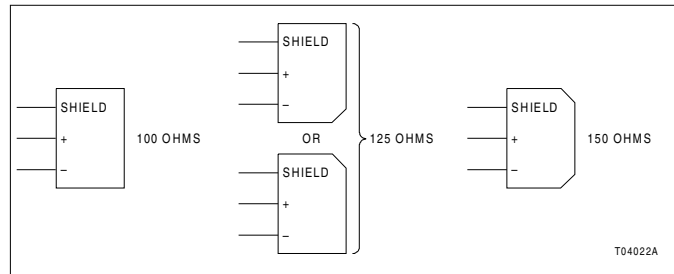


Figure 3-39. Types of Terminating Resistors

Determining the Maximum Allowable Length of Drops

A terminator is placed at each end of the TransNet bus (to reduce electrical noise). The most direct path between the TransNet terminating resistors represents the main trunk of the TransNet bus. Any cable drop used to connect a DIO module, power supply, fiber optic converter, redundant network selector, or ITB/CIO board from the main trunk of the TransNet bus is considered a stub from the network. The maximum allowable length of any stub is dependent upon the following rules:

- If the main trunk of the TransNet bus is ≥ 160 feet, the maximum length of any stub is 16 feet.
- If the main trunk of the TransNet bus is under 160 feet, the maximum length of any stub can be no more than one-tenth the length of the main trunk.

Some stubs are easy to recognize, such as the two in Figure 3-34. It is obvious that each stub connecting one of the DIO modules to a junction box on the network must meet the stub rule. Because the TransNet bus is terminated at the ITB/CIO board, the main trunk runs from the terminator at the top left of the illustration to the ITB/CIO board containing the other terminator at the bottom right of the illustration.

Keeping in mind the fact that the main trunk of the network is defined by the most direct route between the two terminators, it is also easy to see that in Figure 3-35 the cable connecting the ITB/CIO board to the TransNet bus must be considered a

stub. In this case the ITB/CIO board does not contain a terminator, so that cable is not part of the main trunk.

However, a more complicated topology such as that pictured in Figure 3-36 requires more careful consideration. In this case the main trunk of the TransNet bus runs from the terminator at the top left of the illustration to the terminator at the top right. Therefore, the ITB/CIO board is considered to be connected to a stub from the main trunk. The maximum length determined using the stub rule applies to the **total** of the length of the cable from junction box C on the main trunk to junction box F, **plus** the length of the cable from junction box F to the ITB/CIO board.

Likewise in Figure 3-36, the maximum allowable cable length between any of the DIO modules in one of the clusters and the TransNet bus must include all cabling, even if a junction box is used. For example, the length of the cable between junction boxes A and D must be considered part of the length of the stub connecting one of the modules in the cluster on the left with the main trunk.

In the case of a redundant network such as that shown in Figure 2-5, the calculation of allowable maximums is more complex. Consult your system integrator for advice on stub maximums in redundant installations.

Network Attenuator

If a remote cabinet contains more than eight distributed I/O module, a TransNet network adapter (NA-100-X, NA-125-X, or NA-150-X) should be installed in the middle of the TransNet network. For example, if the remote cabinet contains 14 distributed I/O modules, then a network attenuator should be installed between the seventh and eighth module. Refer to [Appendix D](#) for additional details.

Redundant Hardware Requirements

Implementation of a redundant DIO configuration requires the addition of a:

- Second DIO board.
- Second ITB/CIO board (for backup DIO board).



- Second TransNet bus connected to the ITB/CIO board of the backup DIO board.
- Redundant network coupler linking both ITB/CIO boards to both TransNet cables.
- Redundant network selector to connect both TransNet cables to the DIO modules.

The dual TransNet cables do not provide full redundancy to each node. Each DIO module has only one communication port available for communications. Therefore, only one bus can be run to a remote node. To allow for dual busses which are required for redundancy, a redundant network selector is required between the dual TransNet busses and the single bus connected to a DIO module.

NOTE: It is recommended that DIO modules should be grouped in a cabinet to reduce the chance of a single point-of-failure problem with the cable to the DIO modules.

The function of the redundant network coupler is to provide the backup DIO board with a copy of each command issued to a DIO module by the primary DIO board. The remote network selector sends the reply from the DIO module over both TransNet busses. The backup DIO board database will match that of the primary DIO board in readiness for a switchover.

NOTE: Only the contents of the databases will be automatically made the same. Configuration changes made to the primary DIO board must be copied to the backup DIO board as described in [Section 6](#).

Additional information for the placement and wiring of the redundant network coupler and the redundant network selector are shown in Figures [2-4](#) and [2-5](#).

Redundant Network Coupler

Figure [3-40](#) shows the redundant network coupler. The IIOP side of this coupler is to be mounted toward the DIO board, and the TransNet side is to be mounted to the side where the TransNet cable is located.

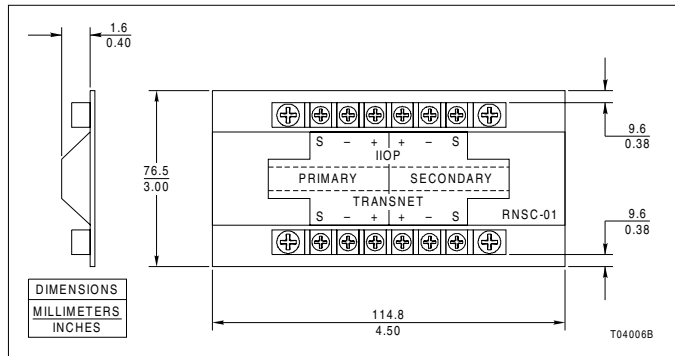


Figure 3-40. Redundant Network Coupler

Redundant Network Selector

The following information explains the LEDs and status pins of the redundant network selector which is shown in Figure 3-41. Figure 3-42 shows the mounting dimensions.

Red LEDs Four red LEDs are provided to indicate which fuse is open. The four fuses of the redundant network selector are explained in Table 3-14.

Table 3-14. RNS Fuse Functions

Fuse	Function
INT	Protects the internal power supply. If this fuse is blown, the selector will not transmit data.
P1	Protects against excessive current draw in the primary (main) external power supply.
P2	Protects against excessive current draw in the secondary (backup) external power supply.
POUT	Protects the output power against excessive current draw by the modules.

NOTE: The P1 and P2 outputs must be terminated if unused.

Green LEDs Three green LEDs indicate good internal power, good primary external power, and good secondary external power.

Input power status is indicated by a relay connected to status pins 10, 11, and 12 (NO, COM, NC). The connections between

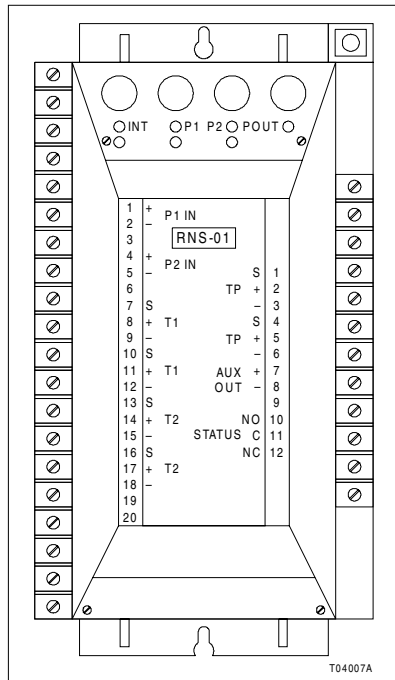


Figure 3-41. Redundant Network Selector

pins 10 and 11 will be open when main and backup power is present and is greater than or equal to 20 VDC, and the internal power supply is functioning. The connections will close when either of the power sources drops below 20 VDC or the internal power supply fails.

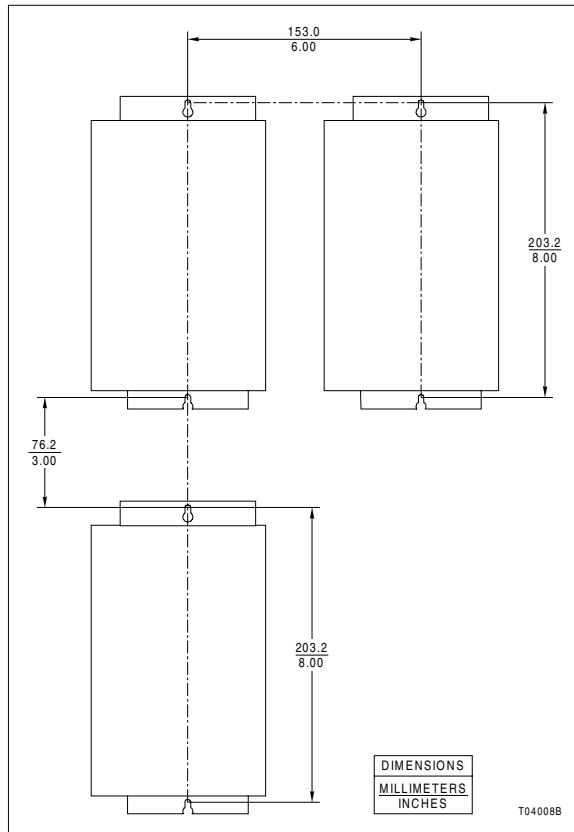


Figure 3-42. Redundant Network Selector Mounting Dimensions





Introduction

After installing the distributed I/O (DIO) hardware modules, the modules must be configured. The configuration of the DIO modules is divided into two tasks.

1. The first task is to program the DIO module address and type into each termination base for communications.
2. The second task is to configure the individual programmable parameters of the DIO hardware modules and the linkage to the CIO database modules.

DIO Module Bus Addressing

A unique communication address must be assigned to each of the DIO modules in order for them to communicate with the DIO board. Every DIO module on the TransNet bus must have a unique communication address.

A DIO module bus address is stored in the EAROM of the termination base along with other configuration information. When power is applied to the DIO module, information is read from the EAROM to determine the DIO module bus address.

Termination bases are shipped with a default configuration. Part of this configuration is the default address of 121 (1 to 120 are the valid bus addresses). It is necessary to program each base with a unique address. This is accomplished either through the remote I/O module configuration menu of the human system interface (HSI) or with an optional termination base programmer.

Remote I/O Module Configuration Menu

Assigning a new address to a DIO module can be performed through the distributed I/O configuration menu accessible from an HSI interface. This method requires that one module at a time be assigned an address. The module must be plugged



into the termination base, then a new address can be assigned. The steps required to accomplish this are:

1. Access the remote I/O module configuration window from the HSI interface. (Refer to the HSI interface instructions.) Briefly, the procedure to access this window is:
 - a. Click on the appropriate Harmony DCU in the system status display (SSD).
 - b. Select *Configure CIO* from the resulting pop-up menu
 - c. Select the desired DIO board.
 - d. Enter *Remote I/O Configuration*.
2. At the *FUNCTION =* prompt, enter **NE** to change the address from 121 to an address from 1 to 120. Figure 4-1 is an example of the change address window.

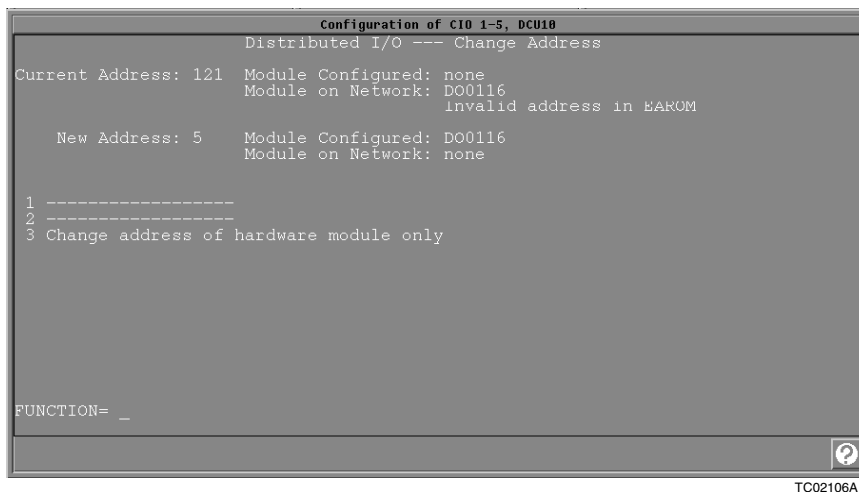


Figure 4-1. Distributed I/O - Change Address

3. Enter **3**, and answer **Y** to the prompt.
4. Change the address.

5. Repeat these steps for each DIO module. Do **not** install another module until assigning the address to a previously installed module.

Termination Base Programmer

The second method which can be used to assign addresses involves using the termination base programmer, which is a separately purchased item and resembles a DIO module. The module has the same LEDs as other DIO modules and plugs into the base in the same manner as other DIO modules. The visual difference is that the base has one thumb wheel switch and a pushbutton in the middle. The switch is for setting the address, while the pushbutton is for actually writing the address to the termination base. The following steps should be used:

1. Plug the termination base programmer into the termination base. The green power LED should be a steady LED. A flashing green LED indicates that the termination base programmer is bad.
2. Set the base address by moving the thumb wheel switch to the correct address. This address is specified in decimal format.
3. Press the red pushbutton in the middle of the base. This will download the module address into the termination base. The LEDs should appear as shown in Table 4-1.

Table 4-1. Termination Base Programmer LEDs

Base Programmer	LED Color	Before Programming	After Programming ¹
OK	Green	On	Flashing
Power	Green	On	On
Address error ²	Red	Off	Flashing
EAROM error ²	Red	On	Flashing

NOTES:

1. Only one LED will flash.

2. If the address specified is greater than 120, then the address error light will flash and the EAROM error light will go out.

Tables 4-2 and 4-3 list the LED status conditions visible on the termination base programmer before and after programming.

**Table 4-2. LED Status Indications Before Programming**

Condition	Fault	LED Active	Comm
EAROM OK	Off	On	Off
EAROM header error	On	Off	On
EAROM CRC error	Off	On	On
EAROM write count exceeded	On	On	Off

Table 4-3. LED Status Indications After Programming

Condition	Fault	LED Active	Comm
EAROM header error (Base Type = 0)	Slow flash	Off	Slow flash
OEM Mismatch (Base Type = 0)	Slow flash	Off	Off
Address > 121	Off	Off	Slow flash
EAROM header error (after programming)	Rapid flash	Off	Rapid flash
EAROM CRC error (after programming)	Off	Off	Rapid flash
EAROM write count exceeded (programmed successfully)	Slow flash	Slow flash	Off
EAROM programmed successfully	Off	Slow flash	Off

DIO Modules and Controlware

The CIO database modules are Controlware II modules which reside in the dual-port memory of the DIO board. These modules are generated by DIO application software, not by Controlware running in the distributed control processor (DCP) board of the Harmony DCU. The CIO database module is used to transfer distributed data between the DIO hardware modules and the Controlware II modules and CCL in the DCP board and the HSI interface.

When a DIO module is physically connected and configured on the TransNet bus, it is automatically linked to one or more CIO database modules. The CIO database module selection is based on DIO module type and single or block mode selections made during the DIO configuration process described in this

section. The DIO module type specifies input/output type, analog/discrete type, and the number of channels (Table 4-4).

Table 4-4. CIO Database Module Groups

I/O		Single Type Module ¹	Block Type Module ¹
Input	Analog	AIO module FIX = 0	AIOB module FIX = 0, 2
	Discrete	DIOB module FIX = 6	DIOB module FIX = 0, 2, 4
Output	Analog	AIO module FIX = 1	AIOB module FIX = 1, 3
	Discrete	DIOB module FIX = 7	DIOB module FIX = 1, 3, 5

NOTE:

1. Details about the AIO, AIOB and DIOB modules and their individual FIXes are described in [Section 5](#).

Modes

Single and block modes are the two schemes for:

- Establishing the relationship between the DIO hardware modules and the CIO database modules.
- Determining whether data from a DIO module channel will be accessible by a tag name (single mode) or an element in an array (block mode).

Single

If single mode is selected, the single type module is used and the module tag name is set to the DIO module channel name assigned during this configuration process. Two single mode examples follow:

- When AI0016 is configured in single mode, 16 AIO modules (FIX = 0) are selected from the CIO database modules. Therefore, each channel data is assigned to one AIO module.
- When DI11532 is configured in single mode, 32 DIOB (FIX = 6) modules are selected from the CIO database modules. Each channel data is assigned to one DIOB module.



Table 4-5 shows the relationship between the DIO hardware modules and the CIO database module with single mode selection.

Table 4-5. Relationship Between DIO Hardware Module (Single Mode) and CIO Database Module

DIO Hardware Module	CIO Database Module		
	Module	FIX	Output Atom
AI0008	AIO	0	OUT
AI0016	AIO	0	OUT
AI0108	AIO	0	OUT
AI0108-3W	AIO	0	OUT
AI0116	AIO	0	OUT
AI0116-3W	AIO	0	OUT
AI1508	AIO	0	OUT
AI1516	AIO	0	OUT
AO42008	AIO	1	OUT
AO42016	AIO	1	OUT
DI0516	DIOB	6	OBIT
DI0516-C	DIOB	6	OBIT
DI0532	DIOB	6	OBIT
DI0532-C	DIOB	6	OBIT
DI11516	DIOB	6	OBIT
DI11532	DIOB	6	OBIT
DI23016	DIOB	6	OBIT
DI23032	DIOB	6	OBIT
DI2416	DIOB	6	OBIT
DI2416-C	DIOB	6	OBIT
DI2432	DIOB	6	OBIT
DI2432-C	DIOB	6	OBIT
DI4816	DIOB	6	OBIT
DI4832	DIOB	6	OBIT
DO0016	DIOB	7	OBIT
DO0016-M	DIOB	7	OBIT
DO0116	DIOB	7	OBIT
DO0116-M	DIOB	7	OBIT

Block

If block mode is selected, the block type module is used and the module tag name is set to the DIO module name assigned during this configuration process. Two block mode examples follow:

- When AI0016 is configured in block mode, one AIOB (FIX = 2) is automatically selected from the CIO database modules. The name of the DIO module will automatically become the tag name of the AIOB module. Therefore, 16 analog data are stored in an analog data array: channel one is stored in OUT[0], channel 16 data is stored in OUT[15].
- When DI11532 is configured in block mode, one DIOB (FIX = 2) is automatically selected from the CIO database modules. The name of the DIO module will automatically become the tag name of the DIOB module. Therefore, 32 discrete data are stored in two 16-bit arrays: channel one data is stored in OTW1[0], channel 32 data is stored in OTW2[15].

Table 4-6 shows the relationship between the DIO hardware module and the CIO database module with Block Mode selection.

Table 4-6. Relationship Between DIO Hardware Module (Block Mode) and CIO Database Module

DIO Hardware Module	CIO Database Module		
	Module	FIX	Output Atom
AI0008	AIOB	0	OUT[]
AI0016	AIOB	2	OUT[]
AI0108	AIOB	0	OUT[]
AI0108-3W	AIOB	0	OUT[]
AI0116	AIOB	2	OUT[]
AI0116-3W	AIOB	2	OUT[]
AI1508	AIOB	0	OUT[]
AI1516	AIOB	2	OUT[]
AO42008	AIOB	1	OUT[]
AO42016	AIOB	3	OUT[]
DI0516	DIOB	0	OTW1



Table 4-6. Relationship Between DIO Hardware Module (Block Mode) and CIO Database Module *(continued)*

DIO Hardware Module	CIO Database Module		
	Module	FIX	Output Atom
DI0516-C	DIOB	4	OTW1
DI0532	DIOB	2	OTW1, OTW2
DI0532-C	DIOB	5	OTW1, OTW2
DI11516	DIOB	0	OTW1
DI11532	DIOB	2	OTW1, OTW2
DI23016	DIOB	0	OTW1
DI23032	DIOB	2	OTW1, OTW2
DI2416	DIOB	0	OTW1
DI2416-C	DIOB	4	OTW1
DI2432	DIOB	2	OTW1, OTW2
DI2432-C	DIOB	5	OTW1, OTW2
DI4816	DIOB	0	OTW1
DI4832	DIOB	2	OTW1, OTW2
DO0016	DIOB	1	OTW1
DO0016-M	DIOB	1	OTW1
DO0116	DIOB	1	OTW1
DO0116-M	DIOB	1	OTW1

Configuration Examples

The following two sections are examples of how to configure the DIO system for two different installations: a flow control loop configuration and a motor control valve configuration.

Flow Control Loop Installation

A flow control loop and a DIO module connection is shown in Figure 4-2.

The flow signal, 4 to 20 milliamperes, is converted to a 1 to 5 VDC signal by a 250 ohm resistor and connected to channel seven terminal of AI0016 (address = 10). The signal corresponds to 0 to 20 GPM. The valve control signal, 4 to 20 milliamperes, is supplied from channel eight of AO42016 (address = 20).

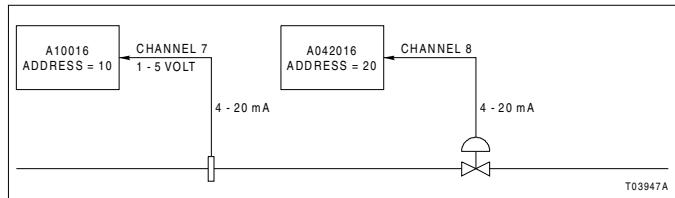


Figure 4-2. Flow Control Line

The flow control loop in single mode is shown in Figure 4-3.

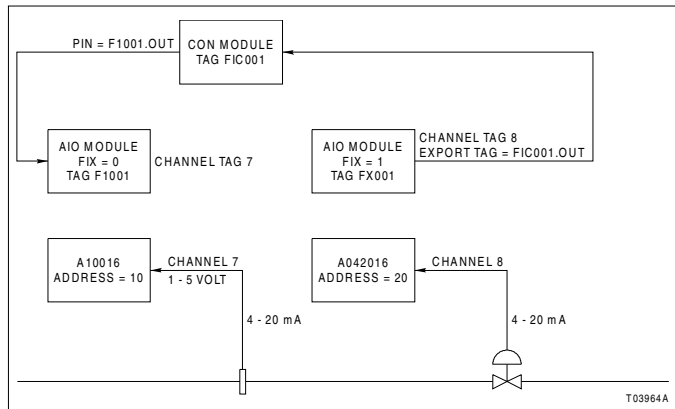


Figure 4-3. Single Mode for a Flow Control Line

The following three modules are used for flow control:

Tag Name	Module Type
FIC001	CON module
FI001	AIO module (FIX = 0)
FX001	AIO module (FIX = 1)

- The FIC001 is directly softwired to the CIO database module FI001.
- The CIO database module FX001 is directly softwired to the FIC001 module output using the export tag, which belongs to the FX001 module.



- The tag name FI001 is the channel tag seven of the AI0016 DIO module.
- The tag name FX001 is the channel eight tag name of AO42016 DIO module.

The advantage of single mode configuration is that if the flow line connection is changed from channel seven to channel 15, only the channel configurations of AI0016 need to be changed; the channel seven configuration is moved to channel 15.

The flow control loop in block mode is shown in Figure 4-4.

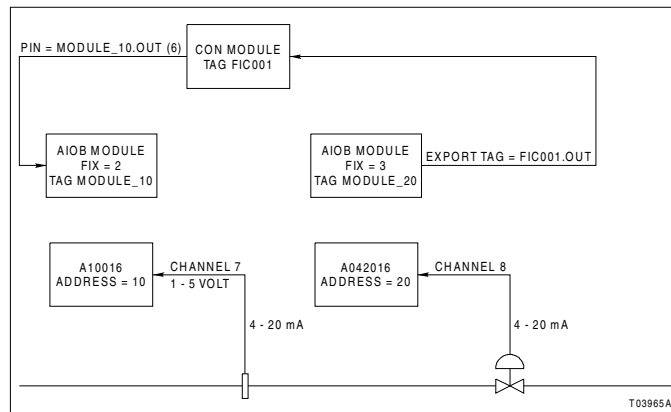


Figure 4-4. Block Mode for a Flow Control Line

When block mode is selected in the AI0016 configuration, the AIOB module (FIX = 2) is selected which contains 16 analog input values. The module tag name, Module_10, becomes the tag name of the AIOB module and the flow signal on channel seven is assigned to Module_10.OUT[6].

When block mode is selected in the AO42016 configuration, the AIOB module (FIX = 3) is selected which contains 16 analog output values. The module tag name, Module_20, becomes the tag name of the AIOB module and the channel eight export tag is configured to FIC001.OUT.

The block mode can handle multiple analog inputs or outputs with a single CIO database module. This saves DIO memory and CPU time.

NOTE: In block mode, when the flow line connection is changed from channel seven to channel 15, the Module_10.OUT[6] software pointer and CCL expression must be changed to Module_10.OUT[14].

Figure 4-5 shows a configuration which handles a distributed signal as a local signal, which is called local block mode. The flow signal is connected to the ANI module through the CIO software pointer. The ANI module transfers the bad status of the distributed I/O to the FIC001 controller, so that the controller freezes the output following the standard bad signal handling logic provided by Controlware II.

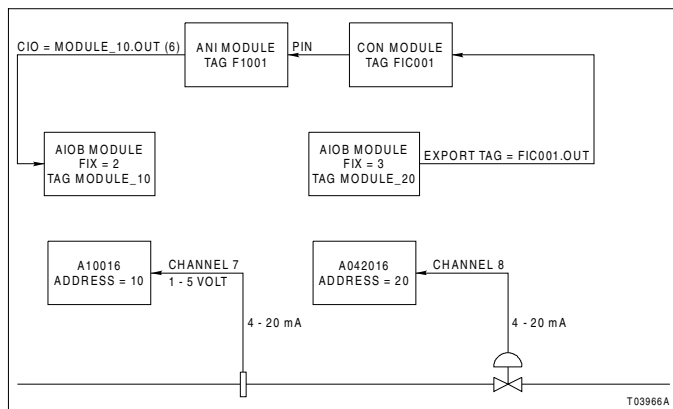


Figure 4-5. Local Block Mode and a CIO Pointer for a Flow Control Line

The advantage of local block mode is that when a flow line connection is changed from channel seven to channel 15, the only configuration change is reassigning F1001.CIO to Module_10.OUT[14]. No other softwiring or CCL changes need to be made.

The analog signal scaling of the flow control loop works as shown in Table 4-7.



Table 4-7. Analog Signal Scaling of Flow Control Loop

Mode	DIO Module		ANI Module		CON Module	
	High Range	Low Range	IUR	ILR	IUR	ILR
Single	20.0	0.0	N/A	N/A	20.0	0.0
Block	20.0	0.0	N/A	N/A	20.0	0.0
Block-local	100.0	0.0	20.0	0.0	20.0	0.0

The output is always 100.0, which corresponds to 20.0 milliamperes and 0.0 corresponds to 4.0 milliamperes or 0.0 milliamperes depending on the configuration.

Motor Control Valve Implementation

A motor control valve and DIO module connection is shown in Figure 4-6. The motor control valve requires two drive signals and provides two valve status feedback signals.

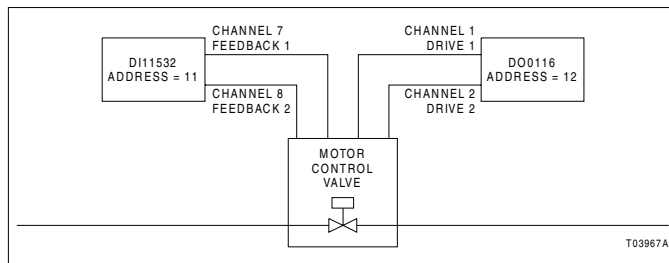


Figure 4-6. Motor Control Valve Installation

DI11532 (address = 11) channels seven and eight are used for receiving the feedback signals and DO0116 (address = 12) channels one and two are used for the drive signals.

The motor control valve is controlled by the DCD module using the CIO database modules in single mode. The feedback contact pointers are directly connected to the CIO database modules. The CIO database modules are connected to the DCD module outputs (Fig. 4-7).

Figure 4-8 shows the block mode CIO database module implementation. The feedback contact pointers are directly connected to a bit array of the CIO database module. The channel export tags are connected to the DCD module outputs.

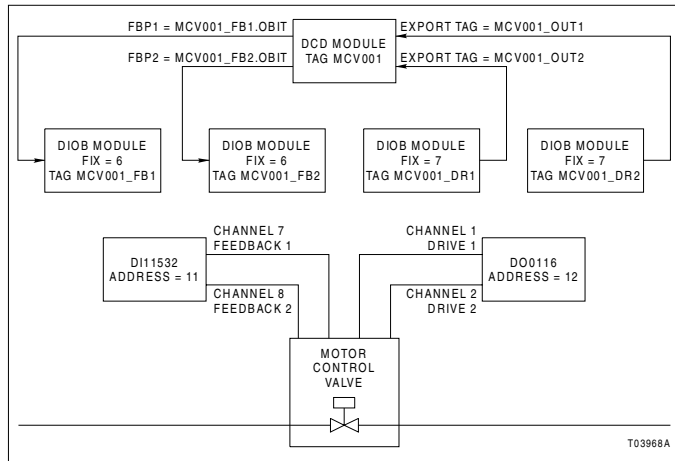


Figure 4-7. Single Mode for a Motor Control Valve Installation

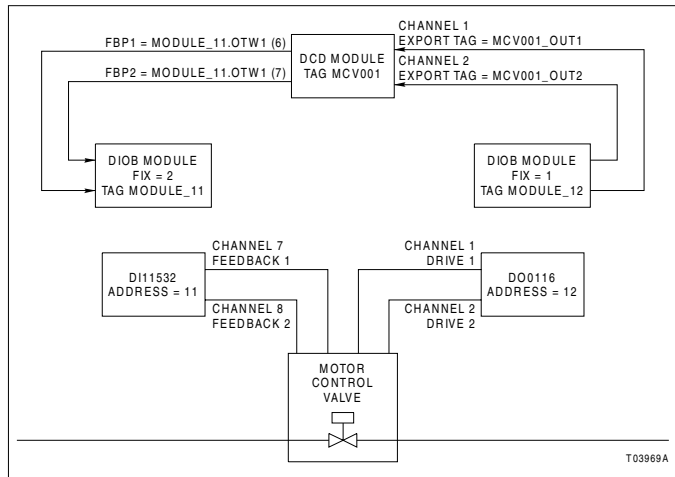


Figure 4-8. Block Mode Application

Local block mode application to the motor control valve implementation is shown in Figure 4-9. The local-block mode application to discrete inputs is beneficial for the generation of



exception messages for each status change of the remote discrete inputs.

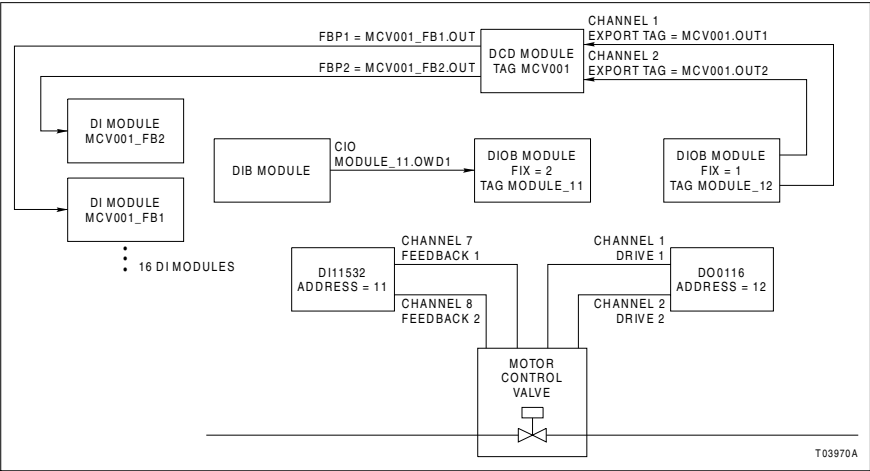


Figure 4-9. Local Block Mode and CIO Pointer for a Motor Control Valve Installation

The local-block mode application for discrete inputs is beneficial for the generation of exception messages on each status change of remote discrete inputs.

Advantages and Disadvantages of Single and Block Modes

Table 4-8 lists advantages and disadvantages to the single and block modes.

Table 4-8. Block/Single Mode Advantages/Disadvantages

Mode	Advantages	Disadvantages
Block	Exact image of DIO module	No individual tag name
Single	Individual tag name	Many modules
		CPU overhead
Local block	Individual tag name	Extra Controlware modules
	DI status change report	—

Configuration

This section gives the procedure to configure the DIO module programmable parameters. This section first discusses access to the windows via the HSI interface, followed by an explanation of the screen layout and commands used. The remainder of this section is devoted to an explanation of the windows and their content, and how they influence the configuration of the DIO modules.

Figure 4-10 is a diagram of the flow of the window options. There are three levels involved:

- Distributed I/O configuration (first level).
- Module edit (second level).
- Channel selection (third level).

Accessing the Configuration

To access the configuration process:

1. Access the Harmony DCU menu by opening an operator window containing the system status display, then clicking on the name of the Harmony DCU to be configured.
2. Select *Services > Configure CIO*.
3. In the select CIO slot window, click the toggle button to the left of the DIO board to be configured, then click *OK*. The distributed I/O system configuration menu is displayed. The menu items are:

- 1 *Scan Activation/Deactivation*
- 2 *Remote I/O Configuration*
- 3 *Data Dictionary Configuration*
- 4 *Database Configuration*
- 5 *Dump Error Log*
- 6 *Startup Scan Delay Period*

Enter **1** to activate or deactivate I/O scanning. If the Harmony DCU is restarted, or if the auto/suspend switch on the DCP board or the DIO board is cycled while the I/O scan is deactivated, scanning will resume. Also, if a switchover occurs in a

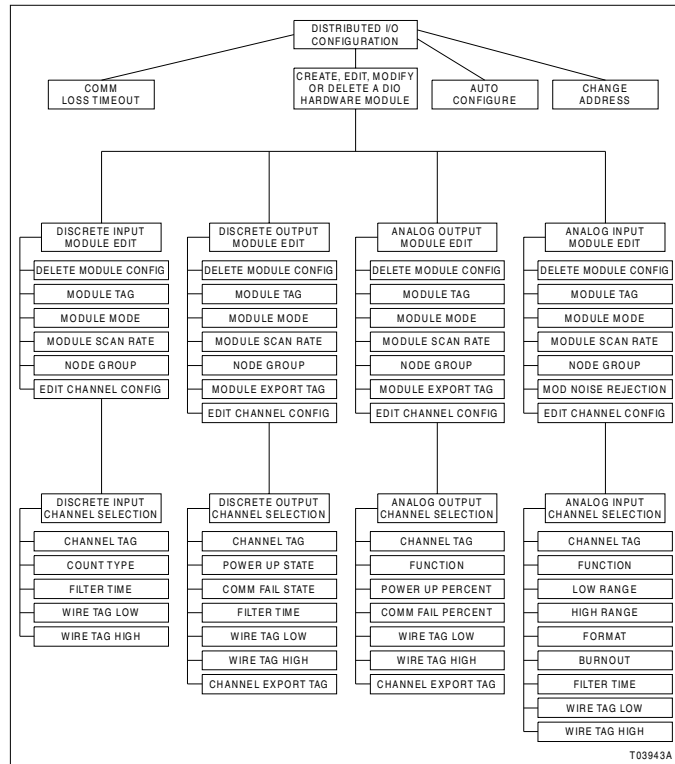


Figure 4-10. Distributed I/O Configuration Hierarchy

redundant DIO board setup, the deactivated scanning operation will resume.

NOTE: The scan activation/deactivation state is not part of a dumped DIO database. Therefore, every time a DIO database load operation is performed, the I/O scan will be activated.

Enter **2** to configure the DIO parameters.

Enter **3** to view and change the data dictionary configuration, including module complement. Data dictionary configuration is described in [Section 7](#).

Enter **4** to view and change the CIO database module configuration, such as TAG, OUT, BIN, BOU, etc., resulting from DIO configuration. Configuration of the database directly is described in [Section 8](#).

Enter **5** to view the contents of the error log record or to clear the log. These errors, logged by the TransNet bus processor (a daughter board of the DIO board), are presented in the format:

```
#<integer>:<time> <date>:<task> <error
number>:<description>:IOM <station address>
```

where:

<integer>	Number assigned sequentially as the error is logged.
<time>	Time the error was logged, displayed as hours:minutes:seconds.
<date>	Date the error was logged, displayed as day-month-year.
<task>	Task being performed by the TransNet bus processor option board when the error occurred.
<error number> and <description>	Identify the error.
IOM	Input/output module.
<station address>	Unique address assigned to each termination base as described earlier in this section.

Enter **6** to view and change the startup scan delay period. This is a user-configurable interval of from 0 (the default) to 60 seconds. The startup scan delay period begins when DIO scanning is started (i.e., when the Harmony DCU is restarted after loading the Controlware database, when the auto/suspend switch on the DCP board or the DIO board is cycled, or after loading the DIO database).

The startup scan delay period provides a mechanism for simultaneous connection of the DIO modules to Controlware. The entire DIO database complement is introduced to the existing DCU database simultaneously. This relieves the DCU control strategy from having to address the various states which occur



when a DIO database is only partially merged with the Controlware database.

When a DIO board starts up, its database is merged with the existing Controlware database. This merge operation is not instantaneous. Each of the DIO database tag names is merged (linked with the existing Controlware database) independently. Depending on the size of the DIO database and other factors, this merge operation typically requires from 10 to 20 seconds to complete, although larger configurations can take up to 60 seconds to complete. Two control actions begin to occur as this merge is taking place:

- The existing Controlware database begins to receive and process analog and discrete process readings from the input modules which have been linked.
- The DIO board begins to update the output modules with values received from points in the existing Controlware database which have been linked.

The startup scan delay period provides time for the DIO board to completely merge with the existing Controlware database before these two control actions are allowed to occur. This is accomplished as follows:

- During the startup scan delay period, the bad output status bit will be forced to one (BOU = 1) in all of the AIO, AIOB, and DIOB modules that have been assigned to input modules.
- During the startup scan delay period, the DIO board will not update output modules.

When the startup scan delay period has elapsed, the bad output status for all of the AIO, AIOB, and DIOB modules that have been assigned to input modules will no longer be forced to a one. Any existing Controlware modules that reference these AIO, AIOB, and DIOB modules will begin receiving valid process readings and statuses on their next scan.

When the startup scan delay period has elapsed, the DIO board will be ready to update its output modules. Before this delay period has elapsed, the AIO, AIOB, and DIOB modules should have initial values.

Of particular interest while troubleshooting the network are communication errors logged during the IO_SCAN task. If the system fails to perform as anticipated, look for errors generated during the DIAGNOSTICS task.

Program Operation

The program has a hierarchical screen structure (Fig. 4-10). This structure is comprised of three groups: remote I/O module configuration (refer to **Remote I/O Module Configuration** in this section), the module edit screens (Section 3.4.5.4), and the channel screens (refer to **Channel Level Configuration** in this section). Each window uses a similar format. Each screen has three parts: a header, a central block, and a scratch pad.

Each screen describes the function that is being performed (header) and a list of available choices (central block). The central block of most windows display an index number to the left of the choices available (i.e., *1 Edit Channel Configuration*, *2 Delete Module Configuration*, etc.), while others require that text (i.e., tag name) or values (i.e., scan time) be entered at the *FUNCTION =* prompt (scratch pad). Depending on the choice that is made, an additional window may be displayed.

Use the keys shown in Table 4-9 at the *FUNCTION =* prompt during the configuration process of the individual DIO module programmable parameters.

Table 4-9. Function Keys

Keys ¹	Description
E or EX	Exit and save from current menu. Return to previous menu.
F or N	Page forward. Some windows cannot display all of the relevant information. These windows indicate that more data is available by displaying the current page number of the data and the total pages of data (i.e., 1 of 4, 2 of 4, etc.).
B or P	Page backward.
H	Return to top configuration menu without saving configuration. Changes are not saved.
?	Calls a quick reference of these keys

NOTE:

1. Keys are not case sensitive; that is, upper or lower case for each of the alphabetic characters listed is accepted by the configuration program.



Macro Commands

Macro commands are supported from the remote I/O module configuration window (refer to **Remote I/O Module Configuration** in this section) and from windows which can be accessed from the remote I/O module configuration window (refer to **Channel Level Configuration** in this section). This section provides a description of the macro format, examples, and applications (including a brief description and applicable examples).

Command Format

The command is entered at the *FUNCTION* = prompt in the remote I/O module configuration window, or at the *FUNCTION* = prompt of any submenu accessed through the remote I/O module configuration window. Use the command format defined here:

M *Range Function1 Function2 Function3 ...*

where:

<i>Range</i>	Defined in Table 4-10.
<i>Function1</i>	Function code: an item number in the module edit window displays (refer to Create, Edit, Modify, or Delete in this section) or submenus summarized in Tables 4-12 and 4-13.
<i>Function2</i>	Function code: an item number on a submenu accessed through the input module edit window display summarized in Tables 4-12 and 4-13.
<i>Function3</i>	Function code: submenu items accessed through the next higher level menu summarized in Tables 4-12 and 4-13.

Table 4-10. Macro Range Commands

Symbol	Description	Example
.	All applicable selections.	.
<i>n</i>	Single numeric character; this module or channel <i>n</i> only.	5
<i>nn-mm</i>	All in the numeric range from <i>nn</i> to <i>mm</i> (inclusive).	5-12
<i>-mm</i>	All, up to and including this number <i>mm</i> .	-12

Table 4-10. Macro Range Commands (continued)

Symbol	Description	Example
<i>nn-</i>	Beginning with this number <i>nn</i> and all numbers which follow.	5-
Substring	All matching module types.	AO

Metacharacter Substitution

There are four symbols (Table 4-11) which can be used singly or in combination with other commands. These symbols are short form commands used in place of longer commands that simplify the command format line.

Table 4-11. Metacharacter Substitution Symbols

Symbol	Description
#	Changes to current channel number.
@	Changes to current TransNet address.
\$	Changes to two character family (e.g., DI).
%	Changes to a space character (for tag deletion).

Menu Item Description List

Table 4-12 is the analog menu items list and Table 4-13 is the discrete menu items list. These tables supply the numeric references used in the command format line. The items listed in these tables are the *Function* used in the command format line.

Macros can be used from the remote I/O module configuration window and any submenu which can be accessed through this window (an example is shown in Figure 4-12).

The tables list menu choices (index number followed by the menu choice) in the module edit windows, and all submenu choices available from the module edit windows for each of the four module types.

To use these tables:

1. Find the module type: analog input (AI), analog output (AO), discrete input (DI), discrete output (DO).
2. Select the numeric character which precedes the menu item. If necessary, select a numeric character for a submenu



choice. All submenu choices accessible from the module edit windows are shown in these tables.

A more complete definition of each of the menu items for the module edit windows is given in **Create, Edit, Modify, or Delete** in this section. A more complete definition of each of the submenu items accessible from the module edit windows is given in **Channel Level Configuration** in this section.

Table 4-12. Analog Menu Items List

	No.	Description	No.	Description	No.	Description
Analog Input	Analog Input Module Edit Display Selections:		Sub Menu Selections:			
	1	Edit Channel Configuration Select Channel Number first; the Channel Edit Configuration Menu is displayed.	1	Channel Tag		
			2	Function	1	1 - 5.0 VDC
					2	± 5.0 VDC
			3	Low Range		
			4	High Range		
			5	Format		
			6	Burnout		
			7	Filter Time Time Constants for Modules: AI00XX & AI15XX or AI01XX & AI02XX	1	0 msec or 0 msec
					2	10 msec or 50 msec
					3	25 msec or 100 msec
					4	50 msec or 250 msec
					5	100 msec or 500 msec
					6	250 msec or 1000 msec
			8	Wire Tag Low		
			9	Wire Tag High		
	2	Delete Module Configuration				
	3	Module Tag				
	4	Module Mode	1	Single		
			2	Block		
	5	Module Scan Rates				
	6	Node Group				
	7	Dump EARAM Block				
	8	Module Noise Rejection	1	60 Hz		
			2	50 Hz		

Table 4-12. Analog Menu Items List *(continued)*

	No.	Description	No.	Description	No.	Description
Analog Output	Analog Output Module Edit Display Selections:		Sub Menu Selections:			
	1	Edit Channel Configuration Select Channel Number first; the Channel Edit Configuration Menu is displayed.	1	Channel Tag		
			2	Function	1	4 - 20 mA
					2	0 - 20 mA
			3	Power Up Percent		
			4	Comm Fail Percent		
			5	Wire Tag Low		
			6	Wire Tag High		
	7	Channel Export Tag				
	2	Delete Module Configuration				
	3	Module Tag				
	4	Module Mode	1	Single		
			2	Block		
	5	Module Scan Rate				
	6	Node Group				
	7	Dump EARAM Block				



Table 4-13. Discrete Menu Items List

	No.	Description	No.	Description	No.	Description
Discrete Input	Discrete Input Module Edit Display Selections:		Sub Menu Selections:			
	1	Edit Channel Configuration Select Channel Number first; the Channel Edit Configuration Menu is displayed.	1	Channel Tag		
			2	Count Type		
			3	Filter Time	1	0 msec
					2	10 msec
					3	25 msec
					4	50 msec
					5	100 msec
					6	250 msec
	4	Wire Tag Low				
	5	Wire Tag High				
	2	Delete Module Configuration				
	3	Module Tag				
	4	Module Mode	1	Single		
			2	Block		
	5	Module Scan Rate				
	6	Node Group				
	7	Dump EARAM Block				
	8	Reset Counters				

Table 4-13. Discrete Menu Items List *(continued)*

	No.	Description	No.	Description	No.	Description
Discrete Output	Discrete Output Module Edit Display Selections:		Sub Menu Selections:			
	1	Edit Channel Configuration Select Channel Number first; the Channel Edit Configuration Menu is displayed.	1	Channel Tag		
			2	Power Up State	1	OFF
					2	ON
			3	Comm Fail State	1	OFF
					2	HOLD
					3	ON
			4	Filter Time	1	0 msec
					2	10 msec
					3	25 msec
					4	50 msec
					5	100 msec
					6	250 msec
			5	Wire Tag Low		
			6	Wire Tag High		
			7	Channel Export Tag		
	2	Delete Module Configuration				
	3	Module Tag				
	4	Module Mode	1	Single		
			2	Block		
			3	Export Block		
	5	Module Scan Rate				
	6	Node Group				
	7	Module Export Tag				
	8	Dump EARMOM Block				



Macro Examples

The following table shows example macro applications from the module configuration menu for analog input modules.

Example	Definition
M . 2	Delete all modules.
M AI 2	Delete all AI modules.
M AI02 2	Delete all AI0208 and AI0216 modules.
M 3-50 2	Delete all modules from address 3 to 50 inclusive (a prompt will be displayed for confirmation).
M . 3 \$_Module_@	Add module tags in format (e.g., DI_Module_10).
M . 3 %	Remove all module tags.
M . 4 1	Change all modules to single mode.
M . 4 2	Change all modules to block mode.
M . 5	Enter scan rates (a prompt for each module will be displayed)
M . 7 1	Change noise rejection to 60 Hz (where applicable)
M . 7 2	Change noise rejection to 50 Hz (where applicable)
M . 1 5 1 @_ChanFive	Set channel label for channel 5 on all modules
M 3 1 7 1 NewChanSeven	Set channel label for module 3, channel 7 only

The following table shows example macro applications from the channel selection menu for an individual module.

Example	Definition
M . 1 \$@_Chan_#	Add channel tags in the format: DI10_Chان_7
M . 1 %	Remove channel tags
M 3-7 1 %	Remove channel tags for Channels 3 to 7 inclusive
M . 2 1	Set function to 1 - 5 VDC (assuming AI module)

The following table shows example macro applications from the module configuration menu.

Example	Definition
M . 1 M . 1 \$@_Chan_#	Add channel tags to all modules
M . 1 M . 1 %	Delete all channel tags
M AI 1 M 1-4 1 \$@_Chan_#	Add channel tags to all AI modules, channels 1 to 4

Example	Definition
M AI 1 M . 2 1	Set all AI functions to 1 - 5 VDC
M AO 1 M . 2 1	Set all AO functions to 4 - 20 mA
M A 1 M . 2 1	Set all AI and AO functions to Selection 1
M AO 1 M 3 50	Set all AO power-up defaults to 50%
M AO 1 M . 4 999	Set all AO comm loss defaults to HOLD

The following table shows example macro applications from the channel selection menu for an individual module.

Example	Definition
M . 1 \$@_Chan_#	Add channel tags in the format: DI10_Chan_7
M . 1 %	Remove channel tags
M 3-7 1 %	Remove channel tags for channels 3 to 7 inclusive
M . 2 1	Set function to 1 - 5 VDC (assuming AI module)

The following table shows examples of nested macro applications from the module configuration menu.

Example	Definition
M . 1 M . 1 \$@_Chan_#	Add channel tags to all modules
M . 1 M . 1 %	Delete all channel tags
M AI 1 M 1-4 1 \$@_Chan_#	Add channel tags to all AI modules, channels 1 to 4
M AI 1 M . 2 1	Set all AI functions to 1 - 5 VDC
M AO 1 M . 2 1	Set all AO functions to 4 - 20 mA
M A 1 M . 2 1	Set all AI and AO functions to selection 1
M AO 1 M 3 50	Set all AO power-up defaults to 50%
M AO 1 M . 4 999	Set all AO comm loss defaults to HOLD

Applications

Module Tag Configuration **M . 3 \$ _Module_ @**

The module tags are set to include the TransNet bus address of the module in the tag:

AI_Module_1
DI_Module_11



AO_Module_8
DO_Module_32

Channel Tag Configuration **M . 1 M . 1 \$@_Chan_#**

All channel tags are set to include the TransNet bus address of the module in the tag, as well as the channel number:

AI1_Chان_1
AI1_Chان_2
AI1_Chان_3
AI1_Chان_4
.
DI11_Chان_1
DI11_Chان_2
DI11_Chان_3
DI11_Chان_4
.
AO8_Chان_1
AO8_Chان_2
AO8_Chان_3
AO8_Chان_4
AO8_Chان_5
.
DO32_Chان_1
DO32_Chان_2
DO32_Chان_3
DO32_Chان_4
DO32_Chان_5

Export Tag Configuration **M AO 1 M 7 @_CON#.OUT**

Each AO module export tag is set to include the TransNet bus address of the module, as well as the associated channel number:

8_CON1.OUT
8_CON2.OUT
8_CON3.OUT
8_CON4.OUT
8_CON5.OUT

M DO 1 M . 7 @_DO#.OUT

Each DO module export tag is set to include the TransNet bus address of the module, as well as the associated channel number:

32_DO1.OUT
 32_DO2.OUT
 32_DO3.OUT
 32_DO4.OUT
 32_DO5.OUT

M DO 4 3

All DO modules are set to export block mode.

M DO 6 @_DOB.OUB

Block export tags are set to include the TransNet bus address of the module:

32_DOB.OUB

Function Configuration **M AI 1 M . 2 1**

All AI modules are set to 1 to 5 VDC.

M AO 1 M . 2 1

All AO modules are set to 4 to 10 milliamperes.

M DO 1 M . 3 2

All DO modules are set to hold from Comm Loss default.

M AO 1 M . 4 999

All AO modules are set to hold from Comm Loss default.

Remote I/O Module Configuration

The initial screen is remote I/O module configuration shown in Figure 4-11. From this window, the following functions can be accessed:

- Selection of DIO modules not currently defined on the TransNet bus (refer to **Select I/O Module** in this section).
- Display of available DIO modules found on the bus (refer to **Auto Configure** in this section).
- Selection of communication loss time-out settings (refer to **Comm Fail Time Out (For All DIO Modules)** in this section).



- Ability to create, edit, modify, or delete a DIO hardware module (refer to **Create, Edit, Modify, or Delete** in this section).

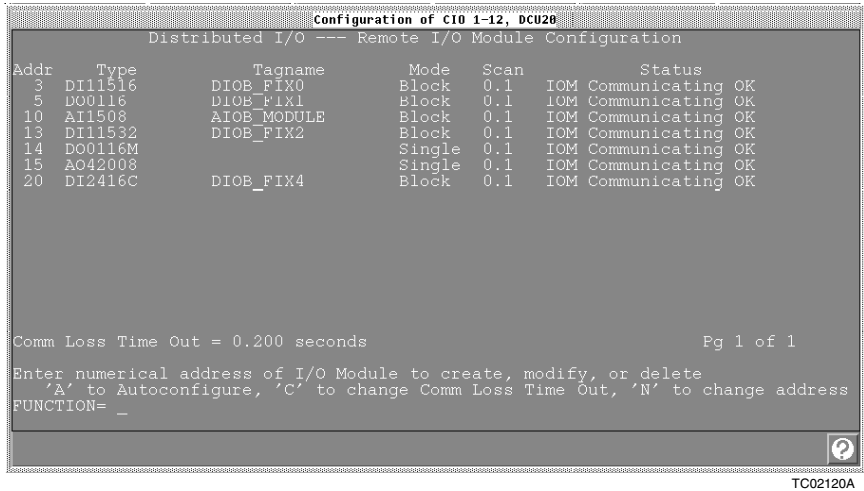


Figure 4-11. Remote I/O Module Configuration

There are a maximum of seven command choices which can be made at the *FUNCTION* = prompt (Table 4-14).

Table 4-14. Remote I/O Module Configuration Commands

Command	Description
A (auto configuration)	Searches the TransNet busses for all available DIO modules. Any DIO module found, and not currently appearing in the list, will be added to the list (refer to Auto Configure in this section).
C (comm fail time out)	Used to configure the amount of time that a DIO module continues operation without communications from the interface before the link is considered to have failed. The default is 200 msec.

Table 4-14. Remote I/O Module Configuration Commands (continued)

Command	Description
Address number	Corresponds to the address number which is stored in the termination base, if the module has been located and put in the list automatically. The module edit window for the module at the entered address will be displayed (refer to Create, Edit, Modify, or Delete in this section). If the module has not been located and placed in the list automatically, the select I/O module window will be displayed (refer to Select I/O Module in this section).
TAGS	Produces a unique tag name for each module. The tag name produced is the address of module. For example: Module_1, Module_120. These tag names can be renamed individually as explained in Channel Level Configuration in this section.
S (scan rate)	Globally redefines the scan rate. For example: S 0.2 RETURN The scan rate for all modules is set to 0.2 (0.0 is off, the default scan rate). The scan rate can be redefined for each module individually as explained in Create, Edit, Modify, or Delete in this section.
NE or NEW (bus address)	Accesses the addressing function through remote I/O module configuration. The address function permits the configuration of the termination base addresses. Refer to Remote I/O Module Configuration Menu in this section.
M (macro)	Permits configuration of DIO hardware modules and CIO database modules globally. M commands are explained in Macro Commands in this section.

In order to use the **C**, **TAGS**, **S**, and **M** commands at least one module must appear in the remote I/O module configuration window.

Each of the column headers in this window are defined below.

<i>Addr</i>	Module address as defined via the terminal base programmer or using the NE command.
<i>Type</i>	DIO module type: AI, DI, AO, DO.
<i>Tagname</i>	Can be up to 16 characters, either globally defined by the system or uniquely defined by the user.
<i>Mode</i>	Block or single.



<i>Scan</i>	Ranges from 0.0 (off) to 9.9 seconds, defined globally by the user or uniquely defined for each module.
<i>Status</i>	Current module status.

Select I/O Module

If an address is entered for which no DIO module currently exists, then the select I/O module window is displayed. At the *FUNCTION* = prompt, enter the number to the left of the module type, and press **RETURN**.

To specify either AI0108 or AI0108-3W, select AI0108; to specify either AI0116 or AI0116-3W, select AI0116.

Auto Configure

From the remote I/O module configuration window (Fig. 4-11), enter **A RETURN**. The TransNet bus is searched for all DIO modules installed and configured by the termination base programmer. The DIO modules found on the bus are added to the list.

Comm Fail Time Out (For All DIO Modules)

The comm fail time out represents the amount of time that a DIO module will continue operation without communications from the Harmony DCU before the link is considered to be down. If the link is down, the DIO module assumes its default fail state. If a DIO module does not receive valid communications for a specific period of time, the DIO module reverts to the default condition defined (refer to **Channel Level Configuration** in this section). For discrete outputs, this state can be:

- Turn off.
- Turn on.
- Hold last value.

Analog outputs can be configured to hold the last value or go to a preselected percentage.

NOTE: Hold last value is the recommended condition for both discrete and analog outputs.

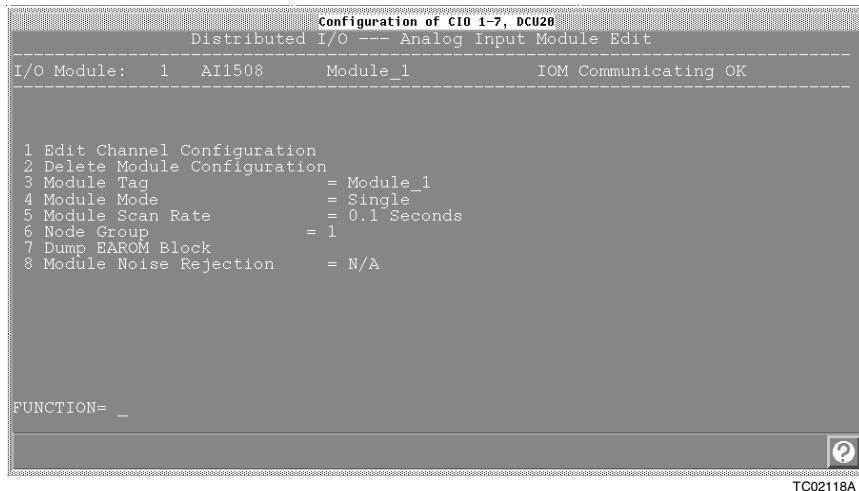
At the *FUNCTION* = prompt of the remote I/O module configuration window (Fig. 4-11), enter **C RETURN**. The following message displays:

ENTER NEW COMM LOSS TIME OUT (0.200 to 10.000 seconds):

Type in the time out time and press **RETURN**. The time out should be 3 to 5 times the scan rate.

Create, Edit, Modify, or Delete

The module edit window (Fig. 4-12) displays information pertinent to the module. The module edit screens for the discrete input, analog input, discrete output, and analog output modules are almost identical.



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Figure 4-12. Module Edit

From this configuration level the following are supported for all four module types:

- 1 Entry to channel level configuration.
- 2 Deletion of module configuration from the DIO system.
- 3 Module tag configuration. The module tag can be configured using the **TAGS** command at the remote I/O module configuration level using the standard formation (e.g., Module_1, Module_16, etc.). The module tag configuration allows for 16



full ASCII character module tag names for the module tag used in the block mode.

- 4 Module mode configuration. This configures the module to single or block mode.
- 5 Module scan rate configuration. The module scan rate can be configured in the module bus level configuration to a common scan rate. This configuration allows the module scan rate to be changed to one different from the common scan rate.
- 6 Node group assignment. The node group assignment of the module is only applicable to redundant DIO installations. Allowable entries are integers in the range from 0 to 20. Normally, all modules sharing a common remote network selector (i.e., all modules in a remote module cluster) should be assigned to the same node group. This results in a switchover if the primary DIO board loses communication with all modules assigned to the same node group.

Two additional menu items, seven and eight, may be displayed depending on the module type. Those menu items are described below:

- 7 Module export tag configuration. The module export tag for DO type modules are configured.

- **or** -
- 7/8 Dump EAROM block. EAROM block contents of the DIO module will be dumped.

- **or** -
- 8 Reset counters. The counter in the DI type module will be reset.

- **or** -

Module noise rejection configuration. AI modules with model numbers AI01XX have a choice of acquisition times. The acquisition time is the time required to collect a single sample from every channel. The module is programmed to acquire data at a 50 hertz or 60 hertz rate. This parameter should be set to the frequency of the line voltage. This allows the module to better reject these frequencies when they occur as a common mode voltage. This will improve the performance of the module.

To select an item in this window, enter the number which precedes the desired choice. Entry to channel level configuration is described in *Channel Level Configuration* in this section. Module export tag configuration is described in *Module Export Tag* in this section.

Module Export Tag

When the export block mode is used with a DO hardware module, all channels of the module export data to a module capable of handling 16-bit packed data. To enter the tag name of the module getting the data, enter **6** to select module export tag configuration from the module edit window (Fig. 4-12). Enter the tag name.

If the module export tag is configured as the DOB module output:

1. The export tag exports the DOB module eight-bit output to the low byte and the next DOB module eight-bit output to the high byte to the DO hardware module.
2. Both DOB modules' BOIH must be set.

For example, if \$DOB001.OUTB = Module Export Tag, then \$DOB001.OUTB and DOB002.OUTB are exported to the DO hardware module.

If the module export tag is configured as the PTB module output, (\$PTB001.OUT = Module Export Tag) the 16-bit outputs (a packed data array of 16-bit pointers of the PTB module) is exported to the DO hardware module.

Channel Level Configuration

Channel information windows are used for the channel level editing function. This function is accessed through the module edit window (Fig. 4-12) for all four DIO module types.

Channel Configuration Access

To access the channel parameter window:

1. Access the remote I/O module configuration window (Fig. 4-11).
2. Select the module to be configured, then press **RETURN**.



3. Enter **1 RETURN** to select edit channel configuration.
4. Enter the channel number to be configured, then press **RETURN**.

DIO Channel Configuration

The discrete input, discrete output, analog input, and analog output modules require that the channel parameters be configured. The channel parameters to be configured for each of the module types are defined in Tables 4-15 through 4-18.

Table 4-15. Analog Input Channel Parameters

Parameters	Description
Channel tag	16 character tag name; used to identify a certain channel on a specific DIO module; also used as the module tag name in single mode.
Function	Type of input signal to be read.
Low range	Refer to Table 4-19.
High range	Refer to Table 4-19.
Format	For temperature sensing devices, permits a choice between °C and °F. For signal values or signal wires when input is at full scale.
Burnout	Checks the electrical continuity of the input sensor for modules with thermocouple functions. If input sensor is open, the module posts an error and drives input value for that channel either full scale positive (up scale) or full scale negative (down scale).
Filter time	The purpose of the filter is to attenuate noise that can occur at the input. This filter responds much the same to a simple RC low pass filter. Six time constants are provided: AI00XX & AI15XX: 0 msec, 10 msec, 25 msec, 50 msec, 100 msec, or 250 msec. AI01XX & AI02XX: 0 msec, 50 msec, 100 msec, 250 msec, 500 msec, or 1,000 msec.
Wire tag low	Terminal description; up to 16 characters.
Wire tag high	Terminal description; up to 16 characters.

Table 4-16. Analog Output Channel Parameters

Parameters	Description
Channel tag	16 character tag name; used to identify a certain channel on a specific DIO module; also used as the module tag name in single mode.
Function	Selection of 0 - 20 mA or 4 - 20 mA signal.

Table 4-16. Analog Output Channel Parameters *(continued)*

Parameters	Description
Power up percent	State each channel assumes when system is powered up. State is held until DIO board initiates communications and sends new input values to the DIO module. Output values can be set from 0 - 100% of full scale.
Comm fail percent	State each channel assumes on loss of communications with Harmony DCU. If comm fail time-out value elapses because of bad communications with DIO board, the comm fail default state is assumed until the DIO board reinstates communications. Output values can be set from 0 - 100% or enter 999 to hold current value. Hold last value is the recommended entry.
Wire tag low	Terminal description; up to 16 characters.
Wire tag high	Terminal description; up to 16 characters.
Channel export tag	Used to identify tagname.atom of the Controlware II module which will be the source of data.

Table 4-17. Discrete Input Channel Parameters

Parameters	Description
Channel tag	16 character tag name; used to identify a certain channel on a specific DIO module; also used as the module tag name in single mode.
Count type	Available on first four channels only; designated with a -C (counter) as the last character in the model number; counts each time there is an on/off input transition.
Filter time	Distinguishes between spurious input signals and a true on condition. The filter ensures that the signal be there for prescribed length of time. Filter can be set to 0 msec, 10 msec, 25 msec, 50 msec, 100 msec, or 250 msec.
Wire tag low	Terminal description; up to 16 characters.
Wire tag high	Terminal description; up to 16 characters.

Table 4-18. Discrete Output Channel Parameters

Parameters	Description
Channel tag	16 character tag name; used to identify a certain channel on a specific DIO module; also used as the module tag name in single mode.
Power up state	State channels assume when power is turned on. Held until DIO board initiates communications and new output values are sent to the DIO module. Set each channel to be either on or off.
Comm fail state	State each channel assumes when loss of communications with DIO board occurs. If comm fail time-out value elapses because of bad communications with DIO board, the comm fail default state is assumed until the DIO board reinstates communications. Each channel can be set to on, off, or hold state. Hold last value is the recommended entry.



Table 4-18. Discrete Output Channel Parameters (continued)

Parameters	Description
Filter time	Available for modules designated with a -M (monitored) as the last character in the model number. Distinguishes between spurious input signals and a true on condition. The filter ensures that the signal be there for prescribed length of time. Filter can be set to 0 msec, 10 msec, 25 msec, 50 msec, 100 msec, or 250 msec.
Wire tag low	Terminal description; up to 16 characters.
Wire tag high	Terminal description; up to 16 characters.
Channel export tag	Used to identify tagname.atom of the Controlware II module which will be the source of data.

Analog Input Signal type

There are two types of analog input DIO modules:

- High level input module (AI1508 and AI1516).
- Universal input module (AIXX08 and AIXX16).

There are three groups of universal input modules:

- AI0008 and AI0016 (signal values and thermocouples).
- AI0108 and AI0116 (signal values, RTD, and slidewire resistor).
- AI0208 and AI0216 (signal values, RTD, and slidewire resistor).

High Level Input The high level input modules accept signals within the range of ± 5 VDC, or 1 - 5 VDC. The configuration screen will display these choices. Select the desired function.

Universal Input (AI0008 and AI0016) :**Signal value:** programs the A/D converter to real values with the selected voltage range.

- ± 5 VDC
- ± 12.5 mVDC
- ± 25 mVDC
- ± 50 mVDC
- ± 100 mVDC

Thermocouple type: programs the A/D converter to read a particular type of thermocouple. Also sets up the DIO module to do the necessary cold junction compensation and linearization for this thermocouple.

J
J Din
K1
K2
K Din
T
E
C
S
R
B
N

Universal Input (AI0108
and AI0116)

Signal value: sets the A/D converter to read values within the selected voltage range.

0 - 5 VDC
0 - 12.5 mVDC
0 - 25 mVDC
0 - 50 mVDC
0 - 100 mVDC

Pt/Ni RTD type: the A/D converter is programmed to read a particular type and range of RTD. At the same time, the module is also automatically set up to do the necessary linearization for the RTD. In addition to the type of RTD, the function selected also chooses the temperature range of the RTD.

Pt 385 60 °C
Pt 385 400 °C
Pt 385 879 °C
Pt 391 60 °C
Pt 391 400 °C
Pt 391 879 °C
Pt 392 60 °C
Pt 392 400 °C
Pt 392 879 °C
Ni 120 7 °C
Ni 120 150 °C
Ni 120 320 °C

Platinum and nickel RTDs are accepted. For instance, a platinum 385 RTD with a range of -199 to 60 °C is displayed as Pt 385 60 °C. A nickel 120 with a range of -79 to 320 °C is shown as Ni 120 320 °C. The platinum RTDs all have a low range of -199 °C and the nickel RTDs have a low range of -79 °C.



Slide wire resistance: a slide wire is a general name for a three-terminal device that measures some physical parameter by changing the resistance of a potentiometer. The DIO module supplies a current to this device and measures the resulting voltage across the potentiometer. The DIO modules are set up to measure a range of resistances.

100 Ohm slide
125 Ohm slide
250 Ohm slide
1000 Ohm slide
10k Ohm slide

Analog Input High and Low Ranges

The values stored in CIO database modules (and those that are accessible via global DBA) from analog input are floating point engineering values. In order for the DIO modules to correctly convert field values into engineering values (temperature, pressure, and flow) for storage in the CIO database modules it is necessary to assign engineering unit numbers to the full scale positive and full scale negative numbers in the DIO modules.

The selection of the high and low ranges is dependent on the function as shown in Table 4-19.

Table 4-19. Analog Input Module High and Low Ranges

Module	Functions	High Range	Low Range
AI1508 AI1516	±5.0 VDC	Engineering value of 5.0 VDC	Engineering value at -5.0 VDC
	1 - 5 VDC	Engineering value of 5.0 VDC	Engineering value at 1.0 VDC
AI0008 AI0016 AI0108 AI0116	Signal value	Engineering value at positive selected value	Engineering value at negative selected value
	RTD	High range value of application	Low range value of application
	Slide wire	High range value of application	Low range value of application
AI0108-3W AI0116-3W	RTD	High range value of application	Low range value of application



Introduction

The transfer of data between Controlware II and remote stations such as DIO hardware modules is accomplished by means of Controlware modules which reside in the dual-port memory of the DIO board. In this section the Controlware modules are referred to as CIO database modules to differentiate them from the Controlware II modules in the main distributed control processor (DCP) board of the Harmony DCU. The CIO database modules have the same structure as the DCP board Controlware II modules.

CIO Database Module

CIO database modules are generated by the DIO application software based on the DIO data dictionary stored in the dual-port memory of the DIO board.

When the DIO application software is started, the default DIO data dictionary and DIO database are created in the dual-port memory by the DIO software and logically they become a part of the Harmony DCU data dictionary and database.

The appropriate CIO database modules (set to the correct FIX) are created automatically during the distributed I/O configuration process, as described in [Section 4](#), based on the type of hardware module being configured and the data collection mode used (single or block). Once the CIO database modules have been created, tag names must be assigned to enable access to data. If using block mode the tag name is specified for the block of data for a DIO hardware module. If using single mode a tag name is assigned to access the data for each channel in the DIO module.

Input DIO Modules

In the case of input DIO hardware modules the tag name assigned during distributed I/O system configuration determines the source of the data stored in the CIO database module. Once the input data is stored in the CIO database modules



in the dual-port memory of the DIO board, the data becomes accessible to global database access (global DBA) and Controlware II modules in the DCP board. The data can be accessed in a number of ways:

- A Controlware II module in the Harmony DCU database can be configured to point to an atom in the CIO database module. The CIO database module atoms are described in this section.
- A CCL program running in the Harmony DCU can access the data. There is no difference between writing a CCL statement to access a Controlware II module resident in the DCP board and writing a statement to access a CIO database module resident in the dual-port memory of the DIO board.
- An operator at an HSI interface can call up a point display for the CIO database module.

Output DIO Modules

In the case of output DIO hardware modules the tag name assigned during distributed I/O system configuration determines the destination of the data stored in the CIO database module. There are several ways the data could have been written to the module:

- During DIO configuration the module export tag could have been configured to specify a Controlware II module in the Harmony DCU database.
- A CCL program running in the Harmony DCU could have written the data to one of the CIO database module OUT atoms described in this section
- An operator at an HSI interface could have entered the value while the point display for the CIO database module was called up.

Analog Input/Output (AIO) Module

Each AIO module is used to transfer data from one DIO hardware module's analog input channel or analog output channel to the AIO module's OUT atom. Whether the AIO module trans-

fers data for an input channel or output channel depends on the AIO module FIX.

Function Summary

Description	FIX
Analog data input	0
Analog data output	1

Atoms

Atom	Description
ASTA	Alarm logical status 03 bad input 04 bad output 29 normal
AUT	Automatic mode bit
BIN	Bad input status bit
BOU	Bad input status bit
FIX	Function index
FMT	Display format; defines the number of digits to the right of the decimal
ILR	Instrument lower range
IUR	Instrument upper range
LCK	Lock bit
MODE	Mode 24 normal 28 manual
MSET	MSET number
MSTA	Module logical status 03 bad pointer 04 bad input 05 bad output 46 normal
OUT	Module output
PRI0	Module priority



Atom	Description
STAT	Point status byte (one STAT atom required for OUT value) (Refer to Database Transfer Status in this section)
TAG	Module tag name Standard tag name
TTYP	Display template type, display only Set to 128
ULCK	Disable lock condition bit

Function Description

Analog Input (FIX = 0)

Function: The AIO module set to FIX = 0 stores data from one DIO hardware module's analog input channel in the AIO OUT atom. TAG, IUR, and ILR are configured during the DIO configuration process described in **Section 4**.

A change in BIN or BOU results in a change of the AIO module's ASTA and MSTA logical status. The BIN bit indicates the status of the data from the DIO hardware module. On means that the input data is bad because of communication failure or remote equipment failure. The BOU bit indicates the module OUT atom status. On means that BIN is set or that a computation error was made during the module processing.

Analog Output (FIX = 1)

Function: The AIO module set to FIX = 1 converts the data specified by the export tag configured during DIO data collection configuration to 0 to 100 percent of range.

OUT = export tag value

BIN bit indicates the status of the Controlware II data specified by the export tag. The BOU bit indicates the module's OUT status. On means BIN is set or that the DIO hardware module has had a failure.

Special Considerations

In addition to the AIO module which can transfer data for a single channel as described in this section, an AIOB module is available which transfers a block of analog data. The AIOB

module is described in **Analog Input/Output Block (AIOB) Module** in this section. Before deciding whether to use AIO or AIOB modules, weigh the advantages and disadvantages of each (described as follows and in Section 3).

An AIOB module can store about six times more distributed data in dual-port memory than an AIO module can, but the data in an AIOB module can only be accessed as an array of analog data. AIO module OUT data is identified by a tag name (or module ID).

Examples:

03_AIO001.OUT accesses AIO module data.

03_AIOB001.OUT[0] accesses the first element in an array of AIOB module data.

03_AIOB001.OUT[15] accesses the last element in the same array of AIOB module data.

The standard hierarchical display of the HSI interface for an AIO module shows the output data in a bar graph, while standard AIOB module templates show the output data as an array of data.

Both the AIO module OUT atom and the AIOB module OUT[] array can be softwired with any Controlware II analog pointer, such as XIN, PIN, SIN. The analog pointer tests the connected module's BOU bit to decide whether the data is good or bad. Both AIO and AIOB module BIN and BOU bits indicate the status of the entire module. When a module is disconnected or fails, its BIN and BOU are set. This causes a control loop using the module for inputting the process variable (PV) to freeze the control loop operation the same way as the local process I/O does.

The advantage of single mode is that the field wiring connection changes do not effect softwiring and CCL programs (refer to **Section 4**).

AIOB module output array data, however, can be softwired to an ANI module by means of a CIO pointer. The ANI module provides BIN/BOU processing, filtering, and high/low alarm tests for the data obtained via the CIO pointer. Although the local block mode needs additional Controlware modules, this mode has two advantages:



- Field wiring connection changes only effect ANI modules or DI modules, but do not effect other softwiring or CCL programs.
- Status changes in the DIOB module are reported as alarm or status change messages through the DI module.

Both the AIO module output and the AIOB module output data array can connect to a Controlware II module atom, or to another CIO database module atom. The atom that is to be the source of the data is specified when the export tag is configured for the channel during DIO data collection configuration as described in [Section 4](#).

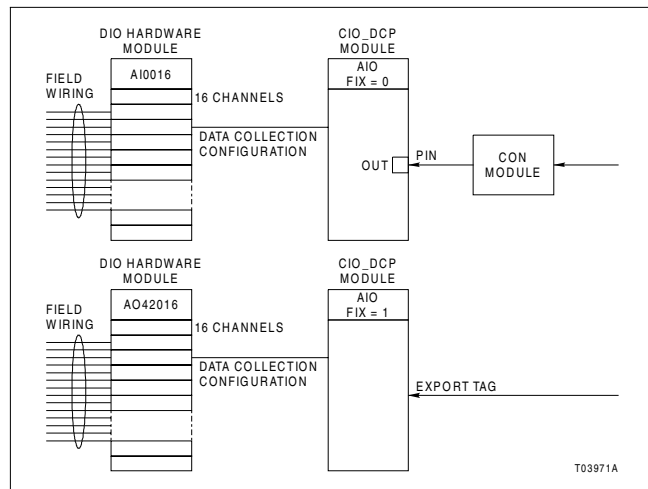


Figure 5-1. Closed Analog Loop Using AIO Modules (Data Transfer Using Single Mode)

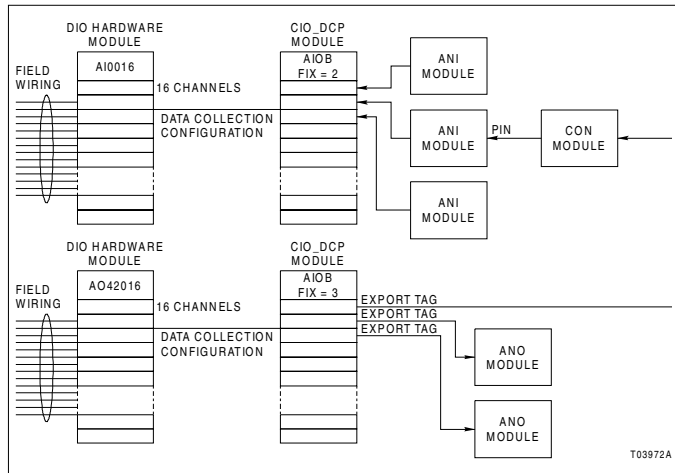


Figure 5-2. Closed Analog Loop Using AIOB Modules (Data Transfer Using Block Mode)

Analog Input/Output Block (AIOB) Module

This module is used for handling a block of analog data. The analog input data can be softwired to Controlware modules in the Harmony DCU database using analog type pointers. The status of the data will not be checked. However, the CIO pointer is provided in the ANI module. Configuring this atom to point to the AIOB module results in the input data being transferred into the ANI module output. The ANI module does provide a check on bad status, filtering, and alarming.

Function Summary

Description	FIX
8 analog data inputs	0
8 analog data outputs	1
16 analog data inputs	2
16 analog data outputs	3



Atoms

Atom	Description
ASTA	Alarm logical status 29 normal
AUT	Automatic mode bit
FIX	Function index
FMT	Display format; defines the number of digits to the right of the decimal
LCK	Lock bit
MODE	Mode 24 normal 28 manual
MSET	MSET number
MSTA	Module logical status 03 bad pointer 46 normal
OUT[]	Array of maximum of 16 outputs (based on FIX)
PRIO	Module priority
STAT[]	Array of maximum of 16 point status bytes (based on FIX), corresponding to each OUT[] value (Refer to Database Transfer Status in this section)
TAG	Module tag name Standard tag name
TTYP	Display template type, display only Set to 129
ULCK	Disable lock condition bit

Function Description

Eight Analog Inputs Module (FIX = 0)

Function: The AIOB module set to FIX = 0 stores data from up to eight analog input channels on DIO hardware modules in the OUT[] array. The status of the data from the channels is in the STAT[] array.

Eight Analog Output Module (FIX = 1)

Function: The AIOB module set to FIX = 1 stores an array of up to eight analog outputs in OUT[]. The status is in the STAT[] array. The analog output data is collected from a Controlware II module. The atom that is to be the source of the data is specified when the export tag for the channel is configured during DIO data collection configuration as described in [Section 4](#).

16 Analog Inputs Module (FIX = 2)

Function: The AIOB module set to FIX = 2 stores data from up to sixteen analog input channels on DIO hardware modules in the OUT[] array. The status of the data from the channels is in the STAT[] array.

16 Analog Output Module (FIX = 3)

Function: The AIOB module set to FIX = 3 stores an array of up to sixteen analog outputs in OUT[]. The status is in the STAT[] array. The analog output data is collected from a Controlware II module. The atom that is to be the source of the data is specified when the export tag for the channel is configured during DIO data collection configuration as described in [Section 4](#).

Special Considerations

Refer to special considerations under *Analog Input/Output (AIO) Module* in this section.

Digital Input/Output Block (DIOB) Module

The DIOB module is used to store discrete values of input or output data. The FIX of the module determines whether the module stores input or output data. The FIX also determines whether the module is used to store a single input or output, or packed data. FIXes are available to store one, two, or four bytes of packed data. Each byte of packed data stores eight bits of data obtained from eight different inputs or outputs.

When dealing with input data the DIOB module is pointed to by a DIB module. The DIB module uses a CIO pointer for this purpose. Sixteen bits of packed data from the DIOB module is obtained by the DIB module. The packed data is unpacked into



the 16 DI hardware modules associated with the DIB module at the scan rate specified in the DIB module.

When dealing with output data the DIOB module's export tag specifies any logical data in Controlware modules to be used as the source of the data.

When a DO hardware module is set to the block export tag mode, the DIOB module's block export tag specifies 16 bits packed logical value in Controlware Modules which are to be used as the source of the data.

When the block export tag is configured as the DOB module output:

1. The export tag exports the DOB module eight-bit output to the low byte and the next DOB module eight-bit output to the high byte of the DO hardware module.
2. Both DOB modules' BOIH must be set.

Example:

\$DOB002.OUTB

This export tag exports \$DOB001.OUTB and DOB002.OUTB to the DO hardware module.

When the block export tag is configured as the PTB module output, the 16-bit outputs (a packed data array of 16-bit pointers of the PTB module) is exported to the DO hardware module.

Example:

\$PTB001.OUT

Function Summary

Description	FIX
16 digital inputs	0
16 digital outputs	1
32 digital inputs	2
8 digital outputs	3
16 digital inputs with 4 counters	4
32 digital inputs with 4 counters	5

Description	FIX
Single digital input	6
Single digital output	7

Atoms

Atom	Description
ASTA	Alarm logical status 29 normal
AUT	Automatic mode bit
CNT	Array of 4 counters (analog data)
FIX	Function index
LCK	Lock bit
MODE	Mode 24 normal 28 manual
MSET	MSET number
MSTA	Module logical status 46 normal
OBIT	Single bit output
OTB1[]	Array of 8 digital bit outputs
OTB2[]	Array of 8 digital bit outputs
OTW1[]	Array of 16 digital bit outputs
OTW2[]	Array of 16 digital bit outputs
OWD1	16-bit output word
OWD2	16-bit output word
PRIO	Module priority
STAT[]	Array of 2 Point status bytes STAT[0] for OBIT, OWD2, OTW1, and OTB1 (depending on FIX) STAT[1] for OWD2, OTW2, and OTB2 (depending on FIX) (Refer to Database Transfer Status in this section)
TAG	Module tag name Standard tag name
TTYP	Display template type, display only Set to 130
ULCK	Disable lock condition bit



Function Description

16 Digital Inputs (FIX = 0)

Function: The DIOB module set to `FIX = 0` stores digital input data from DIO hardware modules as an array in the OTW1 atom. The OTW1 atom can be pointed to by a DIB module by means of a CIO pointer. Each bit of OTW1 can be accessed as an element of a 16 bit array.

Examples:

`$DIOB01.OTW1[0]` to access the first bit of OTW1 data.

`$DIOB01.OTW1[7]` to access the eighth bit of OTW1 data.

If `$DIB001.CIO = $DIOB01.OWD1`, then the value of `$DI001.OUT` is the value obtained from `$DIOB01.OTW1[0]` (Remember `OWD1` and `OTW1 [ ]` contain the same data.) and the value of `$DI008.OUT` is the value from `$DIOB01.OTW1[7]`

16 Digital Outputs (FIX = 1)

Function: The DIOB module set to `FIX = 1` stores 16 bits of packed digital output data obtained from the Harmony DCU database. The atom that is to be the source of the data is specified when the export tag for the channel or the block export tag for the module is configured during DIO data collection configuration as described in [Section 4](#).

Examples:

`$DIOB01.OTW1[0]` to store a value of the first channel.

`$DIOB01.OTW1[7]` to store a value of the eighth channel.

`$DIOB01.OWD1` to store a value of the block export tag.

32 Digital Inputs (FIX = 2)

Function: The DIOB module set to `FIX = 2` stores digital input data from DIO hardware modules in OTW1 and OTW2 atoms. The OTW1 and OTW2 can be connected to a DIB module through the CIO pointer of the DIB module. Each bit of OTW1 and OTW2 can be accessed as an element of a 16 bit array.

Examples:

\$DIOB01.OTW1[0] is the first bit of OTW1 data.

\$DIOB01.OTW1[7] is the 8th bit of OTW1 data.

\$DIOB01.OTW2[8] is the 9th bit of OTW2 data.

\$DIOB01.OTW2[9] is the 10th bit of OTW2 data.

If \$DIB001.CIO = \$DIOB01.OTW1, then the value stored in \$DI001.OUT is obtained from \$DIOB01.OTW1[0] and \$DI008.OUT is obtained from \$DIOB01.OTW1[7].

If \$DIB002.CIO = \$DIOB01.OTW2, then the value stored in \$DI017.OUT is obtained from \$DIOB01.OTW2[0] and \$DI024.OUT is obtained from \$DIOB01.OTW2[7].

8 Digital Outputs (FIX = 3)

Function: The DIOB module set to FIX = 3 stores one byte of packed digital output data obtained from a Controlware II atom.

Examples:

\$DIOB03.OTB1[1] to store a logical value of the second channel.

\$DIOB03.OTB1[7] to store a value of the eighth channel.

16 Digital Inputs with Four Counters (FIX = 4)

Function: The DIOB module set to FIX = 4 functions like the FIX = 0 module. In addition it provides storage for four pieces of analog data related to the discrete information. For example, event counts could be stored in the FIX 4 DIOB module. This is useful with DI2416C and DI0516C DIO hardware modules.

32 Digital Inputs with Four Counters (FIX = 5)

Function: The DIOB module set to FIX = 5 functions like the FIX = 2 module. In addition it provides storage for four pieces of analog data related to the discrete information. For example, event counts could be stored in the FIX 5 DIOB module. This is useful with DI2432C and DI0532C DIO hardware modules.

Single Digital Input (FIX = 6)

Function: The DIOB module set to FIX = 6 stores a single digital input from a DIO hardware module in the DIOB module's OBIT atom. This value is accessible via a tag name.



Single Digital Output (FIX = 7)

Function: The DIOB module set to FIX = 6 stores a single digital output obtained from the Harmony DCU database atom specified by the export tag during the DIO data collection configuration as described in [Section 4](#).

Special Considerations

The DIOB module is used to transfer logical data to and from DIO hardware modules. FIXes are available for handling a single value (one bit) in single mode or for handling packed data in block mode. The FIX is assigned automatically by the DIO software during DIO hardware module configuration as described in [Section 4](#). The FIX assigned depends on:

- Whether the hardware module handles input or output data.
- Whether single or block mode has been selected.
- When in block mode, the number of channels supported by the DIO hardware module being configured.

In single mode the logical value is accessible via a tag name. Refer to [Figure 5-3](#) for a diagram showing single mode data transfer.

In block mode a logical value is not accessible via a tag name. Instead a block of values is stored in an atom as an array; each value can be accessed as an element in the array. Each value in a block of data is associated with one channel on an input or output DIO hardware module. There are FIXes available to match the number of channels supported by DIO hardware modules.

- In the case of input DIO hardware modules 16 or 32 channels are supported. The FIXes associated with digital input hardware modules allow the DIOB module to store 16 values (bits) in each atom (array). If the hardware module supports 32 channels, then two atoms (arrays) are available in the FIX.
- In the case of output DIO hardware modules eight or 16 channels are supported. The FIXes associated with digital output hardware modules allow the DIOB module to store eight values (bits) in each atom (array). If the hardware

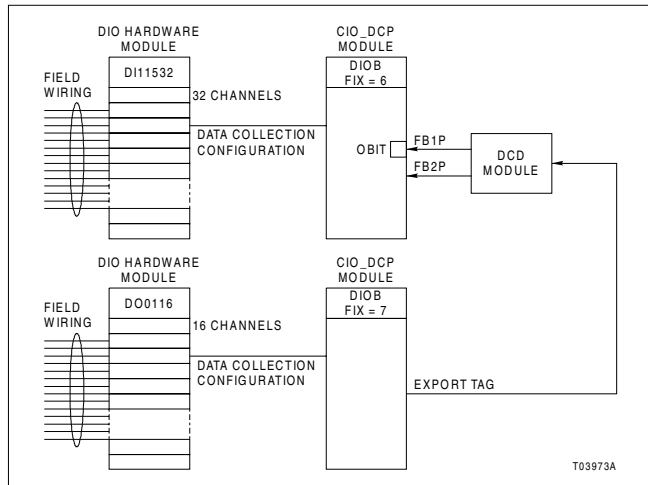


Figure 5-3. Direct Connection of Discrete Input and Output Data (Data Transfer Using Single Mode)

module supports 16 channels, then a 16-bit atom (array) is available in the FIX.

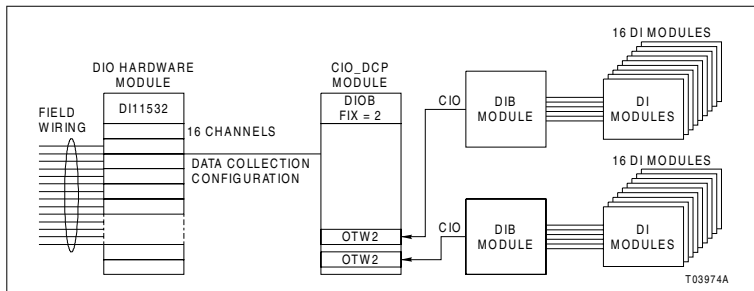


Figure 5-4. Local Block Mode Discrete Input Processing

To access the input data collected from the DIO hardware modules and stored in a DIOB module in the dual-port memory of the DIO board, a DIB module is softwired in the Harmony DCU database to the DIOB module using a CIO pointer. In addition to accessing the values stored in the DIOB module, the DIB



module also monitors the status changes of 16-bit output words containing the same packed digital input data as is stored in the input array, and reports the changes at the scan rate specified in the DIB module.

NOTE: The software is designed in such a way that the DIB module checks the output words instead of the arrays of data because checking the words is faster.

Remember that a DIB module is connected to 16 DI modules. To use the DIB module's CIO pointer be sure that all 16 of the associated DI modules are in service and in automatic mode.

A FIX is available (FIX 4) which, in addition to allowing for 16 inputs to be handled, provides storage for four pieces of analog data related to the digital inputs to be used for storing events counts for the following DIO hardware modules: DI2432C, DI2416C, DI0532C, and DI0516C.

Output data is collected from the Harmony DCU database based on the export tag and the block export tag specified during DIO configuration as described in [Section 4](#).

Database Transfer Status

All CIO database modules have a STAT atom associated with their respective input or output values. The AIOB and DIOB modules have an array of STAT values because each type of module can deal with a block of data. The STAT atom is automatically updated by the DIO board or Harmony DCU on every transaction. The STAT atom contains bits which indicate which board last wrote the database point, whether the value is good, and whether the value was updated since the last operation. The STAT atom is typically used internally, but it can be used by CCL programs within the Harmony DCU.

A STAT atom is a byte field containing eight bits. Reading the bits right to left, the defined values are as follows:

7	6	5	4	3	2	1	0
x	x	x	x	x	—	—	—
							Data Source
					1	—	Harmony DCU
					0	—	CIO board

7	6	5	4	3	2	1	0
Data Status							
1 – Something is wrong with the data, such as no communications, or bad Control-ware data, etc.							
0 – Good data.							
Update Bit							
1 The value has been newly written and has not been read; once the value is read, the CIO board or Harmony DCU will change the value to 0.							
0 No update occurred; nothing was written to this bit; or the update flag was reset.							

Examples:

STAT = 5, equivalent to 00000101 binary, means the value was updated and Harmony DCU wrote the value.

STAT = 1, equivalent to 00000001 binary, means the value was updated and CIO board wrote the value.

STAT = 4, equivalent to 00000100 binary, means the value is not new and the Harmony DCU wrote the value last.

STAT = 6, equivalent to 00000110 binary, means the value is bad and the Harmony DCU wrote the value last.





Introduction

When received, the DIO board will not have the DIO program and database necessary for its operation loaded into the flash memory on the board. However, the DIO software can easily be loaded from the HSI interface. This loading operation is described in ***DIO Program*** in this section.

It is also possible to use the HSI interface to dump a copy of the database (with its data dictionary) from the DIO board to the hard drive of the HSI interface. The copy of the DIO database can then be loaded to the same DIO board where it originated or to another DIO board. The dump and load operations are described in ***DIO Database*** in this section.

File Operations Access

To access the window used to load the DIO program, as well as to dump and load the DIO database:

1. Open a window containing the system status display from the HSI interface.
2. Click on the name of the Harmony DCU on which the operation is to be performed. The Harmony DCU options include:
 - File operations.
 - Services.
 - Operations.
 - Info.
3. Select the file operations option. A file operations window appears similar to Figure 6-1.

The top portion of the window contains the label *DCU file types*, followed by three rows of file type options (only one file type can be selected at a time). Below the rows of file type options is a list box which contains a list of all files available for the file type currently selected, as well as the time and date that the

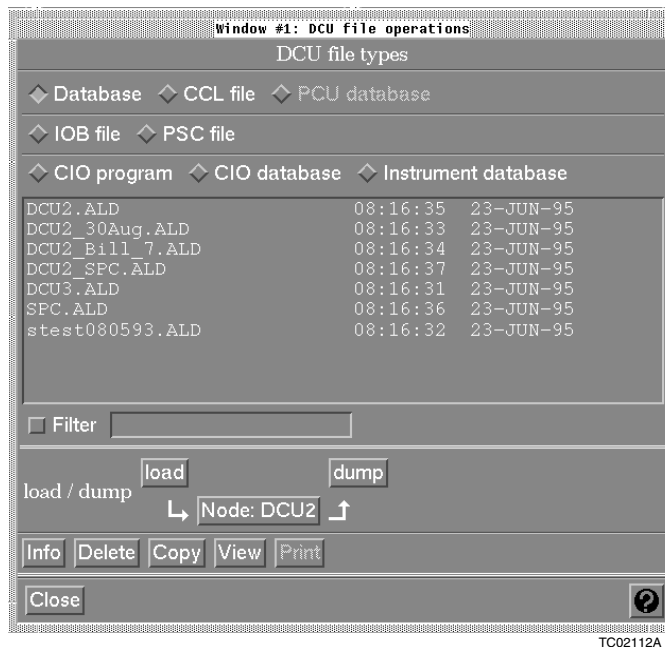


Figure 6-1. DCU File Operations Window

file was created, last modified, or restored from tape. The contents of the file list box will change as the file type is changed.

NOTE: The files listed in the list box reside on the hard disk of the HSI interface, and are available network-wide (i.e. available to all HSI interfaces on the network).

Among the file types available are CIO program, CIO database, and instrument database. The DIO board is a type of CIO board. The CIO program and CIO database file types apply to the DIO board.

Redundant DIO Boards

A redundant DIO board configuration exists when:

- Two DIO boards are mounted in adjacent slots in the Harmony DCU (left one of the pair in an odd-numbered slot).
- Two DIO boards are paired, meaning they are assigned the same logical address (refer to **DIO Program** in this section).
- CIO database modules in the Harmony DCU database associated with the two DIO boards are each configured for redundancy.

DIO Program

NOTE: Before loading the DIO software in the DIO board, be aware that doing so will wipe out the existing database on the board. To preserve the database as it exists on the board, first dump it to the HSI interface as described in **DIO Database** in this section, load the software, then reload the database.

Prior to loading the DIO program, set a logical number (1 to 255) in each DIO board in the Harmony DCU. The logical number of each standalone DIO board must be unique. If the DIO boards are to be redundant boards mounted in adjacent slots (left one in the odd-numbered slot), they must have the same logical address. To set the logical number in the DIO board use the **SL** command (described in **DIO Utilities** in this section), or connect a terminal to the DIO console port.

To display the logical number currently assigned to the DIO board, type the following command at the terminal:

SL RETURN

To change the logical number, type:

SL *n* RETURN

where *n* is the logical number to be assigned to the DIO board.

DIO Program Load

To load the DIO program in a single, nonredundant DIO board:

1. Open the file operations window as described in **File Operations Access** in this section.
2. Select the CIO program file type. A list of available program files will be displayed. (As a result of the standard HSI interface software installation procedure, the DIO software will be



installed on the hard drive.) A program file will have the file extension **.CIOPRG**.

3. Select the program file to be downloaded by clicking on the desired entry in the file list box.
4. Click *load*. A window will open similar to Figure 6-2.

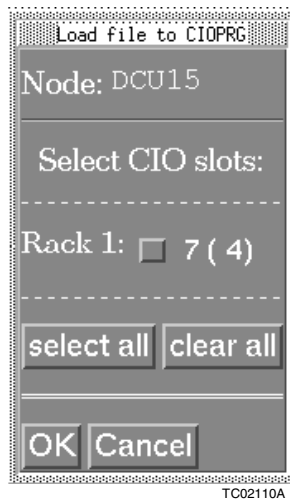


Figure 6-2. Load Program File Selection Window

In Figure 6-2 the Harmony DCU selected from the system status display was DCU15. DCU15 only has one rack and that rack contains only one DIO board. If there were two racks and more DIO boards, all would be shown on this window. The single DIO board in DCU15 is in slot seven, rack one. The logical number of the DIO board is shown in parenthesis after the slot number. The logical number of the DIO board is four.

5. Click on the radio button associated with the DIO board to receive the load. To select all the DIO boards use *select all*.

NOTES:

1. The DIO board operation will be interrupted while the downloading operation takes place.

2. The existing database on any DIO board receiving the program load will be replaced by the default database.
6. Click *OK* to proceed with the loading. A window will open containing the message:

*Downloading CIO Program to Node DCU<n>
from File <name>. Please wait.*

After the program loading operation, the DIO board will be returned to the operational state it was in before the load. This means that if the DIO board was in suspend mode, it will continue to be in suspend mode after the program load. If it was in auto mode (actively communicating with DIO modules), it will again go to control mode after the load operation, even though it is now using the default database instead of the one that was being used prior to the program load.

A preferred method is to:

1. Dump the existing database.
2. Place the DIO board in suspend mode
3. Load the program.
4. Reload the database.
5. Return to auto mode.

While the DIO board is in suspend mode, the DIO modules will go to the state specified for a communications failure condition as described in [Section 4](#).

The number of the Harmony DCU will be shown as well as the name of the file originally selected from the list of available program files.

Before the program is loaded, the DIO board will be placed in hold mode. The fault LED on the DIO board will be lit. While the program load is taking place, the two port LEDs will flash alternately. As long as the *Downloading CIO Program* message is displayed and the three port LEDs continue to flash, the load is progressing. If there is a problem that prohibits a successful load, then an error message will be displayed at the HSI interface. The program load has been successfully completed when:



- The downloading message is no longer displayed (the file operations window will still be open).
- The TransNet LED is lit for approximately ten seconds.

Following the brief lighting of the TransNet LED, the DIO board begins operating with a default database.

DIO Program Load (Redundant DIO Boards)

Loading a DIO program in redundant DIO boards is very similar to the load procedure described for a nonredundant DIO board program load (refer to **DIO Program Load** in this section). Use the following procedure to load a DIO program to redundant DIO boards:

1. Open the file operations window as described in **File Operations Access** in this section.
2. Select the CIO program file type. A list of available program files will be displayed. (As a result of the standard HSI interface software installation procedure, the DIO software will be installed on the hard drive.) A program file will have the file extension **.CIOPRG**.
3. Select the program file to be downloaded by clicking on the desired entry in the file list box.
4. Click **load**. A window will open similar to Figure 6-3.

The window displays all racks, and slots in the Harmony DCU containing CIO and DIO boards. The logical address of the CIO and DIO boards are displayed in parentheses after the slot number. In the example shown in Figure 6-3, the logical address is the same for the two DIO boards in slots seven and eight. The asterisk displayed after the logical address for the board in slot seven is an indication of which board is the primary DIO board.

5. Click on the toggle button associated with the primary DIO board. When the primary DIO board is selected, the backup DIO will also be selected automatically. To deselect the backup DIO board, click its toggle button. It is recommended, however,

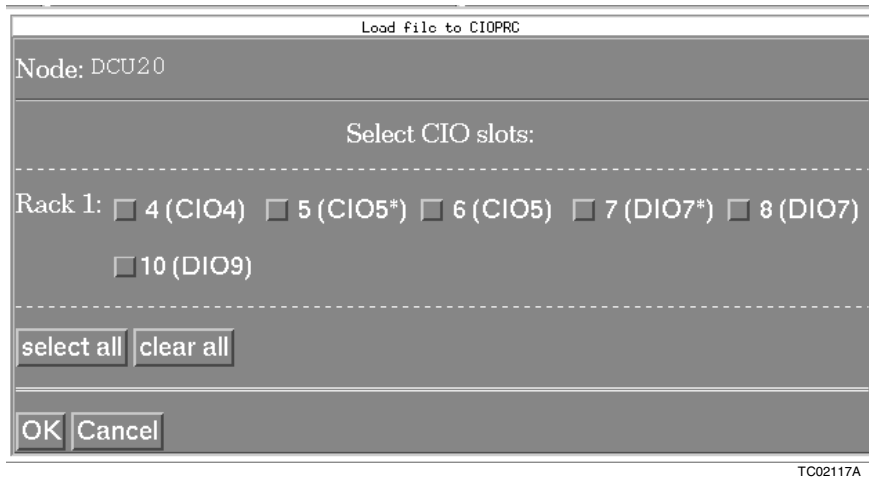


Figure 6-3. Load Program File Selection Window (Redundant DIO Boards)

that both boards be loaded with the program during the same operation.

NOTES:

1. The DIO board operation will be interrupted while the downloading operation takes place.
2. The existing database on any DIO board receiving the program load will be replaced by the default database.
6. Click *OK*. A window with the following message will be displayed.

*Downloading CIO program to node DCU<n> from
file<name>. Please wait.*

This window will be cleared when the operation is completed.

DIO Database

The DIO database consists of the CIO database modules, as well as the default data dictionary. This database can be dumped from the DIO board's dual-port memory to the HSI interface hard drive as described in ***DIO Database Dump*** in



this section. A previously dumped database file can be loaded to a DIO board as described in ***DIO Database Load*** in this section.

NOTE: Because the data dictionary is always loaded and dumped with the database, there is no possibility of a mismatch between the data dictionary and the database.

DIO Database Dump

To dump a DIO database:

1. Open the file operations window as described in ***File Operations Access*** in this section.
2. Select the CIO database file type. A list of available database files will be displayed.
3. Click *dump*. A window will open similar to Figure 6-4.

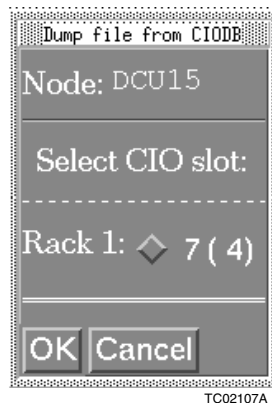


Figure 6-4. Dump Program File Selection Window

In Figure 6-4 the Harmony DCU selected from the system status display was DCU15. DCU15 only has one rack and that rack contains only one DIO board. If there were two racks and more DIO boards, all would be shown on this window. The single DIO board in DCU15 is in slot seven, rack one. The logical number of the DIO board is shown in parenthesis after the slot number. The logical number of the DIO board is four.

4. Click on the radio button associated with the DIO board to be the source of the dump.
5. Click *OK*.

NOTE: Dumping from the DIO board will *not* interrupt DIO operation.

A window will open that contains a default file name in the file name entry box. The default name is based on the selected Harmony DCU. The file extension for database files is **.CIODB**.

NOTE: The **.CIODB** file name extension must be used. If another file name extension is used, the file will not display in the file operations window.

6. Either use the default file name or change it, then click *OK* to proceed with the dump. If a file with the name entered does not already exist, a window will open containing the message:

*Updumping CIO database from node DCU<n> to
file <file_name>. Please wait.*

If the dump is interrupted by clicking *Cancel*, the file containing the partial database will be deleted automatically from the HSI interface hard drive.

If a file already exists with the entered name, a message asking if the file should be replaced will appear.

- Click *No* to stop the dump process and return to the file operations window.
- Click *Yes* to overwrite the existing file.

When the dump has been completed, the newly created database file will be displayed in the list in the file operations window.

DIO Database Load

To load a DIO database:

1. Open the file operations window as described in **File Operations Access** in this section.
2. Select the CIO database file type. A list of available database files will be displayed.
3. Select the database file to be downloaded by clicking on the desired entry in the file list box.



4. Click *load*. A window will open similar to Figure 6-5.

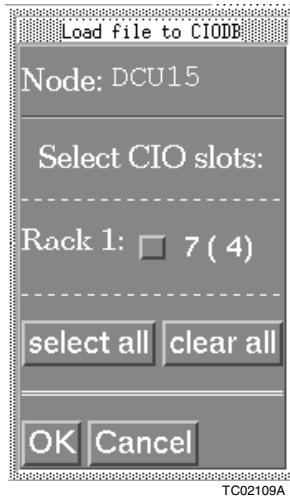


Figure 6-5. Load Database File Selection Window

In Figure 6-5 the Harmony DCU selected from the system status display was DCU15. DCU15 only has one rack and that rack contains only one DIO board. If there were two racks and more DIO boards, all would be shown on this window. The single DIO board in DCU15 is in slot seven, rack one. The logical number of the DIO board is shown in parenthesis after the slot number. The logical number of the DIO board is four.

5. Click on the radio button associated with the DIO board to receive the load. To select all the DIO boards click *select all*.

NOTE: The DIO board operation will be interrupted while the downloading operation takes place.

6. Click *OK* to proceed with the loading. A window will open containing the message:

*Downloading CIO Database to Node DCU<n>
from File <name>. Please wait.*

During the load operation, the control LED on the DIO board will be off. When the load operation is completed the DIO board

will be returned to the state it was in before the downloading was initiated. If the load is unsuccessful an error message will be displayed.

The database load is completed when:

- The downloading message is no longer displayed (the file operations window will still be open).
- The control LED is lit (if the board is not in suspend mode).

DIO Database Dump and Load (Redundant DIO Boards)

DIO board redundancy can only be achieved when the backup DIO board is in a backup ready state. For a backup DIO board to be in the backup ready state, it and the primary DIO board must be identically configured.

When redundant DIO boards are installed, the following instructions should be followed for dumping and loading the DIO database. The procedure to use depends on whether:

- Neither DIO board contains the configuration (database) desired.
- The primary DIO board contains the desired database (includes data dictionary, database, collection list, port setup configuration, etc.).

If neither board contains the desired configuration, but a database file containing the configuration exists on the HSI interface hard drive, only the load procedure is involved to load the database to both boards (refer to ***DIO Database Load to Primary and Backup DIO Boards*** in this section). If the primary board contains the desired configuration, the procedure for accomplishing and maintaining identical configuration is described in ***DIO Database Load from Primary DIO Board to Backup DIO Board*** in this section.

There are three activities that effect the configuration characteristics of the DIO database. When each is performed for redundant DIO boards, the following procedures will guarantee that the database in both boards remain the same.

1. DIO program load. Both boards should be loaded at the same time. After a program load both DIO boards will contain default databases.



2. DIO database load. Both boards should be loaded at the same time.
3. DIO configuration. Configuration should **never** be done in the backup DIO board. After configuration is done in the Primary DIO board, the database should be dumped to the HSI interface and then loaded into the backup DIO board.

NOTES:

1. Dump the primary DIO board database and load it to the backup DIO board each time a change is made to the primary DIO board database.
2. If the DIO database is dumped from the primary DIO board but no configuration changes have been made (e.g. routine backup maintenance), it is not necessary to download the database to the backup DIO board. The primary DIO board database time-stamp is only updated if the primary configuration has been changed.

DIO Database Load to Primary and Backup DIO Boards

Loading a DIO database in redundant DIO boards is very similar to the load procedure described for a nonredundant DIO board program load (refer to **DIO Database Load** in this section). Use the following procedure to load a DIO database to redundant DIO boards:

1. Open the file operations window as described in **File Operations Access** in this section.
2. Select the CIO database file type. A list of available database files will be displayed.
3. Select the database file to be downloaded by clicking on the desired entry in the file list box.
4. Click *load*. A window will open similar to Figure 6-6.

The window displays all racks, and slots in the Harmony DCU containing CIO and DIO boards. The logical address of the CIO and DIO boards are displayed in parentheses after the slot number. In the example shown in Figure 6-6, the logical address is the same for the two DIO boards in slots seven and eight. The asterisk displayed after the logical address for the board in slot seven is an indication of which board is the primary DIO board.

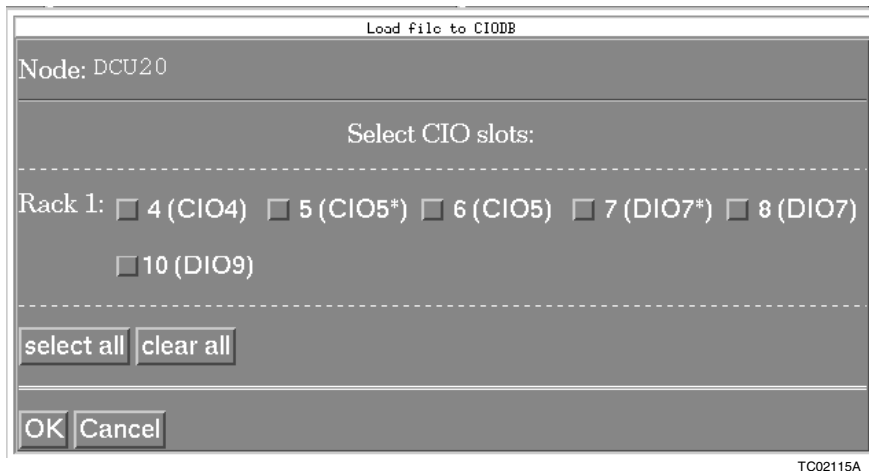


Figure 6-6. Load Database File Selection Window (Redundant DIO Boards)

5. Click on the toggle button associated with the primary DIO board. When the primary DIO board is selected, the backup DIO will also be selected automatically. To deselect the backup DIO board, click its toggle button. It is recommended, however, that both boards be loaded with the database during the same operation.

NOTE: The DIO board operation will be interrupted while the downloading operation takes place.

6. Click **OK**. A window with the following message will be displayed.

*Downloading CIO database to node DCU<n> from
file<name>. Please wait.*

This window will be cleared when the operation is completed.

DIO Database Load from Primary DIO Board to Backup DIO Board

If changes to the primary DIO board database have been made, the databases in the primary and backup DIO boards no longer are the same. For the backup DIO board to be ready to assume functionality as the primary DIO board, the databases must be the same. The following procedure will insure that the backup



DIO board is using the same database as the primary DIO board.

NOTE: Recognition of a *backup not ready* state is displayed as a message at the HSI interface and also is indicated by the LEDs on the DIO boards and in point displays of the HSI interface.

To achieve backup ready status in redundant DIO boards after a configuration change has been made to the database in the primary DIO board, a two-part procedure must be performed:

1. Dump the primary DIO board database to a file. Refer to ***DIO Database Dump*** in this section for the procedures.
2. Load the database file that was just dumped into the backup DIO board. Refer to ***DIO Database Load*** in this section for the procedures.

Assuming that there are no hardware or cabling problems and that the auto/suspend switch on the backup DIO board is set to auto mode, the backup DIO board will become backup ready once its database matches the primary DIO board as a result of this operation.

For redundant operation to be achieved, the primary DIO board must see the backup DIO board as being backup ready. Check that the primary DIO board backup ready LED is lit either by looking at the board or by checking the primary DIO board's point display of the HSI interface. If the primary DIO board's backup ready LED is not lit, cycle the auto/suspend switch on the backup DIO board, either manually or by using the backup DIO board's point display.

When the backup ready LED is lit on both DIO boards in the redundant pair, a switchover can occur if required.

Utilities

DIO Utilities

The utilities function is provided to view DIO board information such as slot, logical address, etc. DIO utilities are accessed

through the same window used to access DIO configuration functions.

1. Open a window containing the system status display from the HSI interface.
2. Click on the name of the Harmony DCU on which the operation is to be performed. The Harmony DCU options include:
 - File operations.
 - Services.
 - Operations.
 - Info.
3. Select the services option.
4. Select the configure DCU option.
5. Select CU (CIO utilities). The CIO utility configuration will be displayed. This window contains information about CIO and DIO boards installed in the Harmony DCU.

NOTE: Type **HE RETURN** to display the help menu.

6. Type **SE RETURN** to select one of the DIO boards.

Table 6-1 lists the pertinent commands available in the utility menu.

Table 6-1. Utility Commands

Command	Description
SL	Set logical address of selected DIO board
SE	Select slot
RESET	Reset selected DIO board; the DIO board changes to ODT mode
START	Begin selected DIO operation

Export Tag List

A utility is installed in the Harmony DCU that is used to display export tags with their status. The utility is accessed through the same window used to access DIO configuration functions:

1. Open a window containing the system status display from the HSI interface.



2. Click on the name of the Harmony DCU on which the operation is to be performed. The Harmony DCU options include:

- File operations.
- Services.
- Operations.
- Info.

3. Select the services option.

4. Select the DCU service support option.

5. Select CET (CIO export tag list).

6. Enter a DIO logical number at the prompt.

7. Type **DSP RETURN** to display the export tag list.

NOTE: If an asterisk (*) displays in the first column it means that the export tag is unlinked.



Introduction

This section provides information to help understand and use DIO data dictionary configuration. The DIO software incorporates a data dictionary consisting of three module types. The set of three standard modules is part the default data dictionary for the DIO board (Table 2-2).

NOTE: Because the DIO board is really a special type of CIO board, the types of modules in the DIO database are referred to as CIO database module types.

During system configuration as described in Section 4, the DIO board automatically selects the appropriate module type for the DIO hardware module and mode (single or block). Like the Controlware modules in the Harmony DCU database (stored in DCP board memory), the modules in the DIO database offer FIXes to accommodate the various ways the module types can be used.

The data dictionary definition is stored within the DIO board's dual-port memory. This allows the Harmony DCU to access the DIO board's database structure and link it into the DCU database structure. In effect, the DIO board's database is a remote database to the Harmony DCU which is attached by the DCU upon DIO board startup. For the purpose of global database access (global DBA), the DIO board database is logically part of the Harmony DCU database.

In most cases the data dictionary will be modified only to change the module mix of the system, that is, to change the quantity of each type of module. For example, a specific application may need more analog modules than the default module mix provides. In such a case, the data dictionary configuration menu described in this section would be used to modify the DIO module mix.

NOTE: For redundant DIO board installations the data dictionary is part of the DIO database. Remember to dump the primary DIO board database and load it to the backup DIO board each time a change is made to the primary DIO board database (refer to Section 6).



Data dictionary configuration is accessed from the distributed I/O system configuration menu. When the selection is made, the data dictionary menu (Fig. 7-1) is displayed.

NOTE: The DIO board must be in suspend mode before data dictionary changes can be made. To put the board in suspend mode, use the auto/suspend switch on the board, or the suspend button in the point display for the CIO database module associated with the DIO board. After making the desired changes to the data dictionary, switch the board back to auto mode.

```

Configuration of CIO 1-11, DCU20
DATA DICTIONARY CONFIGURATION
DATA DICTIONARY NAME:      DEFAULT
1 ID  - Display/Change Data Dictionary ID(NAME) String
2 OVD - Override Loaded Data Dictionary with System Default
3 MIX - Display/Change Data Base Module Complement (Module Mix)
4 ATM - Create/Remove/Change Module Type Atom Characteristics
5 TYP - Create/Remove New Module Types

***** NOTICE *****
* Installation of Data Dictionary Configuration *
* changes requires that the DIO is in Suspend *
* mode. If it is necessary to enter suspend mode *
* at this time then this Configuration session *
* must be restarted. *
*****

MENU COMMANDS: E - exit menu; I - select entry
FUNCTION= 

Exit ?

```

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Figure 7-1. Data Dictionary Configuration Menu

The five data dictionary configuration functions listed on this menu are described in *Data Dictionary Configuration Menu* in this section.

Data Dictionary Configuration Menu

Each item in the data dictionary configuration menu can be selected by either entering the index number at the beginning of the line, or the two or three letter acronym displayed after the number.

Display/Change Data Dictionary ID String

The ID function is used to assign a name to the data dictionary. The name can be up to 14 characters in length. The name is stored as part of the data dictionary's contents. When the data dictionary has been dumped to an off-line ASCII file, or after it has been reloaded, the name can be used for identification purposes.

Enter **1 RETURN** from the data dictionary configuration menu to select the ID function. The following will be displayed:

Enter new Data Dictionary name:

Enter a name of up to 14 characters. Any printable ASCII character is valid. This has no effect on the operational status of the DIO board.

Override Loaded Data Dictionary with System Default

The OVD function is a method of reconciling differences between the structure of a configured database operating with a data dictionary that is different in structure from the DIO board's default data dictionary. This can occur after you have upgraded to the next higher software version. If ABB Automation makes changes to the contents or the structure of the data dictionary for a new software release, databases configured with the previous version of the software may not work with the new version. Executing the OVD function will resolve that problem without requiring that the database be reconfigured.

Enter **2 RETURN** from the data dictionary configuration menu to select the OVD function. The following prompt will be displayed:

Reconfigure CIO Database with System Default Data Dictionary? y/n

Enter **y RETURN** to cause the DIO board to reconstruct the database using the system default data dictionary.

Using the OVD function will change the **structure** of the database to the new format. The contents of the currently configured database will **not** be changed. Also, any changes made to the module mix will be preserved. Likewise, any new atoms or module types created will be preserved.



Display/Change Database Module Complement

The MIX function lists the module type names and the quantity of each type that currently make up the database. Also listed is the size of one module of each type, the amount of memory used by each type, the total amount of database memory used, and the amount remaining. The quantity of modules of each type can be changed. When this is done, the displayed memory usage characteristics are dynamically updated. Menu changes and resulting windows are off-line operations. An install command is provided to reconstruct the database with the new module complement. This function can be used without affecting the current configuration other than adding and removing modules.

Enter **3 RETURN** from the data dictionary configuration menu to select the MIX function. Selecting this function will display the DIO module complement window (Fig. 7-2).

INDEX	TYPE NAME	NUMBER MODULES	SIZE PER MODULE	TOTAL SIZE
1	AIO	250	44	11000
2	AIOB	120	126	15120
3	DIOB	350	54	18900
				45020

BYTES MEMORY LEFT = 10766

MENU COMMANDS: I - INSTALL CHANGES; E - EXIT MENU

ENTER INDEX OR TYPE NAME AND NUMBER MODULES DESIRED:

Exit ?

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Figure 7-2. DIO Module Complement Window

Index The *INDEX* column lists index numbers used to select each module type. This number can be used to specify the module type for which a change in the quantity of modules is desired.

Type Name	The <i>TYPE NAME</i> column lists the name of each module type.
Number of Modules	The <i>NUMBER MODULES</i> column shows the quantity of each module type in the database.
Size Per Module	The <i>SIZE PER MODULE</i> column shows the number of bytes of memory used by a single module of each type.
Total Size	The <i>TOTAL SIZE</i> column shows the number of bytes of memory used for all of the modules of each type.

At the bottom of the total size column is the sum of the total sizes of each type, which is the total size of the database. *BYTES MEMORY LEFT* displays the number of additional database bytes that are available for use.

To change the quantity of modules of a type it is necessary to specify the type and enter the new number of modules desired. To specify the type, enter either the index or the type name.

For example, to change the number of AIOB modules, enter **2 RETURN**. The following prompt will be displayed:

New number modules =

Enter the number of modules desired, then **RETURN**.

After the change has been made the window will show the updated information.

The menu displays what the contents of the database would be if the changes were installed, not the current contents of the database. The operational status of the DIO board is not affected unless the changes are installed.

If the number of each module type required is known before the module complement configuration process is started, it is possible to perform the operation very quickly. For example, if five modules of each type are needed, the following keystroke sequence can be entered:

1 5 RETURN

2 5 RETURN

3 5 RETURN

If any entry causes the total number of bytes used to be more than the memory available in dual-port memory for database



module use, the change is not accepted and the following message is displayed:

CHANGE EXCEEDS MEMORY LIMIT

To cancel all changes and return to the original module complement values, enter **E RETURN**. The previous menu is displayed, and the changes to the module complement are not saved.

To install the changes into the database enter **I RETURN**.

Create/Remove/Change Module Type Atom Characteristics

The ATM function is used to add and remove user-defined atoms, and to assign and change the attributes of those atoms or the module's default atoms.

Enter **4 RETURN** from the data dictionary configuration menu to select the ATM function. Selecting this function will display the change module atom characterizes window (Fig. 7-3). This window lists the current module types that exist in the database. Select a module type from this menu.

```

Configuration of C10 1-11, DCU20
CHANGE MODULE ATOM CHARACTERISTICS

INDEX      TYPE
-----
1          AIO
2          AIOB
3          DIOB

MENU COMMANDS: E - EXIT MENU
ENTER INDEX OR TYPE NAME: 
Exit
  
```

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Figure 7-3. Change Module Atom Characteristics

The module type is chosen by entering either the index number or the module type name. A window will be called up listing the atoms that comprise the selected module type.

From this window, an atom can be added, the attributes of an existing atom can be edited, or a custom atom can be removed.

Add an Atom

To add an atom:

1. Enter **A RETURN** to select *ADD AN ATOM*. The system will prompt for the new atom name.
2. Enter the name in the form:

xyz **RETURN**

Editing an atom and adding a new atom both call up the same window for viewing and changing the attributes (refer to *Changing Attributes of an Atom* in this section).

Edit an Atom

To edit an atom, enter its index number or name, then press **RETURN**. Editing an atom and adding a new atom both call up the same window for viewing and changing the attributes (refer to *Changing Attributes of an Atom* in this section).

Remove a Custom Atom

Only custom atoms can be removed. Standard Controlware atoms (those appearing in the default atom list) cannot be removed. To remove a custom atom:

1. Enter **R RETURN** to select *REMOVE AN ATOM*. The system will prompt for the name of the atom to be removed.
2. Enter the name in the form:

xyz **RETURN**

Changing Attributes of an Atom

The operations that can be performed on attributes of an atom are the same when editing or adding an atom (Fig. 7-4). The names and values of the atom attributes display in two columns. The left column lists attributes that can be changed and



the right column lists attributes that cannot be changed. To change the value of the atom's attributes:

1. Enter the attribute's index number, then press **RETURN**. The system will prompt for the attribute value.

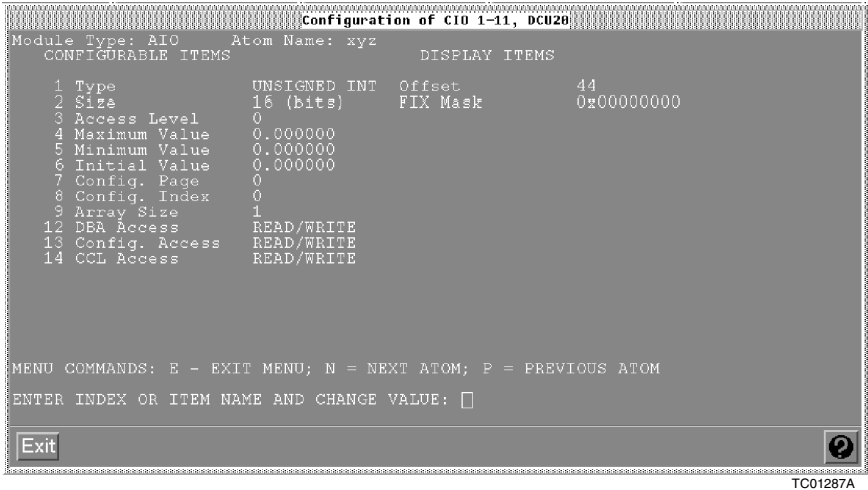


Figure 7-4. Attribute Configuration

2. Enter the new value, then press **RETURN**.

For example, enter **7 1 RETURN** to select attribute seven and enter a value of one. For an AIO module (Fig. 7-4), this would assign it to configuration page one. Entering **9 16 RETURN** for an AIO module would configure an array of 16 data values.

Change all desired values before exiting or going on to a different atom. The window will update to show each change.

To return to the previous window and save the new atom addition, enter **E RETURN** (exit command).

Use the *NEXT ATOM (N)* or *PREVIOUS ATOM (P)* commands to display the atom attribute list for the next or previous atom in the module's atom list.

Create/Remove New Module Types

The TYP function is used to add or remove user-defined module types. When a new module type is created, the default module type atom list is provided. Using this function, the module type can be customized by adding atoms and changing the characteristics of the attributes of those that already exist.

Enter **5 RETURN** from the data dictionary configuration menu to select the TYP function. Selecting this function will display the change module type complement window (Fig. 7-5). This window lists the module types that currently exist in the database.

```

Configuration of CIO 1-11, DCU20
CHANGE MODULE TYPE COMPLEMENT

INDEX      TYPE
-----
1          AIO
2          AIOB
3          DIOB

MENU COMMANDS: A - ADD TYPE; R - REMOVE TYPE; I - INSTALL CHANGES; E - EXIT MENU
FUNCTION= 

Exit
  
```

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Figure 7-5. Change Module Type Complement Window

Create a Module Type

To create a module type:

1. Enter **A RETURN** to select *ADD TYPE*. The system will prompt for the name of the new module type.
2. Enter the name in the form:

xyz RETURN

The following example creates a MNO module type:



A MNO RETURN

This menu does not display the actual module type complement, but an off-line representation of what the module type complement would be if installed using the install (I) command. Any changes can be canceled by entering **E RETURN** at the *FUNCTION =* prompt. The previous window will be called up and the changes to the change module type complement window will not be saved.

Adding and installing a module type causes the data dictionary and database to be reconstructed with one module of the new type. This module consists of a default list of atoms (refer to Table 7-1). The module can be configured using the ATM function, which allows customizing the module (refer to *Create/Remove/Change Module Type Atom Characteristics* in this section).

Table 7-1. Default Atom List

MOD	LCK	BIN	MTYP	CTAG
MSTA	AUT	BOU	REFR	STAT
ASTA	HHA	BPT	SB1	
PSTA	LLA	FIX	LEG	
MODE	HA	PRI0	TAG	
SW1	LA	MSET	TTYP	

Removing a Module Type

To remove a module type:

1. Enter **R RETURN** to select *REMOVE TYPE*. The system will prompt for the name of the module type to be removed.
2. Enter the name in the form:

xyz RETURN

The following example removes the MNO module type:

R MNO RETURN

It is not possible to remove standard CIO database module types. Trying to remove a module type that does not exist causes the following message:

MODULE TYPE DOES NOT EXIST

Shortcut Selection

A shortcut selection option is available throughout data dictionary configuration. A shortcut selects an option and enters a value on a single line. For example, in the MIX function the following shortcut can be used to enter the type and number of modules desired:

AIOB 5 RETURN

-or-

2 5 RETURN





Introduction

This section provides information to help understand and use DIO database configuration. The DIO database consists of a set of Controlware II module types similar in construction to the Harmony DCU database module types. Like the Harmony DCU database in the DCP board, the modules in the DIO database contain elements called atoms.

NOTE: Because the DIO board is really a special type of CIO board, the types of modules in the DIO database are referred to as CIO database module types.

The DIO database resides on the DIO board in local memory known as dual-port memory which can be accessed by both the DIO board and the DCP board across the I/O bus. The DIO database can be saved and restored using DIO load and dump operations (refer to [Section 6](#)).

Like the database on the DCP board, the DIO database module complement is defined by a data dictionary. The default data dictionary for the DIO database will be appropriate for most users. If modifications to the data dictionary are required refer to the procedures described in [Section 7](#).

During software configuration for a typical DIO application, database configuration is normally not used. Most of the configuration required for the DIO hardware modules is done automatically by remote I/O configuration as described in [Section 4](#). However, it is possible to use database configuration accessible from the distributed I/O system configuration menu to examine the contents of the DIO database, and to change the value of some atoms from their defaults.

NOTE: For redundant DIO board installations, remember to dump the primary DIO board database and load it to the backup DIO board each time a change is made to the primary DIO board database (refer to [Section 6](#)).



Database Configuration Option

Database configuration is accessed from the distributed I/O system configuration menu. When the selection is made, the data dictionary menu (Fig. 8-1) is displayed.

Configuration of C10 1-7, DCU20						
DATABASE CONFIGURATION						
PAGE 1 OF 5						
INDEX	TAGNAME	MODTYPE	MODNUM	USERS	MODPNTR	FIX
1	01ani1	AIO	1	1	232221c	0
2	01ani2	AIO	2	1	2322248	0
3	01ani3	AIO	3	1	2322274	0
4	01ani4	AIO	4	1	2322a0	0
5	01ani5	AIO	5	1	23222cc	0
6	01ani6	AIO	6	1	23222f8	0
7	01ani7	AIO	7	1	2322324	0
8	01ani8	AIO	8	1	2322350	0
9	04ano1	AIO	9	1	232237c	1
10	04ano2	AIO	10	1	23223a8	1
11	04ano3	AIO	11	1	23223d4	1
12	04ano4	AIO	12	1	2322400	1
13	04ano5	AIO	13	1	232242c	1
14	04ano6	AIO	14	1	2322458	1
15	04ano7	AIO	15	1	2322484	1

MENU COMMANDS: [1-999] - view a module; E -exit menu

FUNCTION= ☐

Exit

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Figure 8-1. Database Configuration

Index	The <i>INDEX</i> column lists module index numbers used to select a specific module for database configuration.
Tag Name	The <i>TAGNAME</i> column lists database module tag name.
Module Type	The <i>MODTYPE</i> column lists the type database module.
Module Number	The <i>MODNUM</i> column lists the number associated with the module.
Users	The <i>USERS</i> column shows the number of times the tag is used in the database.
Module Pointer	The <i>MODPNTR</i> column shows memory address of the module in the dual-port memory of the DIO board.
FIX	The <i>FIX</i> column shows the function index of the module.

The database display can span multiple pages. Use **N RETURN** to display the next page, or **P RETURN** to display the previous page

To enter the configuration display for any of these modules, select the module by entering its number from the index column (Fig. 8-2).

```

=====
Window #1: Configuration of C10 , DCU20
=====
TAGNAME= 04anc1                                MODTYPE= AIO
MODULE FIX: SINGLE OUTPUT
1 FIX = 1 (0x1)          16 IUR = 100.0          32 STAT = 4 (0x4)
2 TTYP = 128 (0x80)      17 ILR = 0.0
3 MSET = 1 (0x1)         18 QUT = 472.1
4 PRIO = 1 (0x1)
5 SW1 = 13 (0xd)
6 FMT = 1 (0x1)
7 SE1 = 0 (0x0)

10 FRPR = 127
11 UPD = 1 (0x1)

MENU COMMANDS: E - EXIT MENU; F = NEXT MODULE; B = PREVIOUS MODULE
FUNCTION= 

Exit 
=====
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```

Figure 8-2. Module Database Configuration

The *TAGNAME*, *IUR*, and *ILR* cannot be changed using this display. Although all the other fields can be configured, not all the changes made would be effective. Only values specified for the following atoms would effect system operation: *FMT*, *MSET*, *PRIO*, and *TTYP*.

To change a value:

1. Enter the index number of the desired atom, then press **RETURN**. The following prompt will appear:

ENTER <atomname> VALUE:

For example, enter the following to select the *FMT* atom:

6 RETURN

The prompt would be:



ENTER FMT VALUE:

2. Enter the new value, then press **RETURN**. Any value changed using this window is changed in the DIO database as soon as **RETURN** is pressed.

NOTE: During DIO database configuration it is possible to change the FRPR values stored in the dual-port memory of the DIO board. This ability to change the FRPR values is available for troubleshooting purposes only. When configuring the system to control a process do *not* configure FRPR values directly in CIO database modules using DIO database configuration. Instead, configure the desired FRPR values in the ANO and DO modules logically connected to the CIO database modules. At runtime, the ANO.FRPR and DO.FRPR values will be copied into the CIO database modules overwriting any values configured there directly through database configuration.



TransNet Bus

Using copper wire, the TransNet bus has a maximum length of 1.6 kilometers (one mile). However, DIO hardware modules can be located greater distances from the Harmony DCU if fiber optic converters are used to serve as the interface between the copper TransNet and fiber optic cable. Use of fiber optic converters also permits galvanic isolation between copper TransNet segments, and protection against lightning when the TransNet bus must be routed outdoors. A fiber optic converter, CI-FIBER, is available from ABB Automation. The CI-FIBER converter permits extending the TransNet bus up to 6.3 kilometers (3.9 miles) depending on fiber core diameter and fiber attenuation. Refer to the documentation supplied with the converter for details.

NOTE: The CI-FIBER converter is manufactured by H&L Instruments. Their manual provided with the converter supplies information about installing the converter and connecting the converter to the fiber optic portion of the TransNet bus. This appendix provides information needed to connect the converter to the copper portion of the TransNet bus.

All DIO hardware modules, termination bases, and power supplies are designed to be connected to the copper TransNet bus. Fiber optic converters must be used in pairs: one on each end of the fiber optic portion of the TransNet bus.

NOTE: Do *not* serially connect more than two CI-FIBER links. A CI-FIBER link consists of a fiber optic cable with a CI-FIBER converter at each end. For optimum performance, the path between the DIO board and any DIO hardware module cannot include more than four CI-FIBER converters.

The copper TransNet bus carries both 24 VDC power and the AC signal to the DIO hardware modules. The PS-1 power supply and the PSC-24 power supply adapter both couple the AC signal (used for communications between the DIO board and the DIO modules) between different segments of the network while isolating the segments in relationship to DC power. The fiber optic network converter is connected to a PS-1 or PSC-24 on the TransNet bus to receive DC power to operate the con-



verter, and to serve as the signal interface between the copper TransNet bus and the fiber optic portion of the network.

Table A-1 lists fiber optic converter specifications.

Table A-1. Fiber Optic Converter Specifications

Property	Characteristic/Value
ABB Automation part number	CI-FIBER ¹
Power requirement	5 W per converter
Connector type (to TransNet bus)	Female, 9-pin, D-type connector
Connector Type (to fiber optic cable)	ST
Fiber optic cable diameter	50 μ ; maximum length 6.3 km (3.9 m) 62.5 μ ; maximum length 5.6 km (3.5 m)

NOTES:

1. This represents one converter. The fiber optic converters must be used in pairs.
2. It is possible to extend the TransNet bus beyond 6.3 kilometers (3.9 miles). Contact ABB Automation for details.

NOTES:

1. The H&L Instruments manual describes use of MTL modules and of the TransNet bus without the DIO board interface. Whenever the H&L Instruments manual refers to one end of the network in terms of the Host/Master or IIOIP, in Harmony DCU terms they are talking about the end of the network connected to the ITB/CIO board.
2. The H&L Instruments manual provides instructions for conducting an input sensitivity test say to run the transition technology (now MTL) IIOIP software in a mode which displays communications errors. Instead, to view communication errors, access the distributed I/O system configuration menu as described in **Accessing the Configuration** in Section 4. The fifth item on the menu is dump error log. If any errors are in the error buffer, this menu item will be followed by the quantity of errors logged. When the input sensitivity test instructions in the H&L Instruments manual require say to note if errors are occurring, view the distributed I/O system configuration menu to see if the quantity of errors is increasing or use the menu options to view the errors. Neither the count on the configuration menu nor the error display will be refreshed as errors occur. Use **RETURN** to refresh the window.

Fiber Optic Converter Power Supply Connection

Each fiber optic converter is connected to either a PS-1 power supply or a PSC-24 power supply adapter. The converter consumes 5 watts of the available power. The PS-1 power supply derives 24 VDC internally from an AC input, and delivers 20 watts of DC power on the TransNet bus. The PSC-24 adapter relies on a conventional 24 VDC power source; the PSC-24 delivers 72 watts to the TransNet bus.

NOTE: The PSC-24 adapter also provides ORing diodes for the addition of a redundant 24 VDC power supply along with an alarm circuit.

Both the PS-1 power supply and the PSC-24 power supply adapter use the same mechanism for isolating the DC component and coupling the AC communications component between different segments of the TransNet bus. Figure A-1 diagrams the PSC-24 power supply adapter. The PS-1 model is similar. The 24 VDC is generated internally on the PS-1 power supply, and the PS-1 power supply does not have the ISO COMM port.

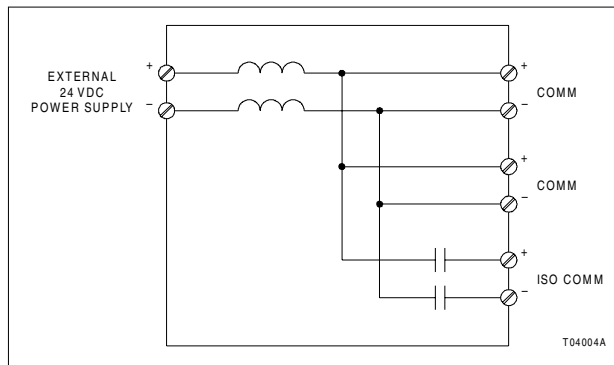


Figure A-1. PSC-24 Power Supply Adapter Diagram

The two COMM ports provided by both the PS-1 power supply and the PSC-24 power supply adapter are connected internally. Both the DC and the AC components of the TransNet bus are normally present at these ports. In the PSC-24 adapter the AC communications component is coupled between the two COMM ports and the ISO COMM port. Because the fiber optic



converter requires both DC power and the AC signal, it must be connected to a COMM port.

In contrast, because the DIO board and ITB/CIO board do not obtain power from the TransNet bus, the ITB/CIO board is connected to the ISO COMM port on the PSC-24 adapter. This is not the only protection against shorting 24 VDC to ground or to some other signal pin when connecting the DIO-to-ITB/CIO cable when the DIO board and TransNet bus are powered. When the J1 and J2 jumpers on the ITB/CIO board are set to the DIO position as described in the ***Distributed Control Unit*** instruction, capacitors decouple the 24 VDC power component (if it exists) from the TransNet bus.

The method of cabling the fiber optic converter to the PS-1 power supply or the PSC-24 power supply adapter depends on the method used for terminating the copper TransNet bus.

Fiber Optic Converter TransNet Termination

As described in **Section 3**, the copper TransNet bus must be terminated. Plan on terminating the TransNet bus at (or close to) the fiber optic converter. The converter provides a female, 9-pin, D-type connector for interfacing with the copper TransNet bus.

If the copper TransNet bus uses 150 ohm cable, terminate it using MTL cable assembly CAI-01-T (length ten feet) and install it between the fiber optic converter and the PS-1 power supply or the PSC-24 power supply adapter. The 150 ohm terminating network is built into the CAI-01-T cable assembly.

If the copper TransNet bus uses 100 or 125 ohm cable, install the terminating network in a junction box installed between the PS-1 power supply or the PSC-24 power supply adapter and the fiber optic converter. This termination scheme is shown in **Figure A-2**. The main trunk of the copper TransNet bus is considered to end at the terminator in the junction box. The distance between the fiber optic converter and the junction box containing the terminating network should not exceed the maximum allowable length for any stub from the network calculated as described in ***Determining the Maximum Allowable Length of Drops*** in **Section 3**.

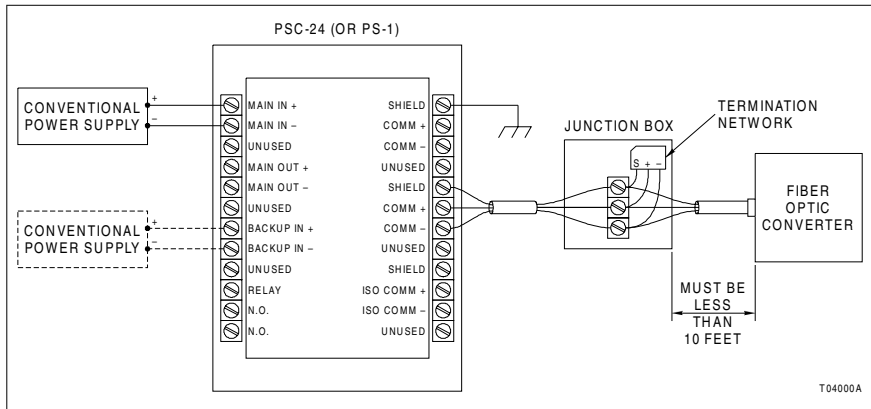


Figure A-2. Junction Box Termination

Example TransNet Fiber Optic Connections

Figure A-3 diagrams the use of a pair of CI-FIBER fiber optic converters to extend the range of a nonredundant DIO system installation up to 6.2 kilometers (3.9 miles) while providing lightning protection and galvanic isolation between the DIO board and the remote module clusters.

Figure A-4 diagrams the components and interconnections required to implement a redundant DIO system with two remote module clusters. The DIO board and the remote module clusters are optically isolated from one another.

Figure A-5 diagrams the components and interconnections required to implement a redundant DIO system with three remote module clusters. The DIO board and the remote module clusters are optically isolated from one another.

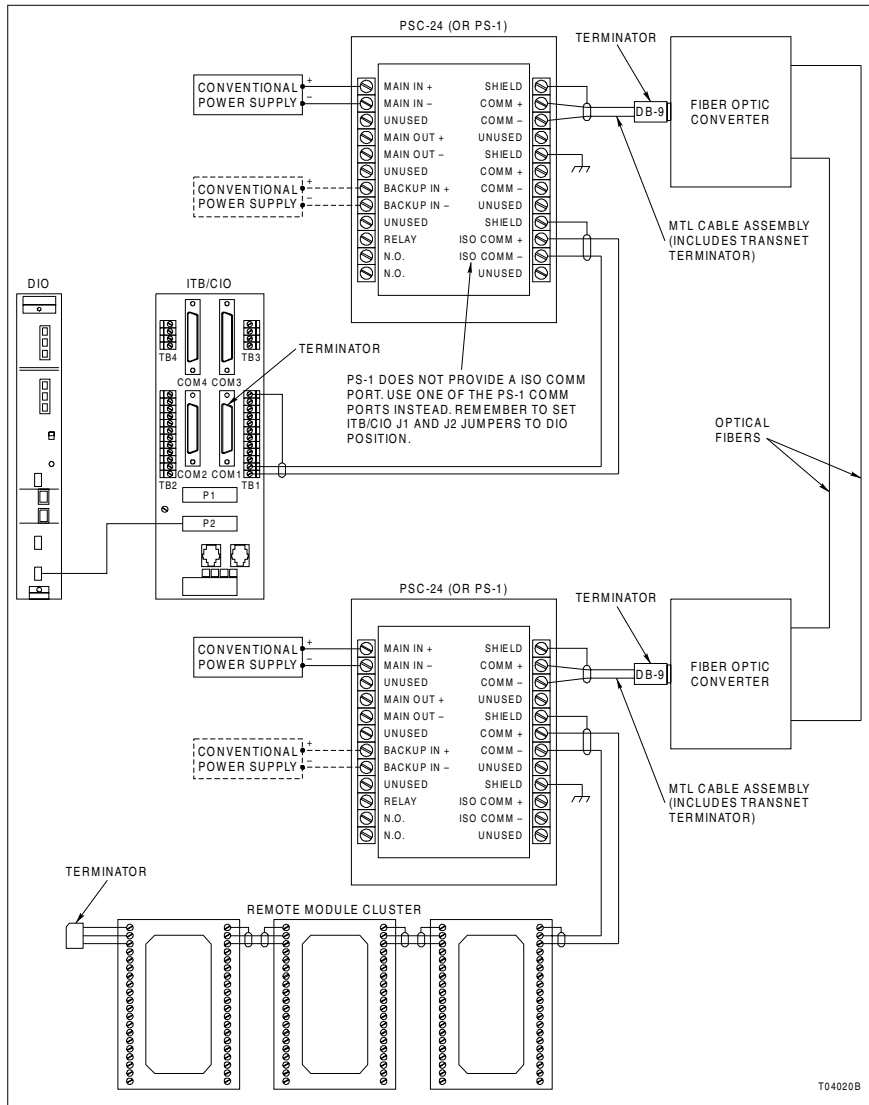


Figure A-3. Nonredundant TransNet Bus Installation Using Fiber Optic Converters

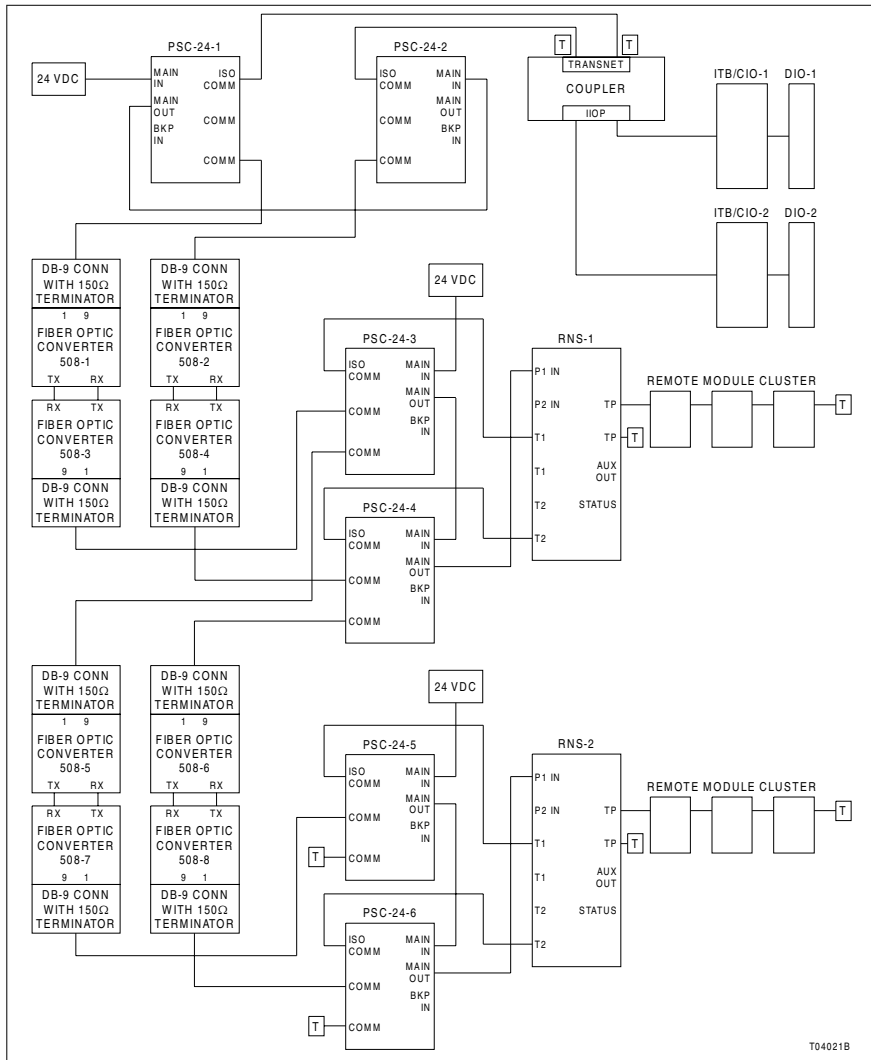


Figure A-4. Redundant TransNet Bus Installation using Fiber Optic Converters (1)

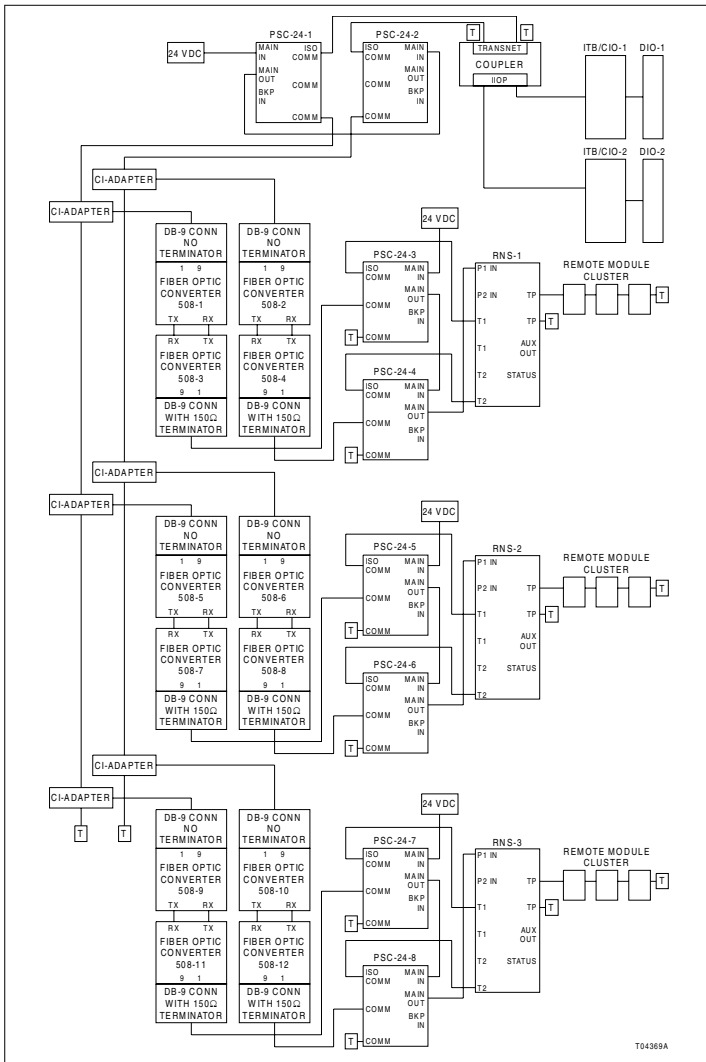


Figure A-5. Redundant TransNet Bus Installation using Fiber Optic Converters (2)



Simulated I/O

Typically, many I/O points are required for testing and demonstrating system operations. In addition, a factory acceptance test requires testing I/O hardware with potentiometers, meters, switches, and LEDs connected to ITB boards. Similarly, testing remote I/O signals through a DIO board interface would require extensive use of meters and indicators.

Figure B-1 shows a simplified typical distributed I/O system hardware setup using DIO hardware modules manufactured for ABB Automation by MTL.

NOTE: Figure c-1 shows only test hardware required for testing a few remote I/O points. Many other pieces of hardware would be necessary to actually test and demonstrate the entire system operation.

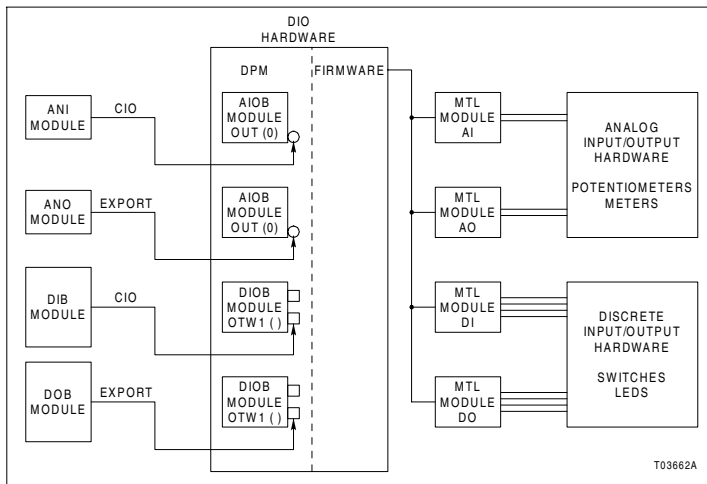


Figure B-1. Remote I/O Hardware for Testing

Configuration of modules in the DIO database can be tested without all this hardware, even if the DIO board is not cabled to receive any remote input and output signals. This testing is



accomplished using the SIM (simulation) Controlware modules configured in the Harmony DCU database. To simulate remote I/O the SIM module can read from and write values to CIO database modules in the dual-port memory of a DIO board. The SIM modules are softwired directly to the CIO database modules.

For the simulation to work, the CIO Controlware module associated with the DIO board must be in simulation mode and the DIO board must be present.

NOTE: Do not confuse the CIO module with CIO database modules. The CIO Controlware module provides information to the DCP board about the DIO board in a particular slot in the card frame. Unlike the CIO database modules (described in this instruction) that are stored in dual-port memory of the DIO board, the CIO module is part of the database stored in the DCP board memory.

Enabling and Disabling Simulation Mode

When the CIO module's SMOD atom has a value of one, the CIO module is in simulation mode. When the CIO module is in simulation mode, the read and write operations specified in the DIO collection list will not be performed.

There are several ways to set the value of CIO.SMOD = 1:

- Set the value of the SMOD atom directly using a configuration tool.
- Set the module set (MSET) to which the CIO module belongs to simulation mode by setting the value of MSET.SMOD = 1. This can be accomplished through configuration.
- Set the entire Harmony DCU to simulation mode by setting the value of DCU.SMOD = 1. Every CIO (and IOB and PTP) module in the DCU will have its SMOD atom set. Changing the value of DCU.SMOD = 0 will take all the modules out of simulation mode. The DCU can be set to simulation mode using a configuration tool.

When simulation mode is disabled (SMOD = 0), the DIO board begins normal operations.

Softwiring CIO Database Modules and SIM Modules

When remote I/O is being simulated, the read and write operations configured in the interface software's collection list are not executed. Instead, values are written to and read from the AIO.OUT, AIOB.OUT[], and DIOB.OTW locations in the DIO database in dual-port memory as the SIM modules in the database stored in the DCP board memory are scanned.

SIM module FIXes are available that use various quantities and combinations of analog and/or discrete input and/or output pointers. For example, the FIX 0 SIM module provides eight analog input and eight analog output pointers. Depending on how the SIM module's XFER[] and DAB[] arrays are configured, the values read from the locations specified by the input pointers can be written to the locations specified by the output pointers.

Each FIX 0 SIM input pointer is configured to point to:

- FIX 1 AIO module OUT atom.
- - *or* -
- FIX 1 or 3 AIOB module OUT[] atom.

The FIX 0 SIM output pointers are also configured to point to:

- FIX 0 AIO module OUT atom.
- - *or* -
- FIX 0 or 2 AIOB module OUT[] atom.

Static Example

To simulate remote I/O it is first necessary to configure the CIO database modules residing in the dual-port memory on the DIO board. This means that the DIO Collection List must be configured, or a DIO database must be downloaded to the board.

Once the collection list has been configured, SIM modules are then configured to read and write data to the CIO database modules to substitute for interaction with remote nodes.



Figure B-2 shows a static I/O simulation using SIM modules. The diagram does not show the CIO module associated with the DIO board. The CIO module that provides information to the Harmony DCU about the DIO board must be set to simulation mode (CIO.SMOD = 1).

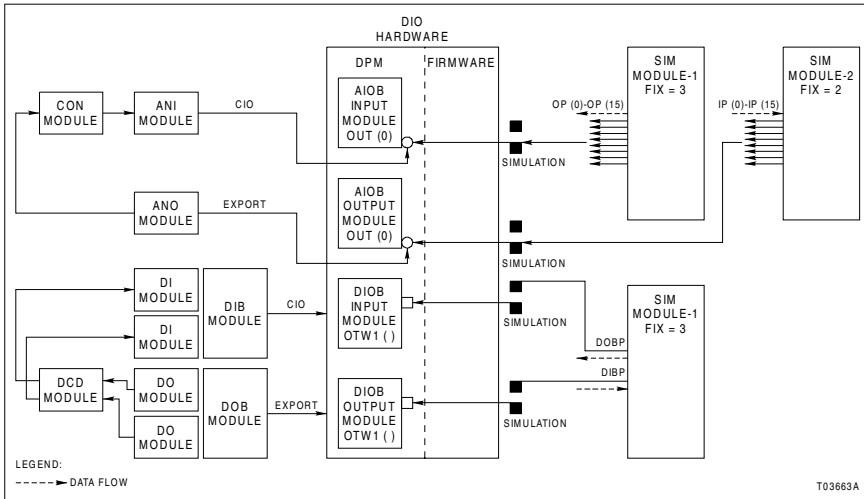


Figure B-2. Distributed I/O Simulation (Static)

Dynamic Example

Figure B-3 shows dynamic simulation of a closed loop control and a DCD module operation using SIM modules. The diagram does not show the CIO module associated with the DIO board. The CIO module that provides information to the Harmony DCU about the DIO board must be set to simulation mode (CIO.SMOD = 1).

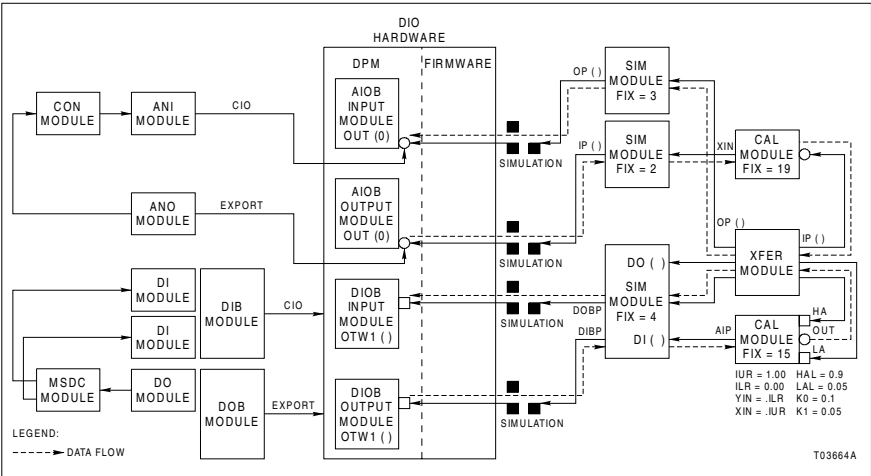


Figure B-3. Distributed I/O Simulation (Dynamic)





EMC

The distributed I/O system has been updated to meet the electromagnetic compatibility (EMC) and low voltage directive compliance standards required to serve the European market. A significant investment was made to evaluate and employ changes to have the DIO system comply with this important standard.

The most important procedural change for DIO system users involves the following modules and base installations. Fortunately the procedure is simple, requiring the installation of ferrite cable clamps to the signal input wiring on the following bases.

NOTE: The modules must also have the CE marking to be in compliance with the EMC and low voltage directives.

NOTICE	Failure to comply with any of the requirements described in this appendix will result in non-compliance with the EMC directive.
---------------	---

PS-170 Power Supply

There are no special installation requirements or external hardware for the PS-170 power supply to meet the EMC directive.

The PS-170 output load must be limited to 5 amperes to meet the EMC directive. The PS-170 maximum output load rating is 6.2 amperes, making reduced rating 80 percent of maximum output. Since prudent design practice does not exceed 80 percent of a power supply's maximum output load, this does not limit the practical performance of the PS-170 power supply.

NOTE: If a 5 ampere output load is exceeded with the PS-170 power supply, the system will not be in compliance with the EMC directive.



Ferrite Cable Clamps

A ferrite cable clamp, also called a split ferrite, is a cylindrical ferrite split in half and mounted in a plastic case which clamps onto a cable. One of these cable clamps is required per channel and is snapped around the signal and return wires. Ferrite cable clamps can be obtained in sets.

Ferrite cable clamps are suitable for shielded/unshielded or twisted/untwisted cable.

There are two ferrite cable clamps for the DIO system which come in sets of eight or 16.

- Models CFK-8 and CFK-16 for wire pairs connecting RTD input, analog output, strain gauge, or DC discrete output modules.
- Models AICFK-8 and AICFK-16 for wire pairs connecting to analog input modules (universal and high-level) modules.

Figures C-1 and C-2 show the ferrite cable clamps.

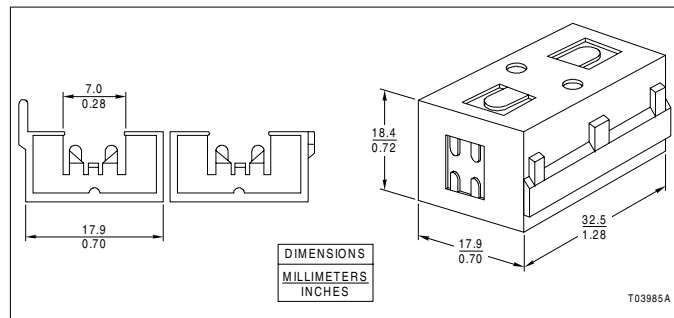


Figure C-1. Ferrite Cable Clamp Model CFK-16

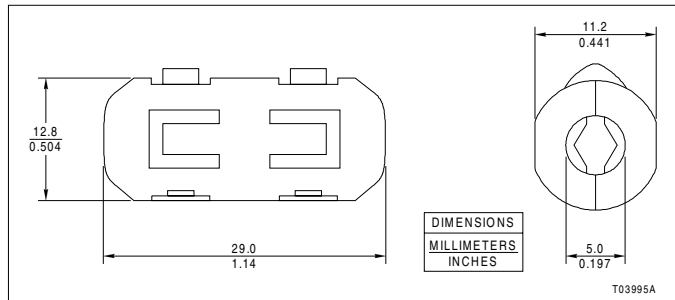


Figure C-2. Ferrite Cable Clamp Model AICFK-16

Ferrite Cable Clamp Installation (All Modules Except RTD Modules)

Ferrite cable clamps are snapped around the signal input/output wires as close to the base or module as possible, generally within 25 to 50 millimeters (one to two inches). Use included locking cable ties to keep the ferrite clamps in place.

NOTE: Although the clamps can be installed at any time (since they wrap around the wire), it is recommended that they be installed before the wiring is dressed and tied down.

Figure C-3 shows ferrite cable clamp installation for all DIO hardware modules except for RTD modules.

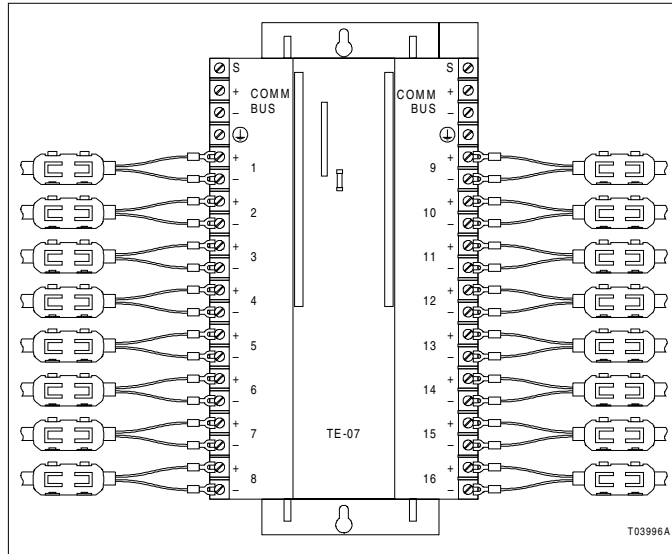


Figure C-3. Ferrite Cable Clamp Installation (for All Modules Except RTD Modules)

3-Wire RTD Module Ferrite Cable Clamp Installation

To install the ferrite cable clamps for three-wire RTD inputs, use two ferrite cable clamps per channel (Fig. C-4). The first ferrite clamps the signal/excitation positive and signal negative lead wires together. The two lead wires must be looped once, then the ferrite is clamped around the loop. The second ferrite is clamped around the excitation negative lead. This lead must be looped once before clamping around the loop. Use included locking cable ties to keep the ferrite cable clamps in place.

NOTE: Although the clamps can be installed at any time (since they wrap around the wire), it is recommended that they be installed before the wiring is dressed and tied down.

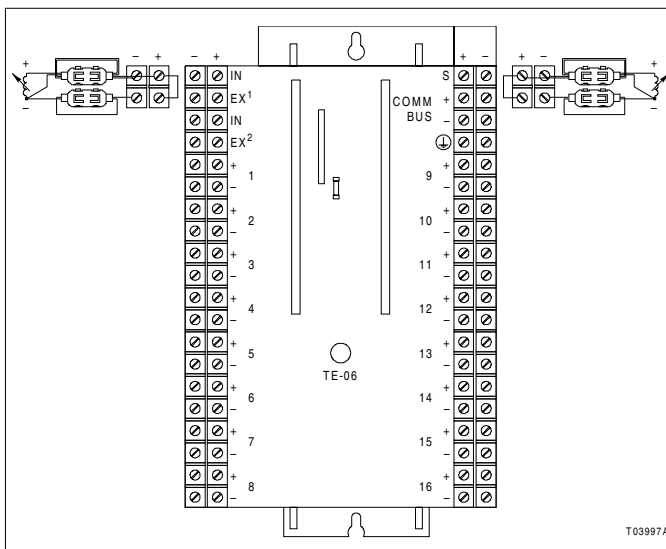


Figure C-4. 3-Wire RTD Module Ferrite Cable Clamp Installation

4-Wire RTD Module Ferrite Cable Clamp Installation

To install the ferrite cable clamps for four-wire RTD inputs, use two ferrite cable clamps per channel (Fig. C-5). One ferrite clamp per pair of lead wires. The two lead wires both positive and negative used for the excitation voltage must be looped once and the ferrite is clamped around the loop. The other two leads that return the signal to the input connection must also be looped once and have the ferrite clamped around the loop. Use included locking cable ties to keep the ferrite clamps in place.

NOTES:

1. Although the clamps can be installed at any time (since they wrap around the wire), it is recommended that they be installed before the wiring is dressed and tied down.
2. Figure C-5 uses a TE06 base as an example with the cable clamps in place; this example is also used for the TE12 strain gauge base.

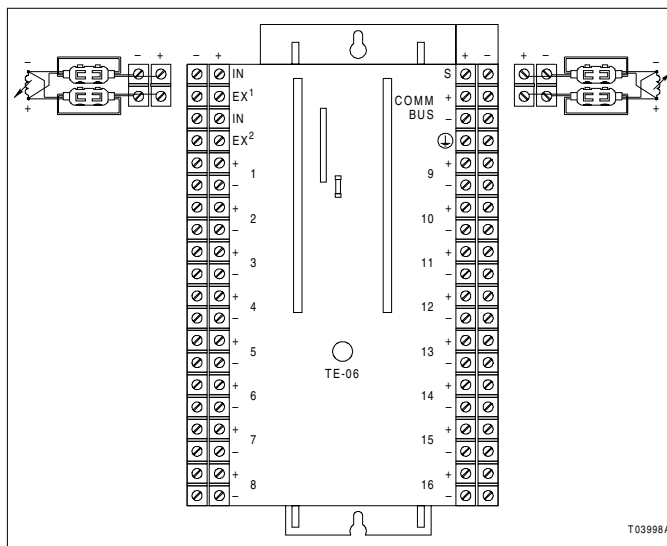


Figure C-5. 4-Wire RTD Module Ferrite Cable Clamp Installation

Modules and Bases

The signal input wiring for the modules with termination bases listed in Table C-1 (TE series) must be modified by installing the ferrite cable clamp kits. Refer to Figure C-3 for all bases except the TE06 base and Figures C-4 and C-5 for the TE06 base.

Table C-1. Modules/Bases Ferrite Cable Clamp Requirements

Base	Module	No. of Clamps	Clamp Kit Part Number
TE03	AO42008	8	CFK-8
	AO42016	16	CFK-16
TE06	AI0108, AI0108-3W	16	1 CFK-16
	AI0116, AI0116-3W	32	2 CFK-16
TE07	AI0008	8	AICFK-8
	AI0016	16	AICFK-16
TE08, TE08-A	AI1508	8	AICFK-8
	AI1516	16	AICFK-16

Table C-1. Modules/Bases Ferrite Cable Clamp Requirements *(continued)*

Base	Module	No. of Clamps	Clamp Kit Part Number
TEF09-5, TE09-A	DO216, DO216-M, DO416	16	CFK-16

NOTE:
1. The modules must also have the CE marking to be in compliance with the EMC directive.

When using ferrite cable clamps for all bases except the TE06 base, the mounting width measured from center to center for bases should be 240 millimeters (9.5 inches). When mounting the TE06 base, the mounting width should be 265 millimeters (10.5 inches) to allow the proper spacing to accommodate the ferrite cable clamps. Refer to Figure C-6 for mounting dimensions.

The analog output, digital output (DC only), RTD input, and analog input modules (universal and high-level only) signal input wiring require ferrite cable clamps for CE mark compliance for the EMC directive.

Digital Output Modules	Refer to Table C-1 for digital output DC module requirements. Digital output AC modules do not need modifications for CE compliance.
Digital Input Modules	Digital input modules do not need modifications for CE compliance.
Analog Output Modules	Refer to Table C-1 for analog output module requirements.
Analog Input Modules	Refer to Table C-1 for analog input module requirements.
RTD Input Modules	Refer to Table C-1 for RTD input module requirements.

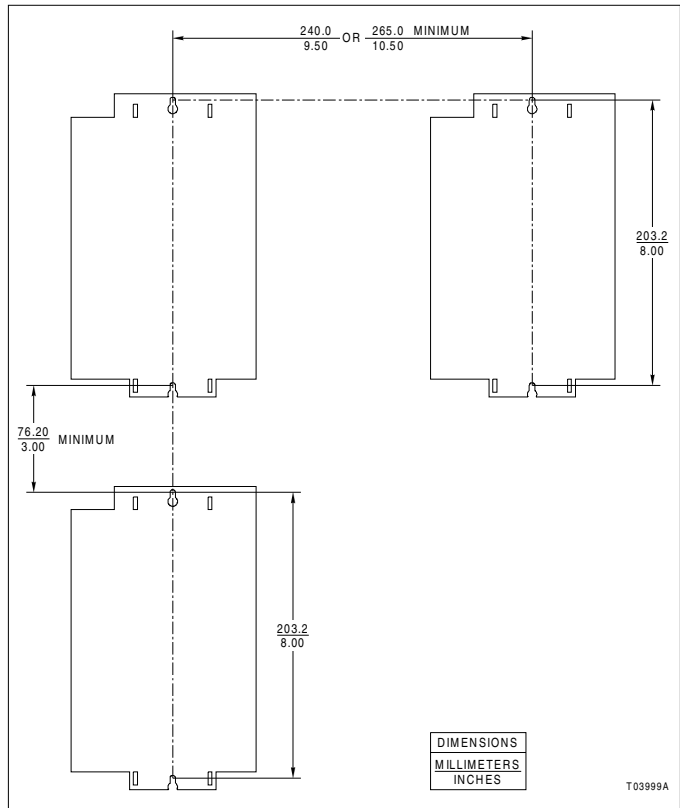


Figure C-6. Base Mounting Dimensions with Ferrite Cable Clamps



Noise

Excessive noise on the TransNet bus can be reduced by means of an optional network attenuator designed to suppress all frequencies in the 1.5 to 2.0 megahertz range. This includes both internal noise generated on the TransNet bus itself and noise from external sources such as RFI and AC power lines.

Be sure to choose a model that matches the nominal impedance of the cable used for the TransNet bus (Table D-1). Attenuators are available for networks with 100, 125 and 150 ohm impedance.

Table D-1. TransNet Noise Attenuators

Model	Nominal Impedance	Attenuation
NA-100-3	100 Ω	3 dB
NA-100-5	100 Ω	5 dB
NA-125-3	125 Ω	3 dB
NA-125-5	125 Ω	5 dB
NA-150-3	150 Ω	3 dB
NA-150-5	150 Ω	5 dB

Resultant Signal Attenuation

Installing a network attenuator on the TransNet bus will have the affect of attenuating the signal on the bus by 3 dB or 5 dB depending on the attenuator model chosen. This loss must be considered when calculating the signal attenuation as described in *Determining Signal Attenuation* in Section 3.

Remember that the sum of the signal attenuation must be *less* than that shown in Table 3-9.



Installation

The optional network attenuator (example shown in Fig. D-1) is designed to be installed in the middle of the TransNet bus.

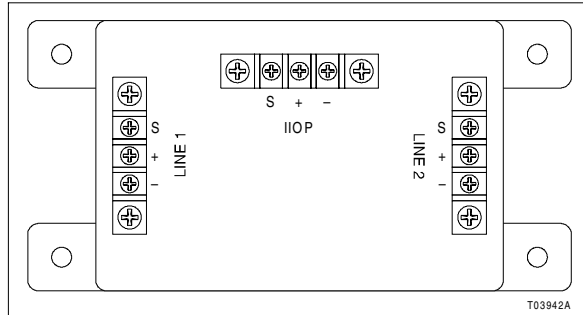


Figure D-1. Network Attenuator

To install the attenuator:

WARNING

The TransNet bus provides both communication capability and 24 VDC power to the DIO hardware modules. Installation of the optional attenuator requires severing the TransNet bus. Be sure that power is removed from the TransNet bus before proceeding with installation of the attenuator.

1. Verify that power to the TransNet bus has been removed.
2. A TransNet bus consists of a cable between two terminating resistors. Locate the center of the TransNet bus. Cut the cable as close to the center of the bus as possible. Each resulting cable end will contain a positive wire, a negative wire, and shielding for the cable.
3. Mount the network attenuator in the desired location using the four screw holes on the mounting feet of the attenuator.
4. Line one attaches to the terminals on the left side of the attenuator. Attach the positive (+) wire, the negative (-) wire, and the cable shielding (S) to the appropriately labeled terminals on the attenuator. Repeat this procedure for line two on the right side of the attenuator.

5. Restore power to the TransNet bus.

Adjusting Signal Attenuation

After the network attenuator has been installed, check to see if the frequency of errors is reduced. Adjustments can be made by substituting attenuators with different dB ratings. For example, if a 3 dB network attenuator is installed, and the noise level is not sufficiently diminished, consider replacing it with a 5 dB version.

Conversely, if a 5 dB network attenuator was installed and the signal is no longer reaching modules at the end of the TransNet bus, a 3 dB network attenuator may suppress noise sufficiently without suppressing the signal.

NOTE: Some DIO installations (e.g., redundant DIO boards) have multiple TransNet segments. Each of these segments may need its own Network attenuator.





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