



**Product Installation Manual**

For

HPTB/32/TR-AI-03



MODEL LISTING		
<u>Model</u>	<u>Part Number</u>	<u>Channels / Function</u>
HPTB/32/TR-AI-03	907912	32-AI

*To avoid damage, failure, or improper operation, read this manual carefully before installing and operating the equipment*

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## 1. GENERAL INFORMATION

### 1.1. INTRODUCTION

This manual provides guidance for the installation, operation, and maintenance of your P+F Multiplexer 2700 and termination board. The solution herein is specifically designed for easy Multiplexer integration with the Triconex TRICON system. Below is a list of termination boards and the Triconex I/O modules with which they were designed to interface.

HPTB/32/TR-AI-03

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The P+F Multiplexer 2700 will be referred to in this manual as the MUX 2700. All further general references to the listed termination boards will be simply HPTB. When referring to the combination of a MUX 2700 and an HPTB, they will be called the HART Interface Solution, or simply HIS.

#### 1.1.1. SYSTEM OVERVIEW

Your HART Interface Solution interfaces up to 32 field located HART devices. The MUX 2700 is a HART signal multiplexer unit which allows access to HART communications on existing 4-20mA wiring. It acts as a gateway device routing communications between the maintenance workstation PC and the HART devices. The MUX 2700 uses Manchester encoding of the HART protocol for the RS-485 link to the maintenance workstation PC. To link to each of the HART devices the MUX 2700 communicates using Bell 202 Frequency Shift Keying (FSK). It interrogates each HART device, retrieves device information, and stores it in an internal database. This information is available to the maintenance workstation software. In this way, the MUX 2700 gives the user access to each HART device as if connected directly at the device itself. A maintenance workstation PC can use this information for configuration, maintenance, calibration, diagnostics, and data access.

The termination board design allows the DCS and field device wiring to be brought together with the MUX to complete the system. Various HPTB board designs allow interface with different I/O cards and may include configurable options including fused / filtered signal lines, loop or device powered instrument lines and 4-20mA or 1-5 VDC signals. HART Interface Solutions are supplied by P+F in several models in order to allow simple and reliable connection between SMART devices and various DCS systems.

#### 1.1.2. HART OVERVIEW

HART is an acronym for "Highway Addressable Remote Transducer". The HART protocol makes use of the Bell 202 FSK standard to superimpose digital signals at a low level on top of the 4-20mA signal. This enables two-way communication and makes it possible for additional information beyond just the normal process variable to be communicated to/from a SMART field instrument. The HART protocol allows a host application (master) to get two or more digital updates per second from a field device. As the digital FSK signal is phase continuous, there is no interference with the 4-20mA signal.

#### 1.1.3. ASSET MANAGEMENT SOLUTIONS (AMS) SOFTWARE OVERVIEW

AMS software provides an easy-to-use means for integrating various device management software packages into a unified system. AMS operates under the Microsoft® Windows® format. It combines the various device (or asset) management tasks into an application with a common look-and-feel and centralized data storage.

AMS provides access to functionality available via the HART communications protocol for any HART device whose Device Description (DD) is registered with the HART Communication Foundation.

For more information on installation of AMS software, consult the AMS Installation Guide.



**1.2. TECHNICAL SPECIFICATIONS**

**1.2.1. MUX 2700 SPECIFICATIONS**

Power Supply	24 VDC nominal [-15%, +25%]
Fuse	Internal (not user serviceable)
Connector Style	2 half pitch 1.27mm 40 pin connectors
Environmental Conditions	
Operating Temperature Range	0 to 55°C (32 to 131°F)
Storage Temperature Range	-20 to 70°C (-4 to 158°F)
Relative Humidity	5 to 90% non-condensing
Signal Channels	Up to 32 unbalanced signal loops
Input Impedance	>5000 Ω
Communication Port	RS-485, differential pair plus GND
Communication Speed	9600 or 19200 baud

**1.2.2. HPTB TERMINATION BOARD SPECIFICATIONS**

Mounting	T type (EN50022, DIN46277-3) or G type (EN50035, DIN 46277-1) DIN rail
Connections	
Power	Combicon style 5.08mm removable screw terminals
Field Wiring	5.08mm screw terminals
Control Wiring	56 pin ELCO style connector
RS-485	Combicon style 5.08mm removable screw terminals
Power Fuse	3.15 A 5x20
Dimensions	
Length	254 mm (10.0")
Width	107 mm (4.2")
Height	79 mm (3.1") without MUX, 208 mm (8.2") with MUX



**1.2.3. RS-485 LINE SPECIFICATIONS**

Communication Port	RS-485, differential pair (isolated)
Communication Speed	9600 or 19200 baud
Multi-Drop Addressing	Up to 31 MUX 2700 modules with 32 channels each
Multi-Network Operation	Software selectable Up to 4 serial lines
Network Addressing	Up to 31 MUX 2700 modules
Network Capacity	Up to 992 loops
SMART Protocol Supported	HART
Total Number of Bits	11
Number of Data Bits	8
Parity	Odd
Number of Stop Bits	1
Transmission Type	2 wire

**1.3. QUALITY ASSURANCE**

Pepperl+Fuchs is an ISO9000 certified company and as such all production is performed under a Quality Assurance program following written procedures which are specific for each product family. During the manufacturing, intermediate testing and inspection, and final inspection phases all products are built according to controlled documentation.

Each MUX 2700 unit undergoes accelerated thermic aging (burn-in) for a minimum 200 hours at 50°C (122°F) with at least 1 cooling thermic cycle at 0°C (32°F) and back to 50°C (122°F). The purpose is to identify weak components that may develop initial fault mechanisms due to "Infant Mortality". Only after a positive burn-in test does the MUX 2700 undergo a complete final inspection which is performed with computerized testing equipment specifically developed by P+F for this purpose.

**1.4. SAFETY INTEGRITY LEVEL (SIL)**

The following is assumed for SIL installations:

- 1.) Both 24V\_A and 24V\_B must be supplied from separate sources.
- 2.) Transmitter must be able to output an overscale current upto 22mA with 12V at its terminals.
- 3.) Supply voltage to this motherboard must be at least 26Vdc, with a minimum current output of 0.75A
- 4.) DCS system has a 99% diagnostics coverage to go to safe state if input is 0V.
- 5.) DCS system is not affected by presence of HART signal.
- 6.) DCS system is expecting a 1V to 5V input from mother board.

See FMEDA report for complete SIL information

**WARNING!**

*The boards may have deviations in the converted signal values by too high potential difference between the negative supply terminal for powering the electronics and earth ground, or by ground loops present in the installation. (See section 2.7.1 and 2.7.2 below for further details.)*

*Ensure that the grounding of the installation is appropriate for industrial applications. Follow the rules for grounding as applicable in the place of installation.*





## 2. INSTALLATION

### 2.1. STORAGE

In case of storage of instruments and accessories, proper care should be taken to protect them from any possible damage. Always store instruments in their sealed original packaging until they are installed.

Provide adequate protection to prevent damages that may be caused by exposure to:

- Rain, excessive humidity and/or temperature excursions (inadequate sheltering).
- Dust (build-up of a corrosive patina that may cause oxidations and reduce isolation).
- Aggressive and polluting atmospheres with consequent corrosion.
- Access by insects/rodents (damage of packing or content).
- Mechanical shocks or unauthorized packing opening.
- Intense vibrations (loosening of fastened parts, fatigue failures, etc.).
- Any other possible risk.

Make sure the storage temperature does not exceed the limits of  $-20$  to  $+70^{\circ}\text{C}$  ( $-4$  to  $158^{\circ}\text{F}$ ) for medium/long term storage (days/months) and  $-25$  to  $+75^{\circ}\text{C}$  ( $-13$  to  $167^{\circ}\text{F}$ ) for short term storage (a few hours) during transportation or shipment.

### 2.2. UNPACKING AND INSPECTION

Upon receipt of the materials, you should check the integrity of the packing and the contents. In case of damage due to shipping, you should promptly and properly report to the shipper, supplying all necessary information.

If the instruments are not for immediate use, we recommend that you check that all characteristics shown on the instrument's label meet order specifications (model, supply voltage and frequency, input/output range, certification, tag etc.) as well as the actual application requirements.

If not installed, equipment should be stored following the recommendations of the previous section.

### 2.3. ENVIRONMENTAL CONDITIONS

HIS products, like most modern electronic equipment, can operate in wide temperature and humidity ranges. However, practical consideration suggests a guideline on operating environment for best results.

- Keep operating temperature below  $35^{\circ}\text{C}$  ( $95^{\circ}\text{F}$ ), ideally between  $20^{\circ}\text{C}$  and  $25^{\circ}\text{C}$  ( $68$  and  $77^{\circ}\text{F}$ ), avoiding wide and rapid temperature excursions.
- Control relative humidity within 40 to 60% to avoid risks of static charges or condensation.
- Limit the presence of corrosive atmosphere, fumes and dust, sealing and purifying the control room area and using air filters in the cabinet air intakes (clean cable entry path), if necessary.
- Reduce vibrations (if any) to safe levels.





**2.4. INTRINSIC SAFETY**

The HIS system can interface HART devices located in Hazardous areas by interposition of suitable galvanically isolated Intrinsically Safe Barriers. The barriers must allow bi-directional HART signal communication in addition to the normal 4-20mA loop current processing.

**2.5. MOUNTING**

The MUX 2700 is a plug-in unit that must be inserted in the appropriate termination board position. Exercise care in the insertion to mate the connector's pins, then firmly press the module to engage the connector. Finally, engage the quick lock tabs on either side to secure the module to the termination board.

The HPTB is designed to be mounted on a T-type or G-type DIN rail.

**2.6. CABLES**

HART signals are brought to the MUX 2700 from the field via 5.08mm 3-tier screw terminal blocks designated TB1. The MUX 2700 communicates to the DCS via the ELCO style connectors designated J1-J2. See **Table 1** below for channel information.

Table 1 – Connector Function

Field Connector Designation	HPTB/32/TR-AI-03 Analog Input
TB1	Channels 1-32
Control Connector Designation	
J1	Channels 1-32

# PEPPERL+FUCHS

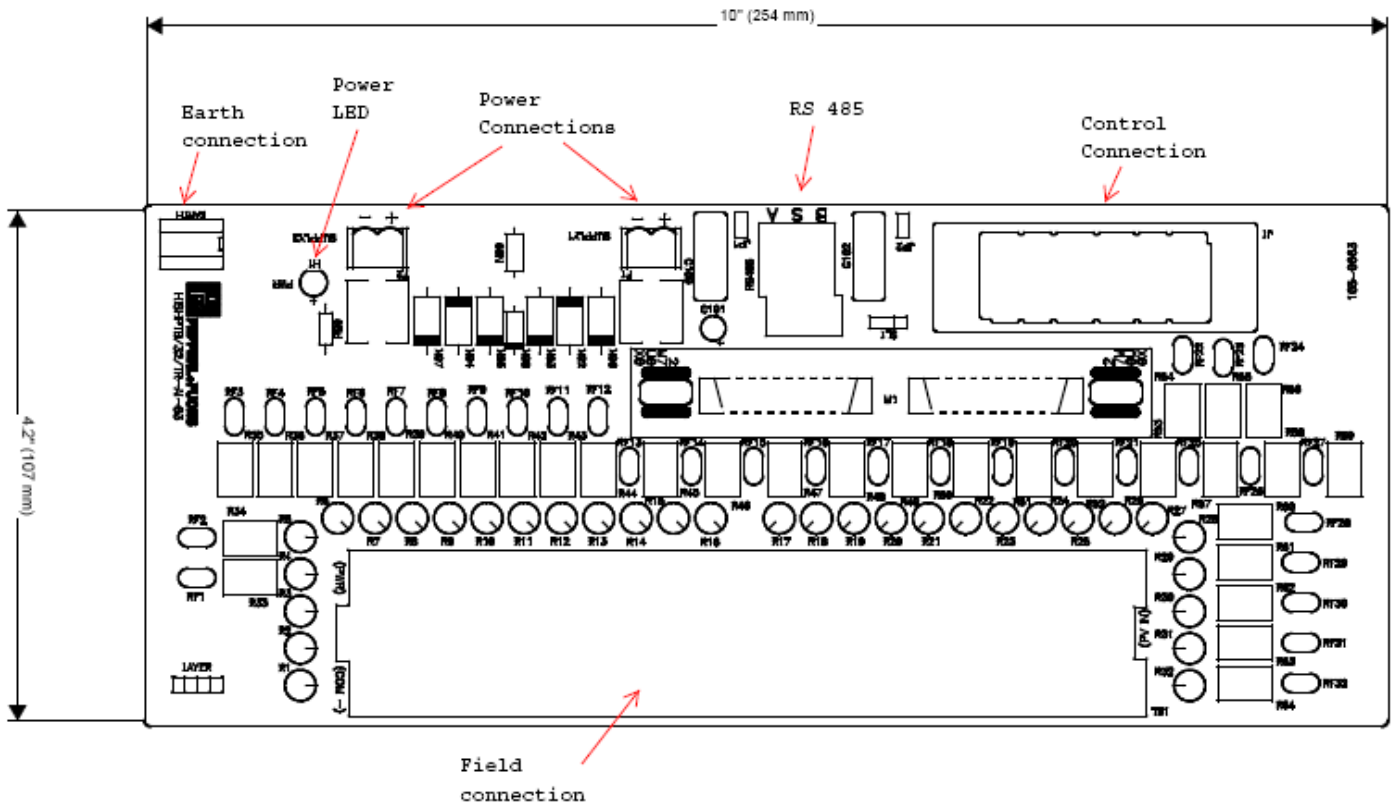
## 2.7. WIRING

The MUX 2700 is a plug-in unit and is connected to the HPTB by two 40 pin connectors. Therefore, all electrical connections (supply, field connections, serial lines, etc.) are made at the termination board unit.

Refer to **Figure 1** for a simplified representation of the termination board configuration and the overall outside dimension of the product in inches.

Figure 1 –HPTB Configuration

**HPTB/32/TR-AI-03**





**2.7.1. POWER**

Connect 24 VDC to the 2-pin removable terminal at the end of the HPTB. The connector is polarized, so you cannot insert it incorrectly. The polarity is marked on the terminals. A reverse polarity shunt diode and series fuse protection are provided to avoid damaging the module in case of accidentally reversing the polarity connection. In this case, the reverse voltage is clamped at -1.2 V and the fuse blows. Restore correct supply polarity and replace the blown fuse. Be certain to reinstall a good, properly sized, new fuse.

**WARNING!**

*Improper supply connections can seriously damage the instrument and result in risk of fire or explosion in hazardous locations!*

DC SUPPLY REQUIREMENTS: The MUX is nominally rated for 24 VDC but will function from approximately 20-30 VDC. The MUX draws a maximum of 30mA from the supply. If the power LEDs fail to light check that the polarity of the supply line is correct.

**WARNING!**

*Note that a crude, poorly filtered or unregulated supply can produce destructive (hundreds of volts) voltage spikes during supply transformer switch-off transient. This could cause minor problems to electro-mechanical components like relays or solenoids but will surely degrade or destroy electronic equipment.*

SUPPLY CONDUCTORS SIZING: Since these HIS boards supply power for the AI channels, a single unit can normally require up to 2.56A and its conductors should be sized accordingly. Pepperl+Fuchs recommends 14 AWG or larger wire be used to power this product.

**2.7.2. GROUNDING**

The HPTB provides an earth terminal lug for connecting the various shield wires to earth. Also included with the HPTB is a DIN rail mountable terminal block. Use of the terminal lug and terminal block for earth grounding will provide the shortest path and best practice for grounding of the HPTB. A 10-14 AWG cable should be secured between the terminal lug and DIN rail block which provides a single point to properly ground field wiring cable shields. This terminal may not be necessary to use if best practice grounding techniques are employed.

The HPTB board provides connections of the shield pins T, H, w, and FF for J1 though a customer selectable jumper to provide direct connection to the earth terminal lug, or to provide this connection through capacitive coupling. Refer to **Table 2**.

The HPTB also provides customer selectable capacitive coupling for the shielding. Setting the shield to be direct coupled or capacitively coupled is accomplished through jumper shunts. Placing the jumper shunt across the pins will bypass the capacitor and direct couple the corresponding shield to earth. Refer to **Table 2** for a complete list of the shunts and the associated shield. For best practice any shield should be direct coupled at one end of the circuit.

Table 2 – Shield Configuration

Jumper Shunt #	HPTB/32/TR-AI-03 Analog Input
JP1	RS-485 earth connection
JP2	J1 earth connections



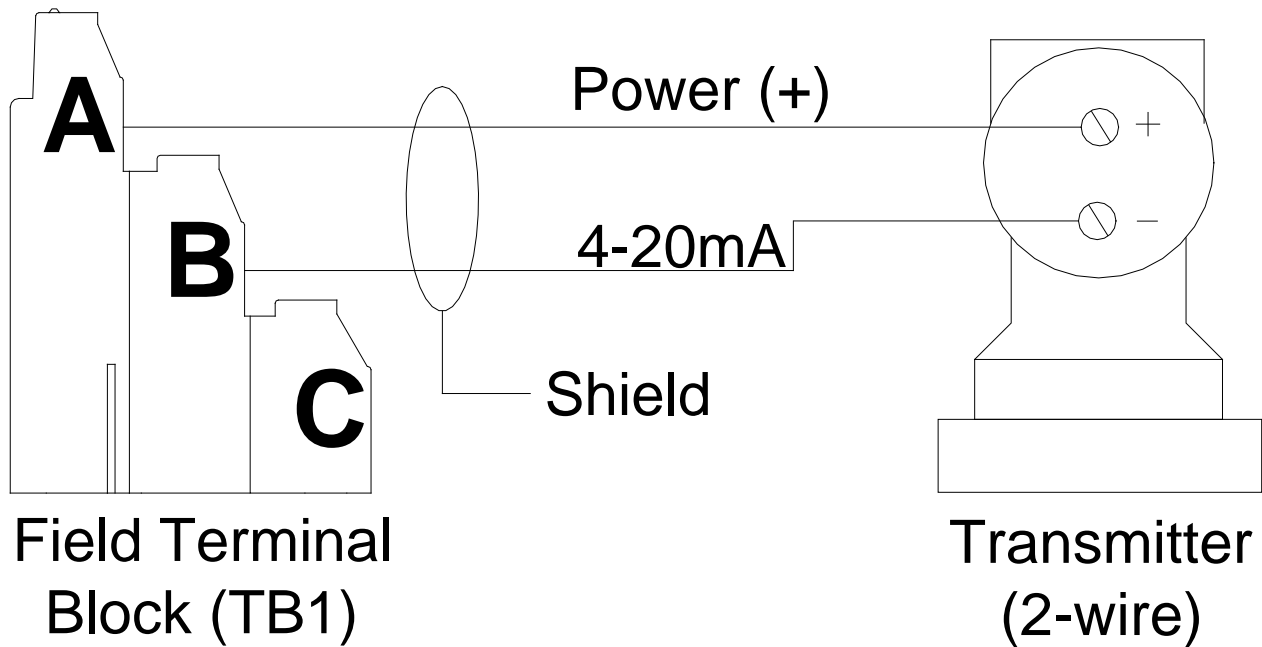


**2.7.4. FIELD CONNECTIONS**

All field wiring is connected via the 3-tier screw terminal block (TB1). To obtain best results from this device the use of shielded cables is strongly recommended and in the case of cable lengths greater than 30m shielded cables are required to ensure proper function of the HPTB. See **Figures 3-5** below for specific device connections.

Figure 3 – Loop Powered Transmitters (2-wire)

**HPTB/32/TR-AI-03**

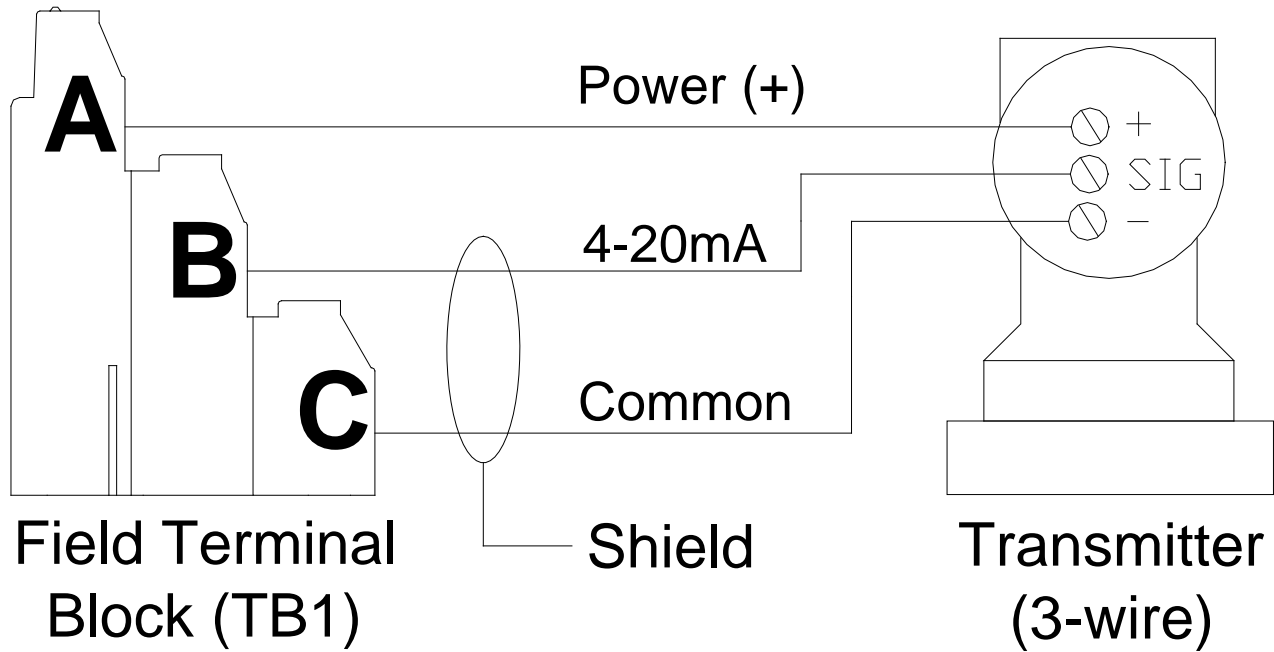


Pepperl+Fuchs recommends that all shield drain wires be connected from as close to TB1 as possible to the nearest grounding point and this point be linked to earth by as short a route as possible.



Figure 4 – HPTB Powered Transmitters (3-wire)

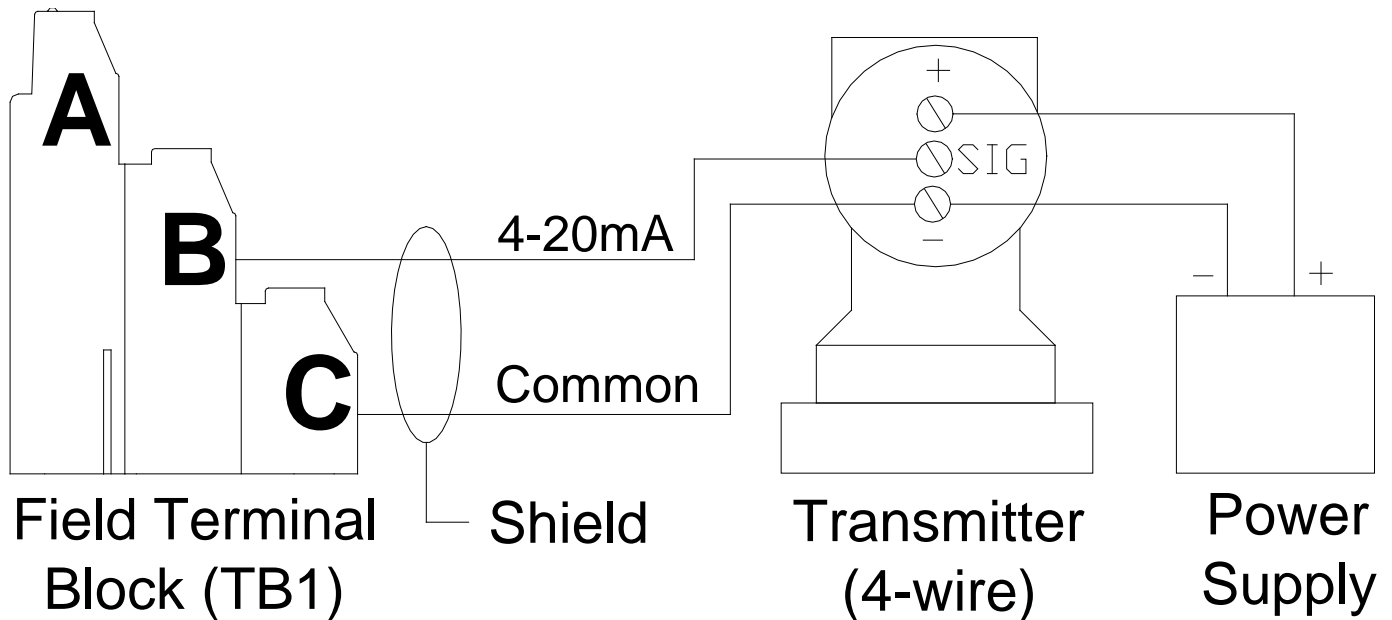
HPTB/32/TR-AI-03



Pepperl+Fuchs recommends that all shield drain wires be connected from as close to TB1 as possible to the nearest grounding point and this point be linked to earth by as short a route as possible.

Figure 5 – Self-Powered Transmitters (4-wire)

HPTB/32/TR-AI-03



The HPTB has one common plane for Channels 1-16 and a second for Channels 17-32. Unless the transmitter has galvanic isolation between its output and power supply the analog loop from the transmitter will link the HPTB common to the transmitter power supply common.

Pepperl+Fuchs recommends that all shield drain wires be connected from as close to TB1 as possible to the nearest grounding point and this point be linked to earth by as short a route as possible.



### 2.7.5. CONTROL CONNECTIONS

The HPTB provides ELCO style connectors (J1-J2) for connection directly to Triconex I/O modules. No adapter or accessory hardware is required. As with field connections it is strongly recommended to use shielded cables should the line length be greater than 30m.

### 2.7.6. HART COMMUNICATOR

In HART communications, there is one slave (field device) and up to two masters (e.g. Multiplexer, HART Communicator, I/O module). The HART Communicator can be connected to the field side terminals as a secondary master. In the software settings, the MUX 2700 must be the primary master in order to use the HART Communicator.

There cannot be more than two masters. If three or more masters are connected, a primary/ secondary conflict will occur and communications will cease with all devices on that loop. When the MUX 2700 is used with a HART compatible I/O system, the MUX 2700 must be configured as the secondary master. Otherwise, configure the MUX 2700 as the primary master. The HHT is a secondary master by default, and can be connected to the loop when no other device on that loop is configured as a secondary master.

#### WARNING!

*Do not connect the HART Communicator to any Intrinsically Safe field wiring unless the communicator is approved as Intrinsically Safe and is suitable for the actual classification of the specific hazardous location. Also consider the HART Communicator safety parameters and equivalent capacitance and inductance before concluding that you can safely connect it to the I. S. side of the circuit □*

## 3. OPERATION

### 3.1. INITIAL SETUP

The default settings for each MUX 2700 are as follows:

Address = 1

Baud Rate = 9600

#### 3.1.1. 2700 SETTINGS

The User Switches buffer has eight inputs from a low profile DIP switch reachable through the front label.

The functions of the switches are as follows:

- Switch 7 (T) Reserved for TEST purposes
- Switch 6 (R1) BAUD RATE 1
- Switch 5 (R0) BAUD RATE 0
- Switch 4 (B4) ADDRESS 4
- Switch 3 (B3) ADDRESS 3
- Switch 2 (B2) ADDRESS 2
- Switch 1 (B1) ADDRESS 1
- Switch 0 (B0) ADDRESS 0

Further information is given on the front and side labels. In particular, the side label gives the correct setting of every DIP switch combination.





### 3.1.2. MUX ADDRESSING

The address of the MUX 2700 is determined by the DIP switches as noted above. Each MUX on the same RS-485 network must have a different address, but they do not have to be sequential and do not necessarily need to start at address 1. Possible addresses are 1-31. Address 0 is invalid and cannot be used. Note that network properties of the software setup refers to “multi-dropping.” This refers to multiple MUX 2700s on the same network, not multiple devices on the same I/O loop (also referred to as “multi-dropping”). Multi-dropping should be enabled in the network setup.

### 3.1.3. BAUD RATE

The baud rate of the MUX 2700 must match the baud rate of the PC Com-Port and the RS-232/RS-485 converter. All three units must have the same baud rate to function properly. The baud rate can be either 9600 or 19200 and is selected as shown on the label located on the side of the MUX unit.

### 3.1.4. RS-232/RS-485 CONVERTER

An RS-232 to RS-485 converter must be placed between the HIS and the computer’s RS-232 port. P+F recommends the Keithley M2000 converter for non-CE applications. Any standard converter is acceptable, but other models have not been tested by P+F. Alternate brands are available with CE certification.

If only one RS-232 to RS-485 converter is used in setting up the system, then the RS-485 network must be less than 1200 meters (4000 feet). If the network surpasses 1200 meters, an RS-485 repeater must be used. The Keithley M2000 can function as a repeater instead of a converter. The repeater amplifies and retransmits the original RS-485 signal enabling transmission over longer distances.

## 3.2. START-UP SEQUENCE

The proper start-up sequence for the HIS system is as follows:

1. Make all field and control connections to the termination board.
2. Connect RS-485 communications and adjust network settings as appropriate.
3. Plug the MUX 2700 into the termination board.
4. Apply 24VDC to HIS board or power up field devices.
5. After the MUX start-up sequence is complete then initiate AMS.

## 3.3. CONFIGURATION

Each channel of the HIS board can accommodate a SMART device. For details on device wiring please refer to **Section 2.7.4**. For information on setting the shield jumpers refer to **Section 2.7.2**. No other configuration is required on the HPTB.

## 3.4. MUX INDICATORS

Three LEDs on the top of the MUX 2700 indicate status. Normal operation is as follows :

- PWR ON – After power is applied the green LED will flash for a period of 15 seconds and then glow solid. The 2700A MUX power LED will not flash. Power is applied to the MUX automatically when it is plugged into the socket on the termination board.
- FAULT – This red LED should not be lit during normal operation.
- HART TX – This yellow LED shows communication with field devices.



**3.5. MODES OF OPERATION**

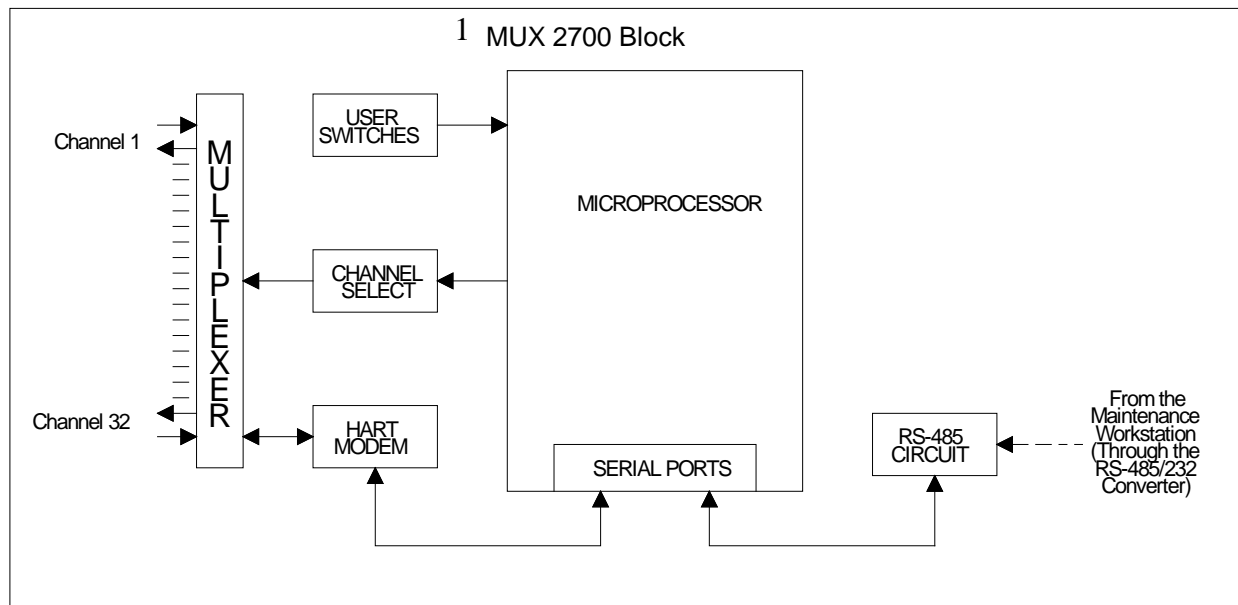
SCAN MODE - This command sent to the MUX 2700 from the software will instruct the MUX to periodically scan each device automatically. Normally the MUX 2700 will only communicate with a device when instructed by the software.

BURST MODE – This command instructs the field device to automatically send information without being commanded to do so. This mode breaks from the normal master-slave relationship inherent in HART communication, but the MUX 2700 will support it when burst mode is selected in the software.

**3.6. SYSTEM OPERATION**

Referring to **Figure 6**, the heart of the MUX 2700 is the microprocessor. One serial port together with the HART modem generates the physical layer of the HART protocol, while the channel select circuit together with the channel multiplexer links one specific channel (device) at a time. An RS-485 circuit completes the link between the maintenance workstation PC and the field devices. The switch selectable circuit provides information required by the MUX 2700 for initialization and configuration; specifically, the baud rate for communications to the maintenance workstation PC and the MUX 2700 address.

Figure 6 – MUX Operation





## 4. TROUBLESHOOTING

### 4.1. GENERAL

Due to the modular nature of the HIS system, a communication failure may occur anywhere in the data transfer link from the software to the field device. In order to identify where the loss of communication has occurred, it is important to understand which components are working correctly. Often, some simple checks will save hours of troubleshooting. Some of the most common mistakes are: improper wiring connections, baud rate mismatches, improper network settings, and improper addressing of the MUX 2700.

### 4.2. MUX 2700

The LEDs on the front of the MUX 2700 provide a convenient indication to the user that the MUX 2700 is operational. After the MUX 2700 self-test, the <Pwr On> light should be on, the <Fault> light should be off and the <HART Tx> light may either be off or flashing steadily.

When power to the MUX 2700 is cycled all the lights will come on. Next the green <Pwr On> LED will flash for approximately 15 seconds while the MUX undergoes a self-test. After the successful completion of the self-test the LED will go solid on. For the next 60 to 120 seconds, the <HART Tx> light will flash three times for each channel. During this time, the MUX 2700 is scanning each of the 32 channels. When it is finished, the <HART Tx> LED will either flash steadily or turn off altogether. If you see all of the above occur, the MUX 2700 is operating properly.

*Note : The MUX 2700A will behave the same except the power LED will not flash during its self-test.*

In addition, the TEST setting on the option switches can be used to gain confidence that the module is functioning. Follow the procedure below to use this feature:

1. With the power off, set the end switch to the TEST position (ON). The module should not be connected to the RS-485 network, the RS-485 address switches have no effect. If an RS-485 terminal is connected to the module, the BAUD rate switches should be set.
2. Turn the power on. The LEDs should light for about 1 second each in sequence (RED, YELLOW, GREEN...).
3. If the LEDs do not flash, there is a fault with the module and it should be returned for replacement.
4. To return to normal operation, remove power to the MUX 2700 and set the TEST switch to the OFF position. Ensure that the correct BAUD rate is selected and that an RS-485 address is set. Then, re-apply power.



If you suspect the MUX 2700 is not functioning properly, please refer to **Table 4** below for a summary of some possible problems.

Table 4 – MUX 2700 Troubleshooting

Symptom	Cause	Solution
Lights flash sequentially	TEST switch is ON	Turn off the power Set TEST switch off Restart the system
No LEDs lit	Power failed or fuse blown	Check 24 VDC supply Check <PWR ON> LED Verify fuse intact
Yellow <HART TX> LED continually flashes	Scanning is enabled	Go to the configuration properties of the MUX and disable scanning mode
Red <FAULT> LED is lit	Self-test fault	Contact Pepperl+Fuchs Technical Support for further instructions

## 5. MAINTENANCE

Pepperl+Fuchs apparatus do not require any particular maintenance under normal operating conditions. They are designed to operate trouble-free and with high stability for long periods.

**WARNING!**

*Any repair made by unauthorized personnel may completely invalidate the safety characteristics of the unit and could void all warranties. Repair not made by Pepperl+Fuchs is fully at user's risk and responsibility. In addition, the warranty terms of the unit will be null and void to all effect.*

## 6. GLOSSARY

DCS	Distributed Control System
FSK	Frequency Shift Keying
HART®	Highway Addressable Remote Transducer
HIS	HART Interface Solution
HHT	Hand Held Terminal
HPTB	HART Panel Termination Board
IS	Intrinsic Safety
PLC	Programmable Logic Controller



## 7. CONTACT INFORMATION

World Wide Web

Website: [www.pepperl-fuchs.com](http://www.pepperl-fuchs.com)

International Headquarters

Europe

Pepperl+Fuchs SE

Lilienthalstraße 200

Mannheim

68307 Germany

Phone: + 49 621 776-0

Fax: + 49 621 776-10 00

Email: [info@de.pepperl-fuchs.com](mailto:info@de.pepperl-fuchs.com)

Website: [www.pepperl-fuchs.com](http://www.pepperl-fuchs.com)

Regional Headquarters

North America

Pepperl+Fuchs Inc. - USA Headquarters

1600 Enterprise Parkway

Twinsburg, OH 44087

USA

Phone: +1-330 425 3555

Fax: +1-330 425 4607

Email: [sales@us.pepperl-fuchs.com](mailto:sales@us.pepperl-fuchs.com)

Website: [www.pepperl-fuchs.com](http://www.pepperl-fuchs.com)

Regional Headquarters

Asia Pacific

Pepperl+Fuchs Pte Ltd - Asia Pacific

P+F Building

18 Ayer Rajah Crescent

139942 Singapore

Phone: +65 779 90 91

Fax: +65 873 16 37

Email: [sales@sg.pepperl-fuchs.com](mailto:sales@sg.pepperl-fuchs.com)

Website: [www.pepperl-fuchs.com](http://www.pepperl-fuchs.com)