

**MC-4040**  
**SMARTREPEATER**  
**(ALSO USED IN MC-4020)**

**Manual Part Number 180-0558B**

**December 16, 2004**

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# 1. INTRODUCTION

## 1.0. General

The American Mine Research MC-4040-SR Smart Repeater/Splitter is an upgrade of the MC-4040 Repeater/Splitter. The Smart Repeater/Splitter uses a re-designed 253-0364 PC Board Assembly that provides significant improvement in the MC-4000 Mine Monitoring System performance. In addition to regenerating the input port signal and sending the signal to the three output ports, it provides the MC-4000 System Master Station operator information to troubleshoot and isolate a communications problem. It may be used as a Line-Powered (28 VDC power from the data transmission line) repeater or it may be installed in a MC-4020 Remote or BM-4000 Belt Master and powered locally.

## 1.1. Features

The features of the MC-4040-SR Smart Repeater/Splitter are summarized below:

- Replaces MC-4040 Repeater/Splitter.
- Regenerates data line communications signal.
- Comm Output Port Transceiver devices fault protected to +/- 60 VDC
- 15 VDC to 28 VDC Line-Powered or powered from MC-4020 Remote.
- Comm Input Port isolated from three output ports when MC-4020 powered.
- Allows Master Station operator to remove 28 VDC power from and/or disable communications to the output ports.
- 38.4 Kbaud rate.
- Kill-Feature for use with MC-4020 Remote.
- May be used with the MC-4020 I/O PC Board.
- BCD Switch Addressable from 1-99.
- Transmit and Receive LEDs on all ports simplifies troubleshooting.
- Biased and terminated output ports.
- Transient protection of output ports.
- Input and output port communication chips in sockets.
- Smart Repeater locks out comm ports with communication problems.
- Smart Repeater removes power from comm output ports if shorted.
- Selectable 400 milliamperes or 250 amperes comm port short circuit value
- Smart Repeater Analog Data available at Master Station.
  - 1) Comm Line bias voltages for three ports.
  - 2) Comm Line received data peak voltages for three ports.
  - 3) Communication errors for three ports.
  - 4) DC voltage value powering the Smart Repeater PC board.
  - 5) Current drain for each of the three output ports.

## **1.1. Features (cont.)**

- Smart Repeater Digital Data available at Master Station:
  - 1) Port Open status indication for three ports.
  - 2) Port Short status indication for three ports.
  - 3) AC Power indication when used with MC-4020 Remote.
  - 4) Comm Port short circuit current trip value.
  - 5) Comm port short circuit current trip enable/disable selection.
  - 6) Kill Switch position.
  
- Smart Repeater Controls available at Master Station:
  - 1) Enable/Disable communications with three output ports.
  - 2) Reset Comm Port Error Count
  - 3) Apply/Remove DC power to/from three output ports.
  - 4) Kill Remote when powered from MC-4020.

## 2. SPECIFICATIONS

- Size: 12"W x 8.25"H x 4.75"D
- Weight: 12 lbs.
- Operating Voltage: +15VDC to +28VDC
- Operating Current: 115 ma. At 15VDC  
95 ma. At 20 VDC  
75 ma. At 28 VDC
- Comm Port Short  
Circuit Current Value: 250 for Line Power 4040  
400 for MC-4020
- Input Port: 2-Wire Isolated RS-485
- Output Ports: Three 2-Wire RS-485

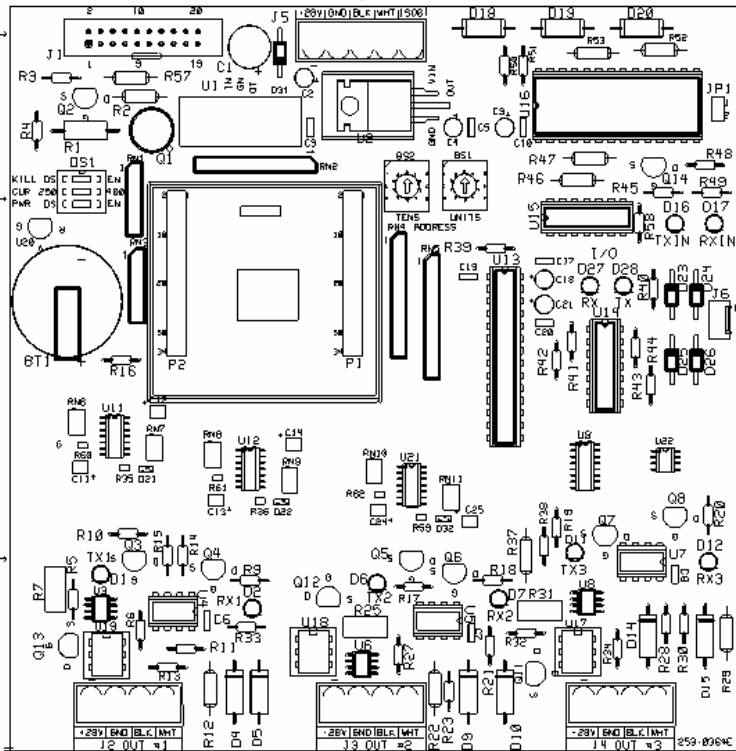
J5 COMM INPUT CONNECTOR

POS	LABEL	FUNCTION	CONNECTIONS
1	-28V	DC POWER INPUT FOR PCB	1) OUTBY DATA LINE DC POWER + 2) 402B I/O PCB I+ POWER + 3) BMS-4000 POWER SUPPLY +
2	GND	DC GROUND INPUT FOR PCB	1) OUTBY DATA LINE DC POWER GND 2) 402B I/O PCB I+ POWER GND 3) BMS-4000 POWER GND
3	BLK	DATA - INPUT SIGNAL	OUTBY DATA LINE -
4	WHT	DATA - INPUT SIGNAL	OUTBY DATA LINE -
5	ISOG	ISOLATE DC GROUND INPUT	OUTBY DATA LINE DC POWER GND WHEN USED WITH MC-4020 REMOTE OR BMS-4000 BELT MASTER REMOTE

J1 CONNECT TO MC-4020  
POWER SUPPLY PCB

DS1 SWITCH

POS	LABEL	OFF	ON
1	KILL	KILL REMOTE DISABLED	KILL REMOTE ENABLED
2	CUR	250 MA	400 MA
3	PWR	DISABLE	ENABLE



J2, J3, J4 COMM OUTPUT CONNECTOR

POS	LABEL	FUNCTION	CONNECTIONS
1	-28V	DC POWER OUTPUT FOR INBY DEVICES	INBY DATA LINE DC POWER +
2	GND	DC POWER GROUND FOR INBY DEVICES	INBY DATA LINE DC POWER GROUND
3	BLK	DATA - OUTPUT SIGNAL FOR INBY DEVICES	INBY DATA LINE -
4	WHT	DATA - OUTPUT SIGNAL FOR INBY DEVICES	INBY DATA LINE -

FIGURE 1, SMART REPEATER/SPLITTER CONNECTION DIAGRAM



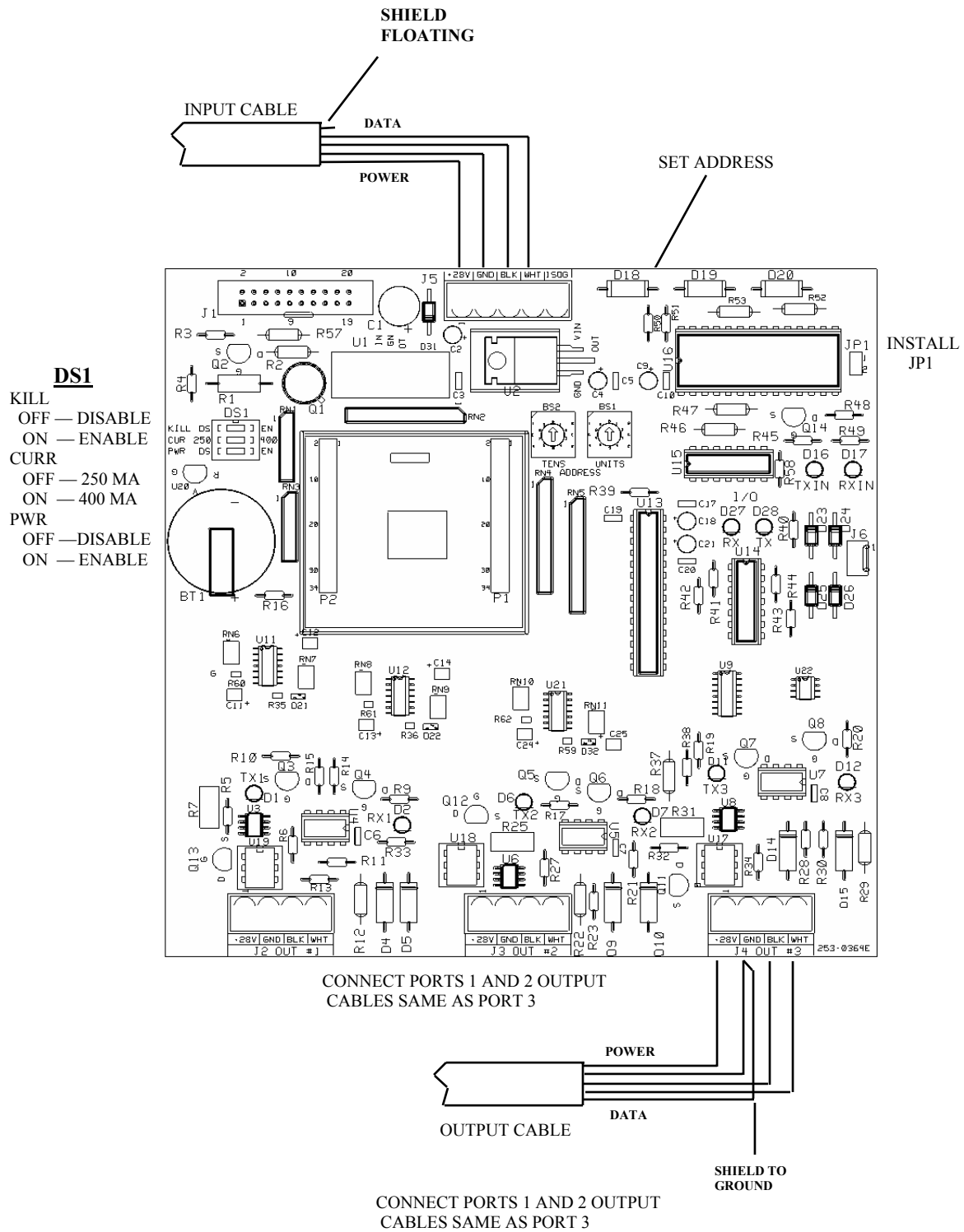


FIGURE 2, LINE POWERED SMART REPEATER/SPLITTER INSTALLATION

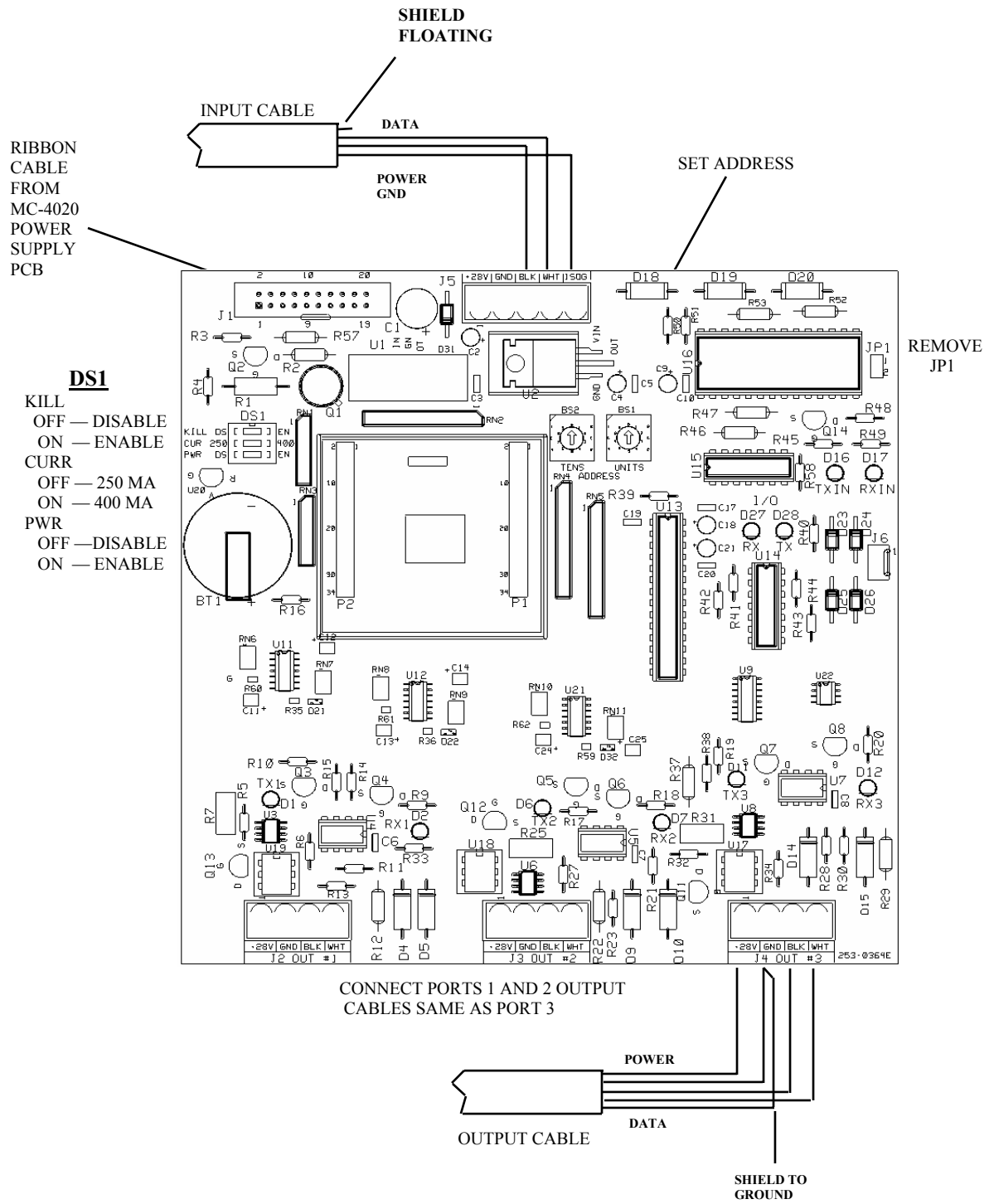


FIGURE 3, MC-4020 SMART REPEATER/SPLITTER INSTALLATION

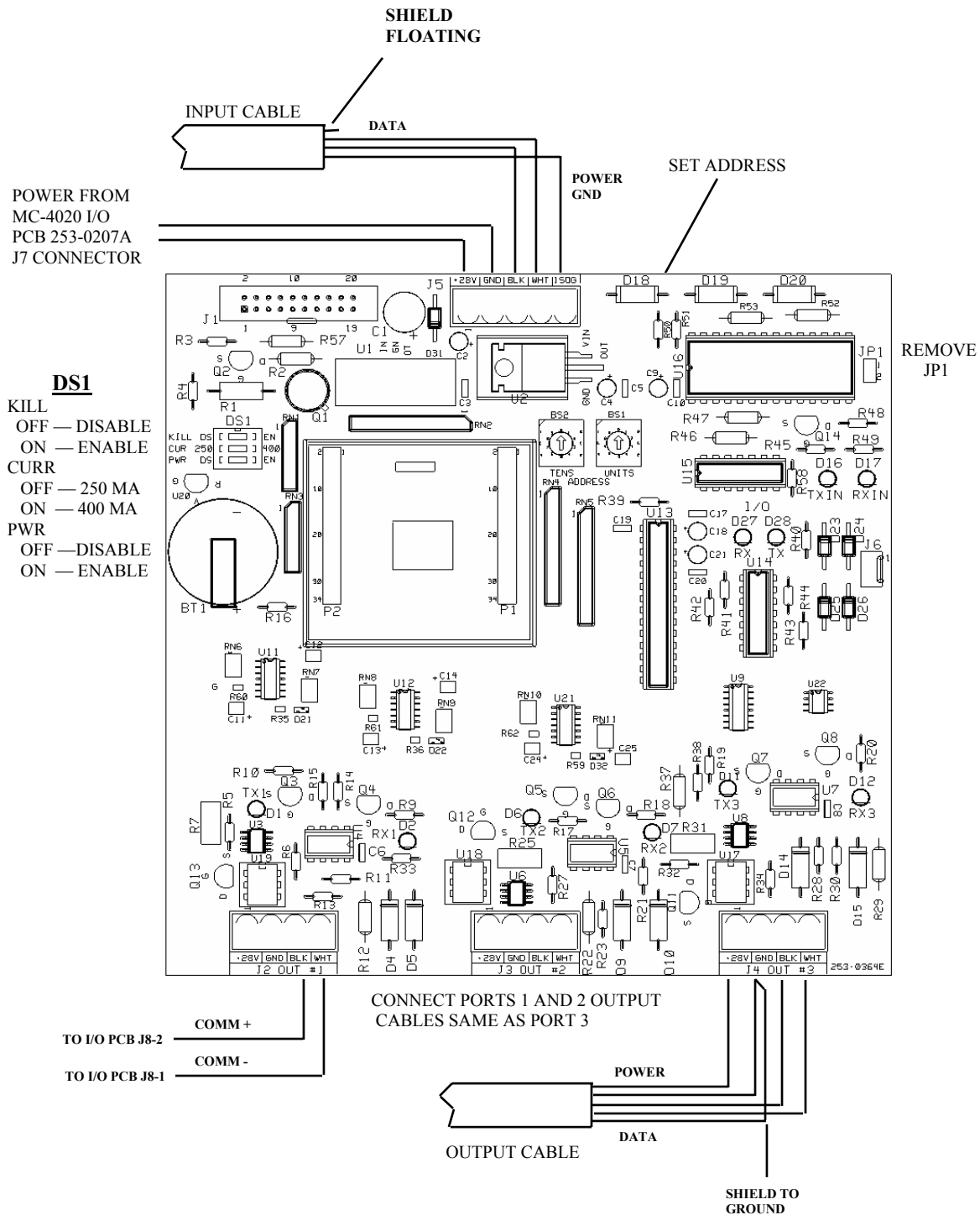


FIGURE 4, MC-4020 I/O SMART REPEATER/SPLITTER INSTALLATION

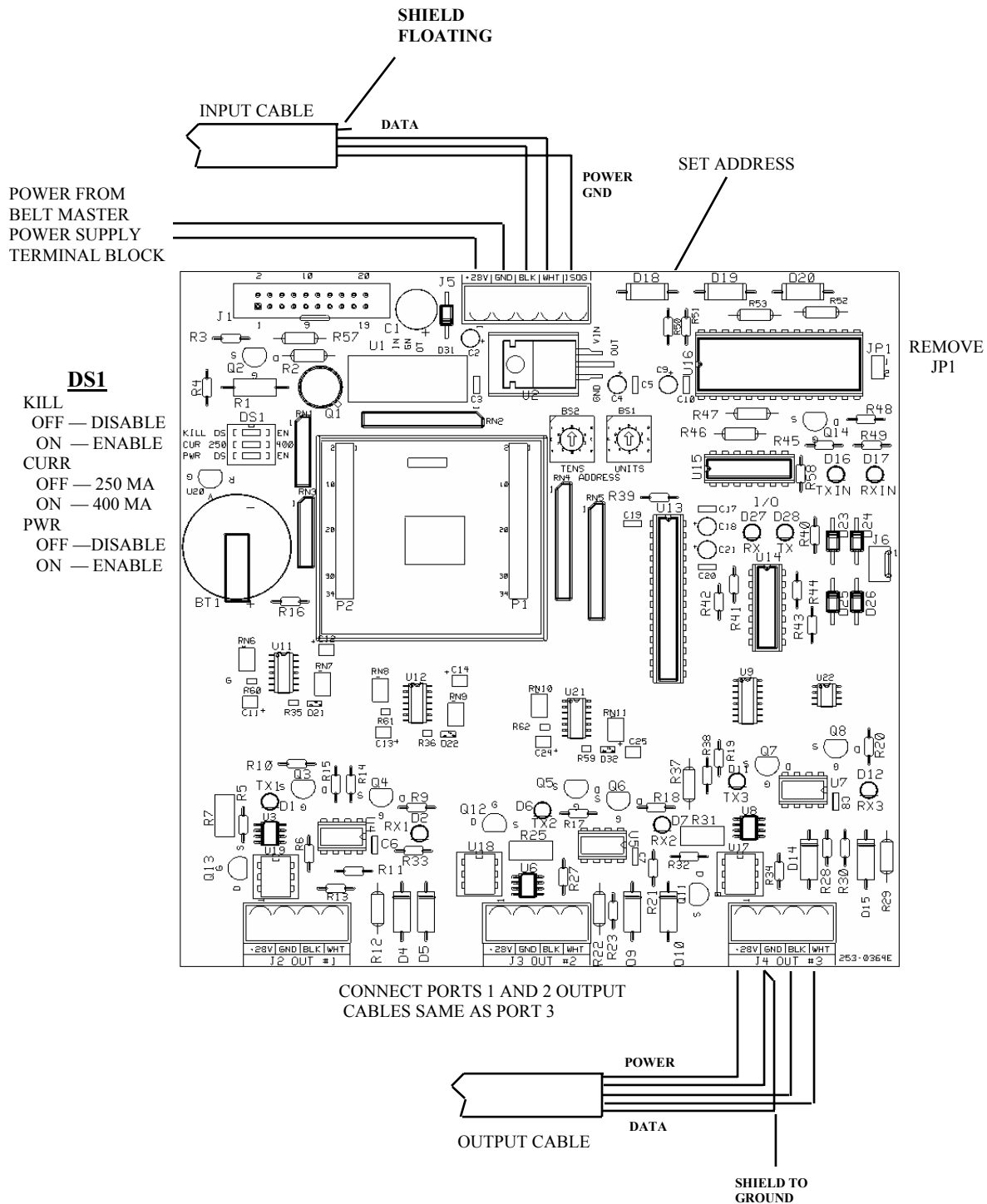


FIGURE 5, BMS-4000 SMART REPEATER/SPLITTER INSTALLATION

### 3. INSTALLATION

**Note: To fully receive the benefits of using the 253-0364 Smart Repeater PC Board when it is used to replace existing 253-0211 Repeater PC Boards in a mine-wide monitoring system, the 253-0211 PC Boards should be replaced from “Outby”(first repeater connected to the Master Station) to “Inby”.**

The MC-4040-SR may be used as a Line-Powered Repeater/Splitter. When used in this manner, the Repeater/Splitter receives its power from the pair of wires that are a part of the communications line. In this mode of operation, the input communications port **IS NOT ISOLATED** from the three output ports because the input power and output power ground systems must be connected.

The MC-4040-SR (253-0364) PC Board may be used with the MC-4020 Remote. When used in this manner, it receives its power from the MC-4020 Remote Power Supply. In this mode of operation, the input communications port ground **IS ISOLATED** from the ground system of the three output ports. This isolation of ground systems is beneficial because it reduces ground loop noise thus resulting in improved communications.

The MC-4040-SR (253-0364) PC Board may also be used with the BMS-4000 Belt Master Remote.

#### 3.1. Line-Powered Smart Repeater/Splitter(Refer to Figures 1 and 2)

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##### 3.1.1. J5 Input Port Connections:

- 1) Connect the Outby Comm Line (+ DC) voltage wire to J5-1(28VDC).
- 2) Connect the Outby Comm Line (—DC) voltage wire to J5-2(GND).
- 3) Connect the Outby Comm Line (Comm +) wire to J5-3(BLK).
- 4) Connect the Outby Comm Line (Comm -) wire to J5-4(WHT).
- 5) Insure that the Outby Comm Line shield wire is **NOT CONNECTED**.

##### 3.1.2. J2, J3, J4 Output Port Connections:

- 1) Connect the Inby (+ DC) voltage wire to JX-1(28VDC).
- 2) Connect the Inby (—DC) voltage wire to JX-2(GND).
- 3) Connect the Inby (Comm +) wire to JX-3(BLK).
- 4) Connect the Inby (Comm -) wire to JX-4(WHT).
- 5) Connect the Inby Comm Line shield wire to JX-2(GND).

### **3.1. Line-Powered Smart Repeater/Splitter(Cont.)**

#### 3.1.3. DS1 Switch

- 1) DS1-1 rocker switch to (OFF, left) position to Disable Kill..
- 2) DS1-2 rocker switch to (OFF, left) position to set comm port current over current value to 250 milliamperes. (ON, right) for 400 milliamperes.
- 3) DS1-3 rocker switch to (OFF, left) position to Disable port over-current.

#### 3.1.4. BS1 and BS2 Switches:

- 1) Use BS1 to select the remote address units value.
- 2) Use BS2 to select the remote address tens value.

#### 3.1.5. JP1 Isolated Ground Jumper:

**Install Jumper JP1** to connect the J5 Input Port ground to the Comm Output Port ground system.

### **3.2. MC-4020 Powered Smart Repeater/Splitter(Refer to Figures 1 and 3)**

#### 3.2.1. J1 Ribbon Cable Connector:

Remove power from the MC-4020 Remote and place the ribbon cable plug from the remote power supply PCB into Smart Repeater/Splitter PC Board J1.

#### 3.2.2. J5 Input Port Connections:

- 1) Connect the Outby Comm Line (—DC) voltage wire to J5-5(ISOGND).
- 2) Connect the Outby Comm Line (Comm +) wire to J5-3(BLK).
- 3) Connect the Outby Comm Line (Comm -) wire to J5-4(WHT).
- 4) Insure that the Outby Comm Line shield wire is **NOT CONNECTED**.

#### 3.2.3. J2, J3, J4 Output Port Connections:

- 1) Connect the Inby (+ DC) voltage wire to JX-1(28VDC).
- 2) Connect the Inby (—DC) voltage wire to JX-2(GND).
- 3) Connect the Inby (Comm + ) wire to JX-3(BLK).
- 4) Connect the Inby ( Comm - ) wire to JX-4(WHT).
- 5) Connect the Inby Comm Line shield wire to JX-2(GND).

#### 3.2.4. DS1 Switch:

- 1) DS1-1 rocker switch to (OFF, left) position to Disable Kill..
- 2) DS1-2 rocker switch to (OFF, left) position to set comm port current over current value to 250 milliamperes. (ON, right) for 400 milliamperes.
- 3) DS1-3 rocker switch to (OFF, left) position to Disable port over-current.

## **3.2. MC-4020 Powered Smart Repeater/Splitter(Cont.)**

### 3.2.5. BS1 and BS2 Switches:

- 1) Use BS1 to select the remote address units value.
- 2) Use BS2 to select the remote address tens value.

### 3.2.6. JP1 Isolated Ground Jumper:

**Remove Jumper JP1** to isolate the J5 Input Port ground from the Comm Output Port ground system.

## **3.3. MC-4020 Powered Smart Repeater/Splitter with I/O PC Board (Refer to Figures 1 and 4)**

### 3.3.1. Remote I/O PC Board:

Install the Remote I/O PC Board (253-0207) as described in manual 180-0210A.

### 3.3.2. J5 Input Port Connections:

- 1) Connect the (+ DC) voltage from J7-1 of the I/O PC Board to J5-1.
- 2) Connect the (—DC) voltage from J7-2 of the I/O PC Board to J5-2.
- 3) Connect the Outby Comm Line (Comm +) wire to J5-3(BLK).
- 4) Connect the Outby Comm Line (Comm -) wire to J5-4(WHT).
- 5) Insure that the Outby Comm Line shield wire is **NOT CONNECTED**.

### 3.3.3. J2, J3, J4 Output Port Connections:

- 1) Connect the Inby (+ DC) voltage wire to JX-1(28VDC).
- 2) Connect the Inby (—DC) voltage wire to JX-2(GND).
- 3) Connect the Inby (Comm + ) wire to JX-3(BLK).
- 4) Connect the Inby ( Comm - ) wire to JX-4(WHT).
- 5) Connect the Inby Comm Line shield wire to JX-2(GND).

### 3.3.4. J8 Remote I/O PC Board (253-0207) Connections:

- 1) Connect the I/O PC Board J8-1 (Comm - ) wire to J2-4(WHT).
- 1) Connect the I/O PC Board J8-2 (Comm + ) wire to J2-3(BLK).

### 3.3.5. DS1 Switch:

- 1) DS1-1 rocker switch to (OFF, left) position to Disable Kill..
- 2) DS1-2 rocker switch to (OFF, left) position to set comm port current over current value to 250 milliamperes. (ON, right) for 400 milliamperes.
- 3) DS1-3 rocker switch to (OFF, left) position to Disable port over-current.

### 3.3.6. BS1 and BS2 Switches:

- 1) Use BS1 to select the remote address units value.
- 2) Use BS2 to select the remote address tens value.

### **3.3. MC-4020 Powered Smart Repeater with I/O PC Board(cont.)**

#### 3.3.7. JP1 Isolated Ground Jumper:

**Remove Jumper JP1** to isolate the J5 Input Port ground from the Comm Output Port ground system.

### **3.4. BMS-4000 Powered Smart Repeater/Splitter (Refer to Figures 1 and 5)**

#### 3.4.1. J5 Input Port Connections:

- 1) Connect the (+ DC) voltage from BM Power Supply TB2-7 to J5-1.
- 2) Connect the (—DC) voltage from BM Power Supply TB2-10 to J5-2.
- 3) Connect the Outby Comm Line (Comm +) wire to J5-3(BLK).
- 4) Connect the Outby Comm Line (Comm -) wire to J5-4(WHT).
- 5) Insure that the Outby Comm Line shield wire is **NOT CONNECTED**.

#### 3.4.2. J2, J3, J4 Output Port Connections:

- 1) Connect the Inby (+ DC) voltage wire to JX-1(28VDC).
- 2) Connect the Inby (—DC) voltage wire to JX-2(GND).
- 3) Connect the Inby (Comm +) wire to JX-3(BLK).
- 4) Connect the Inby (Comm -) wire to JX-4(WHT).
- 5) Connect the Inby Comm Line shield wire to JX-2(GND).

#### 3.4.3. DS1 Switch

- 1) DS1-1 rocker switch to (OFF, left) position to Disable Kill..
- 2) DS1-2 rocker switch to (OFF, left) position to set comm port current over current value to 250 milliamperes. (ON, right) for 400 milliamperes.
- 3) DS1-3 rocker switch to (OFF, left) position to Disable port over-current.

#### 3.4.4. BS1 and BS2 Switches:

- 1) Use BS1 to select the remote address units value.
- 2) Use BS2 to select the remote address tens value

#### 3.4.5. JP1 Isolated Ground Jumper:

**Remove Jumper JP1** to isolate the J5 Input Port ground from the Comm Output Port ground system.



### **3.5. Master Station Polling of the Smart Repeater/Splitter**

- 1) In order to use the Smart Repeater/Splitter, the Monitor System Master Station computer must have the WinMac program installed with the Smart Repeater/Splitter as an optional **Remote Type**.
- 2) From the Configuration Menu select either the Line Powered or AC Power Smart Repeater/Splitter type. The proper Default parameters will be used by the computer to calculate and display analog values and digital conditions.
- 3) Enable communications with the Smart Repeater/Splitter PC Board.
- 4) Select Smart Repeater/Splitter address from the Remote Status Menu.
- 5) Use the Detail Button to view the Analog and Digital Status.
- 6) Use the Controls portion of the Status Menu to disable communications, reset Communication Output Port Errors or remove power from the Communication Output Ports.

## **4. INTERPRETATION OF DATA**

Interpretation of the Smart Repeater/Splitter data available at the Master Station will allow the operator to quickly isolate and correct a data line communications problem.

### **4.1. Analog Channel Data**

#### **4.1.1. Port Bias**

The correct comm output port bias voltage is an indication that the communications line is properly terminated and it does not have an external voltage applied to the communications line. A properly terminated line will have a bias voltage reading between 0.15 VDC and 0.45 VDC, depending on the condition and length of the wire. Voltages less than 0.15 VDC indicate improper termination or a low resistance (SHORT) on the comm output port wire. Voltages higher than 0.45 VDC indicate improper termination or an (OPEN) in the comm output port wire.

#### **4.1.2. Port Level**

The correct comm output port level voltage is an indication of the peak to peak signal level of the reply from the devices attached to the comm output port. Values below 0.5 volts or above 5 indicate problems with the wiring or the device/s attached to the comm output port.

#### **4.1.3. Port Errors**

Port errors is an indication of problems with the structure of the reply from a device or devices attached to the comm output port. It could be caused by comm line noise or a problem with a remote or sensor. Use the Master Station Remote Controls Window Enable/Disable Button to reset communication port errors.

#### **4.1.4. Power Supply**

Power Supply voltage indicates the DC voltage present at the Comm Input Port connector J5 positions 1 and 2. This voltage is supplied from the Outby Comm wiring when the Smart Repeater/Splitter is Line Powered. It can also be supplied by the MC-4020 Remote power supply. The voltage should be between 15 VDC and 28 VDC.

#### **4.1.5. Port Draw**

Port Draw is an indication of the current being supplied to devices powered from the Smart Repeater/Splitter Comm Output Port. This current should not exceed 200 milliamperes for line powered the MC-4040 and 300 for use in the MC-4020. Currents above 250 ma for line powered 4040 and 400 ma for the 4020 will cause the Smart Repeater to automatically shutdown the port.

## **4.2. Digital Channel Data**

### **4.2.1. Port Open**

The Smart Repeater/Splitter analyzes the Comm Output Port voltages to determine that they are within acceptable levels. Bias voltages above normal level indicate the port wiring is open or unterminated. The Port Open status flag is then sent to the Master Station. This status flag can be configured by the Master Station operator to activate an alarm.

### **4.2.2. Port Short**

The Smart Repeater/Splitter analyzes the Comm Output Port voltages to determine that they are within acceptable levels. Bias voltages below normal level indicate the port wiring is shorted. The Port Short status flag is then sent to the Master Station. This status flag can be configured by the Master Station operator to activate an alarm. This status flag can also be configured by the Master Station operator to automatically disable the Comm Port communications using the Master Station Digital Auto-Control feature.

### **4.2.3. I/O Comm**

The Smart Repeater/Splitter returns to the Master Station a status flag indicating the Remote I/O PC Board (253-0207A) failed to respond with data.

### **4.2.4. AC Power**

The Smart Repeater/Splitter returns to the Master Station a status flag indicating the presence/absence of AC Power to the MC-4020 Remote Power Supply.

### **4.2.5. Kill Switch**

The Smart Repeater/Splitter returns to the Master Station a status flag indicating the position of the Kill Switch.

### **4.2.6. Port Over-current Value Switch**

The Smart Repeater/Splitter returns to the Master Station a status flag indicating the position of the over-current value (250 ma or 400 ma) at which the SR will remove power from the comm output port. .

### **4.2.7. Over-Current Enable/Disable Switch**

The Smart Repeater/Splitter returns to the Master Station a status flag indicating the position of the comm port over-current enable/disable switch.

## **4.3. Digital Control Channel**

### **4.3.1. Port Enable**

Comm Output Port communications may be enabled/disabled from the Master Station. This feature allows the operator to temporarily isolate any communications line branch that may be causing communications problems with the mine monitoring system. The Port Enable Control may be toggled manually by double clicking on the desired control. Or the Port Enable Control may be automatically toggled by properly configuring the Digital Auto-Control function for each port. Note: A separate control line must be configured to enable and disable the comm port. Communication Port Errors are also cleared when the port is Disabled.

### **4.3.2. Comm Output Port 1 and 2 Power**

Comm Output Port #1 and #2 DC voltage may be applied/removed from the Master Station. This feature allows the operator to turn off/on power to isolate any communications line branch that may be causing problems with the mine monitoring system. The Port Power Control may be toggled manually by double clicking on the desired control. Or the Port Power Control may be automatically toggled by properly configuring the Digital Auto-Control function for each port. Note: A separate control line must be configured to remove/apply power to the comm port.

### **4.3.3. Comm Output Port 3, Remote Kill**

Digital Channel Control #5 has a dual function. If the Smart Repeater/Splitter PC Board DS1 (Kill Enable Switch) is ON, toggling the Digital Channel Control #5 to the OFF condition will Kill power to the MC-4020 Remote. If the Smart Repeater/Splitter DS1 (Kill Enable Switch) is OFF, toggling the Digital Channel Control #5 to the OFF condition will remove DC voltage from Comm Output Port #3.

## **5. TROUBLESHOOTING**

### **5.1. At the Remote**

- 1) Insure that the Smart Repeater/Splitter PC board is installed properly according to the Installation (Section 3) and the intended application.
- 2) Insure that the Smart Repeater/Splitter PC board has 15 VDC to 28 VDC at either connector J1 or J5.
- 3) Verify the communications signal is applied to the Smart Repeater/Splitter PC board Input Port by verifying that the RXIN LED is blinking.
- 4) For each blink of the RXIN LED there should be a corresponding blink of each Output Port TX LED. If the Smart Repeater/Splitter PC board is requesting data from a Remote I/O PC Board, the I/O TX LED will also blink.
- 5) If sensor or remote connected to the Output Port # or I/O port responds to the request for data, the corresponding RX LED will blink and the TXIN LED will blink.
- 6) If a sensor or remote fails to respond to request, move the port output cable to another port.

### **5.2. At the Master Station**

- 1) If a particular branch of the mine monitoring system is experiencing communications problems, use the Remote Status Menu and select the DETAIL Button of the Smart Repeater/Splitter address controlling the branch.
- 2) Observe the Control Channels Window and insure the Port is enabled and Power is ON.
- 3) Use the Digital Channels Window to observe the Port Short, Port Open and Port Fault states.
- 4) Use the Digital Channels Window to confirm AC Power ON, Over-current value and Over-current enable switch states if the Smart Repeater/Splitter PC board is being used with a MC-4020 Remote.
- 5) Use the Analog Channels Window to verify the Power Supply voltage is between 15 VDC and 28 VDC.
- 6) Use the Analog Channels Window to verify the Port Bias voltage is between 0.15 VDC and 0.45 VDC.
- 7) Use the Analog Channels Window to verify the Port Level voltage is greater than 0.5 VDC.
- 8) Use the Analog Channels Window to verify the Port Draw current is consistent with the devices being powered from the port.
- 9) Use the Analog Channels Window to verify the Port Errors is not excessive.

## 6. REPLACEMENT PARTS

<b>Part Number</b>	<b>Description</b>
253-0364	Smart Repeater/Splitter Board
027-0268	Comm Output Port IC
027-0259	Comm Input Port IC
310-0115	Rabbit Core Processor Module