User Manual

Original Instructions

Allen-Bradley

1718 Ex I/O

Catalog Numbers 1718-AENTR, 1718-IJ, 1718-OB2, 1718-OB2L, 1718-IBN8, 1718-IBN8B, 1718-IT4B, 1718-IR4B, 1718-IF4HB, 1718-CF4H, 1718-PSDC, 1718-A20, 1718-A10, 1718-CBL65, 1718-CBL3, 1718-ARM

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Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous vole may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Appendix C

Additional HART Protocol Information

Appendix D

Engineering Unit Code Numbers

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual
- the purpose of this manual
- related documentation
- supporting information

Who Should Use This Manual

This manual is intended for trained and qualified personnel who are responsible for mounting, installation, commissioning, operation, maintenance, and disassembly of 1718 Ex I/O.

For more information, see Target Group, Personnel on page 11.

Purpose of This Manual

This manual provides information and describes the procedures that are used to install, wire, troubleshoot, and operate 1718 Ex I/O.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
1718 Ex I/O Installation Instructions, publication 1718-IN001	Describes how to install and wire the 1718 Ex I/O input and output modules
1718 Ex I/O Technical Data, publication 1718-TD001	Provides specifications, wiring diagrams, and module block diagrams for 1719 Ex I/O
1718 Certification Bulletin, publication 1718-CT001	Provides 1718 Ex I/O certification information and links to control drawings.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.

You can view or download publications at http://www.rockwellautomation.com/literature/. For Release Notes and other publications specific to your module, search the catalog number of the module. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

Product Specifications

Introduction

Remote I/O systems, consisting of I/O modules, gateways, bus termination modules, power supplies, and a backplane, form the interface for signals to be transmitted from the explosion hazardous area (Ex area), to the safe area (non-hazardous area). With appropriate surrounding enclosures, remote I/O systems can be installed in Gas-Ex areas of Zone 1. Using remote I/O, a wide range of digital and analog sensors and actuators can be connected to process control systems over a fieldbus. Specific measures need to be taken to disconnect I/O modules with Ex-e front connectors during ongoing operation. To do so, observe the safety notices in this manual. The gateway is the interface between the I/O modules on the backplane and the process control system. Power supplies are used to power the I/O modules and adapter/gateway.

All components of the FB remote I/O with Ex-q protection meet the FB concept. This simplifies the evaluation of modules from an explosion protection point of view.

This manual sets out how to work with the hardware. Refer to the software manual for the gateway and the I/O modules for information on the configuration of the gateway and the I/O modules.

Table 1 - 1718 Ex I/O Modules

Type	Catalog Number	Description
Communication Adapter	1718-AENTR	Ex I/O EtherNet/IP Adapter
Digital Input	1718-IJ	Ex I/O Frequency Counter
	1718-IBN8B	Ex I/O 8 Point Digital Input NAMUR Wide
	1718-IBN8	Ex I/O 8 Point Digital Input NAMUR
Analog Input	1718-IF4HB	Ex I/O 4 Channel HART Analog Input Wide
	1718-IR4B	Ex I/O 4 Channel RTD Input
	1718-IT4B	Ex I/O 4 Channel Thermocouple Input
Configurable Analog Input/Output	1718-CF4H	Ex I/O 4 Channel HART Analog Configurable
Digital Output	1718-OB2	Ex I/O 2 Point Digital Output 23V
	1718-OB2L	Ex I/O 2 Point Digital Output 16.5V
Power Supply	171-PSDC	Ex I/O DC Power Supply
Backplane	1718-A20	Ex I/O 20 Slot Chassis
	1718-A10	Ex I/O 10 Slot Chassis
Connection Cable	1718-CBL65	Ex I/O Chassis Extension Cable 0.65 m
	1718-CBL3	Ex I/O Chassis Extension Cable 3 m
Placeholder	1718-ARM	Ex I/O Empty Slot Cover

1718 Ex I/O Components

1718 Ex I/O Components Overview

See the following graphic and table for the descriptions of different 1718 Ex I/O components:

Figure 1 - 1718 Ex I/O Components Overview

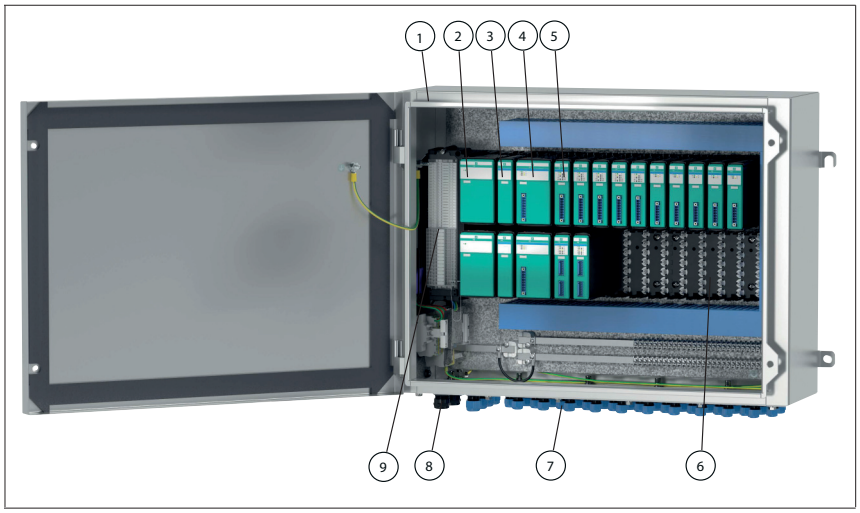


Table 2 - 1718 Ex I/O Components Overview

	Description		Description
1	Field Unit (Surrounding Enclosure)	6	Backplane
2	Power supply	7	Cable gland for field lines
3	Bus termination module	8	Cable gland for power supply and bus cables
4	Adapter	9	Ex-e-terminals and IP30 cover
5	I/O module		

Field Units

Field units (surrounding enclosures) serve to protect all electronic components against environmental influences and are an integral part of explosion protection. The enclosures are made of glass fiber reinforced polyester or stainless steel and are available in various versions. The surrounding enclosures contain backplanes for the connection of modules. The modular concept allows multiple surrounding enclosures to be flanged together to create the required expansion level. Each surrounding enclosure contains Ex-e terminals for power and communication lines. For safety, these are individually equipped with protective covers (IP30) and touch protection.

The surrounding enclosures are equipped with a rating plate listing all safety-relevant information, e.g., type of ignition protection, temperature class, permissible ambient temperature and permissible power.

Plastic enclosure

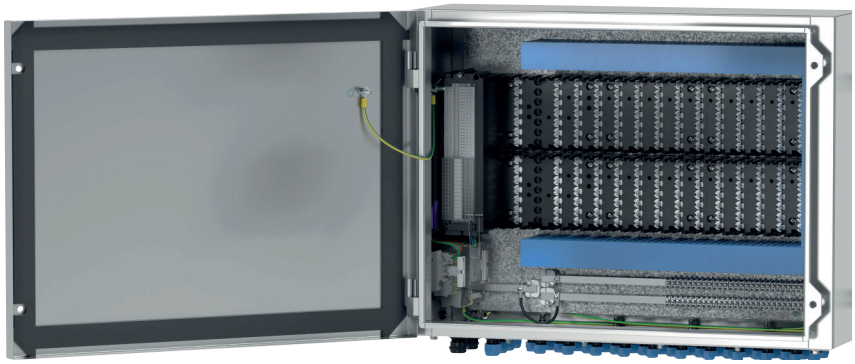
Glass fiber reinforced polyester offers a high level of mechanical protection for both onshore and offshore plants.

Figure 2 - Field unit with plastic enclosure partially without cover and modules

Stainless steel enclosure

The stainless steel enclosure ensures a high level of corrosion resistance for onshore and offshore plants.

Figure 3 - Field unit with stainless steel enclosure without modules



Enclosure Material Availability

Modular plastic and stainless steel enclosures are available in various sizes and designs, and custom solutions are also available. Depending on the version, the device units comprise base, redundancy, and expansion backplanes installed in the corresponding surrounding enclosures.

Figure 4 - Available field units

Catalog Number	Type		Max. number of slots	Material	
	Field unit	Redundant field unit		Stainless steel	Polyester
FB9210-PF0-G					
FB9210-S60-G					
FB9220-PF0-G					
FB9220-S60-G					
FB9240-PF0-G					
FB9240-S70-G					

Backplanes

Function

The modules are plugged into the backplane, which in turn is installed in a plastic or stainless steel enclosure. The backplane supplies the modules with energy and provides internal wiring.

Any I/O module can be inserted into any I/O slot, enabling a mixture of I/O functions in one field unit. Power supplies, adapters/gateways, and bus

termination modules are installed in their reserved slots. These are mechanically coded to avoid confusion.

WARNING: Risk of death as a result of using a damaged or tampered backplane.

Using a defective or tampered backplane means that explosion protection can no longer be guaranteed.

- Do not use a damaged backplane.
- The backplane must not be tampered with.
- In the event of a fault, the backplane must always be replaced with an original backplane from Rockwell Automation.

Figure 5 - Overview of backplanes

Catalog Number	Description
1718-A20	Universal backplane
	20 slots
	Redundant: adapter and power supply
1718-A10	Universal backplane
	10 slots
	Redundant: adapter and power supply

Design and Dimensions

The following backplanes are operated as a base backplane and extension backplane. Connect the two backplanes using the backplane cordset.

1718-A20

- Redundant configuration with slots for 2 gateways/adapters, 2 bus termination modules, 2 power supplies
- Slots for max. 20 narrow or 10 wide I/O modules
- For PROFIBUS DP, MODBUS RTU, MODBUS TCP, Ethernet

Figure 6 - 1718-A20 Dimensions

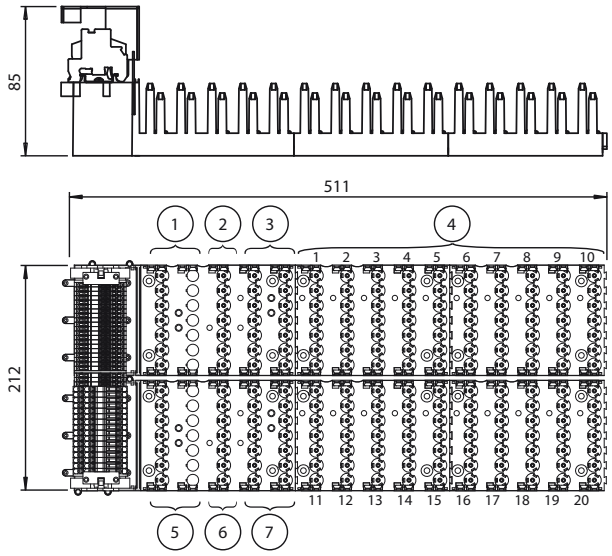


Table 3 - 1718-A20 Dimension Descriptions

Number	Description
1	Power supply
2	Bus termination module when used as a base backplane Empty slot when used as an extension backplane
3	Adapter when used as a base backplane Empty slot when used as an extension backplane
4	Slots for 20 narrow or 10 wide I/O modules
5	Redundant power supply
6	Bus termination module for redundant gateway/redundant adapter when used as a base backplane Empty slot when used as an extension backplane
7	Redundant adapter when used as a base backplane Empty slot when used as an extension backplane

1718-A10

- Redundant configuration with slots for 2 adapters, 2 bus termination modules, 2 power supplies
- Slots for max. 10 narrow or 5 wide I/O modules
- For PROFIBUS DP, MODBUS RTU, MODBUS TCP, Ethernet

Figure 7 - 1718-A10 Dimensions

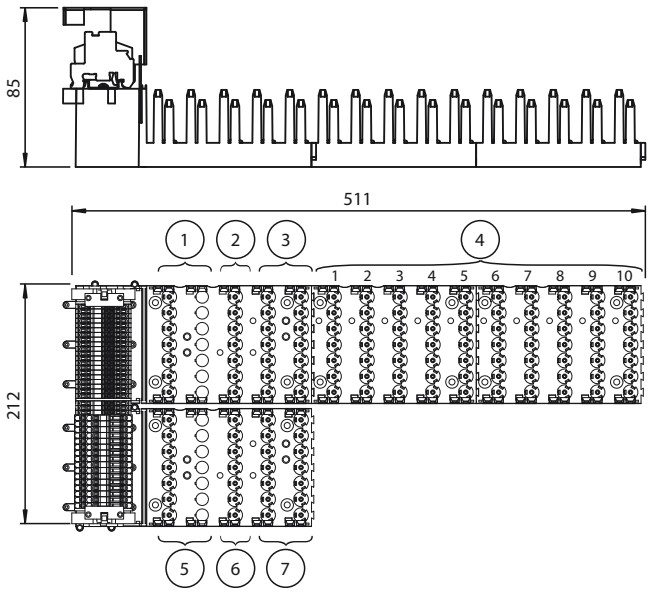


Table 4 - 1718-A10 Dimension Descriptions

Number	Description
1	Power supply
2	Bus termination module when used as a base backplane. Empty slot when used as an extension backplane
3	Gateway when used as a base backplane Empty slot when used as an extension backplane
4	Slots for 10 narrow or 5 wide I/O modules
5	Redundant power supply
6	Bus termination module for redundant gateway, when used as base backplane Empty slot when used as extension backplane
7	Redundant adapter when used as a base backplane Empty slot when used as an extension backplane

I/O Modules

I/O modules are used to modify signals between field devices in explosion-hazardous areas and controllers or control systems in the safe area. The slots for the I/O modules on the backplane are equal, so you can use I/O modules with different functions next to each other. The various I/O modules can be plugged in.

The integrated removal device allows you to quickly install and safely replace modules during ongoing operation if the module has intrinsically safe front connections or no front connections.

The status of each channel is displayed using an LED. This gives your technician clear information about the status of the field device directly on the device itself. For more information about the status LEDs, please refer to the respective datasheets for the modules.

The sockets on the discharge side of the module offer 1, 2, 4 and 8 channels to connect Ex field devices. Using the single-channel modules for controlling valves, including feedback, two additional binary input signals can be transmitted from the field. The portfolio is supplemented with 2-channel modules with shutdown input for emergency shutdown.

When modules are replaced, the new module automatically adopts the settings of its predecessor. This prevents errors when replacing modules.

The 4-channel universal module processes analog inputs and outputs depending on the setting. Each of the four channels can be configured independently of the others.

Figure 8 - 1718 Ex I/O Module

Design and Dimensions of the Modules

The FB remote I/O system is designed in such a way that each I/O module can be connected to the I/O slot it requires on the backplane. The slots on the backplane are limited. Depending on the size, for example, a base backplane can accommodate max. 24 narrow or 12 wide I/O modules.

Power supplies, adapters, and bus termination modules are assigned to fixed slots. To avoid confusion, these are mechanically coded. Adapters and power supplies are always wide modules. Bus termination modules are narrow modules.

Both the I/O modules and the adapters and power supplies are equipped with LEDs on the front that display the device status.

The I/O modules have connections on the front to which the relevant field devices are connected. On the back of the I/O modules there is a coding pin

that prevents an I/O module from being accidentally inserted into a slot that is intended for an adapter or a power supply.

WARNING: Explosion hazard as a result of removing coding pins!

Removing the coding pins means explosion protection can no longer be guaranteed.

Never remove the coding pins from the module.

Figure 9 - Narrow Modules

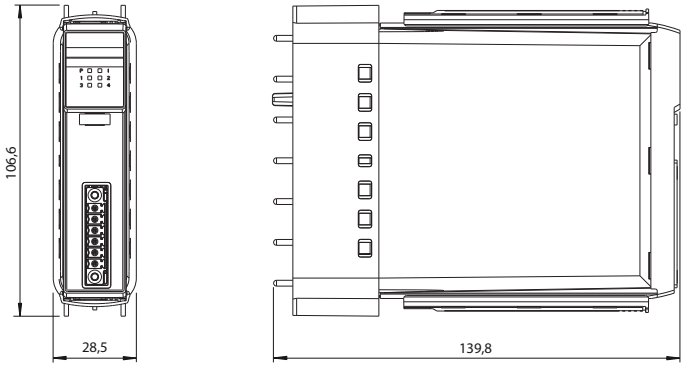
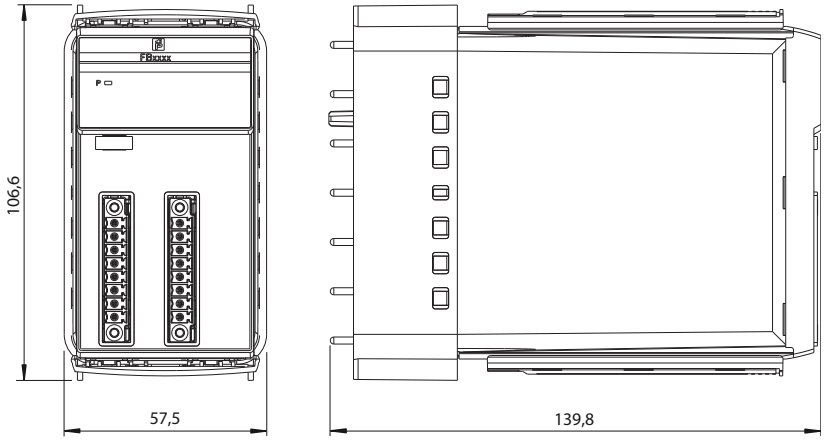


Figure 10 - Wide modules



Adapter

Adapters form the interface between the I/O modules and the process control system. The adapter converts the protocol of the bus integrated in the backplane to the protocol of the higher-level bus system.

Another adapter variant is the gateway. This is described in more detail below.

The gateway (check if there's a gateway module) can be operated directly via the touch screen on the front, meaning it can be configured directly in the field. In addition, the device status is displayed using the four LEDs below the touch screen.

The two Ethernet interfaces on the front connect the device to the Ethernet network.

WARNING: Explosion hazard in Zone 1.

When pulling out an M12 connector in Zone 1, a spark may form that ignites an explosive mixture.

- Do not pull out M12 connectors in potentially explosive atmospheres.
- Use only original Pepperl+Fuchs cables. *(should we write this as cables from the manufacturer Rockwell Automation?)*

WARNING: Property damage due to incorrect terminal assignment.

Incorrect terminal assignment and incorrectly positioned plug-in jumpers can cause damage to the gateway.

- Ensure that the terminal assignment of the gateway is correct. Refer to the backplane information in the Technical Data, 1718-TD001. Terminals 39 and 40 must be inserted when using the Ex-q gateway.
- Ensure that the plug-in jumper is correctly positioned. Refer to the backplane information in the Technical Data, 1718-TD001.

Bus Termination Modules

Bus termination modules prevent the reflection of signals at the end of the bus line. A bus termination module is required in each final unit of a bus line. (Guess we dont have a ROK version of this module - add the figure if we do support).

Power Supply Module

The power supplies provide power to all components of the remote I/O. The slots for adapters are mechanically coded on the backplane and marked accordingly. (Provide product photo)

Placeholder Module

Placeholder modules keep non-wired field circuits in position. This module has no electrical connection. (Provide product photo)

Accessories

Field Wiring

The following accessories are available for field wiring.

Terminal Blocks

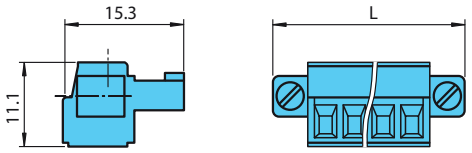
Terminal blocks are wired to the field devices, attached to the front sockets of the I/O modules, and tightened using the side screws. Terminal blocks can come in the form of screw terminals, front screw terminals, or spring terminals. Use blue terminal blocks for intrinsically safe circuits.

Use black terminal blocks for non-intrinsically safe circuits that comply with Ex e type of protection.

Table 5 - Available Terminal Blocks

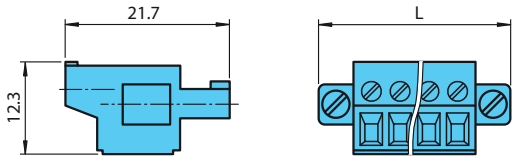
Type	Color	Catalog Numbers
(Side) Screw terminals	Blue	LB9107A, LB9113A, LB9124A, LB9125A
Front screw terminals	Blue	LB9117A, LB9118A, LB9119A, LB9127A
Spring terminals	Blue	LB9107P, LB9115A, LB9116A, LB9126A, (LB9130A)
	Black	LB9109.E.6.1, LB9109.E.8.1, LB9109.E.8.2

Figure 11 - Side Screw Terminal Dimensions



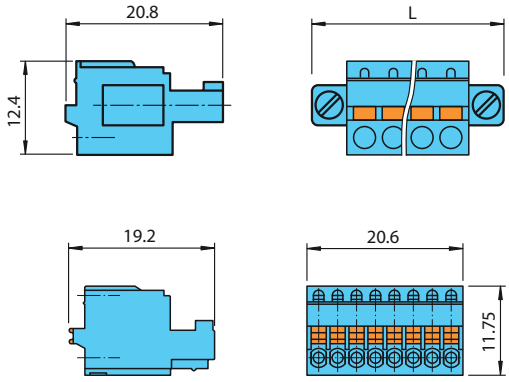
L = 33.3 mm for 6-pin terminals and 40.9 mm for 8-pin terminals

Figure 12 - Front Screw terminal Dimensions



L = 33.3 mm for 6-pin terminals and 40.9 mm for 8-pin terminals

Figure 13 - Spring Terminal Dimensions



L = 33.3 mm for 6-pin terminals and 40.9 mm for 8-pin terminals

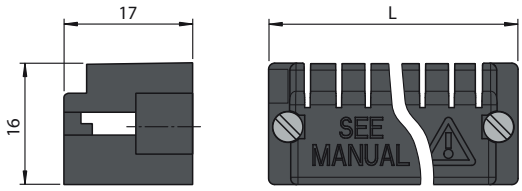
TIP The LB9130A spring terminal for the 1718-IBN8 I/O module is only inserted and not screwed in.

Protective covers

Protective covers (IP30) are used to protect the wiring to the terminal blocks, so that no bare, conductive parts are exposed. Use black protective covers for non-intrinsically safe circuits that comply with type of protection Ex e.

The catalog numbers for protective covers are LB9107.E.6, LB9107.E.8.

Figure 14 - Protective Cover Dimensions



Cold junctions

Cold junctions have a prewired Pt100 thermocouple on terminal openings 1 and 2 for numerically correcting the thermoelectric voltage. Cold junctions are available exclusively in blue. Use blue cold junctions for intrinsically safe circuits.

Table 6 - Cold Junction Catalog Numbers

Catalog Number	Color	Description
LB9112A	Blue	Cold junctions
LB9111A		Cold junctions with a protective cover

Figure 15 - Cold Junction Dimensions

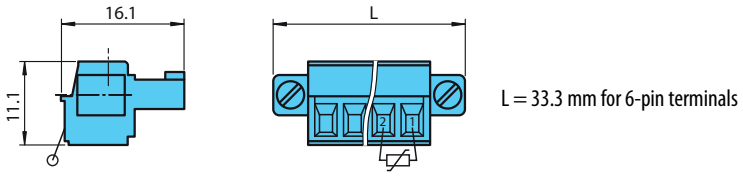
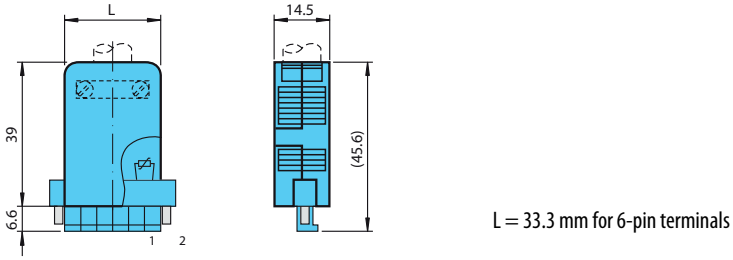


Figure 16 - Cold Junction with Protective Cover Dimensions



Coding pins

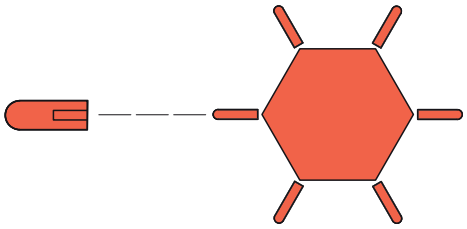
Coding pins provide a unique assignment between I/O modules and terminal blocks or the associated field devices. To do this, the coding pins are pushed into the grooves provided in the front sockets of the I/O modules. This

prevents terminal blocks from being accidentally plugged into another I/O module.

WARNING: Risk of confusing device connections.

When coding the front sockets of the I/O modules, ensure that the codes are mutually exclusive. Otherwise there is the danger of incorrect mapping between devices and circuits in explosion-hazardous areas.

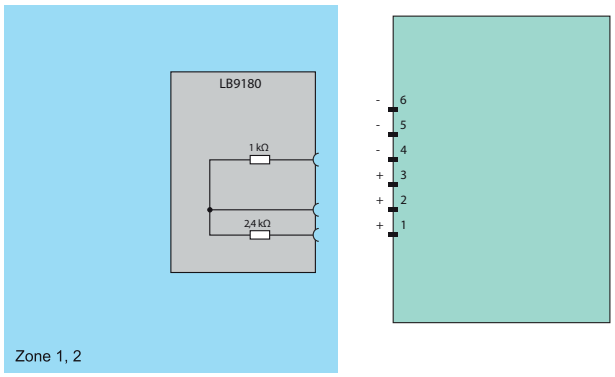
Figure 17 - KF-CP coding pins



Watchdog plugs

The watchdog plug is used with digital outputs with a feedback input (FB2201B - FB2213E). The watchdog plug sends the output signal from the I/O module back to its input channel, making it possible to check the function of the I/O module, as well as the communication between the process control system and the I/O module.

Figure 18 - Block diagram for the LB9180



Resistor network

Most I/O modules have a line fault detection function that can recognize a lead breakage or a short circuit.

If binary I/O modules are used, for example with a mechanical contact, an additional resistor network must be installed to ensure that the line fault detection function can work correctly. Using the additional resistor network, the electronics can distinguish between a closed switch and a short circuit.

To do this, the resistor network must be positioned directly on the field device.

Figure 19 - Dimensions of the F-NR2-Ex1 resistor network

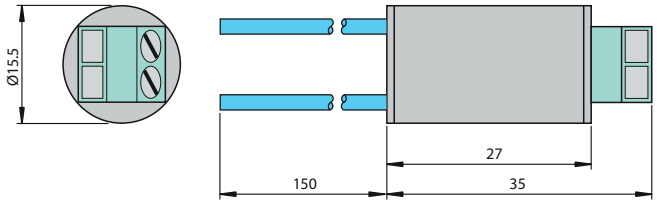
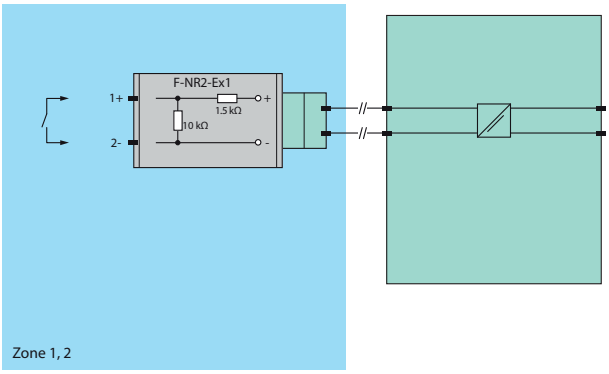


Figure 20 - Block diagram of the F-NR2-Ex1 resistor network



Cordsets

WARNING: Explosion hazard through use of incorrect cordset.

The use of incorrect cables in a potentially explosive atmosphere can create sparks that can ignite the surrounding atmosphere.

Cordset for backplane

The following table shows an overview of possible cordsets. Cordsets establish a local connection between a base backplane and an extension backplane. If a base backplane is extended with an extension backplane with additional I/O modules and power supplies, the backplane cordset ensures data exchange between the adapters on the base backplane and the I/O modules on the extension backplane. The length of the backplane cordset is up to 3 m.

Table 7 - Overview of Cordsets

Catalog Number	Description
FB9272-065	Cordset, length 0.65 m
FB9272-300	Cordset, length 3 m

Cordset for Gateways

There are two types of cordsets for gateways. One with a wired connection in Ex-i protection and one with M12 threaded plugs in Ex-e protection. The gateway cordset provides a local connection between two gateways. If two

gateways are used in a redundant system, they must be connected using a cordset via the front M12 socket or plug to enable internal data exchange.

Notes:

Commissioning

This chapter describes the commissioning of the RS-485-based bus system.

WARNING: When taking measurements in explosion-hazardous areas, there is an explosion hazard from sparks forming.

Use suitable measuring equipment or ensure there is no potentially explosive atmosphere.

Testing physical connection right to the end of the segment

TIP Perform the measurements from the control room.

1. Disconnect the bus connector from the master.
2. Deactivate the terminator on the bus connector (bus start).
3. Measure the voltage at the bus connector between A and B.

   A voltage of U = 220 Ω / (220 Ω + 2 * 390 Ω) * 5 V = 1.1 V must be present between A and B. This voltage is the result of the field-side terminator. If the 1.1 V voltage is not present, there is either no terminator connected at the end, the cable is faulty, or there is no terminating voltage at the 1718 Ex I/O unit.
4. Measure the current at the bus connector between A and B.

   It must be possible to measure a current of I = 5 V / (2 * 390 Ω) ≈ 6.4 mA between A and B. If the current is significantly higher, by a factor of 2 or more, the bus is terminated using more than one terminator. If the current is I ≈0 mA, then either there is no terminator present, the cable is faulty, or there is no terminating voltage. In this case, there should be a resistance of 220 Ω between A and B. Should neither current nor resistance be present, the terminator is missing at the end of the bus or the cable is faulty.
5. Activate the terminator on the bus connector for the master.
6. Plug the bus connector back into the master.

Testing physical 1718 Ex I/O unit connection

TIP Perform the measurements from the control room.

1. Disconnect the bus connector from the master.
2. Deactivate the terminator on the bus connector (bus start).
3. Measure the voltage between A and B on the bus connection of each 1718 Ex I/O unit.

   A voltage of U = 1.1 V must be present between A and B on each 1718 Ex I/O unit.
4. Activate the terminator on the bus connector for the master.
5. Plug the bus connector back into the master.

Configuration of an RS-485-Based Bus System

Configuration of the entire 1718 Ex I/O is conducted via the adapter. Communication with the adapter can be set up via either the fieldbus or the service bus.

TIP Adapter FB8207* can be configured via the service bus only.

For more information, refer to the software manual for the adapter used.

Startup Phase

IMPORTANT Do not start to operate all the 1718 Ex I/O units simultaneously; instead, connect each I/O unit to the master one after the other.

Ensure that the master read cycle and the com unit watchdog are coordinated with one another. The duration for the transition to substitute values must be longer than the duration of a bus cycle.

For the purposes of fault analysis, we recommend using a bus monitor that is capable of passively monitoring data telegrams on the fieldbus.

Operation

During operation, you can access up-to-date measured values and diagnostic information for the I/O modules via the adapter. For more information, refer to the software manual for the adapter used.

In addition, you can read off basic information about supply and communication from the LEDs on the I/O modules and adapters. For more information about the LEDs, refer to the data sheets for the I/O modules and adapters used.

Troubleshoot Your Module

This chapter describes troubleshooting for RS-485-based bus systems.

WARNING: Risk of explosion

When work is performed on the remote I/O unit in hazardous areas, there is a risk of explosion from spark formation.

Before starting any work on the remote I/O unit, familiarize yourself with the instruction manuals for the components and their relevant certificates.

Communication errors

Table 8 - Communication errors

Error	Remedy
Communication error on the fieldbus	• Check that the cables are connected. • Check that the transmitting and receiving lines are wired correctly and have not been swapped. • Check that the nodes are positioned in linear form and without branches. A star-shaped layout is not permitted. • Check that the terminator has been activated. The fieldbus must have exactly two terminators per segment, one at the beginning and one at the end. • In the configuration software, check that the selected address is the same as the remote FB I/O device address. • In the configuration software, check whether the master read cycle and the com unit watchdog are coordinated with one another.
Communication error on the service bus	• Check that the cables are connected. • Check that the nodes are positioned in linear form and without branches. A star-shaped layout is not permitted. • Check that the terminator has been activated. The service bus must have exactly two terminators per segment, one at the beginning and one at the end. • In the configuration software, check that the selected address is the same as the remote FB I/O device address. • Check that the correct interface is preset in the configuration software.
Communication error on the service bus after successfully establishing a connection	• Check that the service bus is galvanically isolated. • If you are using a laptop, operate the laptop using a battery. • Check the settings for the baud rate and transfer direction.
A new remote I/O unit will not work on a bus if other remote FB I/O devices are already operating on the bus	• Check that the terminators are still on the beginning and end of the bus after expansion.
The software cannot locate the adapter when establishing the connection	• Check that the adapter is plugged in correctly.
Communication to the extension backplane is not possible	• Check that the plug-in jumpers are set correctly. • Check that the base backplane and the extension backplane are wired correctly.
Bus-independent deactivation of the I/O modules is not possible	• Check that the plug-in jumpers are set correctly.
Multiple I/O modules fail simultaneously	• Check that the power supply is working properly. • Check that the base backplane and the extension backplane are wired correctly.

Table 9 - Redundancy faults

Error	Remedy
Continuous redundancy switchover	• Check that the correct type of redundancy is selected (media redundancy or application redundancy). • In the configuration software, check whether the master read cycle and the com unit watchdog are coordinated with one another. • Check whether the adapters are connected via the front sockets using com unit cordset LB9140A. • Check that the process control system is set to the correct type of redundancy.
No redundancy switchover when the adapter is removed	• Check that redundancy has been configured at the adapter. • Check whether the adapters are connected via the front sockets using adapter cordset LB9140A.
I/O modules are continuously changing the data	• Check whether one of the com units has not been configured for redundancy mode. If this is the case, both adapters actively try to access the I/O modules and interfere with one another.

Table 10 - Signal faults

Error	Remedy
Faulty signal	• Check whether the I/O module is in simulation mode or whether it is working with substitute values. • Check if there is a short circuit or lead breakage within the circuit. • Check that the field devices and sensors are working properly. • Check the communication path to the I/O module. • If necessary, replace the I/O module.
All signals for a unit are faulty	• Check that the power supply is working properly. • Check the bus connection. • Check the bus communication using a bus monitor.
The output module switches off	Communication with the adapter is interrupted. • Check that the I/O module is plugged into the backplane properly. • If necessary, switch off the status bits for analog outputs in the configuration • software.
Input module sporadically delivers no measured values	• Communication with the adapter is interrupted. Check that the I/O module is plugged into the backplane properly.
Measured values occasionally incorrect	• Check whether the measured value is being distorted by external influences. • Check that the shielding is intact.
I/O module reported to be faulty	• Check that the correct I/O module is plugged in. • Check that the green LED on the I/O module is lit and that the I/O module is correctly plugged in.

Technical Data

ATTENTION: Damage to equipment

Equipment can be damaged by voltages that are too high, for example, in temporary faulty operation.

Ensure that the supply voltage of the power supplies used in Zone 2 does not exceed 33.6V DC (24V x 1.4).

Power Supply

Rated voltage: 24V DC

Use a suitable power supply to implement another supply voltage of 24V DC. The maximum permitted supply voltage for an upstream power supply is 253V AC.

Power consumption:

- Max. 30 W for Zone 2 *(how bout for Zone 1?)* applications
- Max. 45 W for application in safe area

Mechanical Data

Weight:

- Backplane 1718-A20: Approx. xxxx g (xx.x oz)
- Backplane 1718-A10: Approx. xxxx g (xx.x oz)

Dimensions:

- Backplanes: See Design and Dimensions on page 20
- Single-width I/O modules: 16 x 100 x 103 mm (0.63 x 3.94 x 4.06 in.)
- Dual-width I/O modules: 32 x 100 x 103 mm (1.26 x 3.94 x 4.06 in.)
- Adapters and power supplies: 32 x 100 x 103 mm (1.26 x 3.94 x 4.06 in.)

Ambient Conditions

Ambient temperature:

- Power supplies, I/O modules with non-intrinsically safe circuits: -20...+60 °C (-4 ...+140 °F)
- Adapters, I/O modules with intrinsically safe circuits: -20...+60 °C (-4 ...+140 °F)

Storage temperature: -25...+85 °C (-13 °F ... +185 °F)

Relative humidity: 95% noncondensing

Designed for pollution degree 2

Damaging gas: Designed for operation in environmental conditions according to ISA-S71.04-1985, severity level G3

Additional HART Protocol Information

This appendix discusses these topics.

This appendix describes the HART protocol and provides references for additional information about the protocol. Consult the HART protocol specification and vendor-provided documentation for specifics on HART commands.

This appendix provides the following:

- HART protocol background information
- Common practice command sets
- Extended command sets
- References to additional information

HART Field Communication Protocol is widely accepted in the industry as the standard for digitally enhanced 4...20 mA communication with smart field instruments. The HART Protocol message structure, command set, and status are discussed in this appendix.

The HART command set is organized into these groups and provides read and write access to a wide array of information available in smart field instruments:

- Universal commands provide access to information that is useful in normal plant operation such as the instrument manufacturer, model, tag, serial number, descriptor, range limits, and process variables. All HART devices must implement universal commands.
- Common practice commands provide access to functions that can be carried out by many devices.
- Device specific commands provide access to functions that can be unique to a particular device.

Message Structure

Read this section for a description of transaction procedure, character coding, and message structure of the HART protocol. These correspond to layer 2 (data-link layer) of the OSI protocol reference model.

Master-slave Operation

HART is a master-slave protocol. This means that each message transaction is originated by the master; the slave (field) device replies when it receives a command message addressed to it. The reply from the slave device acknowledges that the command was received and can contain data requested by the master.

Multiple Master Operation

The HART protocol provides for two active masters in a system: one primary and one secondary. The two masters have different addresses. Each can positively identify replies to its own command messages. The 1719-IF4HB or 1719-CF4H module acts as primary master. A secondary master, such as a handheld configuration device, may also be connected.

Transaction Procedure

HART is a half-duplex protocol. After completion of each message, the FSK carrier signal must be switched off to let the other station transmit. The carrier control timing rules state that the carrier should be turned on not more than 5 bit times before the start of the message (that is, the preamble) and turned off not more than 5 bit times after the end of the last byte of the message (the checksum).

The master is responsible for controlling message transactions. If there is no reply to a command within the expected time, the master should retry the message. After a few retries, the master should abort the transaction, because presumably the slave device or the communication link has failed.

After each transaction is completed, the master should pause for a short time before sending another command, to provide an opportunity for the other master to break in if it wishes. This way, two masters (if they are present) take turns at communicating with the slave devices. Typical message lengths and delays allow two transactions per second.

Burst Mode

Burst mode is not supported by the 1719 HART analog modules.

Response Code and Field Device Status

Two bytes of status also called the response code and field device status are included in every reply message from a field or slave device. These two bytes convey communication errors, command response problems, and field device status. If an error is detected in the outgoing communication, the most significant bit (bit 7) of the first byte is set to 1 and the details of the error are reported in the rest of that byte. The second byte is then all zeros.

Communication errors are typically those that would be detected by a UART (parity overrun and framing errors). The field device also reports overflow of its receive buffer and any discrepancy between the message content and the checksum received.

In the Studio 5000 software application, if the leftmost bit of the ResponseCode is set, it displays a negative number. In this case, the ResponseCode represents a communication fault. Change the display format to hexadecimal to interpret communication status.

If the leftmost bit of the ResponseCode is 0 (value 0...127), then there was no communication error and the value is a ResponseCode from the HART field device. Response codes indicate if the device performed the command. 0 means no error. Other values are errors or warnings. To understand the ResponseCode, contact your HART field device manufacturer or the HART specification.

See Table 1 for descriptions of the response code and the field device status.

Table 1 - Response Codes and Field Device Status

Response Code		Description	
If Bit 7 is	**And Bits 6…0 are**		
1	16#40	Parity Error	Vertical parity error - The parity of one or more of the bytes received by the device was not odd
1	16#20	Overrun Error	Overrun error - At least one byte of data in the receive buffer of the UART was overwritten before it was read (for example, the slave did not process incoming byte fast enough)
1	16#10	Framing Error	Framing error - The Stop Bit of one or more bytes received by the device was not detected by the UART (for example, a mark or 1 was not detected when a Stop Bit should have occurred)
1	16#08	Checksum Error	Longitudinal parity error - The Longitudinal Parity calculated by the device did not match the Check Byte at the end of the message
1	16#04	(Reserved)	Reserved - Set to zero
1	16#02	RX Buffer Overflow	Buffer overflow - The message was too long for the receive buffer of the define
1	16#01	(undefined)	Reserved - Set to zero
0	0	No command specific error	
0	1	(undefined)	
0	3	Value too large	
0	4	Value too small	
0	5	Not enough bytes in command	
0	6	Transmitter-specific command error	
0	7	In Write-protect mode	
0	8	Update Failed - Update In Progress - Set to Nearest Possible Value	
0	9	Applied Process Too High - Lower Range Value Too High - Not In Fixed Current Mode	

Table 1 - Response Codes and Field Device Status (Continued)

Response Code		Description
If Bit 7 is	And Bits 6…0 are	
0	10	Applied Process Too Low - Lower Range Value Too Low - MultiDrop Not Supported
0	11	In MultiDrop Mode - Invalid Transmitter Variable Code - Upper Range Value Too High
0	12	Invalid Unit Code - Upper Range Value Too Low
0	13	Both Range Values Out of Limits
0	14	Pushed Upper Range Value Over Limit - Span Too Small
0	16	Access restricted
0	32	Device busy
0	64	Command not implemented

If no error was detected in the outgoing communication, the second byte contains status information pertaining to the operational state of the field or slave device.

Table 2 - Field Device Status Bit Mask Definitions

Bit	Bit Mask	Definition
7	16#80	Device malfunction - The device detected a serious error or failure that compromises device operation
6	16#40	Configuration changed - An operation was performed that changed the device's configuration
5	16#20	Cold start - A power failure or device reset occurred
4	16#10	More status available - More status information is available via command 48, Read Additional Status Information
3	16#08	Loop current fixed - The loop current is being held at a fixed value and is not responding to process variations
2	16#04	Loop current saturated - The loop current has reached its upper or lower endpoint limit and cannot increase or decrease any further
1	16#02	Non-primary variable out of limits - A device variable not mapped to the PV is beyond its operating limits
0	16#01	Primary variable out of limits - The PV is beyond its operating limit

IMPORTANT The 16# means this number is Hex display style.

Table 3 - HART Universal Commands

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
0	Read Unique Identified		None		0 1 2 3 4 5 6 7 8 9…11	254 (expansion) Manufacturer identification code Manufacturer device type code Number of preambles required Universal command revision Device-specific command revision Software revision Hardware revision Device function flags[2] Device ID number	 (H) (B)		x x x x x x x x x x
1	Read primary variable				0 1…4	PV units code Primary variable	 (F)	 x	x x
2	Read current and percent of range		None		0…3 4…7	Current (mA) Primary variable %	(F) (F)	x x	x x

Table 3 - HART Universal Commands

Command		Data in Command			Data in Reply			Contained in	
No.	**Function**	**Byte**	**Data**	**Type[1]**	**Byte**	**Data**	**Type[1]**	**Input Tag**	**CIP MSG**
3	Read current and four (predefined) dynamic variables		None		0…3 4 5…8 9 10…13 14 15…18 19 20…23	Current (mA) PV units code Primary variable SV units code Secondary variable TV units code Third variable FV units code Fourth variable[3]		 x x x x	x x x x x x x x x
6	Write polling address	0	Polling address			As in command			
11	Read unique identifier associated with tag	0…5	Tag	(A)	0…11				
12	Read message		None		0…23	Message (32 characters)	(A)		x
13	Read tag, descriptor, date				0…5 6…17 18…20	Tag (8 characters) Descriptor (16 characters) Date	(A) (A) (D)		x x x
14	Read PV sensor information				0…2 3 4…7 8…11 12…15	Sensor serial number Units code for sensor limits and min span Upper sensor limit Lower sensor limit Min span	(B) (F) (F) (F)		
15	Read output information				0 1 2 3…6 7…10 11…14 15 16	Alarm select code Transfer function code PV/range units code Upper range value Lower range value Damping value (seconds) Write-protect code Private-label distributor code	 (F) (F) (F)		 x x x x x x
16	Read final assembly number		None		0…2	Final assembly number	(B)		x
17	Write message	0…23	Message (32 characters)	(A)		As in command			
18	Write tag, descriptor, date	0…5 6…17 18…20	Tag (8 characters) Descriptor (16 characters) Date	(A) (A) (D)					
19	Write final assembly number	0…2	Final assembly number	(B)					
48	Read additional device status		Starting in HART version 7, the data in the command could be the same as in the reply.		0…5 6…7 8 9 10 11 12 13 14…24	Device-specific status Operational modes Standardized status 0 Standardized status 1 Analog channel saturated Standardized status 2 Standardized status 3 Analog channel fixed[4] Device-specific status	s[5]		x x x x x x x x x

(1) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag

(2) Bit 6 = multisensor device. Bit 1 = EEPROM control required. Bit 2 = protocol bridge device.

(3) Truncated after last supported variable.

(4) 24 bits each LSB…MSB refers to A0 #1…24.

(5) Sint []

Table 4 - Common Practice Commands

Command		Data in Command			Data in Reply			Contained in	
No.	**Function**	**Byte**	**Data**	**Type[6]**	**Byte**	**Data**	**Type[6]**	**Input Tag**	**CIP MSG**
33	Read transmitter variables		None		0 1 2…5 6 7 8…11 12 13 14…17 18 19 20…23	Transmitter variable code for slot 0 Units code for slot 0 Variable for slot 0 Transmitter variable code for slot 1 Units code for slot 1 Variable for slot 1 Transmitter variable code for slot 2 Units code for slot 2 Variable for slot 2 Transmitter variable code for slot 3 Units code for slot 3 Variable for slot 3[7]	 (F) (F) (F)		
34	Write damping value	0…3	Damping value (seconds)	(F)		As in command	(F)		
35	Write range values	0 1…4 5…8	Range units code Upper-range value Lower-range value	 (F) (F)			(F) (F)		
36	Set upper-range value (= push SPAN button)		None			None			
37	Set lower-range value (= push ZERO button)								
38	Reset 'configuration changed' flag								
39	EEPROM control	0	EEPROM control code[3]			As in command			
40	Enter/exit Fixed Current mode	0…3[1]	Current (mA)	(F)		As in command			
41	Perform device self-test		None			None			
42	Perform master reset								
43	Set (trim) PV zero								
44	Write PV units	0	PV units code			As in command			
45	Trim DAC zero	0…3	Measured current (mA)						
46	Trim DAC gain	0…3		(F)					
47	Write transfer function	0	Transfer function code						
48	Read additional device status		Moved to Universal Commands in HART version 7.			See 48 in Universal Commands			
49	Write PV sensor serial number	0…2	Sensor serial number			As in command			
50	Read dynamic variable assignments		None	0 1 2 3		PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			x x x x

Table 4 - Common Practice Commands

Command		Data in Command			Data in Reply			Contained in	
No.	**Function**	**Byte**	**Data**	**Type[6]**	**Byte**	**Data**	**Type[6]**	**Input Tag**	**CIP MSG**
51	Write dynamic variable assignments	0 1 2 3	PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			As in command			
52	Set transmitter variable zero	0	Transmitter variable code						
53	Write transmitter variable units		Transmitter variable code						
54	Read transmitter variable information		Transmitter variable code		0 1…3 4 5…8 9…12 13…16	Transmitter variable code Transmitter variable sensor serial Transmitter variable limits units code Transmitter variable upper limit Transmitter variable lower limit Transmitter variable damping value (seconds)	 (F) (F) (F)		
55	Write transmitter variable damping value	0 1…4	Transmitter variable code Transmitter variable damping value (seconds)			As in command			
56	Write transmitter variable sensor serial number	0 1…3	Transmitter variable code Transmitter variable sensor			As in command			
57	Read unit tag, description, date		None		0…5 6…17 18…20		(A) (A) (D)		x x x x
58	Write unit tag, descriptor, date	0…5 6…17 18…20	Unit tag (8 characters) Unit descriptor (16 characters) Unit date	(A) (A) (D)					
59	Write number of response preambles	0	Number of response preambles						
60	Read analog output and percent of range	0	Analog output number code		0 1 2…5 6…9	Analog output number code Analog output units code Analog output level Analog output percent of range			
61	Read dynamic variables and PV analog output		None		0 1…4 5 6…9 10 11…14 15 16…19 20 21…24	PV analog output units code PV analog output level PV units code Primary variable SV units code Secondary variable TV units Tertiary variable FV units code Fourth variable	 (F) (F) (F) (F) (F)	 x x x x	 x x x x x x x x x

Table 4 - Common Practice Commands

Command		Data in Command			Data in Reply			Contained in	
No.	**Function**	**Byte**	**Data**	**Type[6]**	**Byte**	**Data**	**Type[6]**	**Input Tag**	**CIP MSG**
62	Read analog outputs	 0 1 2 3[2]	 Analog output number; code for slot 0 Analog output number; code for slot 1 Analog output number; code for slot 2 Analog output number; code for slot 3[4]	0 1 2…5 6 7 8…11 12 13 14…17 18 19 20…23		Slot 0 analog output number code Slot 0 Slot 0 level Slot 1 Slot 1 Slot 1 level Slot 2 Slot 2 Slot 2 level Slot 3 Slot 3 Slot 3 level[8]	 (F) (F) (F) (F)		
63	Read analog output information	0	Analog output number code		0 1 2 3 4…7 8…11 12…15	Analog output number code Analog output alarm select code Analog output transfer function code Analog output range units code Analog output upper-range value Analog output lower-range value Analog output additional damping value (seconds)	 (F) (F) (F)		
64	Write analog output additional damping value	0 1…4	Analog output number code Analog output additional damping value (seconds)	 (F)		As in command			
65	Write analog output range value	0 1 2…5 6…9	Analog output number code Analog output range units code Analog output upper-range value Analog output lower-range value	 (F) (F)					
66	Enter/exit Fixed Analog Output mode	0 1 2…6	Analog output number code Analog output units code Analog output level[5]	 (F)					
67	Trim analog output zero	0 1 2…6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
68	Trim analog output gain	0 1 2…6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
69	Write analog output transfer function	0 1	Analog output number code Analog output transfer function code						
70	Read analog output endpoint values	0	Analog output number code		0 1 2…5 6…9	Analog output number code Analog output endpoint units code Analog output upper endpoint value Analog output lower endpoint value			

Table 4 - Common Practice Commands

Command		Data in Command			Data in Reply			Contained in	
No.	**Function**	**Byte**	**Data**	**Type(6)**	**Byte**	**Data**	**Type(6)**	**Input Tag**	**CIP MSG**
107	Write Burst mode transmitter variables (for command 33)	0 1 2 3	Transmitter variable code for slot 0 Transmitter variable code for slot 1 Transmitter variable code for slot 2 Transmitter variable code for slot 3			As in command			
108	Write Burst mode command number	0	Burst mode command number			As in command			
109	Burst mode control	0	Burst mode control code (0 = exit, 1 = enter)						
110	Read all dynamic variables		None		0 1…4 5 6…9 10 11…14 15 16…19	PV units code PV value SV units code SV value TV units code TV value FV units code FV value	 (F) (F) (F) (F)	 x x x x	x x x x x x x x

(1) 0 = exit Fixed Current mode.
(2) Truncated after last requested code.
(3) 0 = burn EEPROM, 1 = copy EEPROM to RAM.
(4) Truncated after last requested code.
(5) Not a number exits Fixed-output mode.
(6) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag
(7) Truncated after last requested code. Truncated after last requested variable.
(8) Truncated after last requested level.

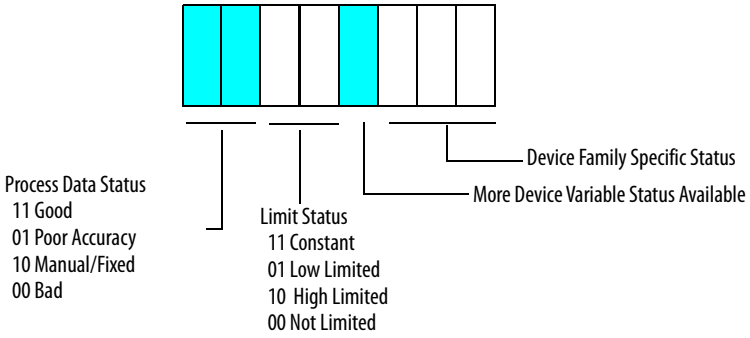
HART PV, SV, TV, and FV Status

HART PV, SV, TV, and FV are dynamic variables that contain the values of device variables, which are various direct or indirect process measurements performed by the HART field device.

Some devices let a set of their internal device variables be mapped to the PV, SV, TV, FV dynamic variables that are automatically collected in the 1719-IF4HB and 1719-CF4H Input Tag.

This mapping is part of the field device configuration, usually performed via a handheld configurator or asset management system, such as FactoryTalk AssetCentre or Endress+Hauser FieldCare system.

HART PVStatus, SVStatus, TVStatus, FVStatus are known as Device Variable Status values. These Status values are composed of groups of bits that indicate the quality of the associated device variable.



The Limit Status can be used to control windup in PID loops.

Table 5 - HART PV, SV, TV, and FV Status Values

HART PV, SV, TV FV Status Values			Quality		Limit		More Status Available?		Device Family Specific	
Decimal	Hex	Binary							Binary	Decimal
0	0	00000000	00	Bad	00	Not Limited	0	No	000	0
1	1	00000001	00	Bad	00	Not Limited	0	No	001	1
2	2	00000010	00	Bad	00	Not Limited	0	No	010	2
3	3	00000011	00	Bad	00	Not Limited	0	No	011	3
4	4	00000100	00	Bad	00	Not Limited	0	No	100	4
5	5	00000101	00	Bad	00	Not Limited	0	No	101	5
6	6	00000110	00	Bad	00	Not Limited	0	No	110	6
7	7	00000111	00	Bad	00	Not Limited	0	No	111	7
8	8	00001000	00	Bad	00	Not Limited	1	Yes	000	0
9	9	00001001	00	Bad	00	Not Limited	1	Yes	001	1
10	A	00001010	00	Bad	00	Not Limited	1	Yes	010	2
11	B	00001011	00	Bad	00	Not Limited	1	Yes	011	3
12	C	00001100	00	Bad	00	Not Limited	1	Yes	100	4
13	D	00001101	00	Bad	00	Not Limited	1	Yes	101	5
14	E	00001110	00	Bad	00	Not Limited	1	Yes	110	6
15	F	00001111	00	Bad	00	Not Limited	1	Yes	111	7
16	10	00010000	00	Bad	01	Low Limited	0	No	000	0
17	11	00010001	00	Bad	01	Low Limited	0	No	001	1
18	12	00010010	00	Bad	01	Low Limited	0	No	010	2
19	13	00010011	00	Bad	01	Low Limited	0	No	011	3
20	14	00010100	00	Bad	01	Low Limited	0	No	100	4
21	15	00010101	00	Bad	01	Low Limited	0	No	101	5
22	16	00010110	00	Bad	01	Low Limited	0	No	110	6
23	17	00010111	00	Bad	01	Low Limited	0	No	111	7

Table 5 - HART PV, SV, TV, and FV Status Values

24	18	00011000	00	Bad	01	Low Limited	1	Yes	000	0
25	19	00011001	00	Bad	01	Low Limited	1	Yes	001	1
26	1A	00011010	00	Bad	01	Low Limited	1	Yes	010	2
27	1B	00011011	00	Bad	01	Low Limited	1	Yes	011	3
28	1C	00011100	00	Bad	01	Low Limited	1	Yes	100	4
29	1D	00011101	00	Bad	01	Low Limited	1	Yes	101	5
30	1E	00011110	00	Bad	01	Low Limited	1	Yes	110	6
31	1F	00011111	00	Bad	01	Low Limited	1	Yes	111	7
32	20	00100000	00	Bad	10	High Limited	0	No	000	0
33	21	00100001	00	Bad	10	High Limited	0	No	001	1
34	22	00100010	00	Bad	10	High Limited	0	No	010	2
35	23	00100011	00	Bad	10	High Limited	0	No	011	3
36	24	00100100	00	Bad	10	High Limited	0	No	100	4
37	25	00100101	00	Bad	10	High Limited	0	No	101	5
38	26	00100110	00	Bad	10	High Limited	0	No	110	6
39	27	00100111	00	Bad	10	High Limited	0	No	111	7
40	28	00101000	00	Bad	10	High Limited	1	Yes	000	0
41	29	00101001	00	Bad	10	High Limited	1	Yes	001	1
42	2A	00101010	00	Bad	10	High Limited	1	Yes	010	2
43	2B	00101011	00	Bad	10	High Limited	1	Yes	011	3
44	2C	00101100	00	Bad	10	High Limited	1	Yes	100	4
45	2D	00101101	00	Bad	10	High Limited	1	Yes	101	5

Note that this Device Variable Status byte is a new HART feature in HART protocol revision 6 and many HART devices do not yet support it. For those devices, the module creates a status value based on the communication status of the device.

If the PV, SV, TV, FV are being collected without communication errors, the value is set to 16#C0, indicating Good, Not Limited. Otherwise, the value is set to 0, indicating Bad, Not Limited, no specific information available.

Notes:

Engineering Unit Code Numbers

Code Number Details

This table maps engineering unit code numbers to their meaning and abbreviations. These codes are used in the process variable range display.

Unit Codes	Description from HART Specification	Abbreviated Units
1	inches of water at 20 °C (68 °F)	inH2O (20 °C or 68 °F)
2	inches of mercury at 0 °C (32 °F)	inHg (0 °C or 32 °F)
3	feet of water at 20 °C (68 °F)	ftH2O (20 °C or 68 °F)
4	millimeters of water at 20 °C (68 °F)	mmH2O (20 °C or 68 °F)
5	millimeters of mercury at 0 °C (32 °FC	mmHg (0 °C or 32 °F)
6	pounds per square inch	psi
7	bars	bar
8	millibars	mbar
9	grams per square centimeter	g/square cm
10	kilograms per square centimeter	kg/square cm
11	pascals	Pa
12	kilopascals	kPa
13	torr	torr
14	atmospheres	atm
15	cubic feet per minute	cubic ft/min
16	gallons per minute	usg/min
17	liters per minute	L/min
18	imperial gallons per minute	impgal/min
19	cubic meter per hour	cubic m/h
20	feet per second	ft/s
21	meters per second	m/s
22	gallons per second	usg/s
23	million gallons per day	million usg/d
24	liters per second	L/s
25	million liters per day	ML/day
26	cubic feet per second	cubic ft/s
27	cubic feet per day	cubic ft/d
28	cubic meters per second	cubic m/s
29	cubic meters per day	cubic m/d
30	imperial gallons per hour	impgal/h
31	imperial gallons per day	impgal/d

Unit Codes	Description from HART Specification	Abbreviated Units
32	Degrees Celsius	°C
33	Degrees Fahrenheit	°F
34	Degrees Rankine	°R
35	Kelvin	°K
36	millivolts	mV
37	ohms	ohm
38	hertz	hz
39	milliamperes	mA
40	gallons	usg
41	liters	L
42	imperial gallons	impgal
43	cubic meters	cubic m
44	feet	ft
45	meters	m
46	barrels	bbl
47	inches	in
48	centimeters	cm
49	millimeters	mm
50	minutes	min
51	seconds	s
52	hours	h
53	days	d
54	centistokes	centistokes
55	centipoise	cP
56	microsiemens	microsiemens
57	percent	%
58	volts	V
59	pH	pH
60	grams	g
61	kilograms	kg
62	metric tons	t
63	pounds	lb
64	short tons	short ton
65	long tons	long ton
66	milli siemens per centimeter	millisiemens/cm
67	micro siemens per centimeter	microsiemens/cm
68	newton	N
69	newton meter	N m
70	grams per second	g/s
71	grams per minute	g/min

Unit Codes	Description from HART Specification	Abbreviated Units
72	grams per hour	g/h
73	kilograms per second	kg/s
74	kilograms per minute	kg/min
75	kilograms per hour	kg/h
76	kilograms per day	kg/d
77	metric tons per minute	t/min
78	metric tons per hour	t/h
79	metric tons per day	t/d
80	pounds per second	lb/s
81	pounds per minute	lb/min
82	pounds per hour	lb/h
83	pounds per day	lb/d
84	short tons per minute	short ton/min
85	short tons per hour	short ton/h
86	short tons per day	short ton/d
87	long tons per hour	long ton/h
88	long tons per day	long ton/d
89	deka therm	Dth
90	specific gravity units	specific gravity units
91	grams per cubic centimeter	g/cubic cm
92	kilograms per cubic meter	kg/cubic m
93	pounds per gallon	lb/usg
94	pounds per cubic feet	lb/cubic ft
95	grams per milliliter	g/mL
96	kilograms per liter	kg/L
97	grams per liter	g/L
98	pounds per cubic inch	lb/cubic in
99	short tons per cubic yard	short ton/cubic yd
100	degrees twaddell	°Tw
101	degrees brix	°Bx
102	degrees baume heavy	BH
103	degrees baume light	BL
104	degrees API	°API
105	percent solids per weight	% solid/weight
106	percent solids per volume	% solid/volume
107	degrees balling	degrees balling
108	proof per volume	proof/volume
109	proof per mass	proof/mass
110	bushels	bushel
111	cubic yards	cubic yd

Unit Codes	Description from HART Specification	Abbreviated Units
112	cubic feet	cubic ft
113	cubic inches	cubic in
114	inches per second	in/s
115	inches per minute	in/min
116	feet per minute	ft/min
117	degrees per second	°/s
118	revolutions per second	rev/s
119	revolutions per minute	rpm
120	meters per hour	m/hr
121	normal cubic meter per hour	normal cubic m/h
122	normal liter per hour	normal L/h
123	standard cubic feet per minute	standard cubic ft/min
124	bbl liq	bbl liq
125	ounce	oz
126	foot pound force	ft lb force
127	kilo watt	kW
128	kilo watt hour	kW h
129	horsepower	hp
130	cubic feet per hour	cubic ft/h
131	cubic meters per minute	cubic m/min
132	barrels per second	bbl/s
133	barrels per minute	bbl/min
134	barrels per hour	bbl/h
135	barrels per day	bbl/d
136	gallons per hour	usg/h
137	imperial gallons per second	impgal/s
138	liters per hour	L/h
139	parts per million	ppm
140	mega calorie per hour	Mcal/h
141	mega joule per hour	MJ/h
142	british thermal unit per hour	BTU/h
143	degrees	degrees
144	radian	rad
145	inches of water at 15.6 °C (60 °F)	inH2O (15.6 °C or 60 °F)
146	micrograms per liter	micrograms/L
147	micrograms per cubic meter	micrograms/cubic m
148	percent consistency	% consistency
149	volume percent	volume %
150	percent steam quality	% steam quality
151	feet in sixteenths	ft in sixteenths

Unit Codes	Description from HART Specification	Abbreviated Units
152	cubic feet per pound	cubic ft/lb
153	picofarads	pF
154	mililiters per liter	mL/L
155	microliters per liter	microliters/L
156	percent plato	% plato
157	percent lower explosion level	% lower explosion level
158	mega calorie	Mcal
159	Kilo-ohms	kohm
160	mega joule	MJ
161	british thermal unit	BTU
162	normal cubic meter	normal cubic m
163	normal liter	normal L
164	standard cubic feet	normal cubic ft
165	parts per billion	parts/billion
235	gallons per day	usg/d
236	hectoliters	hL
237	megapascals	MPa
238	inches of water at 4 °C (39.2 °F)	inH2O (4 °C or 39.2 °F)
239	millimeters of water at 4 °C (39.2 °F)	mmH2O (4 °C or 39.2 °F)

Notes:

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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