EXACTUS® IFM8-IA and IFM8-I Industrial Mux User's Guide
Ver. 1.9

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Introduction

The *EXACTUS*® Industrial Mux (IFM8-IA or IFM8-I) is designed as a data transport device allowing communication between a host system and up to eight pyrometers. In most situations, the Industrial Mux can be connected and operate without any setup or configuration changes. Some of the features that can be configured on Industrial Mux include:

- Activation of the analog outputs.
- Activation of an instrument monitoring system which detects, and alarms, if any instrument should fail or otherwise stop communicating.
- Configuration of settings which will power down the pyrometer electronics, should their internal temperature become too high or too low.
- Adjustment of pyrometer voltage to compensate for excessive cable resistance.

This guide is divided into sections which provide information on:

1. Product Overview
2. Product Specifications
3. Default Parameters
4. Configuration Communication
5. Configuration Menu
6. Alarm Configuration
7. Analog Output Wiring
8. Mounting
9. Maintenance
10. Warnings

Appendix 1 MODBUS/TCP Implementation

1. Product Overview

The Industrial Mux (IFM8-IA) communicates with up to 8 Exactus® units. It contains four interfaces for external equipment: current loop (isolated 0-20mA, 16 bit, 8 channels), RS-485 (isolated, 960K), Ethernet (dual 10/100 Mb/s.), and 2 relays (each NO/COM/NC).

Hardware Configuration (see Figure 1-2):

A. Run Status LED (**Run**)
B. Error Status LED (**ERR**)
C. Power Status LED (**PWR**)
D. Reset Button (**R**)
E. Input 24VDC Power Connection
F. Relay 1 [Form C]
G. Relay 2 [Form C]
H. 2 LAN Ports (**LAN1**, **LAN2**) [Ethernet IP and Modbus TCP]
I. 8 Powered RS422 Pyrometer Ports (**CH1** to **CH8**)
J. 1 Isolated RS458 Port (**RS485**)
K. 1 Auxiliary RS422 Port (**AUX**)
L. 8 Analog Outputs [Individually Isolated 0-20mA, 16 bit resolution]

Reset Button Function:

1. Depress/Release <3 seconds to reboot Mux with user-selected parameters.
2. Depress/Release >3 seconds to reboot and restore factory default settings. (Including IP address)

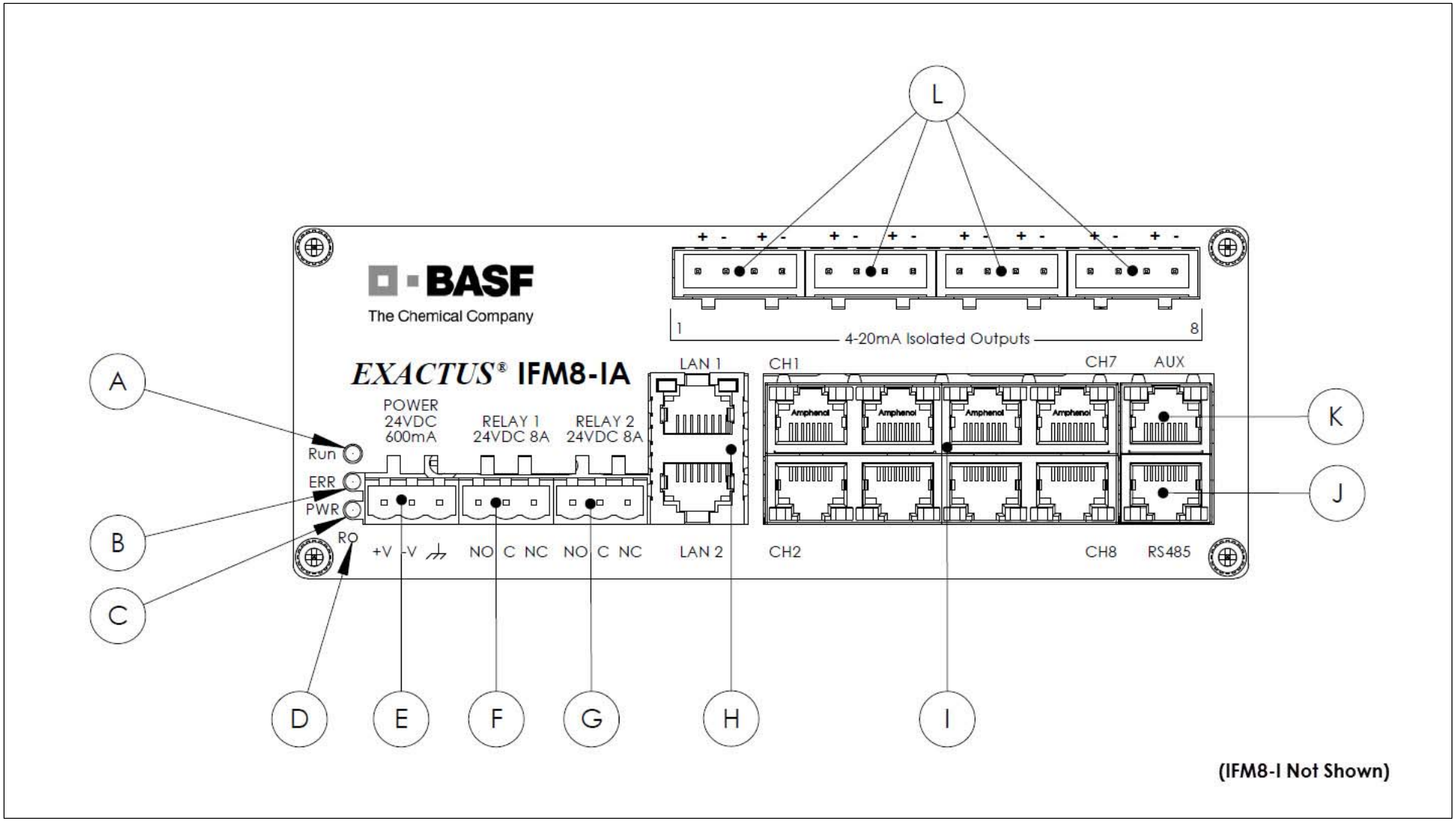


Figure 1-1: IFM8-IA Balloon View

Note: Pyrometer channel numbering sequence varies on some hardware configurations.

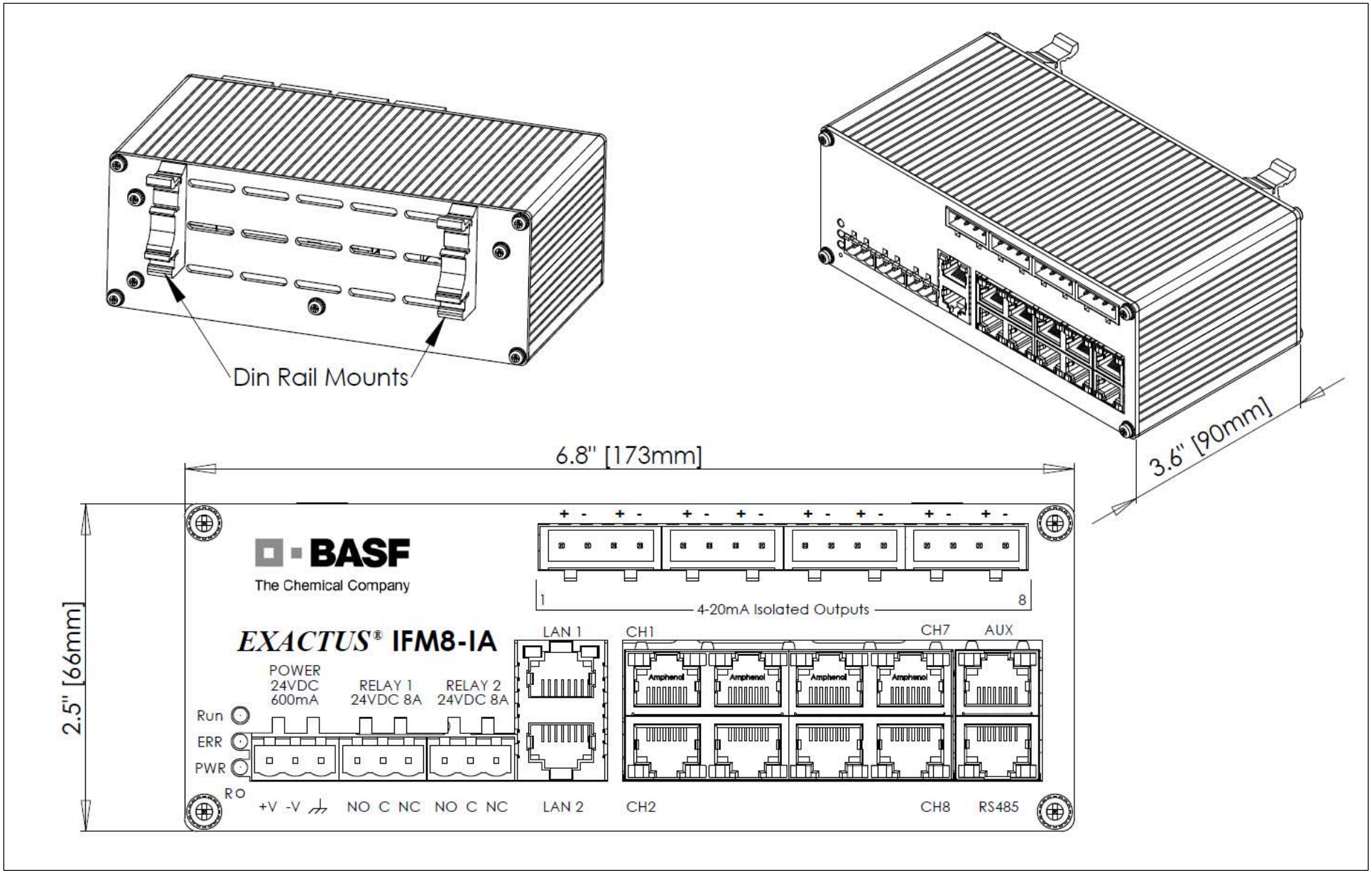


Figure 1-2: IFM8-IA Overview

2. Product Specifications

General Specifications	
Operating Temperature	0 to 70°C
Storage Temperature	-20 to 90°C
Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gasses permitted
Agency Approvals	CE EN61010-1, CB IEC61010-01, EMC EN61326-1, Pending UL 61010-01 and CSA C22.2 61010-1

Mechanical/Certifications	
Size: H x W x D	63.5mm x 173mm x 90mm, 2.5" x 6.8" x 3.55"
Weight with 4-20mA output option	900g, 32oz
Weight without 4-20mA output option	725g, 26oz
DIN Rail Mount	35mm rail

Input Power	
Input Voltage Range	+24VDC (+20VDC to +30VDC)
Power Consumption with 8 Pyrometers	14.0 watts, 600mA (+24VDC)
Pin Assignments	Pin 1 +V
	Pin 2 -V circuit ground
	Pin 3 earth/chassis ground
Terminal Type - Removable	3 pin, 5.00/5.08mm plug
NOTE: Relay drive current (17mA for each relay) is not factored into power rating because relays are only active during an error condition. When active, the system shuts down power to the pyrometers causing power consumption to drop.	

Relays	
Number of Outputs	2
Type of Output	2 - Form-C (NO/COM/NC)
Maximum Switching Voltage	300V AC/DC
Contact Current Rating	8A at 24VDC
Maximum Inrush Current	15A (300 ms)
Minimum Load Current	20mA at 24VDC
Rated Carry Current	8A (70°C)/5A (85°C)
Interrupting Rating (ohmic load) max.	190W (24 VDC)
	85W (48 VDC)
Fuse	No fuse
Commons	2 Isolated
Pin Assignments	Pin 1 NO
	Pin 2 COM
	Pin 3 NC
Terminal Type - Removable	3 pin, 5.00/5.08mm plug

TCP/IP Ports

The Industrial Mux has two RJ-45 Ethernet connectors, but only one MAC address and one TCP/IP address. The ports function as two ports on a switch. Packets entering one connector and not bound for the IFM8-IA are passed to the other connector, thus the IFM8-IA can be daisy-chained.

LAN Ports	
Communications	10/100 Base T Ethernet
Data Transfer Rate	10/100 Mbps
Link Distance	100 meters
Ethernet Port Connectors	RJ45
Port Type	Switch
Ethernet Protocols	TCP/IP, Modbus TCP/IP, Telnet configuration, DHCP (Default Protocol IP Address assigned)
Exposed Ethernet Ports	23: Telnet Port for configuration 502: Modbus/TCP Port 6789 : Mux Server Port 6790 : UDP Announcement Port

Pyrometer Ports	
Number of input Ports (channels)	8
Connectors	RJ-45
Pin Assignments	Pin 1 Tx+ (A) to pyrometer
	Pin 2 Tx- (B) to pyrometer
	Pin 3 Rx+ (A) from pyrometer
	Pin 4 +24VDC (Optional)
	Pin 5 Ground
	Pin 6 Rx- (B) from pyrometer
	Pin 7 Supply +6 to 9.5VDC (configurable), 150mA Max.
	Pin 8 Ground
LED Indicators	Green: Data from pyrometer Amber: Data to pyrometer
Electrical Protocol	RS-422 Full Duplex
Bit Protocol	Asynchronous, 8-bit, 1 stop
Max. Data Rate	921,600 bits/second
Isolation	None – pyrometer ground is power supply/digital ground
Protection	ESD protection on all communication lines, Pyrometer power supply protected against shorts, +24V not protected

Aux Port	
Configuration same as Pyrometer Ports	Optional
Electrical Protocol RS485 half or full duplex	Optional
LED Indicators	Green: Data in, Amber: Data out

Analog Output	
Number of Outputs	8
Output Range	0-20mA
Resolution	16-bits 0.32uA/bit
Output Type	Current modulator
Isolation	Individually Isolated Channels
Loop Power	External power supply required
Load Impedance (total)	1000ohm max load for 24VDC supply
Output signal at power-up and power down	0mA
Max Update Rate per Channel	4 KHz
Settling Time, Full Scale Change	< 5 us
Absolute Accuracy	0.2% of reading, 4-20mA
Accuracy vs. Temperature	±15ppm/°C, 4-20mA
Linearity Error (End to End)	±0.01% of full scale, Monotonic, 4-20mA
Output Stability and Repeatability	±0.4uA after 10min. Warm-up typical
Output Ripple	0.003% of Full Scale
Reverse Polarity Protection	Yes, up to 85V
Over-Current Protection	Yes, limited to 40mA
Maximum Voltage At Output Pins	48VDC (≤24VDC recommended)
Minimum Voltage At Output Pins	4VDC
Terminal Type - Removable	4 pin, 5.00/5.08mm plug

RS-485 Port	
Connector	RJ-45
Pin Assignments	Pin 1 D+ (optional Full duplex +TX A)
	Pin 2 D- (optional Full duplex -TX B)
	Pin 3 (optional Full duplex +RX A)
	Pin 4 (optional +24VDC)
	Pin 5 (optional Trigger)
	Pin 3 (optional Full duplex -RX A)
	Pin 7 (optional +6 to 9.5VDC configurable, 150mA Max.)
	Pin 8 Ground
LED Indicators	Green: Data in Amber: Data out
Electrical Protocol	RS-485 Half Duplex (optional Full duplex)
Bit Protocol	Asynchronous, 8-bit, 1 stop
Max. Data Rate	9600 to 921,600 bits/second
Isolation	Yes (Internally selectable – port must be non-isolated to use Pyrometer supply or +24V)
Protection	ESD protection on all communication lines, Pyrometer power supply protected against shorts, +24V not protected

3. Default Parameters

The Exactus® Industrial Mux ships with the following default parameters:

- Analog output is enabled. Note: Not all Industrial Mux units will include analog outputs. (Only Model number IFM8-IA include the analog output ports)
- Temperature alarm is set to power down all pyrometers when any pyrometer electronics temperature drops below 0ºC (32ºF) or goes above 75ºC (167ºF).
- The coil for Relay 1 is programmed to energize if the pyrometer temperature limits are exceeded. Pyrometers will remain powered down until power to the Industrial Mux is cycled off and back on.
- The Pyrometer Supply Voltage is set to 6200mV – adequate for standard pyrometer power/communication cables up to 15 meters (49 ft).

Note: If these defaults are adequate, no further configuration is necessary.

4. Configuration Communication

If configuration of the Industrial Mux is necessary, a program such as HyperTerminal which is included with some versions of Microsoft® Windows, can be used. Some versions of the Exactus® TemperaSure® software include a 'Configure Mux' menu in the Advanced Mode of operation (see figure 4-0).

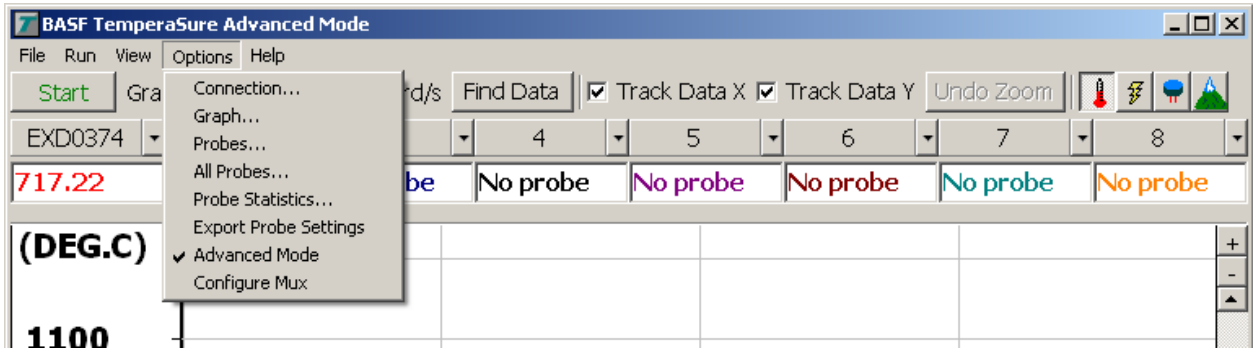


Figure 4-0: Configure Mux option

The following instructions are written for setting up HyperTerminal on Windows XP. Similar steps can be used for other versions of Windows.

1. Connect a CAT5 cable to either of the ports LAN1 or LAN2 and to an Ethernet input on the computer. The cable can be of any LAN type.
2. Set the IP address of the PC:
    a. Right-click on My Network Places and choose 'Properties' from the pop-up menu. See Figure 4-1.

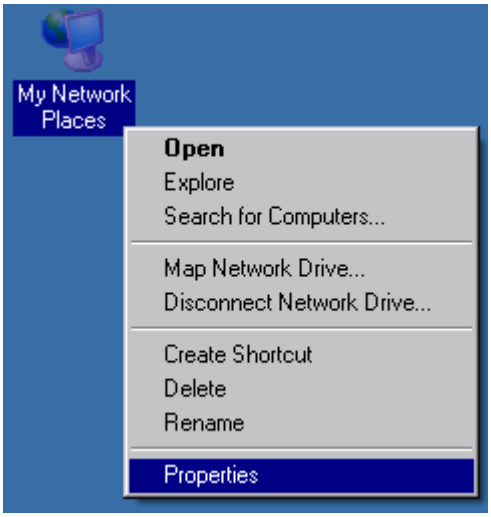


Figure 4-1: Selecting Properties of My Network Places

    b. Double-click on the connection. If there is more than one connection, you can determine which connection to use by unplugging the LAN cable from the Mux, and the Status will change to "Network Cable Unplugged". See Figure 4-2.

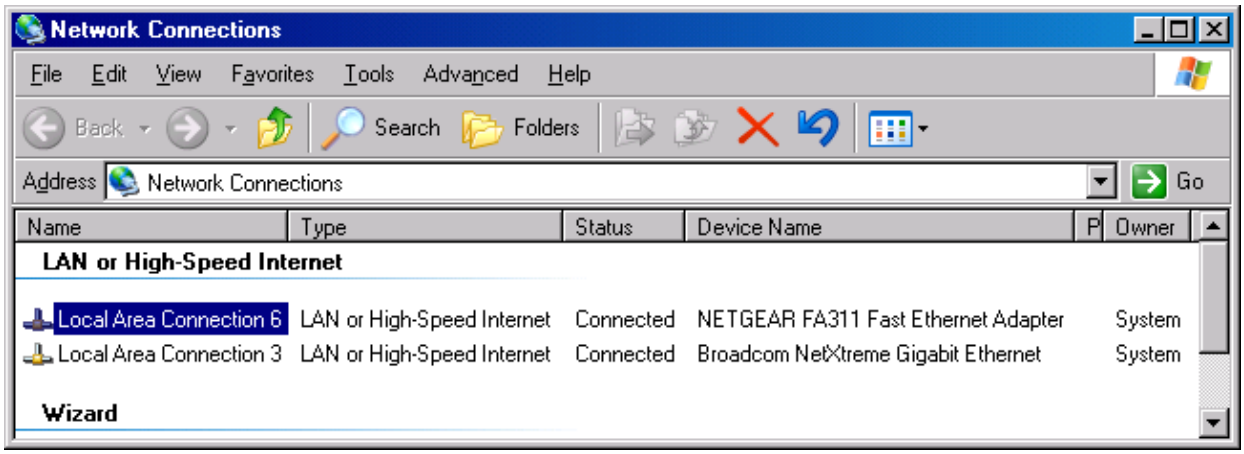


Figure 4-2: Network Connections Screen

c. The following screen (Figure 4-3) will appear. Click the ‘Properties’ button.

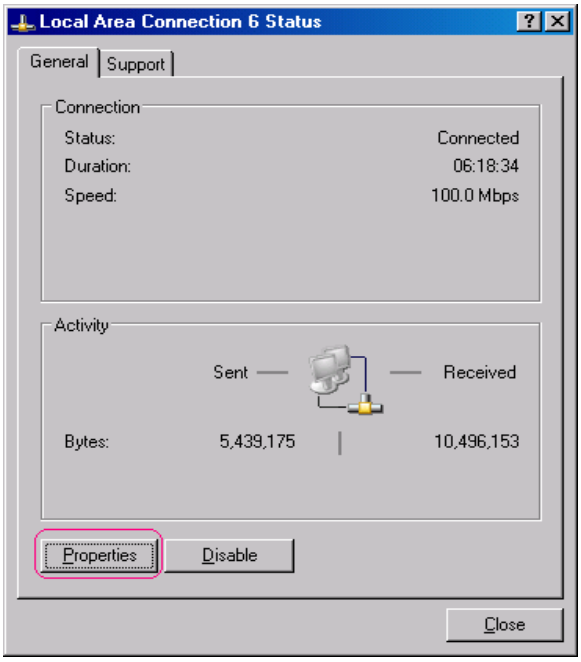


Figure 4-3

d. Double-click the “Internet Protocol (TCP/IP)” line (Figure 4-4), this will bring up the screen shown in Figure 4-5:

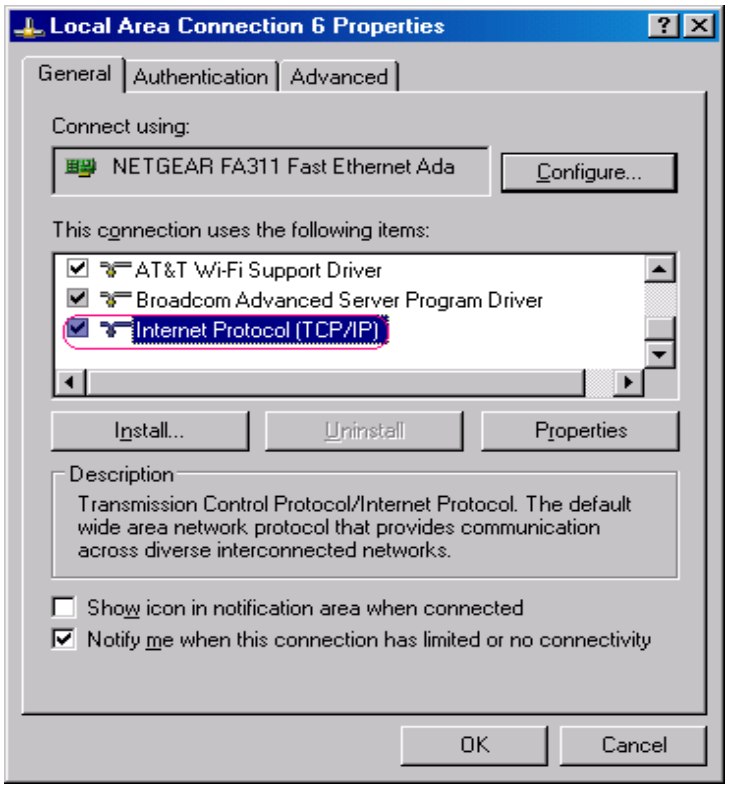


Figure 4-4

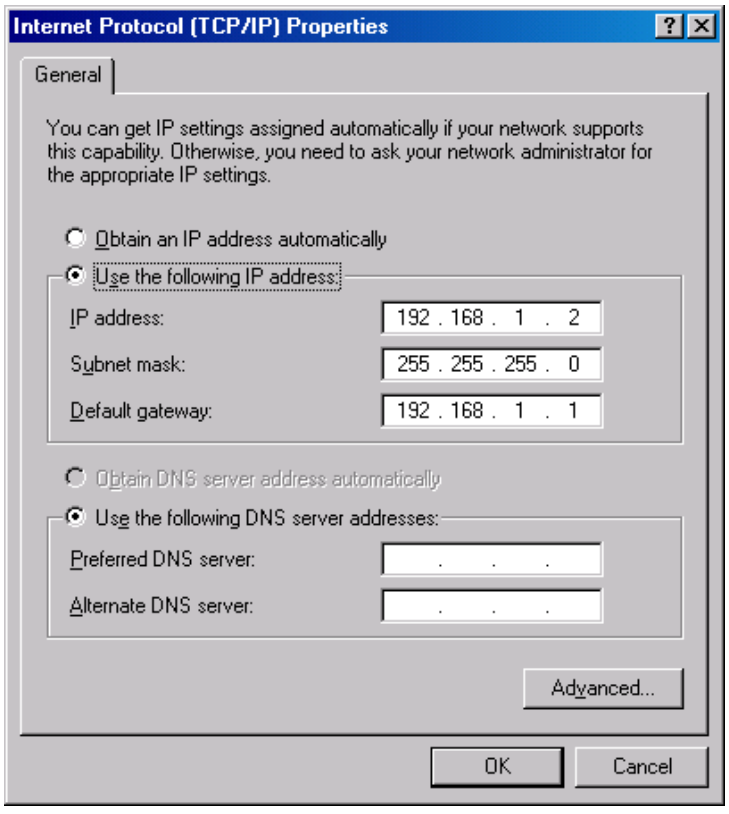


Figure 4-5

e. Click on the radio button ‘Use the following IP address’ and then set the IP address using the following rules:

   i. The first 3 numbers of both the IP address and the Default Gateway must agree with the first three numbers of the Mux’s address (Default Address = 192.168.1.80).

   ii. The last number of the IP address must not be the last number of the Industrial Mux (e.g. if the Default Address is used, this would be ‘80’).

   iii. The last number of the Default Gateway must be 1.

   iv. The Subnet Mast must be 255.255.255.0 as shown above.

f. Click OK on all the dialog boxes that are up. Eventually, the Network Connections dialog (shown in Figure 4-2) will report that the Status is ‘Connected’.

3. Configure the Mux using Windows HyperTerminal

   a. Launch Windows HyperTerminal. You should be able to access it using the path shown in Figure 4-6.

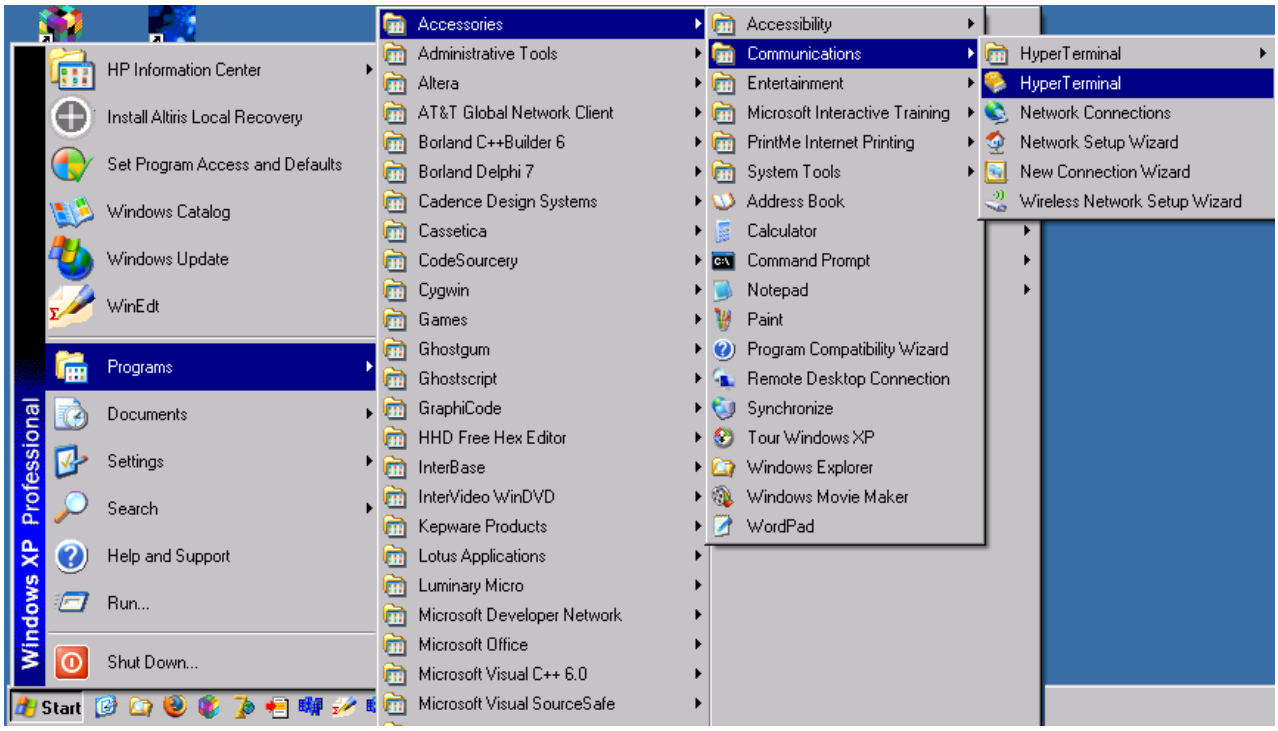


Figure 4-6

b. Choose a name (such as IndMux) and an icon as shown in Figure 4-7 and click OK.

Figure 4-7

c. Select the 'TCP/IP (Winsock)' option from the "Connect using:" drop-down box, then enter the Mux's IP address and click "OK" (See Figure 4-8):

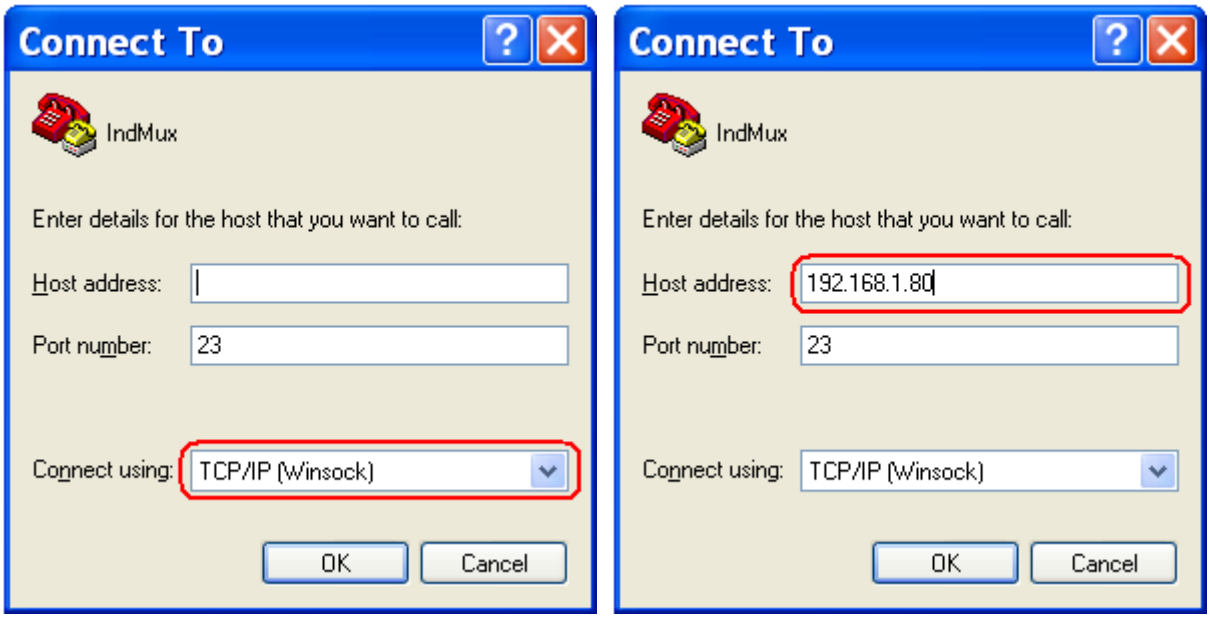


Figure 4-8

d. When you hit the OK buttons, you should get the menu shown in Figure 4-9

Note: Menu structures will very slightly from the illustration dependent on firmware version.

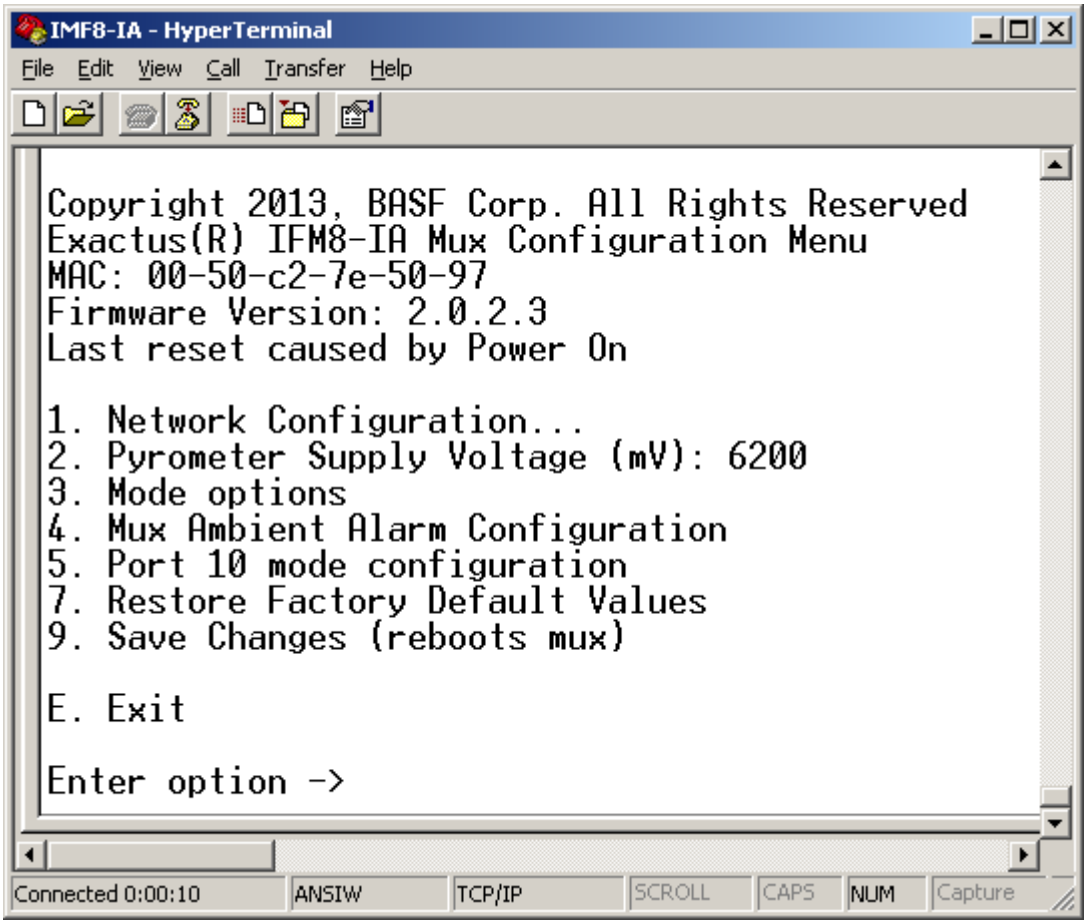


Figure 4-9: Configuration Menu

e. After you make changes to the Industrial Mux configuration, be sure the select '9. Save Changes'. As noted, this will reboot the Industrial Mux.

f. HyperTerminal may not automatically display user keystrokes to the screen. To turn on the echo feature, press the "Properties" button (circled in **red** in Figure 4-10 below), and select the Settings Tab and press the "ASCII Setup... button" (circled in **blue** in Figure 4-10 below) and then select the radio button for "Echo typed characters locally" (see Figure 4-11):

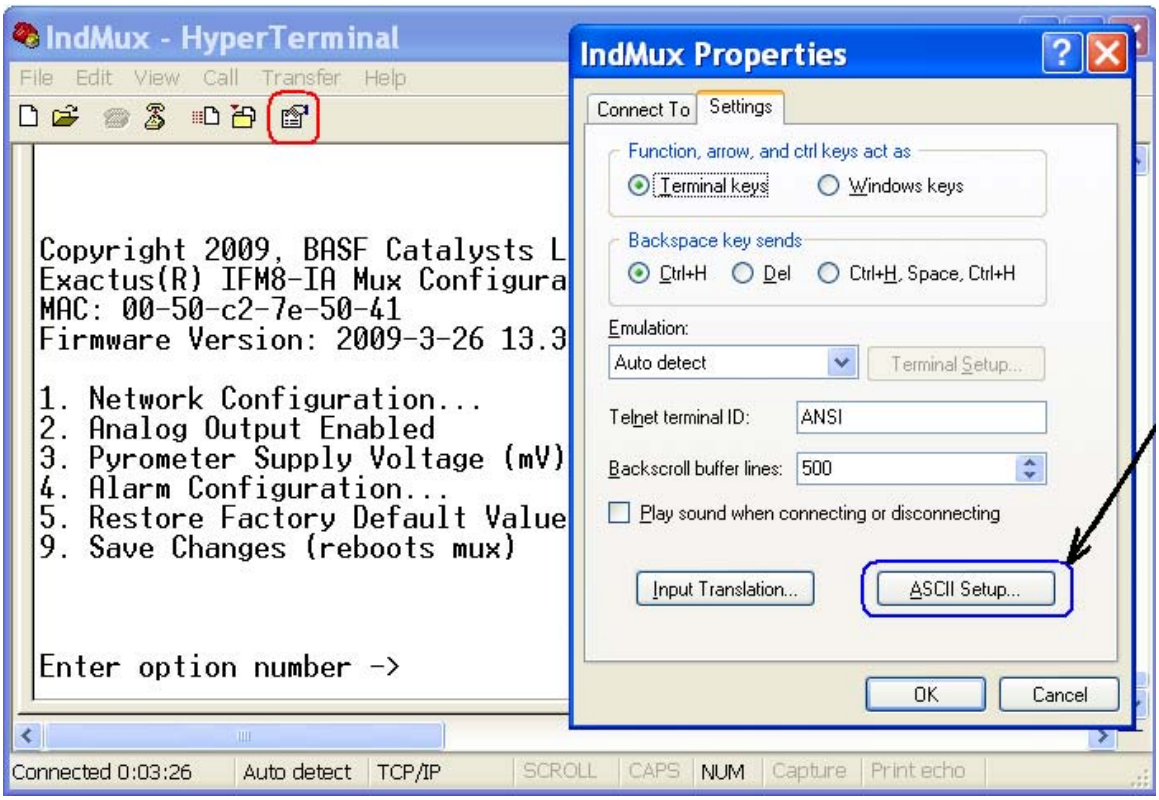


Figure 4-10

Check the “Echo typed characters locally” check box and close the dialog windows.

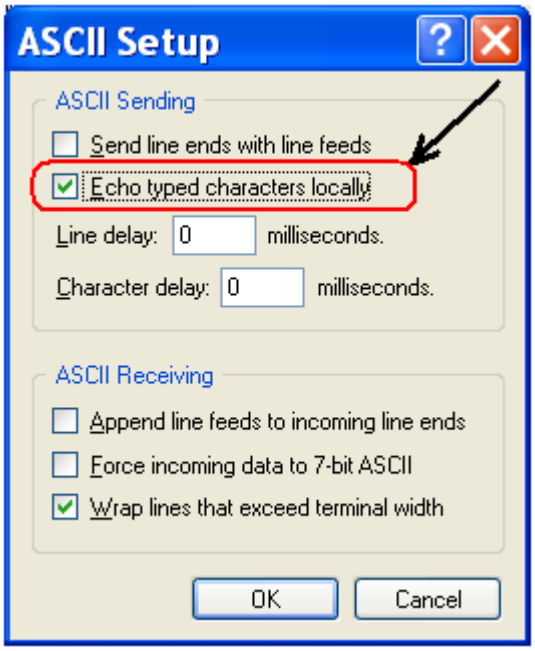


Figure 4-11

5. Configuration Menu

The Configuration Menu is shown in Figure 4-9 above. Below is a description of each menu item:

- *Network Configuration:* Used to set the IP address and other network parameters of the Industrial Mux. This selection is only used when configuring the Mux for use on your network rather than connecting directly to a pc.
    - If used on a DHCP enabled network and Option 1 is "No", the Mux will obtain an IP address automatically when connected to the network.

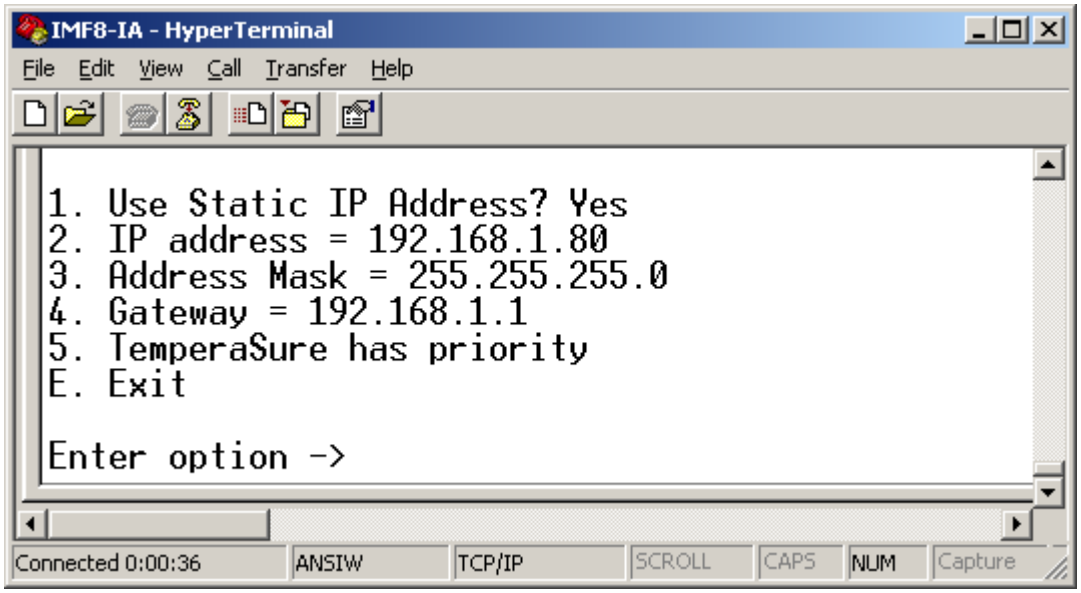
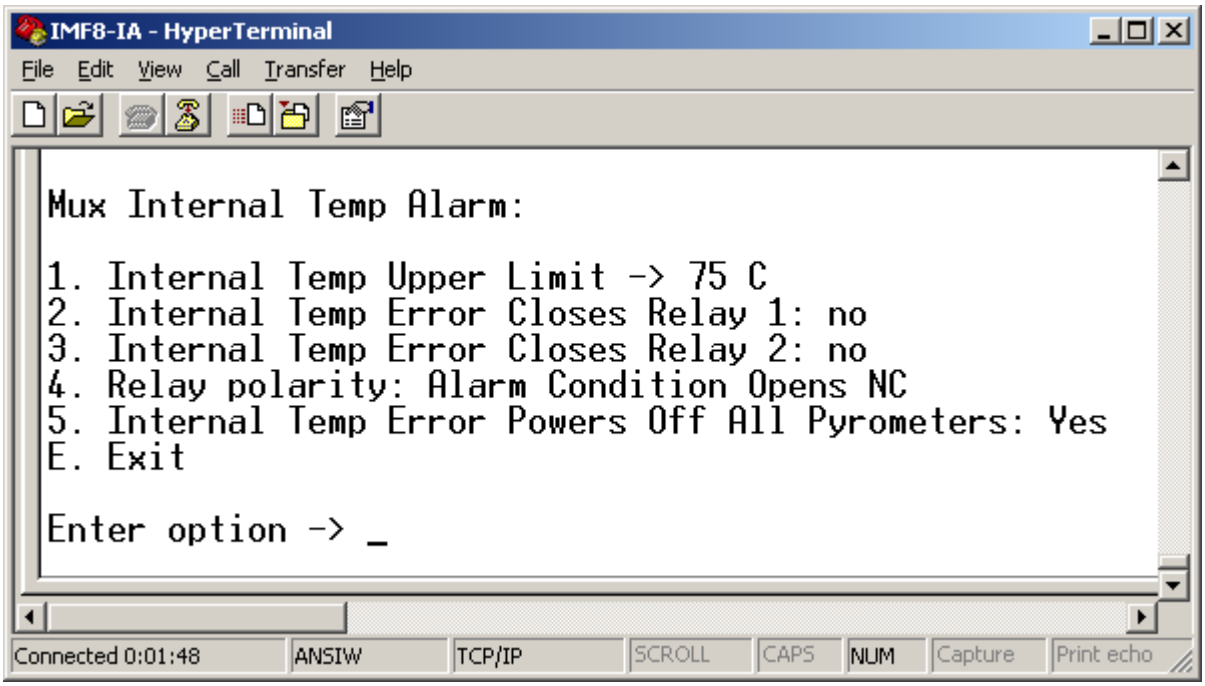


Figure 5-1: Network Configuration sub-menu

- *Pyrometer Supply Voltage (mV):* This is the voltage that supplies power to each Exactus® pyrometer. **(Only adjust after consulting with factory and if the pyrometer communication cable is longer than 15meters; otherwise; it should remain at default value of 6200mv.)**
- *Mode Options:* Used to configure the alarms for individual pyrometers. More detail is provided in Alarm Configuration section.
- *Mux Ambient Alarm Configuration:* Brings up the Mux Internal Temperature Configuration Menus; this screen allows a user to define the allowable operating temperatures for industrial Mux and how the Mux will react to over-temp conditions.
    - *Internal Temp Upper Limit:* Temperature which will trigger error condition.
    - *Internal Temp Error Closes Relay 1:* Will over-temp condition close Relay1?
    - *Internal Temp Error Closes Relay 2:* Will over-temp condition close Relay2?
    - *Relay polarity:* Unlike the other alarms, the polarity of the relay output is selectable for the Mux over-temp condition. The reason is that if the Mux overheats, it may become unable to keep a contact closed. By allowing for selectable polarity, the user can choose to keep the relay in its activated state during

normal operation and have an alarm condition open the relay, so if the Mux alarm is activated the alarm output is active.



- ***Figure 5-2:*** Mux Internal Temperature Configuration Menu

- *Restore to Factory Default Values:* Restores all settings to the Factory Defaults but you must follow this with selecting *Save Changes.*
- *Save Changes:* Saves all settings to their current values and reboots the Industrial Mux. After saving, a message will be displayed saying 'rebooting'. You may now end the HyperTerminal session. If more changes are needed, you will have to click the disconnect icon followed by the connect icon to reestablish the connection; these icons are located at the top of the HyperTerminal display.

6. Alarm Configuration

Selecting 'Mode options' from the Configuration Menu (See Figure 4-9) will bring up the Alarm configuration menu, shown in Figure 6-1.

- *Pyrometer Internal Temperature:* Selecting Option 3 brings up the Pyrometer Internal Temperature configuration setup screen shown in Figure 6-2; this screen allows a user to define the allowable operating temperatures for individual pyrometers. Alarm temperatures can be configured individually for each pyrometer, as can the action which will occur should the pyrometer's temperature goes outside the allowable range. When the Power Down option is chosen for an instrument, and the condition occurs, all pyrometers connected to the Industrial Mux will be powered off. The user must cycle the power to the Mux in order to reset the pyrometers. Depending on the operating speed of the pyrometer, and other environmental factors, the measured temperature of the electronics can be 5 to 12ºC above the ambient air temperature. The submenu for each pyrometer configuration is self-explanatory.

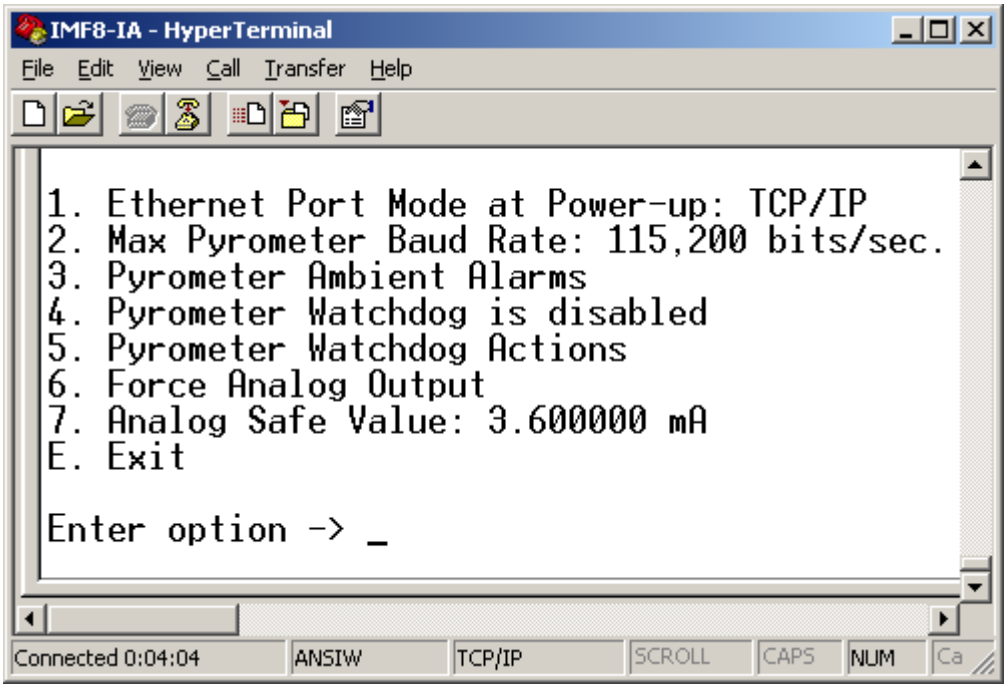


Figure 6-1: Alarm configuration menu

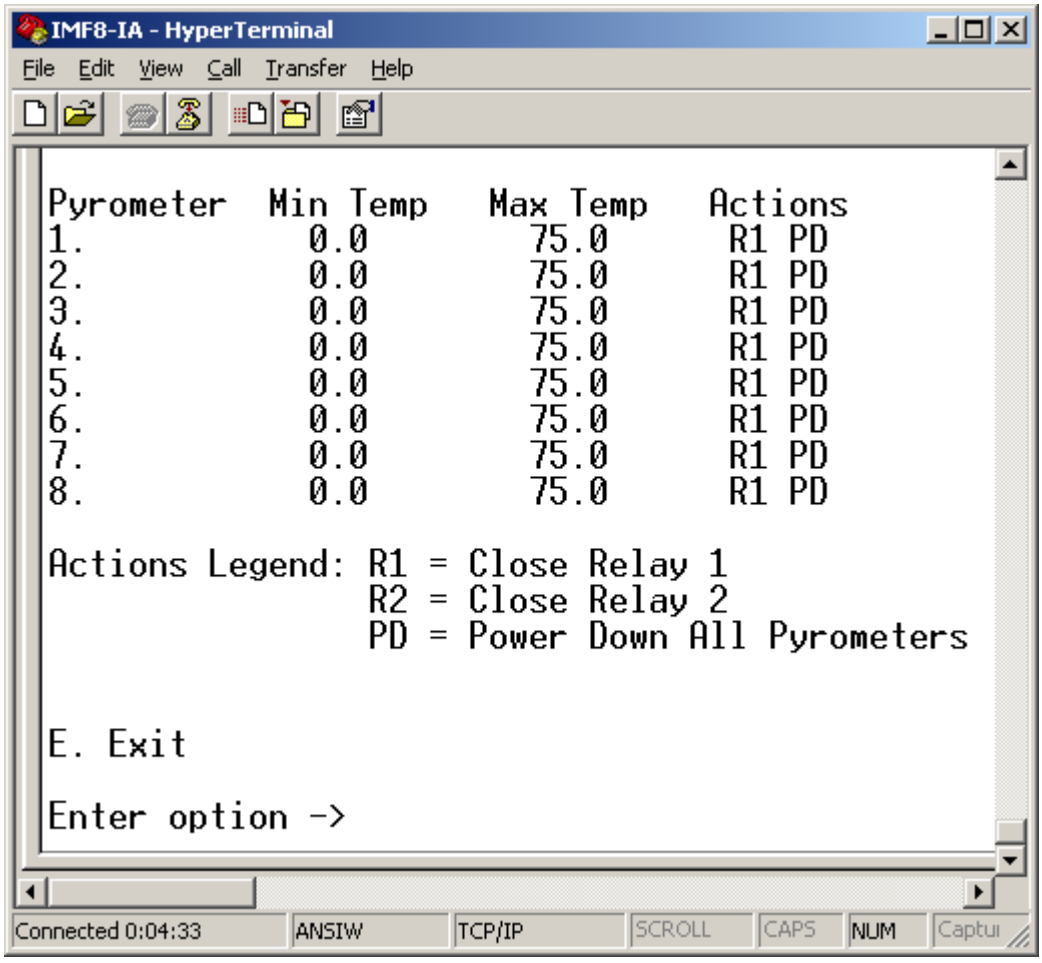


Figure 6-2: Pyrometer Internal Temperature Alarm Configuration Menu

- *Pyrometer Analog Watchdog:* If the Pyrometer Analog Watchdog is activated (Option 4), the Industrial Mux will watch for missed readings from the pyrometer, an indication that the pyrometer has failed in some way. If missed readings occur, the analog output will be forced to the Analog Safe Value and, if programmed to do so, energize one of the relays. When the Pyrometer Analog Watchdog (Item 4 in Figure 6-1) is enabled, then item "5. Pyrometer Watchdog Actions" should be configured. This offering has a self-explanatory submenu for setting the watchdog alarm configuration.
- *Force Analog Output:* Temporarily forces all analog output channels to a user configured value (0-20mA) for testing purposes.
- *Analog Safe Value:* This is the milliamp output that the analog outputs should go to if there is a failure with one of the pyrometers

7. Analog Output Wiring

The analog outputs for the Exactus® Industrial Mux do not generate a voltage to drive the analog output and must receive the voltage externally. Many data logging systems are configured to supply this voltage; if yours is not, you can use the same power supply driving the Industrial Mux to provide the power. This is outlined in the schematic shown in Figure 7-1:

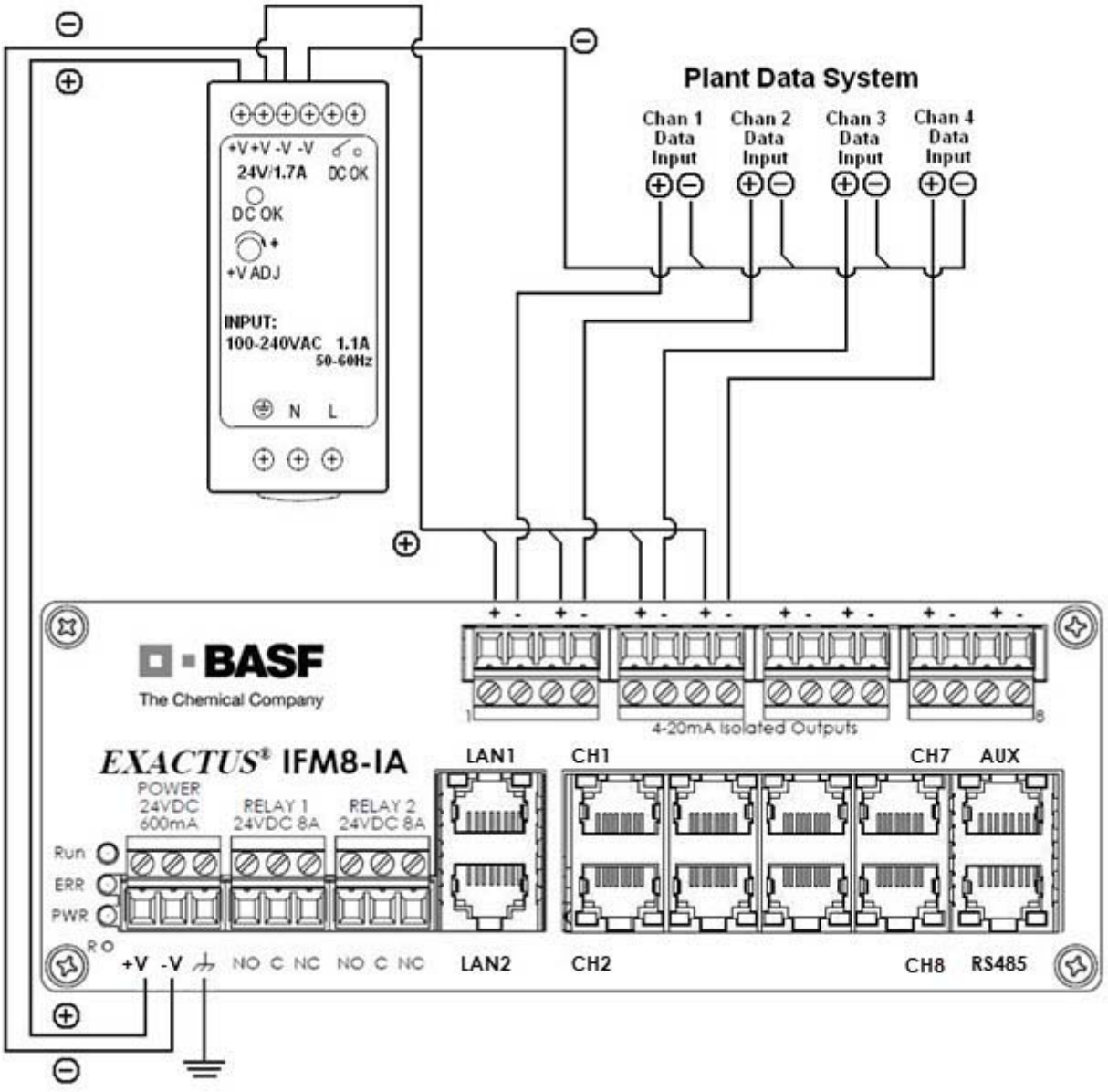


Figure 7-1: Schematic for providing power to analog output loops – only use if plant data system does not already provide the loop power.

8. Mounting

- The back of the IFM8-IA and IFM8-I Mux have DIN mounts for easy attachment to a 35mm DIN rail. To attach the instrument to a DIN rail, first insert the DIN mount onto the bottom of the rail and push the instrument toward the rail until it snaps securely into place. To remove, pull up on the top of the DIN mount top tabs and pull the instrument away for the rail.
- It is recommended that the Mux be mounted in a cabinet or NEMA enclosure rated for area of use. See mounting examples in section 8.1

8.1 Electronics Support Cabinet

The electronics support cabinet provides an air distribution system, power management, and communication necessary to support Exactus® temperature measurement. Typical cabinets may accommodate one to eight Exactus® units.

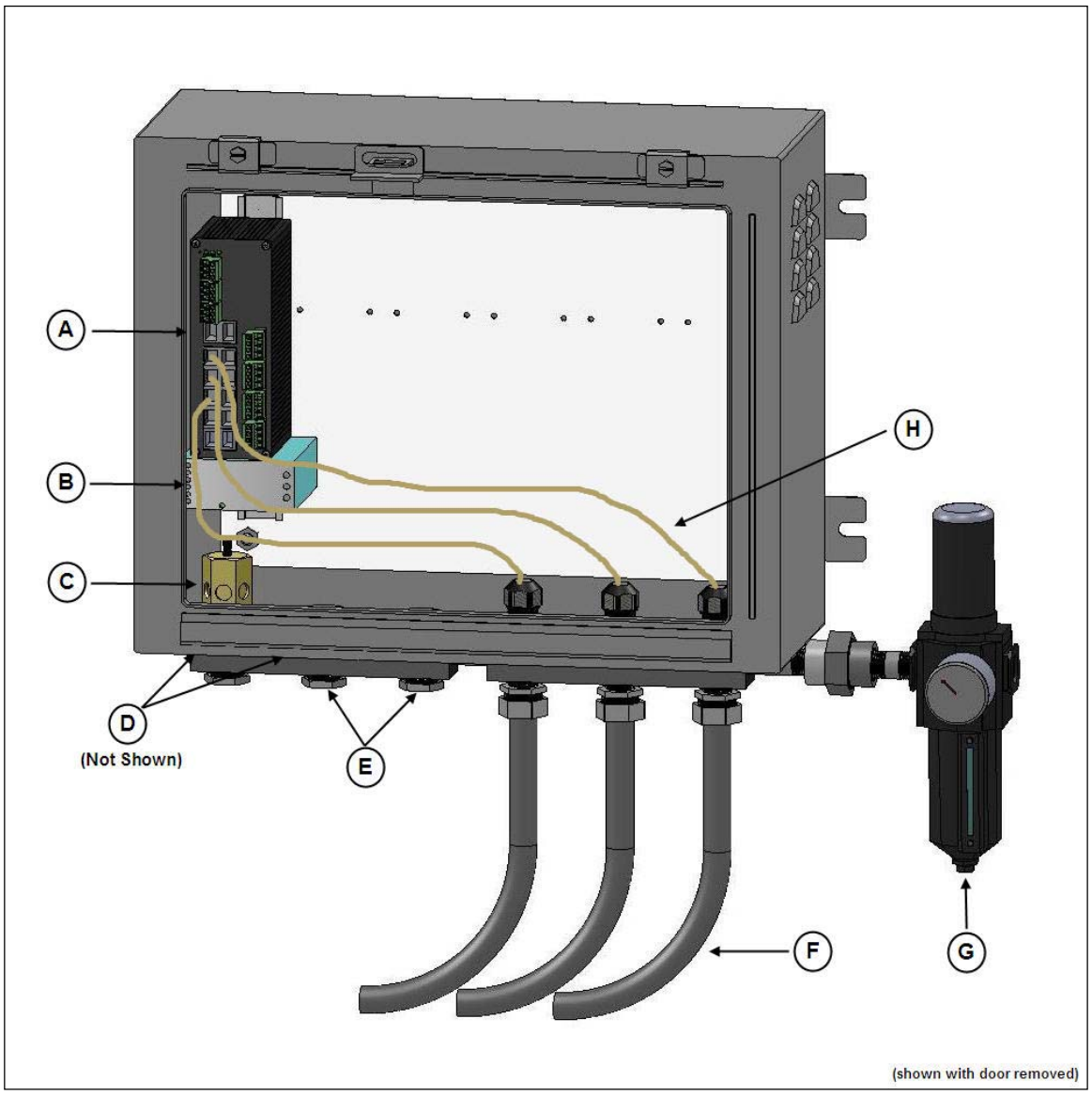


Figure 8-1 – Electronics support cabinet layout example – Integrated Instrument System

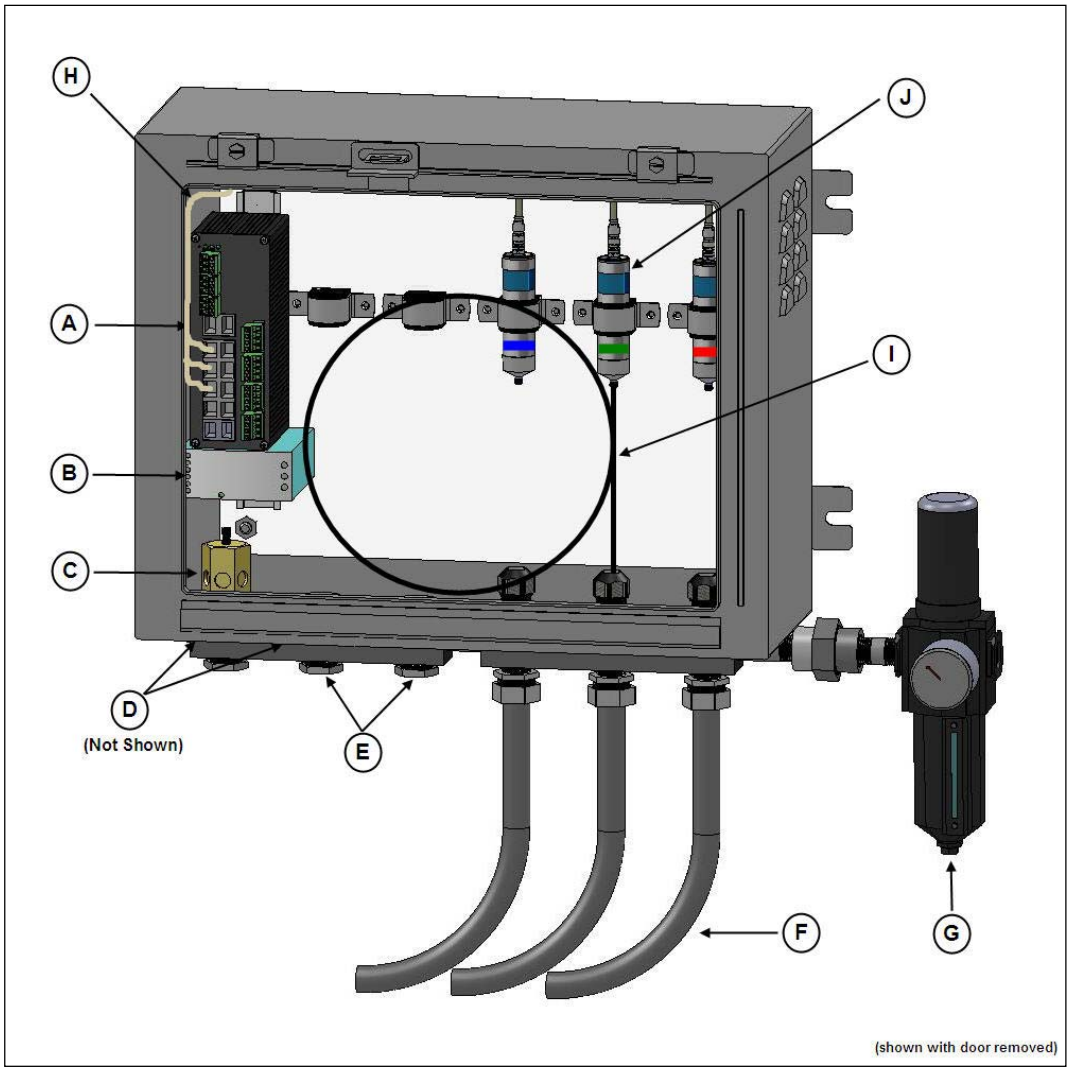


Figure 8-2 – Electronics support cabinet layout example – Fiber Optic Version

Cabinet may not include all of the following components

A. IFM8-IA or IFM8-I (Mux) – Allows for PC communication with all electronic probe modules via Ethernet connection and Analog Output of the temperature measurement through labeled screw terminals for the 4-20mA output.
B. Power Supply – Converts 120/240 VAC to 24 VDC
C. Cabinet Cooling Air Inlet Valve
D. Covered Punch-out holes for Power Input and Signal Output Cables
E. Pyrometer Channel Expansion Locations
F. Conduit - Contains either the fiber-optic transmission or power/data cable and routes the purge air to the optics head assembly.
G. Air Pressure Regulator/Condensate Separator with Pressure Gauge
H. Combined Power/Data Cable

<u>Fiber-Optic Version Only (see Figures 8-2)</u>

I. Fiber-optic Transmission Cable – Transmits light from fiber-optic lens assembly to the electronics module.
J. Pyrometer Electronics Module – Measures intensity of light from the optics and calculates temperature.

9. Maintenance

- If the Mux is mounted in a cabinet, door should remain closed as often as possible. A lock should be used if necessary.

- The ambient temperature of the Mux should be checked in the operating environment at its highest temperature. The temperature should not exceed 70ºC. Doing so will not damage the electronics but may affect the temperature measurement accuracy. If the temperature exceeds 80ºC, failure is possible. Use radiation shielding or the optional purge air to keep the electronics cool.

- Periodically check Mux for signs of deposition of water, oil, dirt, etc. If necessary, clean it by disconnecting the DC power and wiping it down with a soft, slightly damp cloth.

- If the Mux is mounted in a cabinet, check the inside of the cabinet for dirt, oil, water, etc. If discovered, take appropriate action to prevent damage to the electronic components.

10. WARNINGS

- If the equipment is not used in a manner consistent with manufacturer instructions and specifications, the protections provided by the equipment may be impaired

- Use of probe without the IFM8-IA or IFM8-I Mux may degrade measurement quality. The Mux isolates the probe from electrical noise and provides power conditioning.

APPENDIX 1

MODBUS/TCP Implementation

Conventions

This document describes the MODBUS/TCP protocol implementation in the BASF Exactus® IFM8-IA and IFM8-I Industrial Mux. These products are generically referred to in this document as 'mux'. Where hexadecimal constants are used, they are preceded by 0x (e.g. decimal 15 is 0x0f.) This document does not describe the details of the MODBUS/TCP protocol (see www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf)

TCP/IP Port

MODBUS/TCP is implemented over port 502, the standard port number for MODBUS/TCP.

MODBUS Addressing

Each MODBUS device has an 8-bit address. All of the pyrometers are configured to respond to the MODBUS address 0x01. However, the MODBUS/TCP master will address the individual pyrometers according to their port number on the mux. The mux will convert the address in each MODBUS/TCP poll (found in the UID field of the poll) to 0x01 and send the poll on the port indicated by the original UID. To the MODBUS/TCP master, it will appear as if there are *n* devices with distinct addresses, with a range of 0x01 to 0x0n, where n is the number of ports on the mux, but each pyrometer is configured with a MODBUS address of 0x01.

MODBUS register map

The MODBUS/TCP register map is identical to the pyrometers. No MODBUS locations are added or removed. See the pyrometer documentation “BASF Communication Specification.pdf“ for details.