



I/O Module with HART® Communication (BU100H Series)

The I/O Module with HART Communication (BU100H series) is a base-unit type analog input/output module with HART communication functionality for use with DCS controllers manufactured by Azbil Corporation. The BU100H series provides a HART communication interface that works between HART-compatible field devices (HART devices) and Azbil Corporation's InnovativeField Organizer (IFO) device management system. BU100H modules send various parameters and diagnostic information held in the HART device to the IFO in real time using high-speed HART communication with an update cycle of one second.

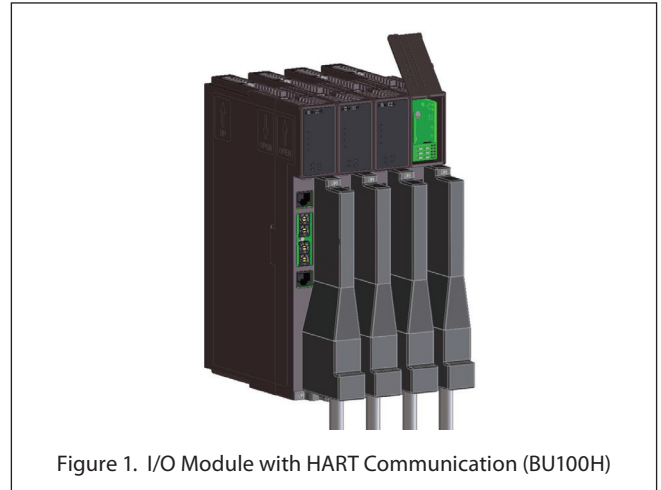


Figure 1. I/O Module with HART Communication (BU100H)

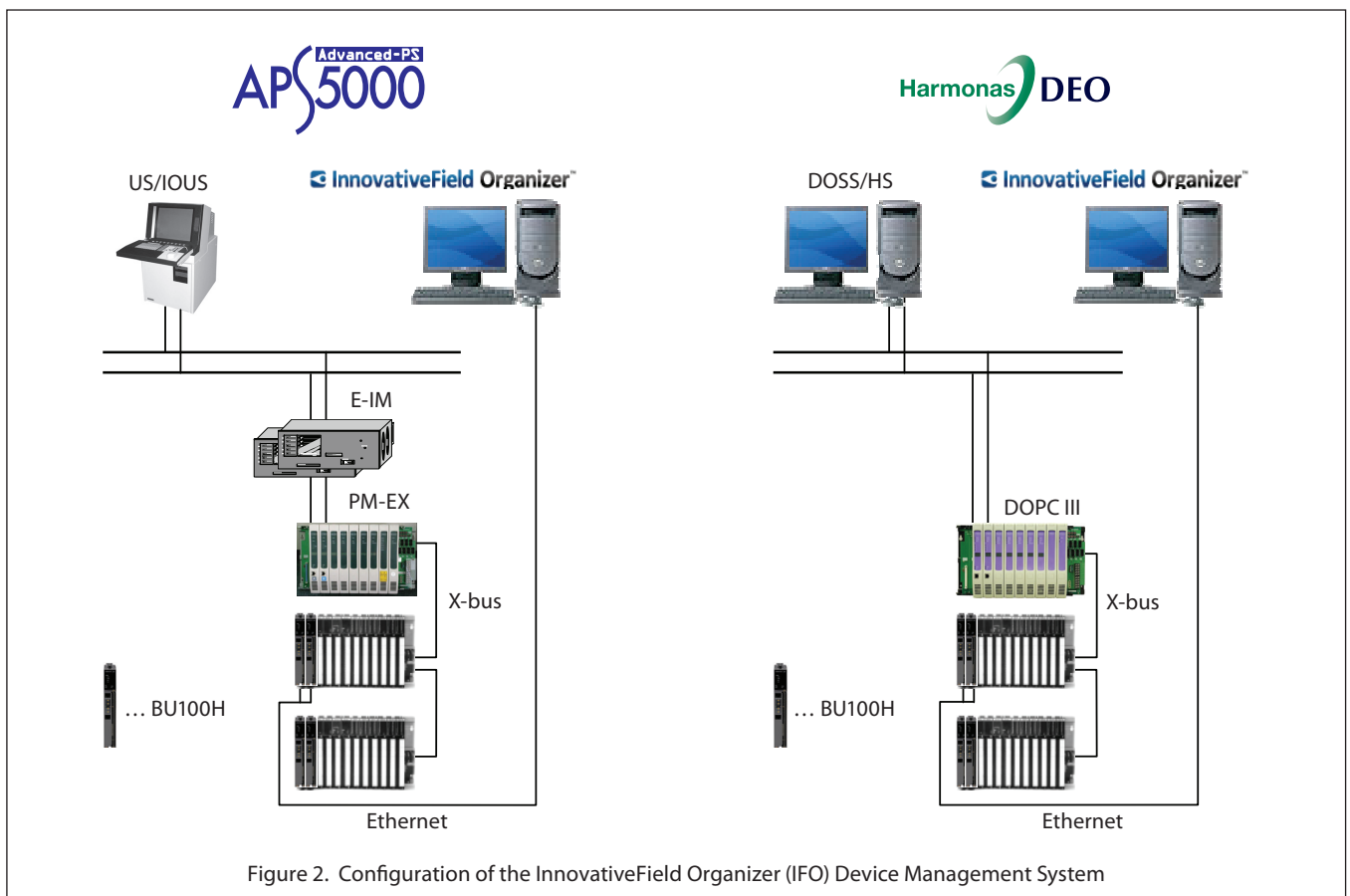


Figure 2. Configuration of the InnovativeField Organizer (IFO) Device Management System

1. Features

■ Enables High-speed HART Communication

- There is a HART model for each channel, enabling 16-channel simultaneous communication and high-speed HART communication with one-second updates for all points. It is possible to send status notifications requiring real-time transmission and highly-useful alert notifications linked to the DCS to the IFO.

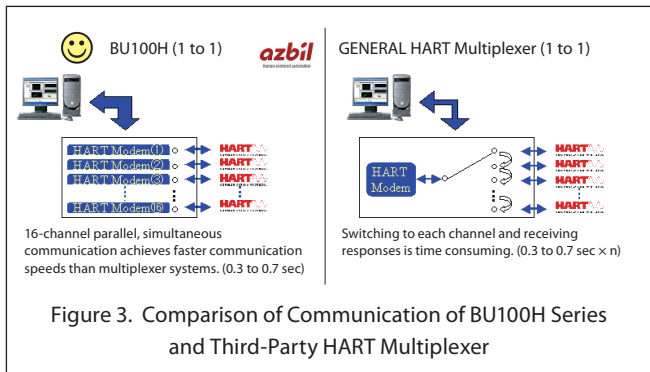


Figure 3. Comparison of Communication of BU100H Series and Third-Party HART Multiplexer

■ Easy HART Integration with Azbil Corporation’s DCSs

- Adopting HART in an existing Azbil Corporation’s DCS is easily achieved by replacing the I/O module and installing simple wiring between the BU100H and IFO if a base-unit type I/O module has been installed in the equipment.* Because existing field wiring can be used as it is, it is possible to avoid unnecessary wiring work and adopt HART relatively simply.
- There is absolutely no need to upgrade the existing DCS for HART integration. The BU100H series is ideal for customers who want to quickly and easily experience the merits of using HART.
- Customers wanting to partially incorporate HART devices into an existing Azbil Corporation’s DCS can do it with the minimum of cost.
 - Possible for an I/O module to exist with another I/O module on the same base unit
 - Possible for HART devices and general 4 to 20 mA devices to exist together on the same BU100H module

*: If the existing system has isolators or barriers, they will also need to be replaced with HART communication compatible devices. (For details, refer to Section 5.7.)

■ Isolated Structure Provides Safe, Reliable Operation

- BU100H series modules have a structure in which the analog input/output and HART communication boards are isolated, so analog input/output is not affected even if HART communication malfunctions. In addition, restoration is achieved by resetting the HART communication card without stopping analog input/output, providing safe, reliable control.

2. Specifications

The BU100H series are HART-compatible I/O modules that can be implemented on the I/O base unit (Table 1). Up to 12 modules can be implemented on a single I/O base unit.

Table 1. I/O Base Units

Model No.	Name
HD-MBU95H	For I/O base unit X-bus
HD-MBU95HC	For I/O base unit X-bus (varnish coating)
J-MBU90	For I/O base unit X-bus
J-MBU90Y	For I/O base unit X-bus (varnish coating)

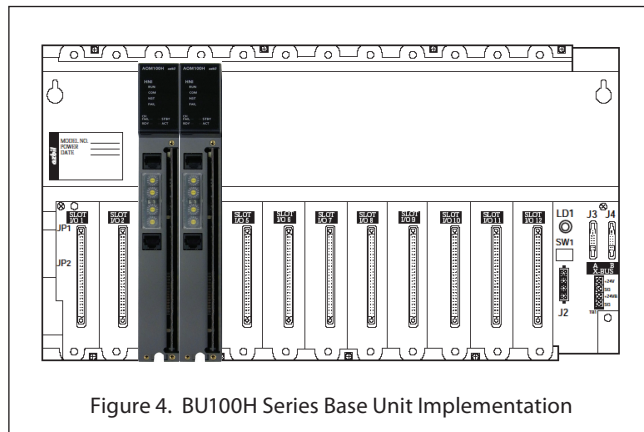


Figure 4. BU100H Series Base Unit Implementation

Currently, there are two types of module in the BU100H series: HART-compatible analog input modules (HAM100H series) and HART-compatible analog output modules (AOM100H series). The following subsections provide details of the HAM100H and AOM100H series.

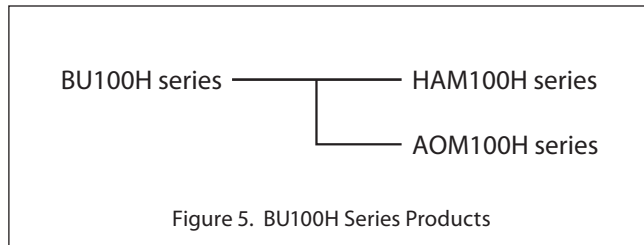


Figure 5. BU100H Series Products

2.1. HART-compatible Analog Input Modules (HAM100H Series)

HAM100H series modules operate with 24 VDC power supplied from the I/O base unit. They are connected to field devices via a dedicated remote terminal panel (RTP). They not only process input of analog signals but also execute the HART communication functions. Up to 16 points can be input per module.

(1) Model Numbers

Table 2. HAM100H Series Model Numbers

Model No.	Name
HD-HAM100H-1	High-level analog input module for X-bus (HART-compatible)
HD-HAM100HC-1	High-level analog input module for X-bus (HART-compatible, varnish coating)
HD-HAM100H-5	High-level analog input module for FX-bus (HART-compatible)
HD-HAM100HC-5	High-level analog input module for FX-bus (HART-compatible, varnish coating)
HD-HAM101H	High-level analog input module for X-bus/PM100 (HART-compatible)
HD-HAM101HC	High-level analog input module for X-bus/PM100 (HART-compatible, varnish coating)

(2) Analog Input Specifications

Table 3. HAM100H Series Analog Input Specifications

Item	Specifications
Points/module	16
Input circuit	Differential input type, non-isolated, multiplexer circuit
Input signal	1 to 5 VDC/4 to 20 mA (converted to 1 to 5 V by the I/V resistor in the AI adapter)
Input range (FS)	0.726 to 5.276 VDC (−6.9 to 106.9%)
A/D conversion resolution	0.01% (14-bit A/D conversion)
Conversion reference accuracy	±0.1% F.S. (voltage input)
AI adapter I/V conversion resistance	250 Ω ± 0.05%, temperature coefficient ± 30 ppm
Effects of temperature change	±0.005%/°C
Effects of supply voltage	±0.01%/V (based on the nominal value of 24 VDC)
Allowable common mode voltage	−3 to +5.5 VDC
Common mode rejection ratio (CMRR)	60 dB or higher (50/60 Hz)
A/D conversion cycle (all points)	50 ms
Transmitter power supply	HD-CHAM00 : Power supply voltage −1.5 V HD-HAM100 : Possible to supply via RTP, (power supply voltage) − (1.5 + 0.01 L) L ≤ 100 m (L: I/O cable length) 25.5 VDC for the standard power supply (HAS-STZ57/67) HD-HAF100 : None
Transmitter power supply current limiter	Possible for each point by the AI adapter
Limited current for short circuit	30 ± 3 mA
Input impedance	5 MΩ or higher (when the system is powered on)
Automatic drift correction	Executed during operation for offset (zero) and gain (span)

Table 4. Remote Terminal Panel (for HAM100H Series)

Model No.	Name	Specifications
HAS-RTP11/J-RTP11	Analog input RTP	Possible to supply power to the transmitter (24 VDC) 16-point input, 4 to 20 mA, 10 to 50 mA or 0 to 5 V, 1 to 5 V (select for each point) The AI adapter should be used for each input point when supplying power to the transmitter.

Table 5. AI Adapter

Model No.	Maximum use current	I/V resistance	Current limit value	Current limit method	Voltage drop (MAX) system	Usage
HAS-AAU20/J-AAU20	25 mA	250 Ω	30 ± 3 mA	Constant current	0.5 V (20 mA)	4 to 20 mA input, with transmitter power supply

2.2. HART-compatible Analog Output Modules (AOM100H Series)

The AOM100H series modules operate with 24 VDC power supplied from the I/O base unit. They are connected to field devices via a dedicated remote terminal panel (RTP). They not only output analog signals but also execute the HART communication functions. Up to 16 points can be output per module.

(1) Model Numbers

Table 6. AOM100H Series Model Numbers

Model No.	Name
HD-AOM100H-1	Analog output module for X-bus (HART-compatible)
HD-AOM100HC-1	Analog output module for X-bus (HART-compatible, varnish coating)
HD-AOM100H-5	Analog output module for FX-bus (HART-compatible)
HD-AOM100HC-5	Analog output module for FX-bus (HART-compatible, varnish coating)
HD-AOM101H	Analog output module for X-bus/PM100 (HART-compatible)
HD-AOM101HC	Analog output module for X-bus/PM100 (HART-compatible, varnish coating)

(2) Analog Output Specifications

Table 7. AOM100H Series Analog Output Specifications

Item	Specifications
Points/module	16
Output range	DC 4 to 20 mA (0 to 100%)
Power range	2.9 to 21.1 mA (–6.9 to 106.9%)
Output accuracy	±0.35% F.S.
Resolution	±0.05% F.S. (12-bit D/A conversion)
Effects of temperature change	±0.025% F.S./°C
Supply voltage sensitivity	±0.1% F.S./V (based on the nominal value of 24 VDC)
Maximum load	750 Ω
Maximum voltage	15 V
Effects of load change	100 Ω or less ±0.1%
Output current read-back check	Available
Output setting for a controller failure	Holding or clearing the output when a control module failure occurs (for each module)
D/A conversion cycle (all points)	50 ms

Table 8. Remote Terminal Panel (for AOM100H Series)

Model No.	Name	Specifications
HAS-RTP20/J-RTP20	RTP for analog output	16-point output, 4 to 20 mA

2.3. HART Communication Functions (Common to All BU100H Series Modules)

The HART communication functions of the BU100H series include “periodic communication,” which reads periodic data from connected HART devices, “command pass through,” which executes a HART command on specific devices with a command from the IFO, and “field event notification,” which notifies a change in the HART device status.

Up to 16 points can be used for HART communication per module. By performing HART communication simultaneously at 16 points, it is possible to establish HART communication at up to 1 second.

Table 9. BU100H Series HART Communication Specifications

Item	Specifications
Applied communication standard	HART Protocol Revision 7.2
Number of communication ports	RTJ45 × 2 ports
Number of HART communication devices	16 devices/module
Transmission rate	1200 bps
Data updating cycle	Maximum speed of 1 second/module
Communication direction	Duplex
Transmission method	Master/slave mode, burst mode (master/slave mode is set in standard shipment)
Redundancy	Non-redundant for HART functions (redundancy possible for the analog section as usual)

2.4. Power Consumption (Common to All BU100H Series Modules)

Table 10. BU100H Series Current Consumption

Item	Maximum current consumption (mA) at 24 VDC		Maximum inrush current/ re-inrush current (A) at 24 VDC
	Current consumption by a single module	When internal-module power supply is used	
HAM100H series	100	480*	3
AOM100H series	140	460*	3

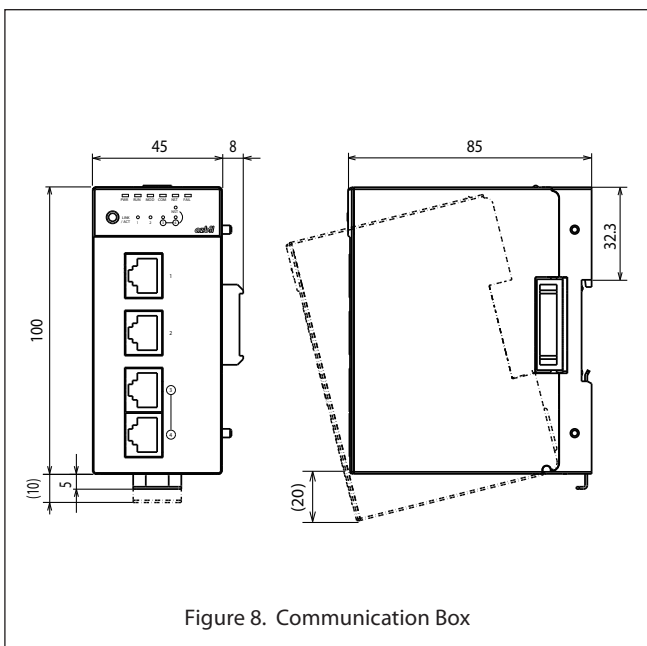
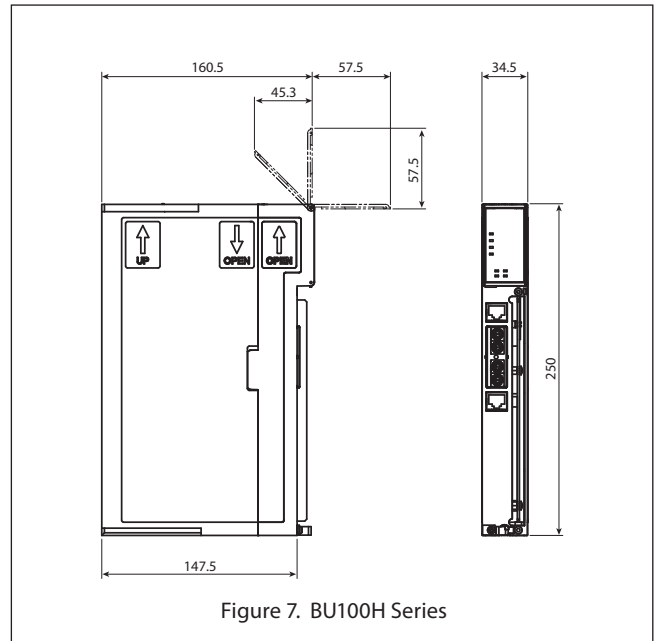
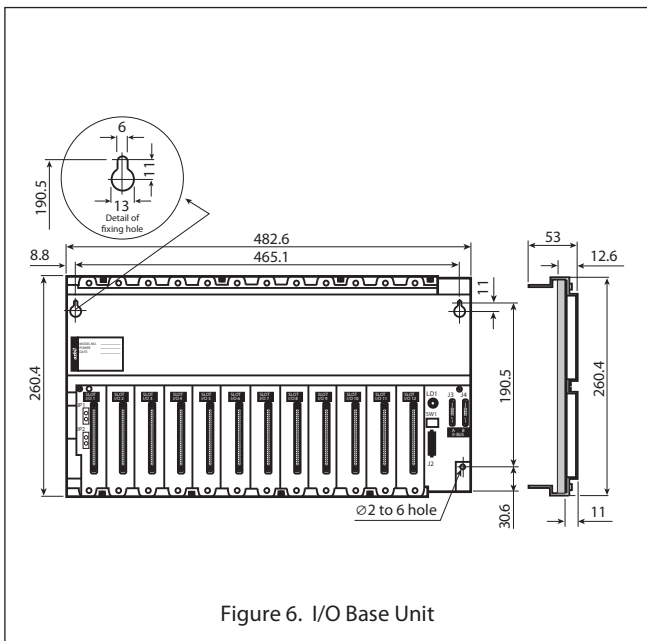
*: Current consumption when current of the input side (e.g., transmitter) is supplied from the module

2.5. Module Weights (Common to All BU100H Series Modules)

Table 11. BU100H Series Module Weights

Item	Weight (kg)
HAM100H series	0.70
AOM100H series	0.70

2.6. External Dimensions (Common to All BU100H Series Modules)



2.7. Installation Environment Conditions

Table 12. BU100H Series Installation Environment Conditions (Azbil Corporation's Standard Cabinet Installation)

Item		Standard condition	Operating conditions	Operating limit	Transport and storage conditions
Ambient temperature	Range (°C)	23 ± 2	0 to 40	0 to 50	-40 to -70
	Rate of change (°C/h)	±5	±20	±20	—
Relative temperature	(% RH)	50 ± 10	5 to 95 (0.020 kg/kg)*	5 to 95 (0.020 kg/kg)*	5 to 95 (0.028 kg/kg)*
Vibration	Acceleration (m/s ²)	0	<1 (9 to 150 Hz)	<1 (9 to 150 Hz)	<5 (9 to 150 Hz)
	Amplitude (mm)	0	<0.35 (2 to 9 Hz)	<0.35 (2 to 9 Hz)	<1.5 (2 to 9 Hz)
Impact	Acceleration (m/s ²)	0	—	<40	<40
	Duration (ms)	0	—	<20	—

*: Maximum absolute humidity (mass ratio of moisture and dry air in moist air (kg/kg'))

3. Device Information Network

The network between BU100H series modules and IFO is called the device information network. The device information network is Ethernet (ANSI/IEEE802.3CSMA/CD) based and used exclusively for HART communication.

Because the device information network is independent from the DCS control network, it enables stable HART communication between BU100H modules and the IFO without being affected by the communication load of the control network.

3.1. Network Configuration

The device information network consists of multiple network groups.

Network groups are ring networks.

Multiple BU100H modules that are connected to the same controller are connected via Ethernet, and the end modules are connected to the communication box (CB) to establish a ring network.

It is also possible to integrate multiple ring networks into one network group by cascading the CBs.

Up to 20 network groups can be controlled per IFO.

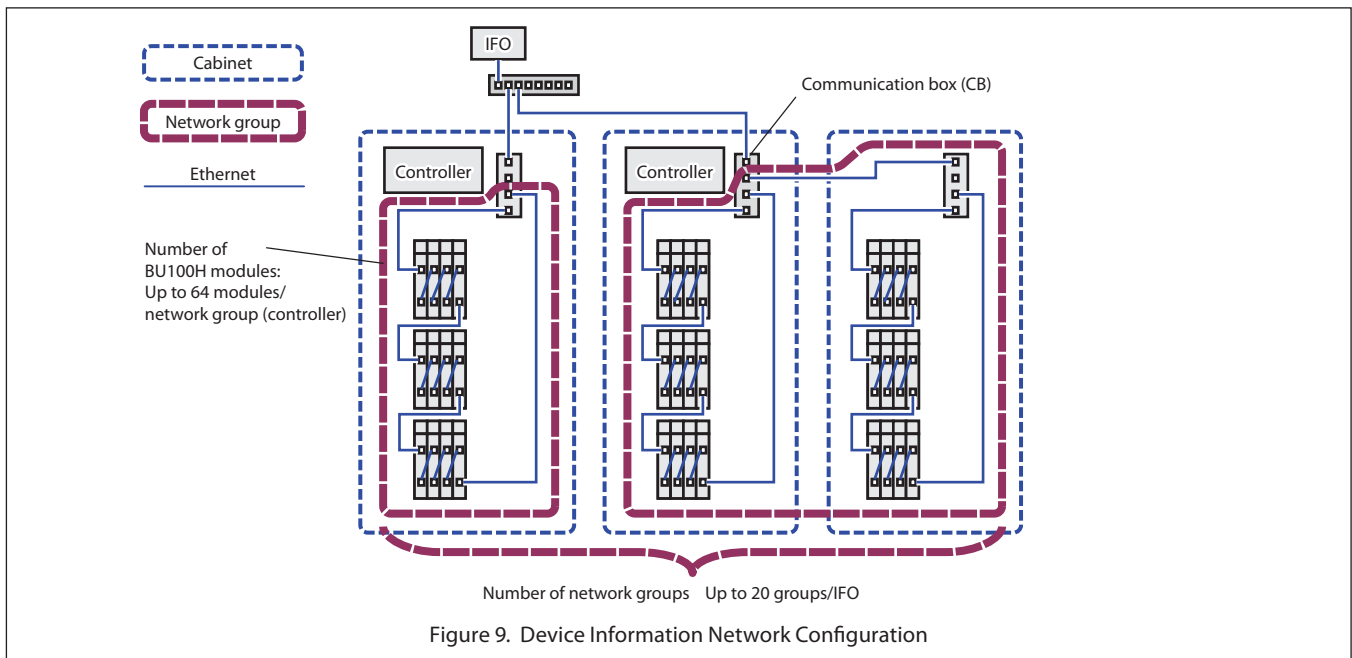


Figure 9. Device Information Network Configuration

Table 13. Device Information Network Specifications

Item	Specifications
Network topology	Ethernet (10BASE-T/100BASE-TX)
Transmission method	CSMA/CD
Standards compliance	ANSI/IEEE802.3
Transmission rate	10 Mbps/100 Mbps
Communication medium	UTP straight cable (CAT5)
Number of network groups	20 groups/IFO
Wiring method	In a network group: Ring Between a network group and IFO: Bus
Transmission distance	Total distance in a network group: 100 m Between a network group and IFO: 100 m
Number of connected HART devices	3000 devices/IFO, 16 devices/module
Number of BU100H connections	64 modules/network group
Number of cascaded communication boxes	Up to 4 connections (4 communication boxes)

Table 14. Communication Box (CB) Specifications

Item	Specifications
Model No.	NX-CB1NR0400 and NX-CB1NR0400 (anti-sulfuration)
Number of communication ports	4 ports × 4 (2 for ring network and 2 for host network)
Communication specification	100Base-TX
Connector	RJ-45
Rated supply voltage	24 VDC
Redundancy	Non-redundant

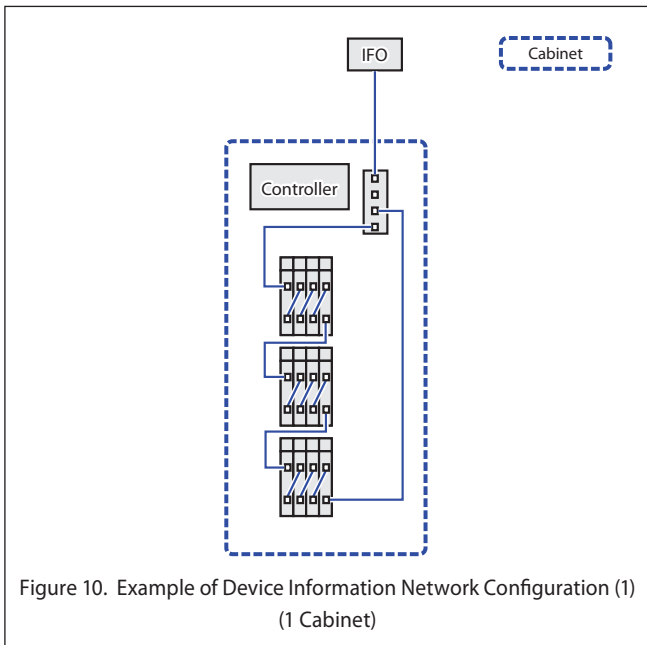


Figure 10. Example of Device Information Network Configuration (1)
(1 Cabinet)

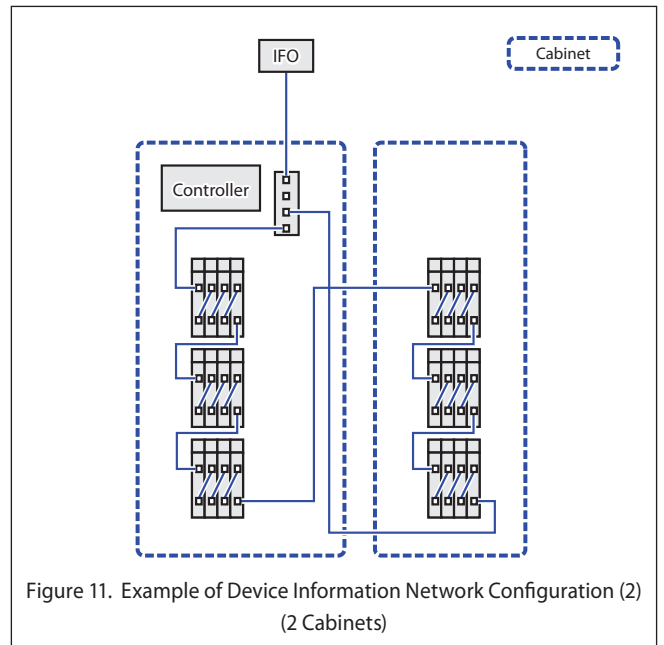


Figure 11. Example of Device Information Network Configuration (2)
(2 Cabinets)

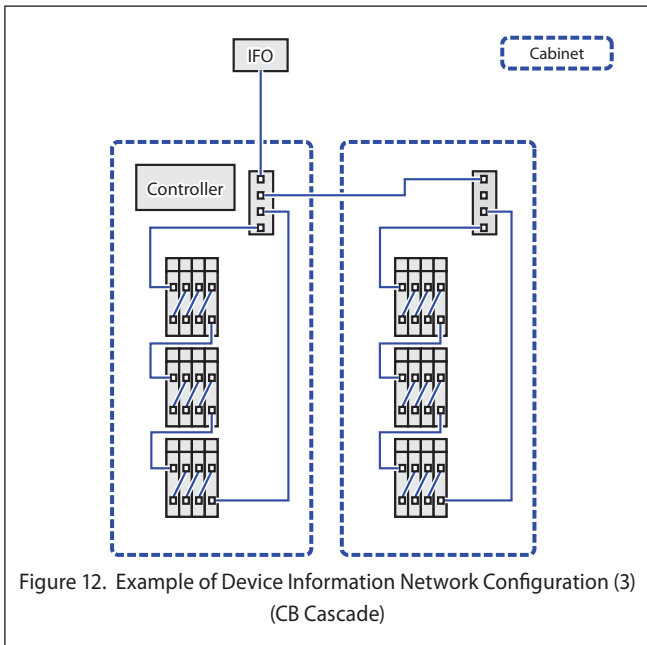


Figure 12. Example of Device Information Network Configuration (3)
(CB Cascade)

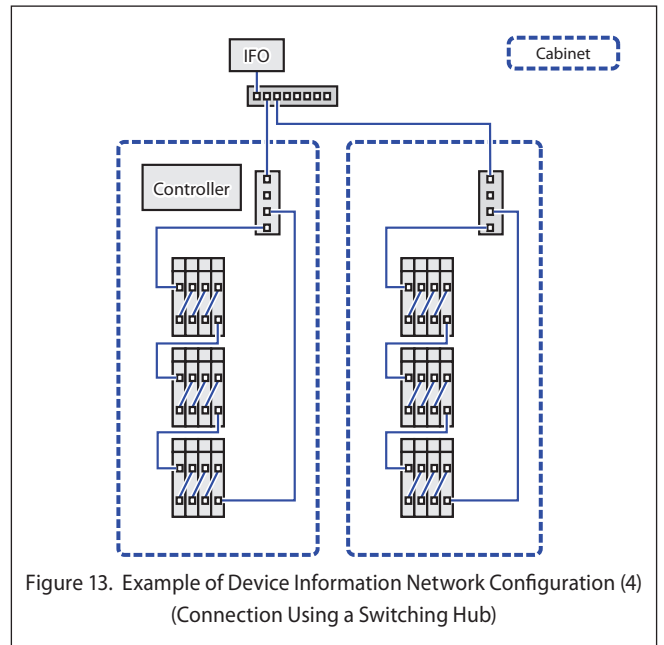


Figure 13. Example of Device Information Network Configuration (4)
(Connection Using a Switching Hub)

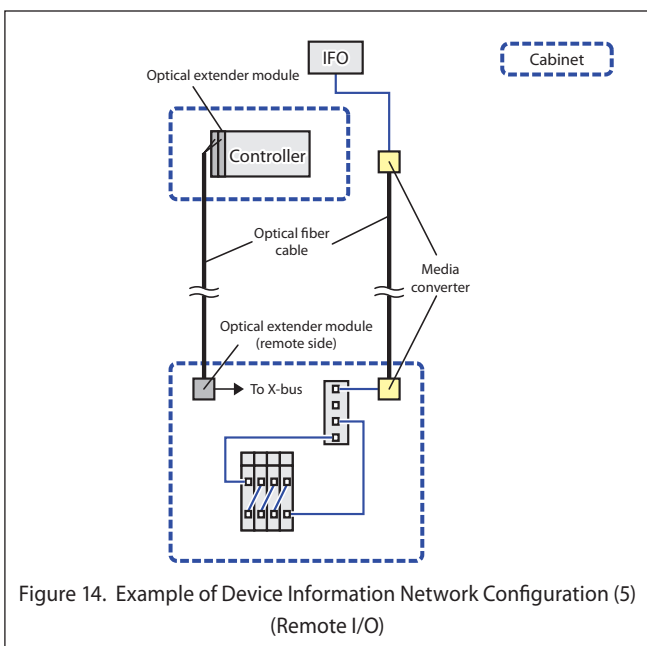


Figure 14. Example of Device Information Network Configuration (5)
(Remote I/O)

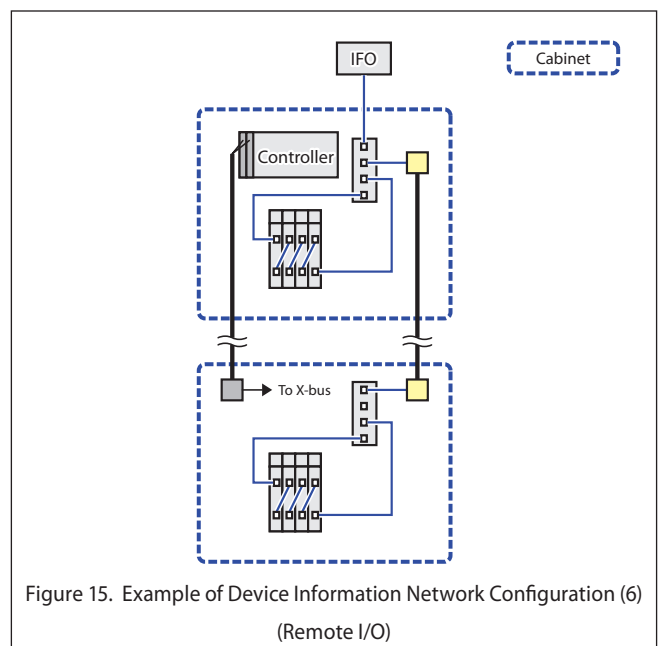


Figure 15. Example of Device Information Network Configuration (6)
(Remote I/O)

3.2. Network Groups

A network group is formed by connecting the modules to be connected to a controller in chains and connecting the head and tail of the ring to the CB. An Ethernet port located at the front of each BU100H module is used to connect them in chains. (Refer to Figure 16.)

A ring network is used as the wiring method. The loop-back functionality of the ring network enables HART communication between other modules to be maintained even if one of the modules stops working or is removed. (Refer to Figure 17.)

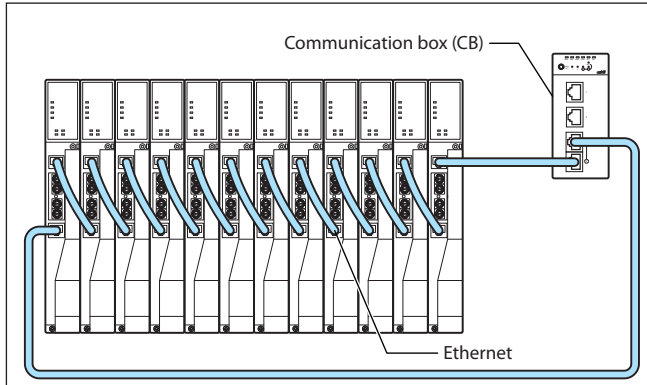


Figure 16. BU100H Series Network (Ring Network)

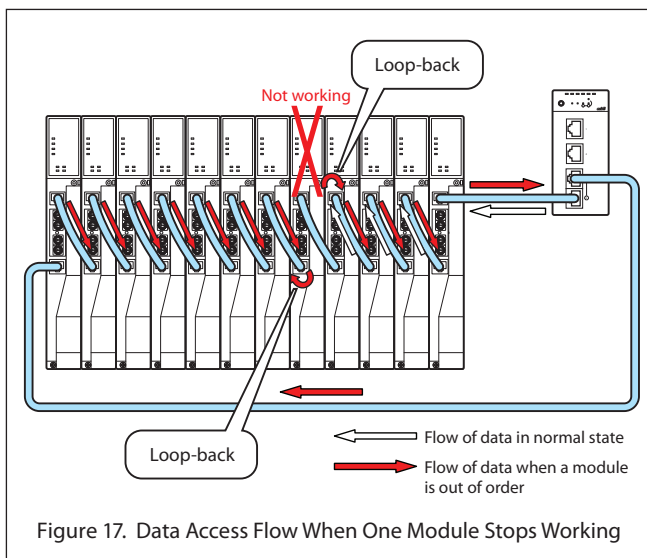


Figure 17. Data Access Flow When One Module Stops Working

4. Compatibility with the Existing System

As with other base-unit type I/O modules, the BU100H series can be connected to Advanced-PS and Harmonas-DEO controllers. Figures 18, 19, and 20 are system configuration diagrams and Tables 15 and 16 provide details.

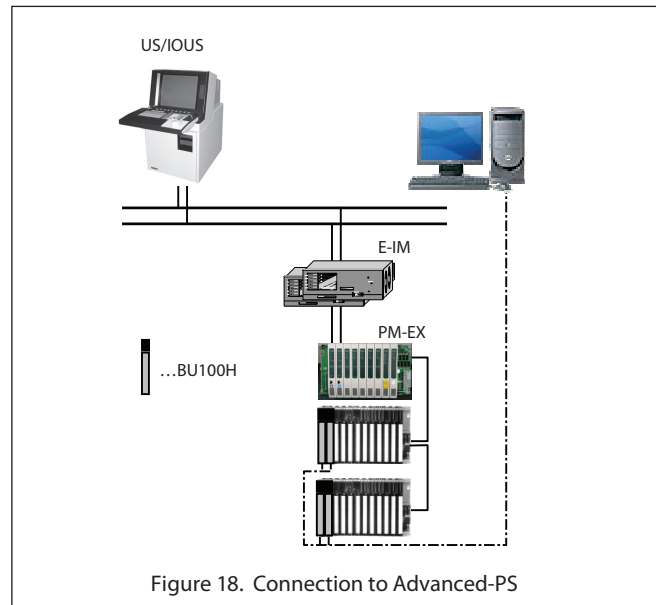


Figure 18. Connection to Advanced-PS

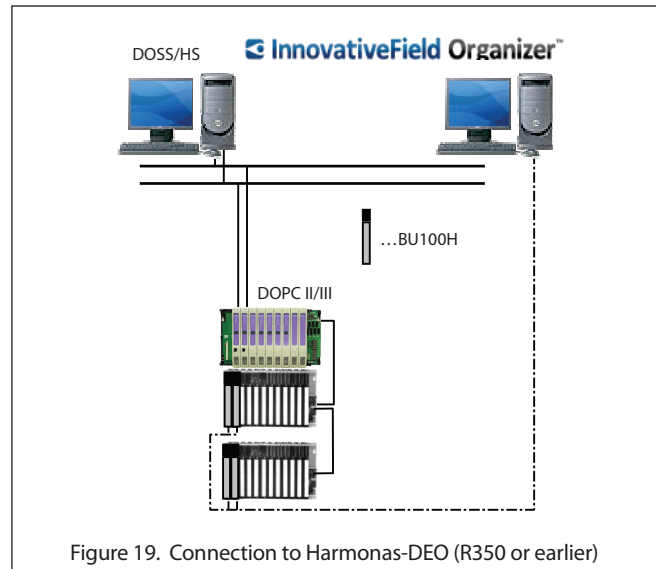


Figure 19. Connection to Harmonas-DEO (R350 or earlier)

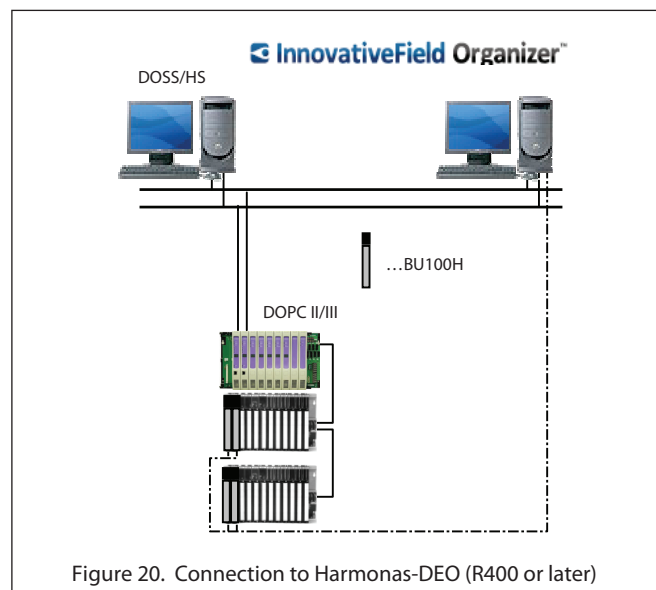


Figure 20. Connection to Harmonas-DEO (R400 or later)

Table 15. Compatibility of HART-compatible Analog Input Modules (HAM100H Series) with Controllers

Model No.	Connectable controller						
	A-MC	PM100	PM-EX	HC	DOPC	DOPC II	DOPC III
HD-HAM101H	○	○	○*1				
HD-HAM101HC	○	○	○*1				
HD-HAM100H-1				○*2	○*2		○*2
HD-HAM100HC-1				○*2	○*2		○*2
HD-HAM100H-5			○*3	○*3	○*3	○	○*3
HD-HAM100HC-5			○*3	○*3	○*3	○	○*3

Table 16. Compatibility of HART-compatible Analog Output Modules (AOM100H Series) with Controllers

Model No.	Connectable controller						
	A-MC	PM100	PM-EX	HC	DOPC	DOPC II	DOPC III
HD-AOM 101H	○	○	○*1				
HD-AOM 101HC	○	○	○*1				
HD-AOM100H-1				○*2	○*2		○*2
HD-AOM 100HC-1				○*2	○*2		○*2
HD-AOM 100H-5			○*3	○*3	○*3	○	○*3
HD-AOM 100HC-5			○*3	○*3	○*3	○	○*3

*1: Can be connected only to PM-EX (X-bus). Cannot be connected to PM-EX (FX-bus). Cannot be connected to HAS/DEO controllers (HC, DOPC, and DOPC II/III) because the connector shape is different.
 *2: Can be connected only to X-bus (1M) types. Cannot be connected to APS controllers (A-MC, PM100, and PM-EX) because the connector shape is different.
 *3: Can be connected only to FX-bus (5M) types. (Only FX-bus (5M) type is available in DOPC II)

5. Precautions and Restrictions

The BU100H series are compliant with SPEC Rev. 7.2 (HCF_SPEC-013) of the HART Association, but the following describes some restrictions regarding functions and quality.

5.1. Precautions Regarding Analog Output Change (AOM100H Series Only)

Because changes in analog current during control output in AOM100H series modules exceed the following specification, HART communication may be affected.

Note that HART communication may not be established in a loop in which the amount of change in control output remains at 25% or higher. However, even if the amount of change in control output remains at 25% or higher, the control output itself is completely unaffected.

- Related specifications:
HCF_SPEC-054 Rev 8.1 13.5 Analog Rate of Change

5.2. Precautions Regarding Noise (AOM100H Series Only)

The AOM100H series modules cannot handle the level of noise (29 Hz/16 V) specified in the following specification. However, since this level of noise is not generated in normal use, in practice it is not a problem.

- Related specifications:
HCF_SPEC-054 Rev 8.1 13.8 Noise Sensitivity at 29 Hz/16 V

5.3. Precautions Regarding Multidrop (HAM100H Series Only)

The HAM100H series is not compatible with a multidrop* configuration as specified in the following specification.

* Multidrop: A method for connecting up to five field devices on the field wiring by fixing the analog current and using HART communications only

- Related specifications:
HCF_SPEC-081 Rev 8.2 HCF_SPEC-127 Rev 7.1 Cmd6

5.4. Precautions Regarding HART Revision (All BU100H Series Modules)

The BU100H series supports HART revisions of Rev 5 or later. Note, however, this does not mean that the connection of all Rev 5 or later HART devices is guaranteed. Contact us if the connection cannot be made successfully.

5.5. Restrictions on Redundancy of HART Communication Functions

The HART communication functions of the BU100H series are not capable of redundancy. Use of the HAM100H and AOM100H series in a redundant structure is not permitted.

To configure redundancy of the analog input/output functions of the AOM100H and HAM100H series, be sure to use either of these in combination with modules on the other side that do not support HART communication. (Refer to Table 17.)

Table 17. Combination of HAM100H Series Modules for Redundancy

HAM100H series model No.	Compatible module model No.
HD-HAM100H-1, HD-HAM100HC-1	HD-HAM100-1, HD-HAM100C-1 HD-HAM70H-1, HD-HAM70HC-1
HD-HAM101H-1, HD-HAM101HC-1	HD-HAM101-1, HD-HAM101C-1 J-HAM70, J-HAM70C J-HAM50, J-HAM50Y
HD-HAM100H-5, HD-HAM100HC-5	HD-HAM100-5, HD-HAM100C-5 HD-HAM70H-5, HD-HAM70HC-5

Table 18. Combination of AOM100H Series Modules for Redundancy*

AOM100H series model No.	Compatible module model No.
HD-AOM100H-1, HD-AOM100HC-1	HD-AOM100-1, HD-AOM100C-1
HD-AOM101H-1, HD-AOM101HC-1	HD-AOM101-1, HD-AOM101C-1
HD-AOM100H-5, HD-AOM100HC-5	HD-AOM100-5, HD-AOM100C-5

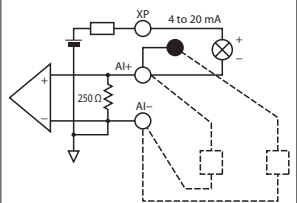
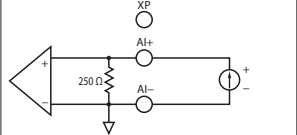
*: An AOM100H series module cannot be used in combination with a product with an old model number. Be sure to use the combinations given in the relevant table. (There are no restrictions for the HAM100H series as long as the combination to be used is selected in accordance with the relevant table.)

5.6. Restrictions When Connecting HAM100H Series Modules and HART Devices

The following table indicates the wiring method to use between HAM100H series modules and HART devices.

In order to maintain reliable HART communication signals, the patterns available for use for HAM100H series modules are limited compared to those for the analog input modules that do not support HART communication (HAM100 and HAM70 series). There are no particular restrictions on AOM100H series modules.

Table 19. Field Wiring Method for HAM100H Series Modules

No.	Connection circuit diagram and description
c)	 <ul style="list-style-type: none"> No grounding for external devices for transmitter power supply current input (4 to 20 mA) A terminal indicated with ● is used for multiple signal branches (points). An AI adapter unit is required.
d)	 <ul style="list-style-type: none"> No grounding for external devices for current input (4 to 20 mA) An AI adapter unit is required.

5.7. Restrictions When Connecting to Third-Party Isolators

Be sure to use the isolators listed in the following table when connecting insulators between BU100H series modules and HART devices. Isolators other than those listed in the table are not supported.

Table 20. Isolators That Can Be Connected to BU100H Series Modules

Manufacturer	Model No.	Type
Cooper Industries Japan K.K.	MTL5046	AO
PEPPERL & FUCHS	KFD2-SCD2	AO
M-System Co., Ltd.	M2DYH-□□	AO/AI
Cooper Industries Japan K.K.	MTL5042	AI
PEPPERL & FUCHS	KFD2-STC4	AI

5.8. Restrictions When Using Field Wiring

For the field wiring between a remote terminal panel (RTP) connected to a BU100H series module and a HART-compatible field device, use a cable that conforms to the specifications in Table 21 and that is recommended in the physical layer standard issued by the HART Association.

When reusing a cable used in the existing field wiring, be sure to check the type of the multi cable and confirm that it is not longer than the maximum cable length specified in Table 22.

Table 21. Field Wiring Cable

	Single	Multiple
Type	Shielded twisted pair	Shielded twisted pair (individually shielded cable is recommended)
Insulating material	Polyethylene	Polyethylene
Cable length	Up to 1500 m	Up to 1500 m
Cable diameter	0.51 mm (#24 AWG) or wider	0.51 mm (#24 AWG) or wider

Table 22. Multi Cable Types and Maximum Cable Length

Type	Name	Insulation coating material	Nominal cross-sectional area (mm ²)	Maximum cable length (m)
Twisted pair	Polyvinyl chloride insulated cable (equivalent to CV*)	Polyvinyl	0.90	721
			1.25	691
			2.00	626
	Polyethylene insulated cable (equivalent to CE*)	Polyethylene	0.90	1500
			1.25	1500
			2.00	1500
Coaxial (parallel)	Polyvinyl chloride insulated cable (equivalent to CV*)	Polyvinyl	0.90	433
			1.25	415
			2.00	375
	Polyethylene insulated cable (equivalent to CE*)	Polyethylene	0.90	1223
			1.25	1172
			2.00	106

CV*: Polyvinyl chloride insulated cable for control
 CE*: Polyethylene insulated cable for control

Notes:

- The maximum cable length specified is only a guideline and does not guarantee communication status. Regardless of whether or not the cable length exceeds the maximum allowable length, noise in the surrounding environment of the field and other factors may affect HART communication.
- The maximum cable length is the total cable length from the I/O module to the HART device. The length of the field wiring cable that can be actually used is the value calculated by subtracting the length of the I/O cable (cable between the BU100H module and the remote terminal panel) from the maximum cable length.
- If the maximum length of the field wiring cable used on the HART device side is specified, be sure to use it within the specified maximum cable length.
- The maximum allowable cable length may be shorter if there is large capacity between the analog signal line inside the HART device and ground.

5.9. Precautions for Changing Over from an Analog Field Device to a HART Device

The output impedance for the AOM100H series is 750 Ω. When changing over from an analog field device to a HART device, check the input impedance for the HART device and confirm that the total input impedance including barriers is less than 750 Ω.

5.10. Precautions Regarding Connection of HART Communicators

When HART communication is being performed in a combination of IFO, BU100H modules, and HART devices, there is a large load because it is periodic communication with a 1-second cycle. Therefore, connecting a HART communicator can result in a connection error or a large lag in communication response. When using a HART communicator, connect it after disabling the HART communication from the IFO in the relevant channel. (For details of the configuration, refer to the RTC-HT Instruction Manual.)

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