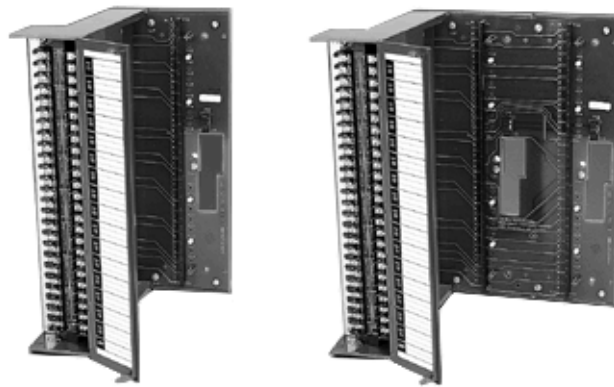


Features and Benefits

- **Intelligent I/O system:** A microprocessor in each I/O assembly executes the I/O portion of the control strategy and provides advanced functions and diagnostics.
- **High performance, deterministic I/O network:** Uses a redundant, high speed serial communication network with an inherent capability for remote communication.
- **Distributed capability:** A high speed I/O communication network designed for long distances combined with flexible enclosure mounting options enables both centralized and remote I/O locations.
- **Inherent redundancy design:** Designed with redundant block power inputs (24 VDC), redundant communications, and optionally redundant I/O modules.
- **Wide variety of I/O types:** Analog (high and low level, and temperature), digital, and control I/O.
- **Significant reduction of installation costs:** I/O assemblies combine chassis, cabling, I/O electronics, power conversion, and termination into one device. Distribution of I/O reduces cable costs.
- **Reduction in total operating costs:** Simplified user configuration with no calibration required, no address switches to set, and downloadable firmware.
- **Compatibility with existing systems:** Works with both the Harmony bridge controller and Harmony area controller; works in combination with Harmony rack I/O and INFI 90® OPEN I/O.



TC00887A/TC00888A/TC00889A

The Harmony input/output (I/O) system sets new standards for user convenience and performance in industrial I/O. A wide variety of I/O building blocks can be combined to form an optimum solution for a specific application. The Harmony I/O system is one part of the Symphony™ Enterprise Management and Control System.

Overview

The Harmony I/O system incorporates a variety of input and output devices (blocks) to interface process signals to the Symphony system. Blocks for analog, digital, and control I/O interface along with remote I/O communication combine to create a complete I/O system. The Harmony I/O system offers a complete solution in a modular, easy to use package. In addition to the I/O devices, the Harmony solution provides many options for ready-to-use I/O communications, I/O mounting, field wiring management, power distribution, and cooling.

Figures 1 and 2 are hierarchical views of the Symphony system showing the various system communication levels and the position of the Harmony I/O system within these levels. Figure 1 shows a Harmony area controller interfacing the I/O system. Figure 2 shows a rack-mounted Harmony bridge controller interfacing the I/O system.

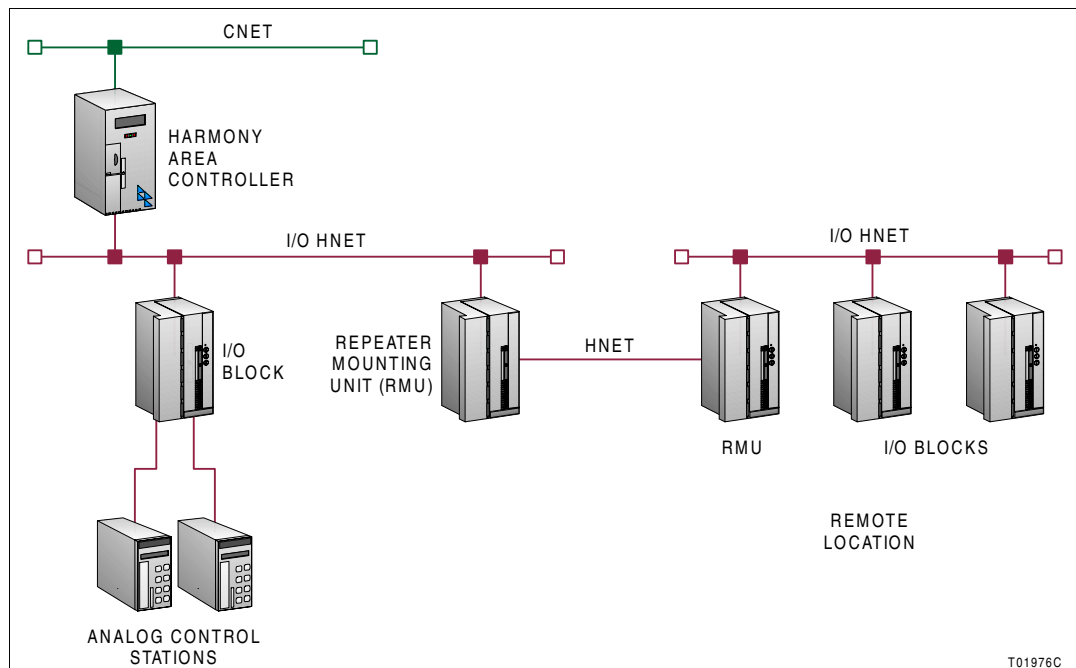


Figure 1. Harmony Area Controller with Harmony I/O System

The main components of the Harmony I/O system are I/O blocks and Hnet. Hnet (Harmony I/O communications network) is the network over which Harmony controllers and Harmony I/O blocks communicate. Together they operate as a subsystem dedicated to the Harmony area controller or BRC-100/200 Harmony bridge controller. The controller performs the actual control functions. The I/O blocks process any inputs from and outputs to field devices for the controller. Communication between the controller and I/O blocks is over Hnet. The controller can communicate with up to 64 Hnet devices. Refer to *I/O Block* and *Harmony I/O Communications Network* in this overview for further explanations.

The I/O types include:

- Analog input (AIN).
- Analog output (AOT).
- Control input/output (CIO).
- Digital input/output (DIO).
- Digital output (DOT).

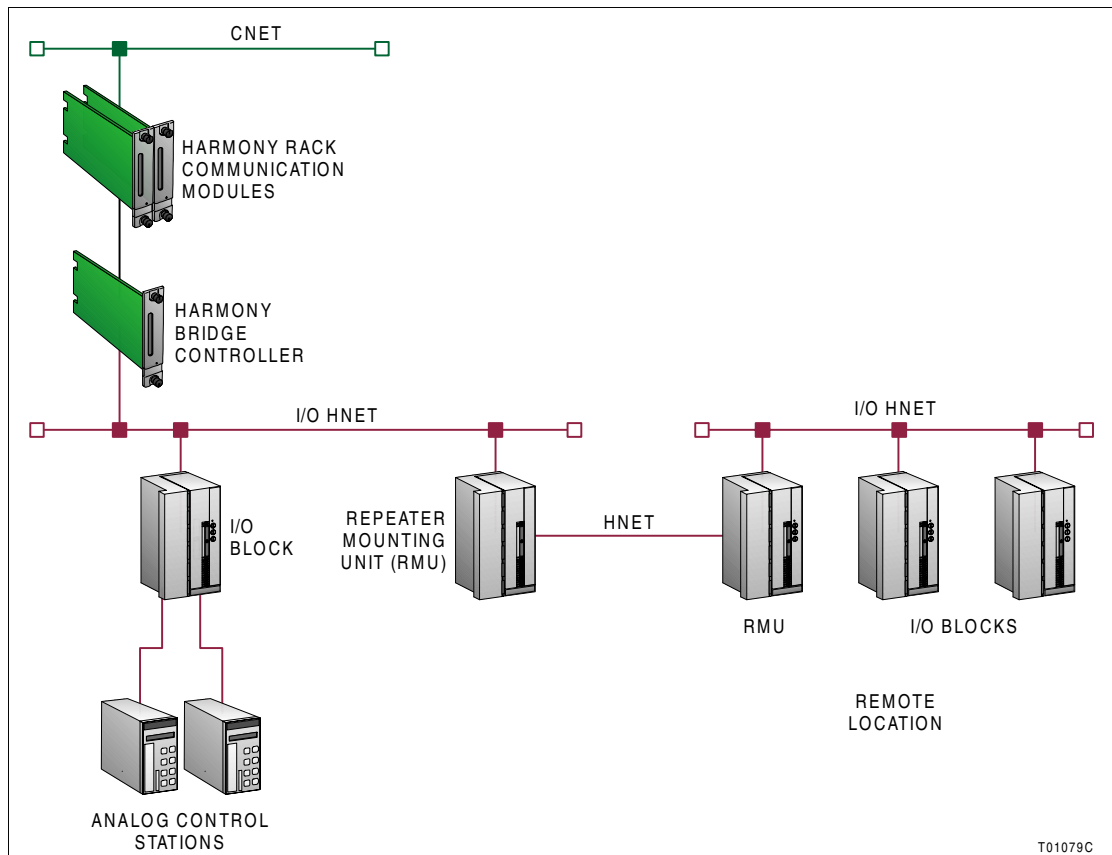


Figure 2. Harmony Bridge Controller with Harmony I/O System

The repeater mounting unit (RMU) is also an important component of the Harmony I/O system. The repeater mounting unit provides mounting slots for Hnet repeaters used to communicate with remote enclosures. Refer to *Repeater Mounting Unit* for a description.

The Harmony I/O system is powered by redundant 24 VDC and provides for separate distribution of field power. Typically, the I/O system is powered by the Modular Power System II. The power system supports redundant power. Refer to *Harmony I/O Power* for a description.

One or more control cabinets house all I/O system components. The block mounting hardware within the enclosure supports a variety of enclosure arrangements. Small cabinet or enclosure mounting is also supported. Refer to *Block Mounting* for a description.

Although not specifically part of the Harmony I/O system, analog control stations (SAC) can connect and communicate through CIO blocks as shown in Figures 1 and 2. Communication is over an RS-485 serial station link.

Advanced Features

The Harmony I/O system offers several advanced features which lower the cost of a Symphony Enterprise Management and Control System:

- Downloadable firmware eliminates PROM changes.

- User-assignable software device labels eliminate the need to manually set hardware addresses.
- User-assignable I/O channel labels simplify configuration. The same label can be used to identify an I/O channel and to define a tag in the system database for easier I/O point recognition.
- Advanced diagnostics of I/O block, I/O channel, and Hnet traffic identifies system problems.
- I/O status can be inhibited from contributing to block status eliminating nuisance alarms.
- Manual override of I/O channel values simplifies system maintenance.

Inputs/Outputs

The Harmony I/O system supports a variety of input and output types, both analog and digital. Analog signals, for example, include pressure and flow transmitter signals, and thermocouple (TC) and RTD temperature inputs. Digital signals are two-state signals that have discrete on and off voltage levels such as relay contacts, switches, and solenoids. Inputs and outputs can be either internally I/O system powered or externally powered. Refer to the Harmony input/output system data sheets for specifics on I/O block input and output capabilities.

Analog Input

The following analog inputs are supported:

- 4 to 20 milliamper.
- -10 to +10 VDC.
- -100 to +100 millivolt (DC).
- Thermocouple:
B, E, J, K, L, N (14 AWG), N (28 AWG), R, S, T, U.
Chinese E, S.
- RTD:
10 Ω copper.
100 Ω platinum (U.S. Lab. Standard, U.S. Industry Standard, European Standard).
120 Ω nickel.
Chinese 53 Ω copper.

Analog Output

The following analog outputs are supported:

- 4 to 20 milliamper.
- 1 to 5 VDC.

Digital Input

Digital input channels can be used to read the states of switches, relay contacts, and solenoids. The following digital inputs are supported:

- 24, 48, and 125 VDC.
- 120 and 240 VAC.

Digital Output

Digital output channels can be used to drive annunciators such as buzzers and lamps and to drive two-state final control elements such as actuators, relays, and solenoids. The following digital output voltages are supported:

- 24, 48, and 125 VDC.
- 120 and 240 VAC.

Harmony I/O Communications Network

The Harmony I/O communications network (Hnet) is a redundant, high speed serial network. The communications architecture allows I/O to reside locally, remotely, or both locally and remotely with no difference in performance and configuration. Currently, the I/O system supports remote distances of up to 1,300 meters (4,265 feet). The maximum distance is dependent on the communications system architecture.

All Harmony I/O devices are designed for redundant Hnet communications. Both channel A and channel B are active at all times. A failure in either channel will not affect system operation.

Addressing

Hnet features automatic addressing using user-defined device labels, which means there are no address switches to manually set. Device labels are software text labels assigned to each block that simplify configuration and maintenance. The device label is a name assigned to a device. In this case, device refers to an I/O block. Labels can be up to 32 characters. The device labels are saved in block memory.

All I/O blocks must have a device label assigned to communicate on Hnet. The controller uses the device labels to direct messages to specific I/O blocks and to identify the source of any received messages. In the control configuration (i.e., control logic), device labels map functions to specific I/O blocks.

Communication Architectures

The system supports a star network architecture. A local Hnet segment connects directly to the controller within a primary enclosure. Remote Hnet segments connect through repeaters and fiber optic cables. Repeaters operate automatically and transparently. No software or hardware configuration is required for remote Hnet applications.

Hnet is distributed to the blocks within an enclosure through the block mounting hardware. Specifically, block mounting columns protect and distribute Hnet to the I/O blocks and repeater mounting units within an enclosure through internal cables and connectors. Columns within a single enclosure or within a multibay enclosure connect to each other.

Harmony Controllers

A BRC-100/200 Harmony bridge controller is a rack-mounted controller that occupies one slot in a module mounting unit. It supports Hnet communication protocol, device labeling, and function code environment necessary to configure and operate the Harmony I/O system. The controller can communicate with Harmony I/O blocks and Harmony rack I/O devices simultaneously. All Harmony I/O system configuration is performed through the controller. The controller is fully compatible with existing configurations.

Like the bridge controller, the Harmony area controller supports the communications protocol and configuration environment necessary to operate the Harmony I/O system. It collects process I/O data, performs control algorithms, and outputs control signals to final control elements through either or both Harmony I/O blocks and rack I/O devices. The area controller offers enhanced communications and process interface abilities.

Function Codes

Function codes are predefined, fixed function algorithms. The controller supports numerous function codes for building the control configuration. The functions they perform range from computing (function generator, square root, etc.) to control (PID, pulse positioner, etc.) to I/O interface (analog input, digital output, etc.).

When interfacing to Harmony I/O blocks, the controller utilizes single channel I/O function codes:

- Analog input/channel (FC 222).
- Analog output/channel (FC 223).
- Digital input/channel (FC 224).
- Digital output/channel (FC 225).

The single channel function codes simplify configuration. One function code configures one channel. A single I/O device definition function code (FC 221) groups the single channel function codes for an entire I/O block. The function codes provide addressing, and startup, execute (i.e., run-time), override, simulation, and failure mode operation specifications.

Each I/O channel function code is an exception reporting function code. Exception reported data can appear as dynamic values, alarms, and state changes on displays and in reports generated by human system interfaces and other system nodes. Exception reporting is automatic. An I/O channel function code will generate an exception report periodically to update data, after a process point reaches a defined alarm limit or changes state, or after a significant change in value occurs.

The Harmony controller allows using both Harmony I/O block function codes and rack I/O function codes concurrently to communicate with both types of devices simultaneously.

Firmware Download

The Harmony I/O block firmware includes a real-time operating system, Hnet support, redundancy link support, and the function code environment. The I/O system supports firmware downloads, which allows I/O block firmware to be updated without having to replace physical components. All firmware downloads are performed using the Composer™ tools and are managed by the Harmony controller.

Compatibility

The Harmony I/O system is fully compatible with existing INFI 90 OPEN systems. The I/O system can be integrated into established installations that currently use INFI 90 OPEN I/O to interface and process input and output signals. Or, the I/O system can be installed to replace existing INFI 90 OPEN I/O.

The Harmony controller can communicate with Harmony I/O and INFI 90 OPEN I/O simultaneously. Communication is over Hnet for Harmony I/O and over I/O expander bus for INFI 90 OPEN I/O.

Repeater Mounting Unit

A repeater mounting unit (Figs. 1 and 2) contains slots for mounting Hnet repeaters. The repeaters are used to extend the I/O communication network to communicate with remote enclosures. The repeater mounting unit:

- Uses Harmony I/O system packaging.
- Mounts on a Harmony I/O block mounting column.
- Connects up to four repeaters to support two redundant Hnet channels (A and B).

An RMU module mounted on a repeater base forms a repeater mounting unit (Fig. 3). The RMU module routes Hnet and power to the repeaters mounted in the repeater base. The RMU assembly occupies one block position on the mounting column. An RMU base is available for mounting on a redundant block mounting column.

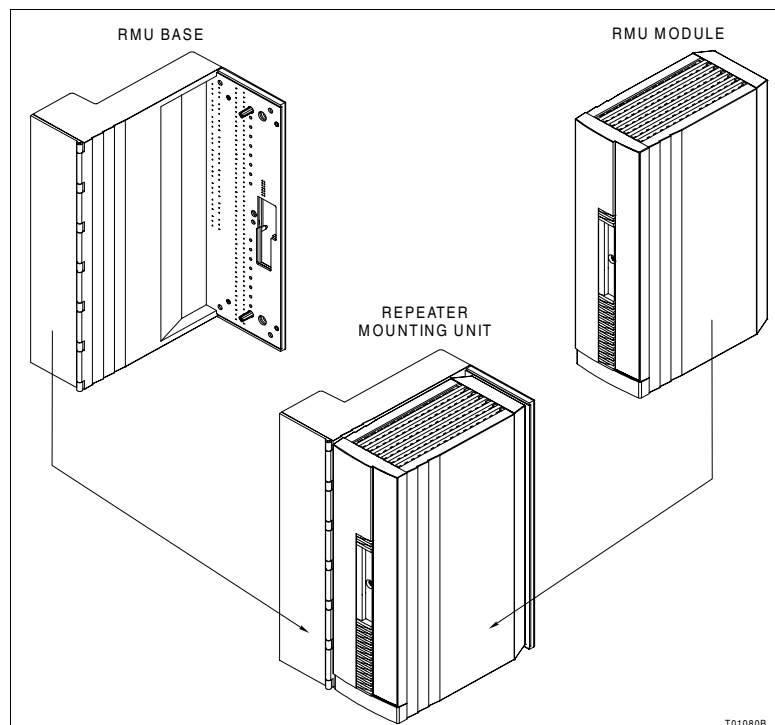


Figure 3. Repeater Mounting Unit

I/O Block

An I/O block (Figs. 1 and 2) interfaces and processes field device input and output signals. An I/O module mounted on a termination base forms an I/O block (Fig. 4). There are several different I/O block types available. The three basic types are analog, digital, and control I/O. All I/O blocks share the same housing layout and connection, configuration, and mounting methods. Refer to the Harmony input/output system data sheets for individual I/O block capabilities.

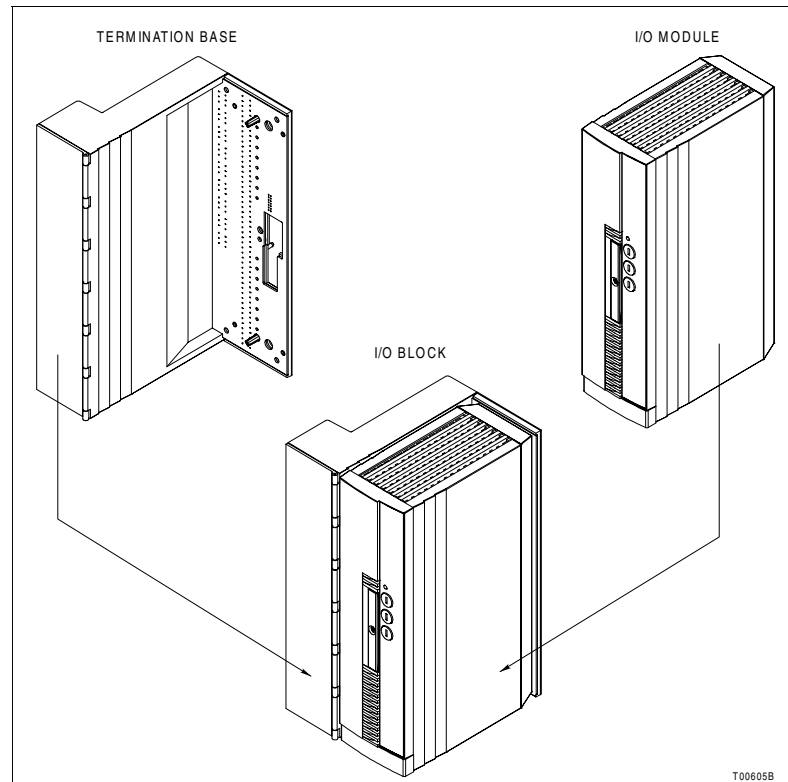


Figure 4. I/O Block

The front panel of an I/O block communicates a considerable amount of information including block type, operating mode, and operating status. Front panel features include:

- Text-based front panel mode and status indicators.
- Front-accessed power fuses with status indicators.
- Front-accessed stop/reset button.
- Front-mounted device ID and user label area protected by a clear plastic cover.

I/O Module

The I/O module contains the block intelligence. The I/O module circuitry consists of multiple printed circuit boards that perform signal conditioning and processing dependent on I/O type. An onboard microprocessor performs engineering units conversion, online diagnostics, and Hnet communications interface. Power conversion functions are also provided. Front panel LEDs provide power and digital I/O status indications.

The I/O module offers the following additional functions:

- Range and mode selection for analog I/O.

- Voltage threshold selection for universal digital inputs.
- Signal buffering.
- Signal conditioning.
- Signal isolation.
- Noise rejection.
- Analog-to-digital and digital-to-analog conversion.
- Readback of outputs.
- Open and short detection on selected modules.
- Cold junction compensation on thermocouples.
- Circuit protection (surges, shorts, over-voltages, etc.).

The I/O module connects to field signals through the base. The module connects to power and Hnet through mounting column connectors. An I/O module can be removed and installed while system power is applied.

Base

In general, a base is a passive device that connects and distributes signals between the I/O module and field wiring terminals and between redundant I/O modules (Fig. 5). There are two types of I/O block bases: screw terminal (S type) to accommodate wire lugs and clamp terminal (C type) for direct stripped-wire connection. Additionally, the terminal strip can be removed from a clamp termination base for cable connection applications. There is a nonredundant and redundant version of each base. In general, a block supports four different base versions. The base has several purposes:

- Field wiring termination.
- I/O channel signal routing.
- I/O module mounting.
- Hardware keying of base to I/O module.
- Shield (i.e., chassis ground) connection.

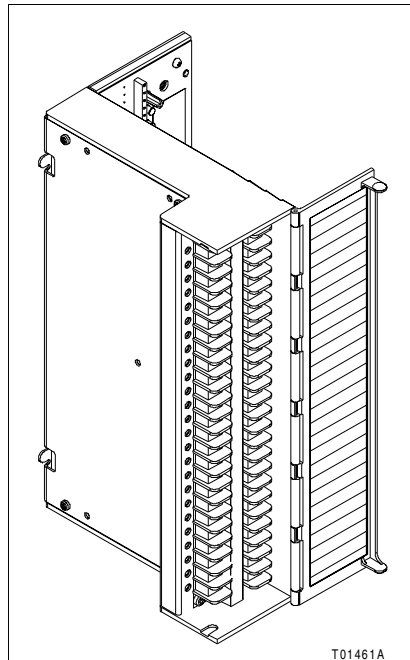


Figure 5. Base

I/O signals connect to the base and are routed internally to I/O module connectors. Field connections remain undisturbed if the module is removed or replaced. Each type of I/O module requires its own type of termination base. Hardware keying using posts on the base and holes in the back of the I/O module prevents an accidental mismatch of I/O module and base.

A nonredundant base provides mounting and connection for a single I/O module. A redundant base is available to provide mounting and connection for two I/O modules that operate redundantly. Refer to *I/O Redundancy* for further explanation.

The number of wiring terminals depends on the number and types of I/O channels. To simplify the installation process, the terminals are clearly marked to identify positive (+) and negative (–) polarity, and RTD, normally open relay contact, and normally closed relay contact wiring connections. Additionally, input and output channel terminals are color-coded for easier recognition. The markings and color coding allow wiring of input and output channels without requiring any additional documentation:

- Black letter on blue background - analog input channel.
- Blue letter on black background - analog output channel.
- Black letter on orange background - digital input channel.
- Orange letter on black background - digital output channel.

The base has a front panel door to conceal the terminal strips and connectors, and to prevent accidental contact. A label is affixed to the inside of the door for identifying field wires.

I/O Redundancy

Redundancy allows backup electronics to read inputs and to drive outputs in the event of a primary failure. As a background diagnostic task, the backup is continuously monitoring its ability to read field inputs and to drive field outputs.

I/O redundancy is accomplished by using two I/O modules of the same type, a wider base to mount and connect the two modules, and a wider mounting column to attach the redundant base (Fig. 6). In this arrangement, the field wiring connects once at the base and is internally routed to both modules. The redundancy feature allows a failed I/O module to be replaced without affecting the operating module in the redundant pair. It also allows a single I/O module (i.e., nonredundant) mounted on a redundant base, with a single channel fault, to be replaced online without affecting the remaining operating channels.

Short Circuit Protection

Most I/O blocks incorporate some type of current limiting where appropriate to protect against short circuits. The current limiting prevents excessive current levels at faulted terminals which could cause circuit damage. Specifically, I/O block channels are protected against shorts across the transmitter or load, across positive and negative terminals, from the positive terminal to ground, and from the negative terminal to ground. A channel will recover to full function after correcting the fault condition.

Auxiliary Input/Output

An auxiliary block extends I/O block capabilities (Fig. 7). There are different types of auxiliary blocks available (refer to the Harmony input/output system data sheets).

An auxiliary block shares a similar housing layout with I/O blocks. Its mounting method is slightly different, however. A cable connects an auxiliary block to its associated I/O block. The

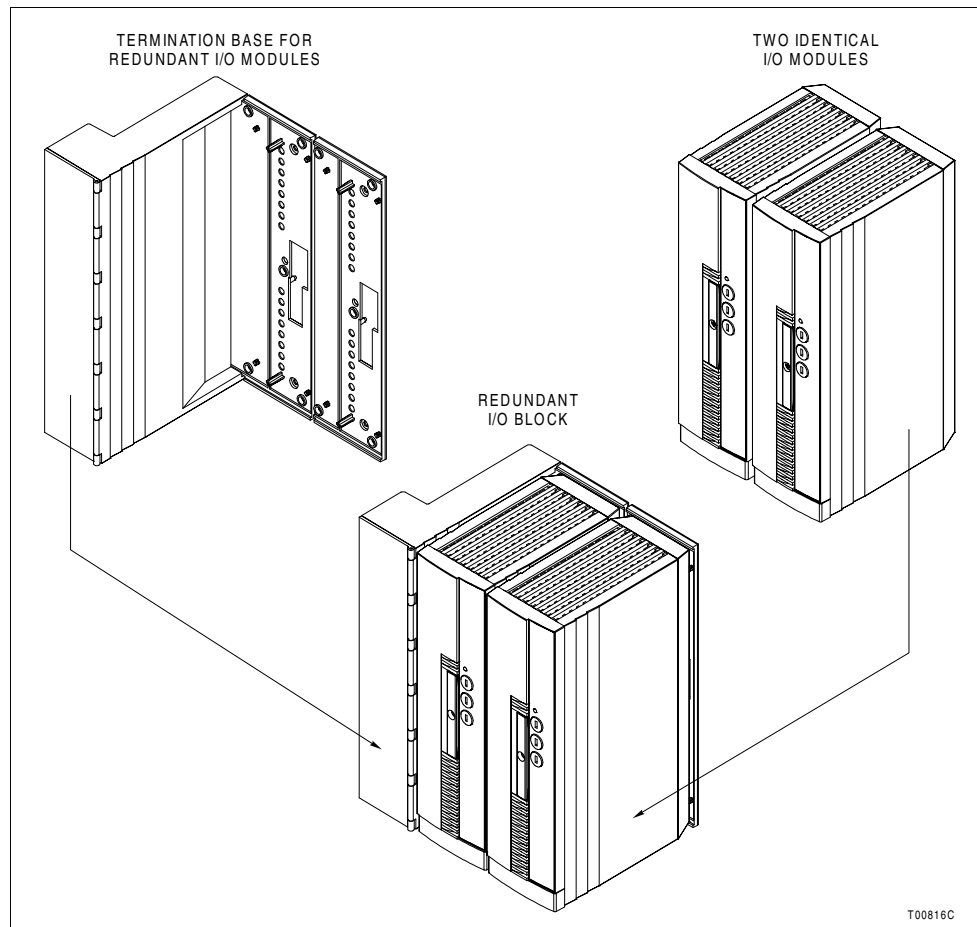


Figure 6. Redundant I/O Block

auxiliary block occupies one block position on the mounting column, but does not connect to either power or Hnet. A front panel door conceals the terminal strips and various circuitry to prevent accidental contact.

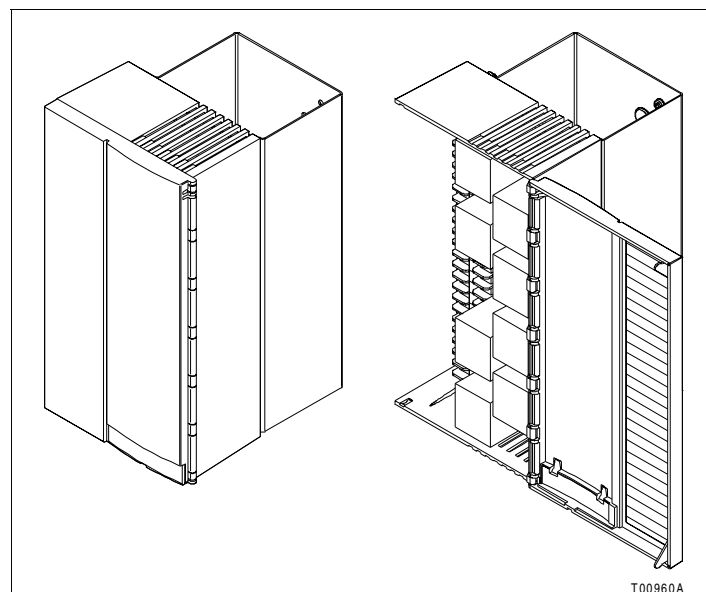


Figure 7. Auxiliary Block

Harmony I/O Power

The Harmony I/O system uses two types of power:

- 24 VDC block logic power.
- 24 VDC, 48 VDC, 125 VDC, 120 VAC, and 240 VAC field power.

Block logic power operates the internal circuitry for I/O modules and for repeaters in repeater mounting units. Field power operates field devices and some I/O channel circuitry depending on the block type. To increase system availability BLP is drawn from redundant sources and distributed with redundant circuits.

Block Logic Power (BLP)

Harmony I/O blocks use +24 VDC power. Redundant 24 VDC power is routed to individual blocks through the mounting column. I/O blocks provide a front panel fuse and LED for each of the power inputs. If one of the power inputs fails, a power failure notification will be sent over Hnet and the remaining power input will assume 100 percent of the load.

Field Power

Field power is separate from block logic power. A separate DC power bus in the mounting column distributes 24 VDC internal field power (IFP) to individual blocks. I/O blocks provide a front panel fuse and LED for this field power input. The power can be used to power four to 20-milliam-pere analog inputs and outputs, and 24 VDC digital inputs and outputs.

Alternatively, local field power (LFP) can connect to each block at the terminal or connector base. Local field power can be used if field power voltages other than 24 VDC are required. For example, the power to drive 125 VDC digital inputs can connect at the terminal or connector base.

In addition, remote field power (RFP) can be supplied on an individual channel basis so different field voltages can be mixed on an I/O block.

Block Mounting

A Harmony I/O system can be mounted in standard ABB Automation enclosures or other commercially available enclosures. The option for small cabinet or enclosure mounting is also provided. The system is designed to be flexible to accommodate various I/O wiring, termination, enclosure size, and location requirements. An I/O block requires front access only, which means blocks can be installed in both the front and back of an enclosure if desired.

Enclosure Arrangements

The number of blocks that can be mounted in a single enclosure varies. The enclosure size, field wiring termination method, enclosure layout, and block redundancy are some factors that affect the maximum number of blocks. To accommodate variations in system requirements, provisions for remote enclosures are provided.

In a small system application, the entire I/O system would most likely reside in a single enclosure. In a large system application, the I/O system may reside in two or more enclosure locations with the controller communicating with remote I/O blocks through Hnet repeaters.

Additionally, remote enclosures provide the ability to separate Harmony I/O blocks from rack I/O devices. This is not a requirement however. Both can reside and operate in the same enclosure.

Mounting Hardware

Block mounting hardware inside the enclosure creates the framework that both secures the I/O system components in place and creates the system backplane to route power, communication signals, and chassis ground. Figure 8 shows the enclosure block mounting hardware: column mounting bars and block mounting columns. In addition to these mounting elements, an enclosure may also contain a module mounting unit. The space at the top of the enclosure is typically reserved for the power system and cooling fans. Two types of mounting columns are available: one for nonredundant I/O and one for redundant I/O.

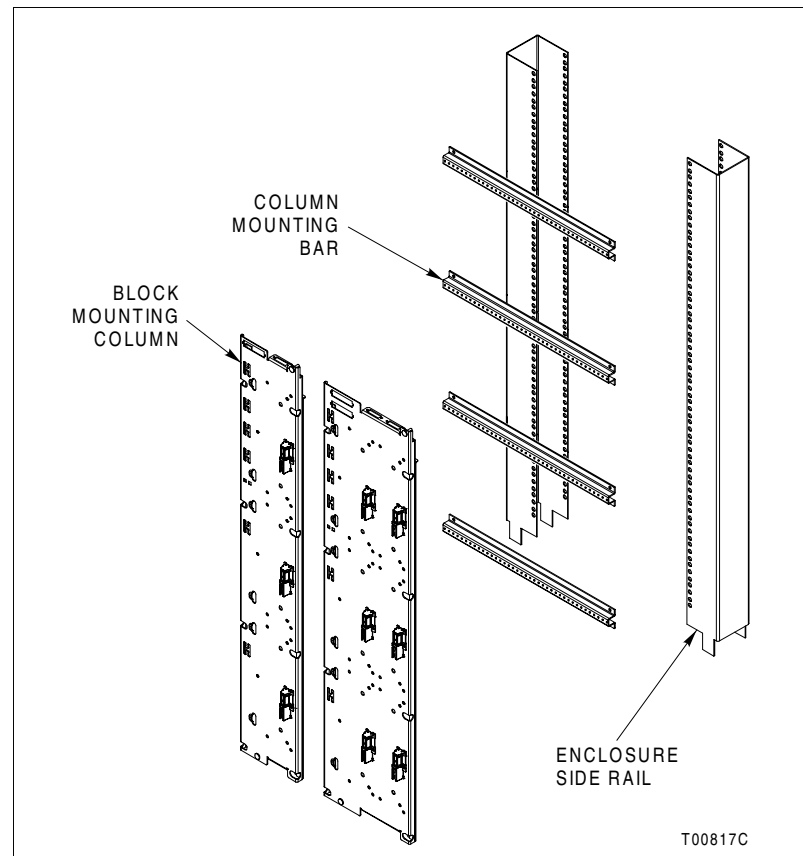


Figure 8. Block Mounting Hardware

Field wiring can enter the enclosure from either the top or the bottom. It then runs through wiring channels formed by the space left between the block columns and attaches to I/O blocks. The width of the wiring channel depends on the column distribution and separation. The wire retainers route the field wiring to keep the wiring confined to the wiring channel.

Packaging

The Harmony I/O system packaging incorporates the following features for I/O blocks:

- Louvered grip detail for easy handling.

- Recessed rear connectors to allow resting on any side or the rear.
- Beveled back edge to facilitate insertion.
- Alignment pins to insure proper mounting.
- Hardware keying to prevent mismatch of I/O module and base.
- Hinged doors to cover wiring terminal strips.
- Front access to wiring terminals and cable connectors to facilitate installation.
- Snap-on, snap-off side panels for quick access to user settings.

Configuration Tools

The Harmony I/O system can be configured and tuned using any configuration tool that supports the function codes. This includes, for example, the:

- Composer for Harmony.
- Conductor Human System Interfaces.

Composer also supports device labeling for I/O blocks.

Related Documents

Table 1. Related Documents

Number	Document Title
WBPEEUD240001??	Harmony Analog Input/Output, Data Sheet
WBPEEUD240002??	Harmony Digital Input/Output, Data Sheet
WBPEEUD240003??	Harmony Control Input/Output, Data Sheet
WBPEEUD240004??	Harmony Input/Output System, Data Sheet
WBPEEUD240009??	Harmony Analog Control Station, Data Sheet

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