MC-4020
Remote Station

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Manual Part #: 180-0209A

DESIGN AND MANUFACTURE ELECTRONIC EQUIPMENT AMR inc.

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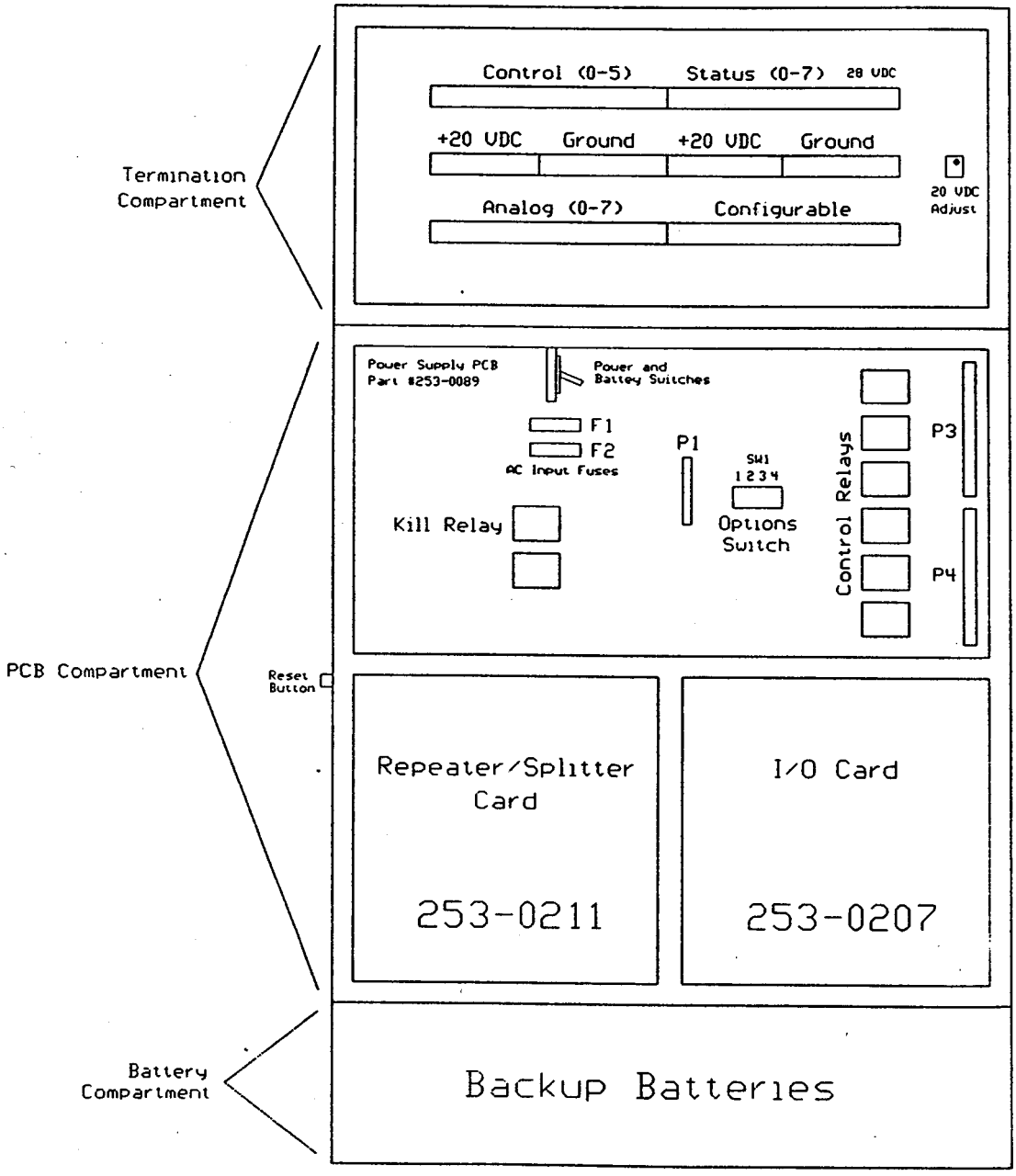
1 Introduction

The MC-4020 is an AC powered remote station with the following features:

- Power supply and batteries to power the unit and provide DC to sensors and other monitoring devices with a minimum of 4 hours battery backup.
- Terminal block area in which to terminate AC power, communications line, analog monitoring, status monitoring, control outputs and to obtain +28 VDC for powering sensors and +20 VDC to power devices in a permissible area through a classified barrier.
- A Repeater/Splitter (#253-0211) card capable of repeating and splitting the MC-4000 data line.
- An I/O (#253-0207) card capable of analog, status and control functions.

The MC-4020 has three compartments as shown in Figure 1. The terminal block board, power and communications line connections are available in the top compartment. The middle compartment houses the power supply and provides space for both the splitter/repeater card and I/O card. The backup batteries are located in the bottom compartment.

Figure 1, MC-4020 Enclosure



1.A Specifications

1.A.1 Physical

Temperature:	0-70 Deg. C.
Humidity:	0-90% RH (no condensation)
Weight:	39 lbs.
Dimensions:	22"H x 13"W x 6"D

1.A.2 Electrical

Input Power:	120 VAC, +15%,-25% at 1 Amp
Emergency Power:	(2) 12VDC, 4.5 AH rechargeable batteries,
	4 hour backup minimum.
Status Functions:	8-16, on-off sensing, 5-240 VAC/DC range, 10 mA maximum.
Analog Functions:	8-16, 8 bit A/D inputs, 0-5 VDC range.
Control Functions:	6, SPST relays rated at 240 VAC, 5 Amp

2. Installation

Installing the MC-4020 is a simple series of tasks which will be explained in the following sections. A summary checklist of this procedure is listed in Section 3.

2.A Setting the Baud Rate and Address

The MC-4000 System offers two different modes of operation as summarized below:

Slow Mode

- 4800 Baud
- Low current allowing more sensors to be placed on a data line before the power has to be repeated.
- Almost any type of data cable can be used.

Fast Mode

- 38.4 kBaud
- Requires 16 gauge low-capacitance data transmission line.

Both modes are quick and efficient. However, the fast mode allows the system to be used for applications where speed is of utmost importance. The mode is selected with position 1 of the Setup Switch of the 253-0211 Repeater/Splitter card (see Figure 2 for detail, Figure 1 for location) where 'ON' is fast and 'OFF' is slow.

For the 253-0211 card's application as an MC-4020, positions 2 and 3 of the Setup Switch should be set to 'OFF'. Position 4 should be set to 'ON'.

Each remote station in the MC-4000 system must have a different address. The address switches, SW1 and SW2 (Figure 2), are self-explanatory. Simply dial up the desired address where SW1 represents the 'ones' place and SW2 represents the 'tens' place.

The 'ADDRESS' and 'CONFIG' switches on the the 253-0207 I/O card (see Figure 3 for detail, Figure 1 for location) are not used in this application and should be set to 0.

Also, a small cable is connect between J4 of the 253-0207 card and J8 of the 253-0211 card.

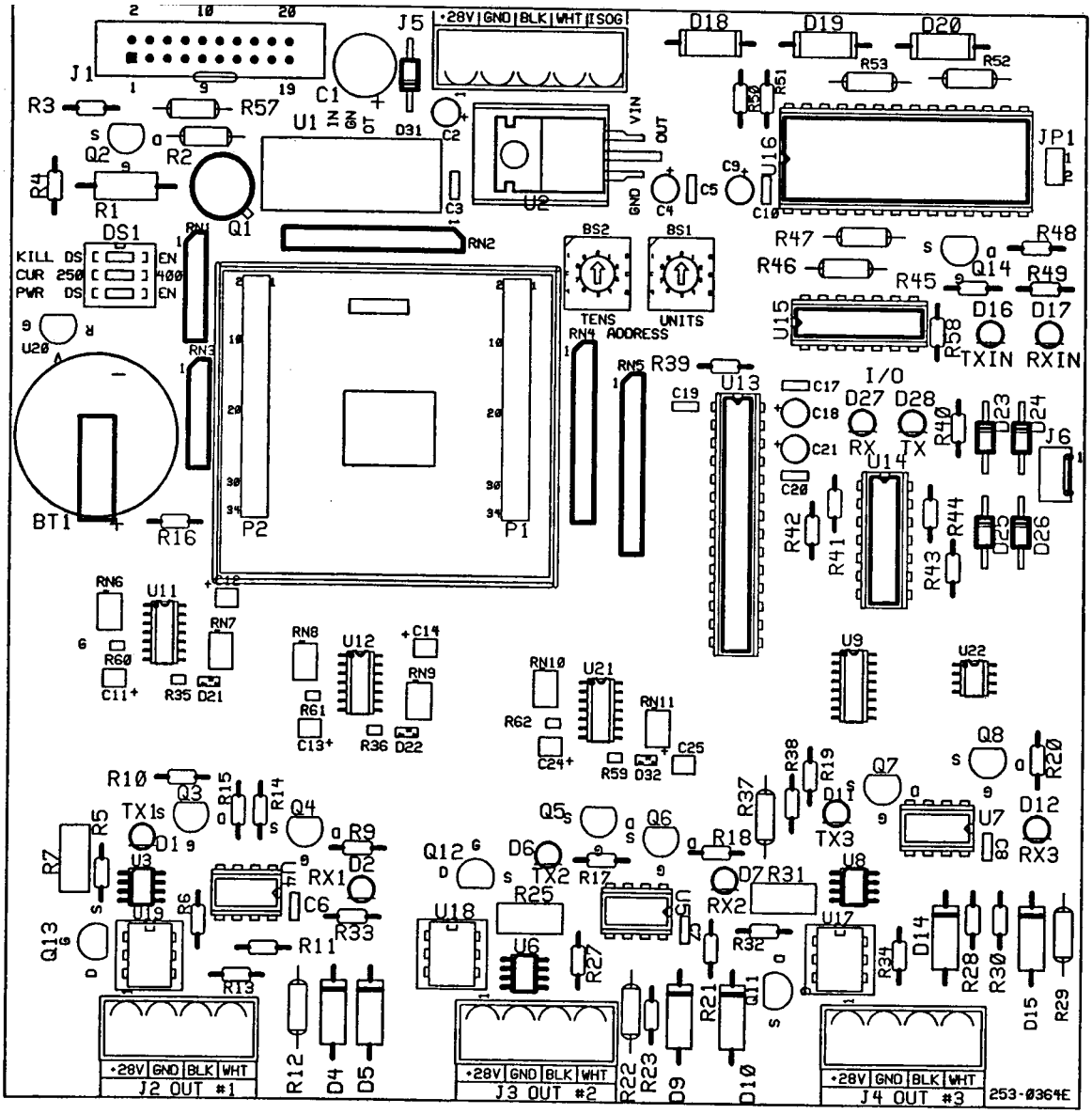
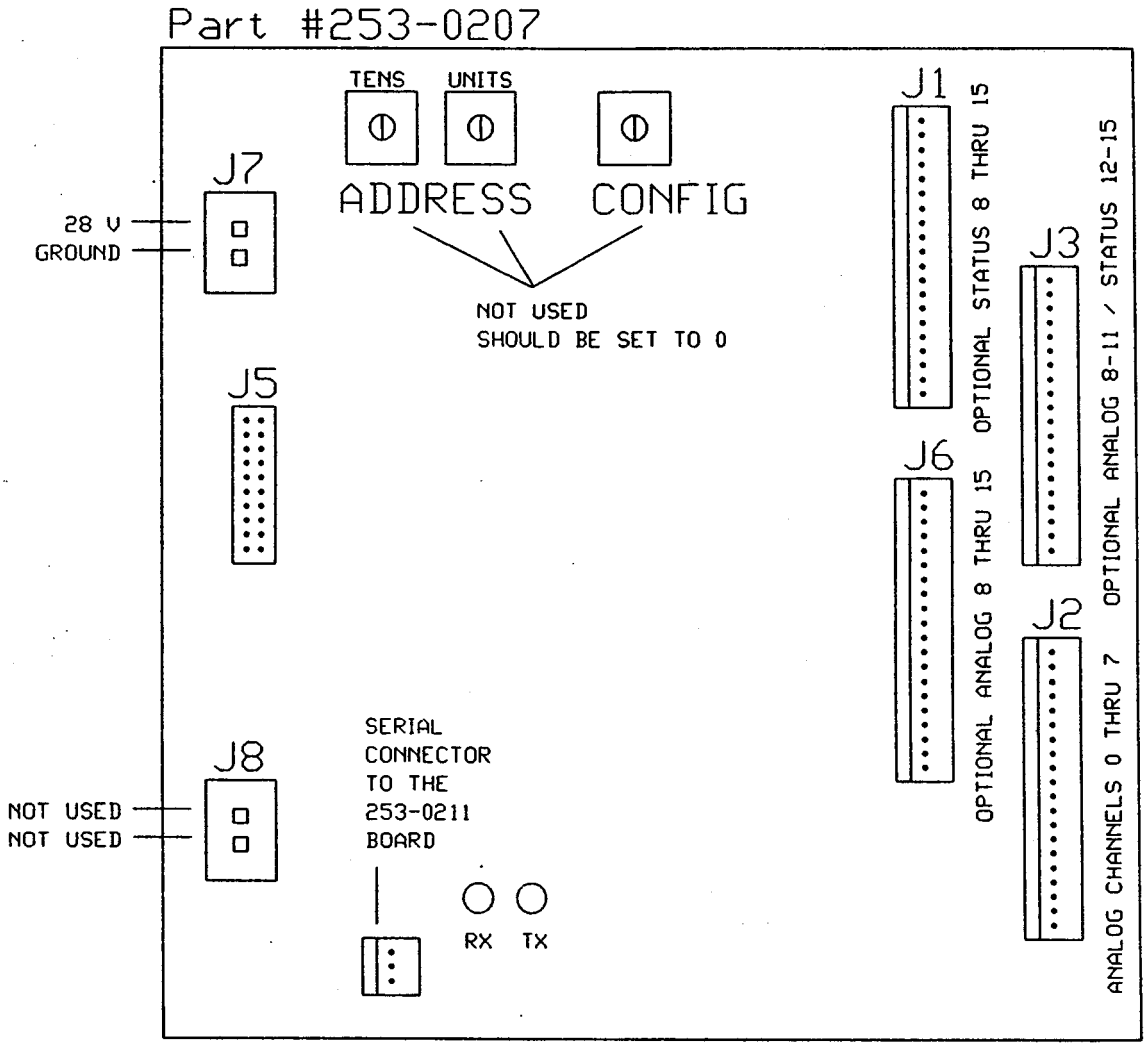

J1
J5
+28V GND BLK WHT ISOG
D18
D19
D20
R53
R52
R3
R57
C1
U1
D31
C2
U2
VIN
OUT
GND
C4
C5
C9
U16
C10
JP1
Q2
R2
R4
R1
Q1
DS1
KILL DS
CUR 250
PWR DS
EN
400
RN1
RN2
BS2
BS1
TENS
UNITS
ADDRESS
R47
R48
R46
R45
Q14
R49
U15
R58
D16
D17
TXIN
RXIN
U20
BT1
R16
P2
P1
RN3
RN4
RN5
R39
U13
C19
C17
C18
C21
C20
I/O
D27
D28
RX
TX
R40
J6
U14
R42
R41
R43
R44
D25
D26
RN6
U11
RN7
R60
C11
R35
D21
RN8
U12
C14
RN9
R61
C13
R36
D22
RN10
U21
R62
C24
R59
D32
RN11
C25
U9
U22
Q8
R20
R10
Q3
TX1
R15
R14
Q4
R5
R9
D1
R7
U3
D2
RX1
C6
R33
R6
U19
Q13
R11
R13
R12
D4
D5
Q12
D6
TX2
R17
Q5
Q6
R18
R37
R38
R19
Q7
TX3
U7
D12
RX3
R25
U18
U6
R27
RX2
R31
D7
U8
U17
R32
R34
D14
R28
R30
D15
R29
R21
Q11
R22
R23
D9
D10
J2 OUT #1
J3 OUT #2
J4 OUT #3
253-0364E

Figure 3, I/O Card Options



2.B Communications

The MC-4020 has one data line input and three data line outputs. These inputs and outputs are brought from the card up to the termination compartment.

The incoming data line should be connected to the terminal block positions marked 'INPUT' in the upper compartment. To utilize one of the outputs, connect the data line to the terminal block in the upper compartment and enable it by sliding the corresponding switch on the card to the 'ON' position (Figure 2).

Receive (RX) and transmit (TX) LEDs are located in the upper right corner of the card to help with troubleshooting. The RX LED indicates that the unit is receiving requests for information from the MC-4010 Master Station. The TX LED will blink when the unit replys to a request containing its own address. The LEDs can be enabled and disabled using the switch located next to them as shown in Figure 1.

2.C Remote Power Up

The AC and battery switches are located on the inside of the unit as shown in Figure 1. When AC power has been connected, turn both these switches on and press the reset switch located on the left side of the unit.

NOTE: Insure that the other end of the cable plugged into J7 of the power supply board is terminated into J5 of the 253-0207 I/O card (Figure 3).

As specified by MSHA the MC-4020 has the ability to be 'killed' by the surface operator in the event of a mine shutdown. Using a relay, the remote 'kills' itself by physically disconnecting the AC line and batteries. The only way to bring the unit 'back to life' is to press the reset button on the left side of the unit.

In some situations, this feature may not be needed. It can be enabled and disabled as follows:

- **Enabled** - place the Options Switch (Figure 1) position 1 *up* and position 4 *down*. To reset the unit when in this mode, the reset button must be pressed and held until the Surface computer instructs the unit the turn the *kill relay* on. When enabled, the kill relay is controlled by channel 5 of the MC-4020. Consequently, this channel should be configured in the MAC software and turned on. (See the MC-4000 MAC Software Manual for more information).
- **Disabled** - place the Options Switch (Figure 1) position 1 *down* and position 4 *up*. In this mode, the unit will automatically reset when the reset button is pressed.

When the MC-4020 has lost AC power and is operating on battery backup, it will automatically 'kill' itself when the batteries drop to a level insufficent to maintain proper operation of the MC-4020.

When implimenting this feature in a total shutdown of the system, care must be taken with respect to the sequence of the remotes killed. The remotes should be deactivated beginning with the most distant one first and then each unit closer to the master, taking care not to kill a repeater until each remote on its branches has been killed first.

2.C.1 Remote AC Power Monitoring

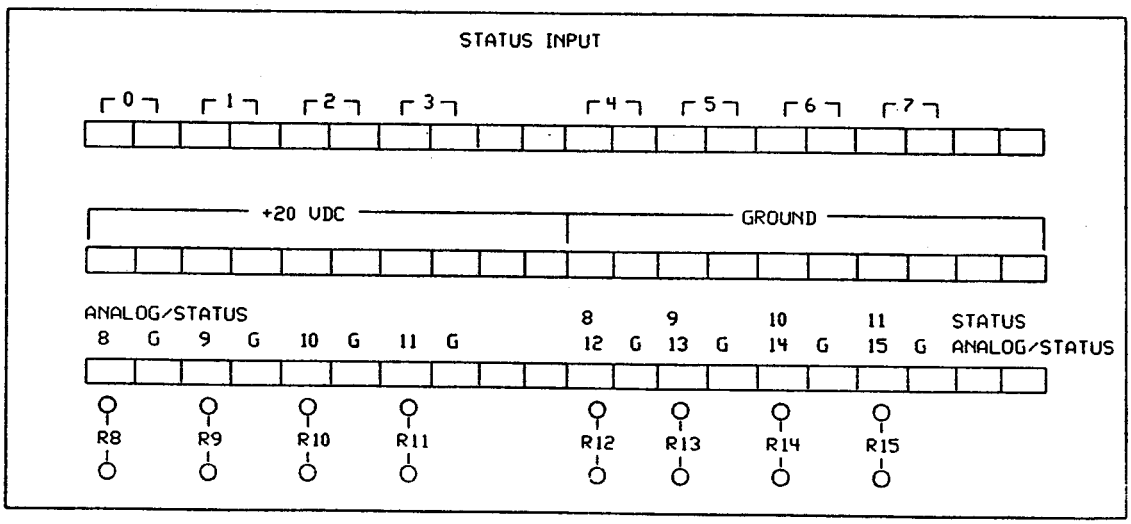
You may want to utilize one of the remotes status channels to monitor the incoming AC power to the unit. To use this option, switches 2 and 3 of the Options Switch (Figure 1) must be in the down position. When enabled, this option occupies channel 7 of the MC-4020. See the MC-4000 MAC Software Manual for instructions on setting up a status channel.

2.D I/O Channels

The MC-4020 can monitor 8 status channels, 8 analog channels and control 6 relay channels. The unit also has 8 additional channels available that can be configured as 8 digital, 8 analog or 4 of each.

The terminations for all of the MC-4020 I/O channels are located in the top compartment as shown in Figure 1. The 8 'CONFIGURABLE' channels are located in the bottom right corner. A more detailed view of this area is shown in Figure 4.

Figure 4, Right Side of the Terminal Block



Four connectors (J1, J2, J3, J6) are located on the 253-0207 I/O card (Figure 3). Two mating cables are terminated here, one of which is always connected to J2. The termination of the other cable determines the use of the 8 'CONFIGURABLE' channels as follows:

- J1 - status channels 8 -15
- J6 - analog channels 8-15
- J3 - status channels 8-11, analog channels 8-11

Figures 5 through 7 show how the terminal block in the top compartment should be used for each configuration.

Figure 5, Status Channels 8 through 15

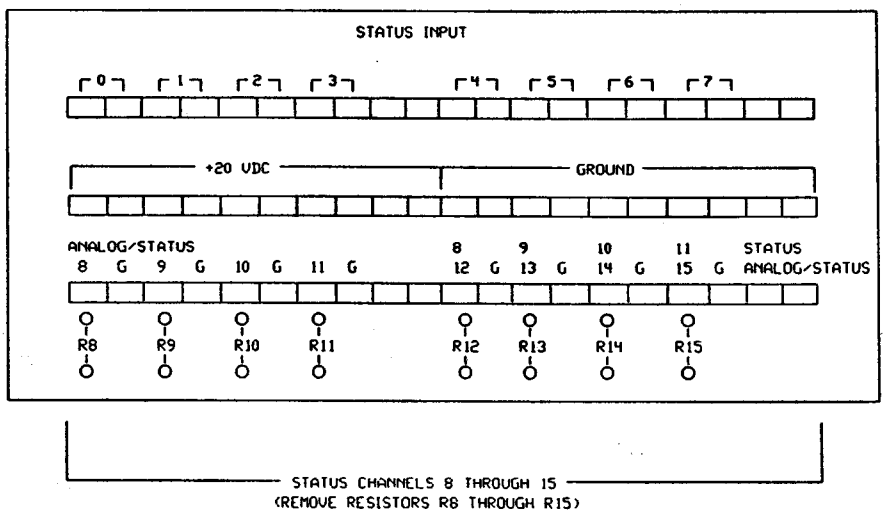


Figure 6, Analog Channels 8 through 15

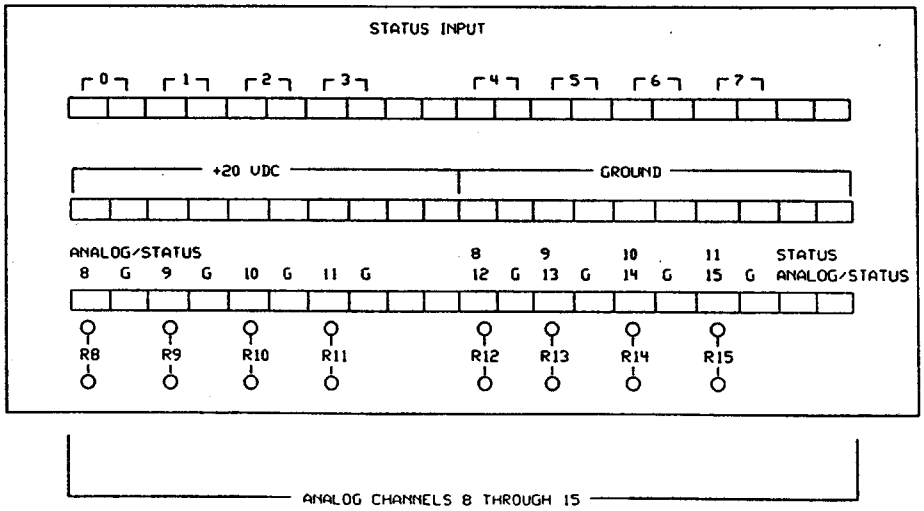
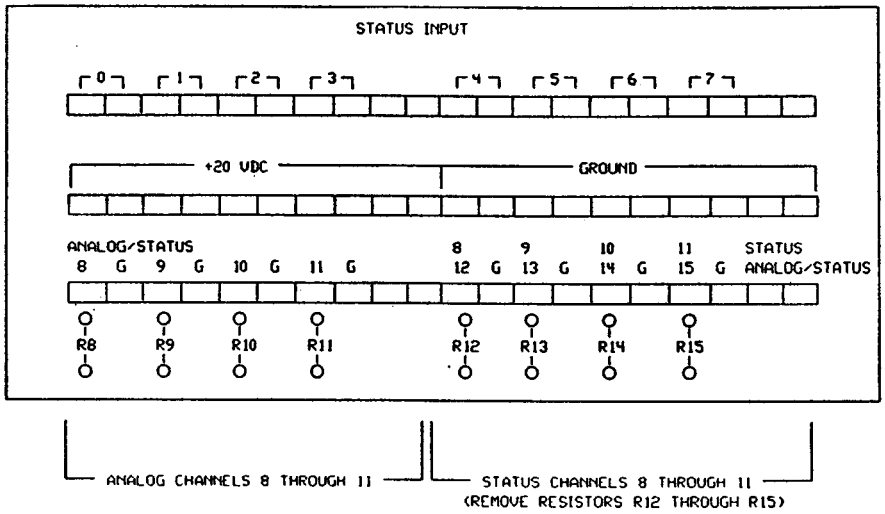


Figure 7, Four Channels of Both



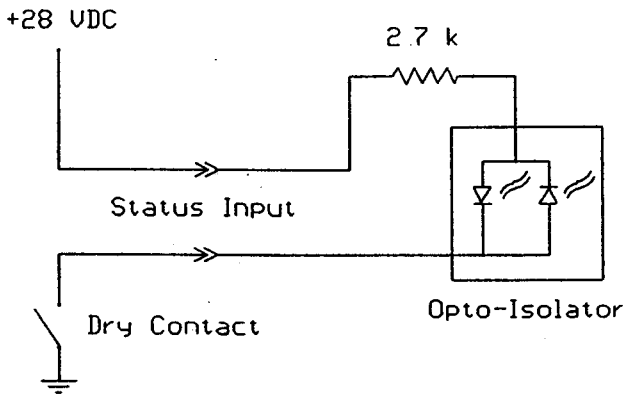
2.D.1 Status Inputs

Each status input is an optically - isolated voltage sensor that requires 5-10 mA of AC or DC current to change states. The current flowing through the opto isolator is limited by use of a series resistor. These resistors are located on the power supply board and are labeled STATUS#0 through STATUS#7 as shown in Figure 14. They can be changed to accommodate whatever voltage the user wants to monitor. However, please note, the current supplied to the opto should not exceed 10 mA and although a current as small as 2 mA may be sensed, 5 mA of current is recommended for stability. When voltage is present, the Remote sees this as an "off" condition, and the absence of voltage as an "on" condition. This is because a closed switch or contact usually indicates that something is running correctly, and a closed switch or contact has no voltage dropped across it.

The power supply board of the MC-4020 is factory configured with 22 k resistors allowing a maximum of 220 VAC/DC to be monitored. A slightly larger resistance can be used to monitor up to 240 VAC/DC.

A 'dry' contact can be monitored by applying a voltage across it as shown in Figure 8. The 28 VDC shown is obtained from the terminal block located beside the status inputs.

Figure 8, Dry Contact Monitoring



In general, connect a small two-conductor wire from the Remote to any switch or contact you want to monitor. Pick the input you want to use and make the connection between the terminal marked with the channel # and the terminal to the right marked G. Remember which input is used. See the MC-4000 MAC Software Manual for instructions on setting up a status channel at the Master Station.

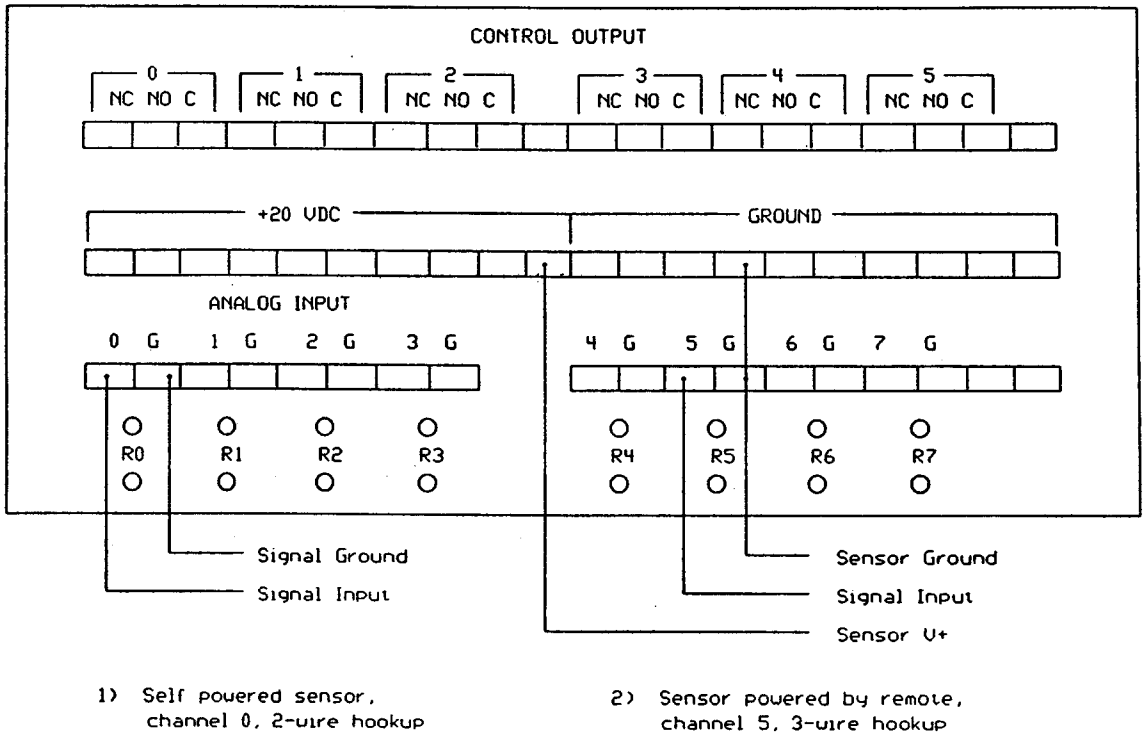
When monitoring any set of contacts that are located in an area where equipment is required to be permissible, a safety barrier of the proper classification must be used. This is necessary to prevent any dangerous voltage levels from entering the permissible area. These contacts must also be monitored with a BLUE Remote. See the section on use and installation of barriers.

2.D.2 Analog Inputs

The analog sensing part of the Remote takes the output of various sensors such as CO monitors or airflow monitors and sends this information to the Master. The A/D converter used in the Remote is rated at 0-5 VDC. Most sensors only put out a maximum of 2 VDC, so ordinarily this won't be a problem.

The most basic setup is that of a 2-wire connection, where the sensor is self-powered and only signal and ground are brought to the Remote. These connections are shown in Figure 9 and labeled on the terminal block of the Remote itself.

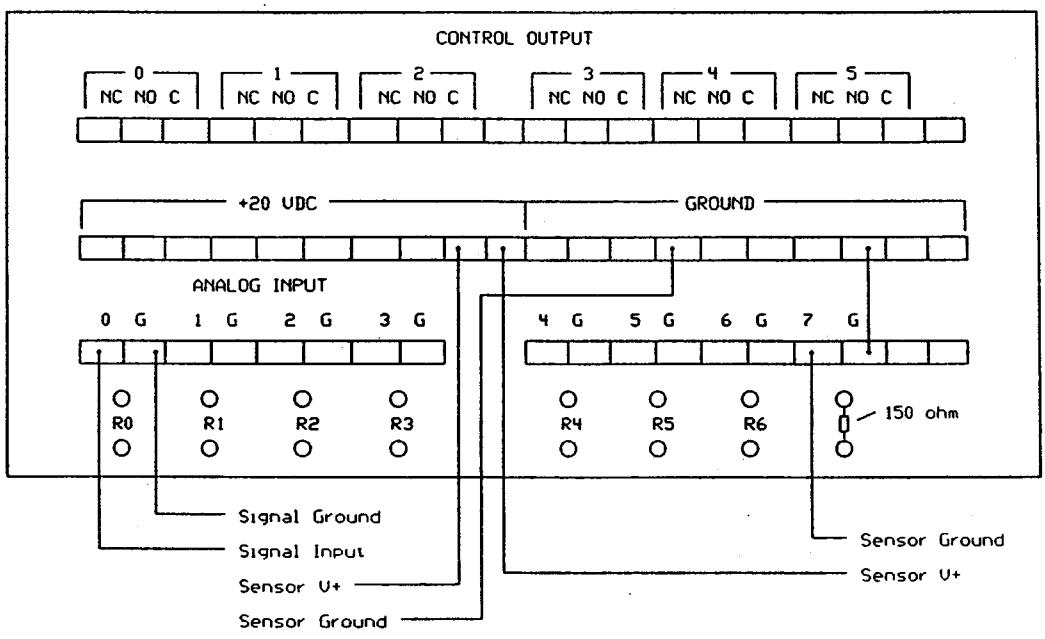
Figure 9, Analog Monitoring



Next, and more common, is that of a 3-wire hookup, where power is fed to the sensor by the Remote. A source of 28VDC at 0.5A is available for powering sensors on the terminal block. The setup for this installation is shown in Figure 9.

In many sensors, two more hookups are quite common. First is the 4-wire sensor, where the sensor requires DC power, DC ground, signal output, and signal ground. In this case the signal and signal ground go to the analog inputs while the DC and DC ground go to the power connections as shown in Figure 10. A 4-20 mA current loop signal is also commonly used, since it is more immune to line noise and line loss. In this configuration, a low value resistor (usually 50 - 150 ohms) is connected in series with the supply ground wire to the sensor. Space on the board is provided for the placement of the resistor. You would then monitor the voltage drop across this resistor with one of the analog inputs. Refer to Figure 10.

Figure 10, Analog Monitoring



3) Differential output sensor, powered by remote, channel 0, 4-wire hookup

4) Current loop sensor, powered by remote, channel 7, 2-wire hookup

When monitoring any sensor that is located in an area where permissible equipment is required, a safety barrier of the proper classification must be used in all connections to that sensor. This sensor must also be monitored with a BLUE Remote. See the section on use and installation of barriers.

2.D.3 Control Outputs

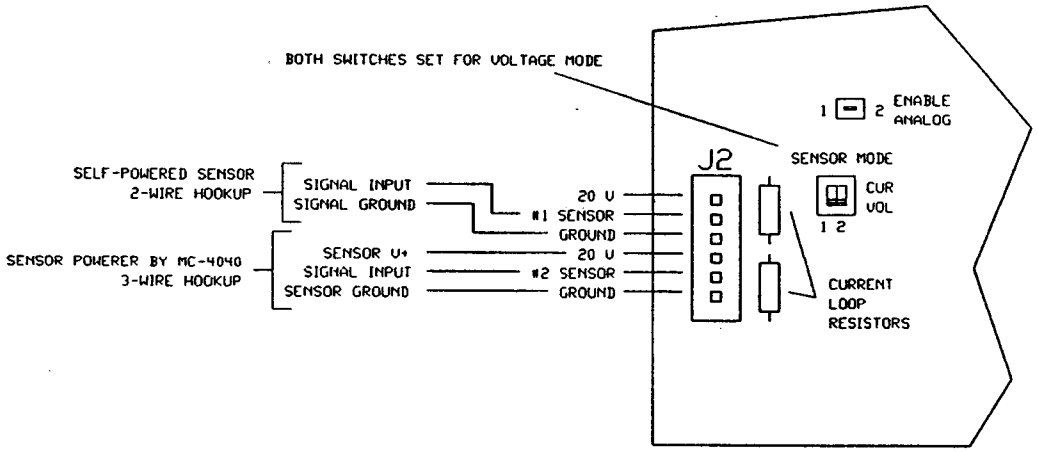
Each Remote has six control relays which can be switched on or off remotely using the Master. These relays are rated at 240VAC, 5A. and have SPST contacts available. Due to the great number of possible hookups, we won't go into detail about their connections. Just think of them as low power control relays which are usually interfaced with contactors or logic for belts, pumps, fans, and so forth.

2.D.4 Repeater/Splitter Analog Inputs

Two extra analog channels are located on the 253-0211 Repeater/Splitter card. Each of these inputs will accept sensors with outputs from 0 to 5 VDC. Current loop sensors which provide a 4-20 mA output are also supported. The most basic configuration where the sensor is self-powered and only the signal and ground are connected to the sensor input is Shown in Figure 11. For this example, the sensor is shown connected to the input marked Sensor #1. Notice that position 1 of the Sensor Mode switch is set for voltage mode.

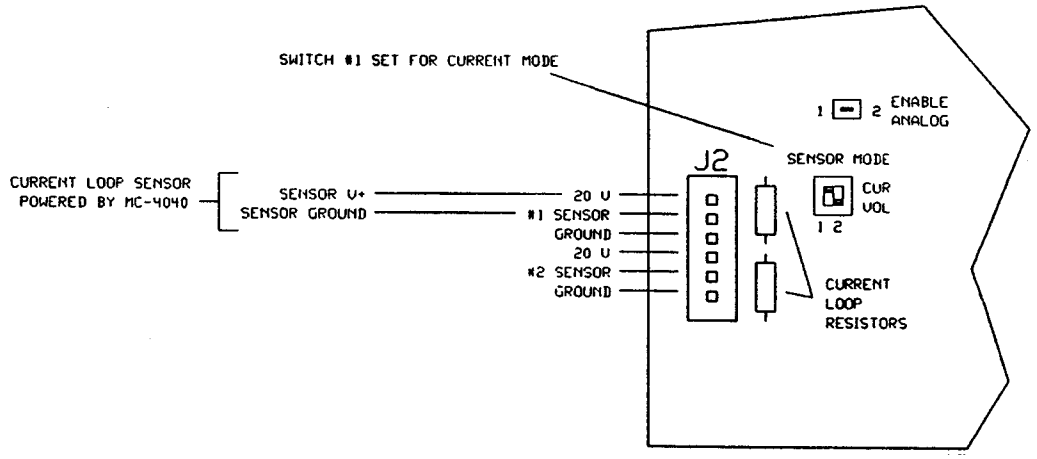
The next possible sensor configuration would be a 3-wire hookup where the sensor is powered from the MC-4020 as shown in Figure 11. The Sensor Mode switch for this type of sensor is also set for voltage mode.

Figure 11, Analog Input Examples



Finally, an example of a current loop sensor is shown in Figure 12.

Figure 12, Analog Input Examples



3 Installation Checklist

- ☐ Set the baud rate and address (Section 2.A).
- ☐ Configure the 'KILL' and the 'REMOTE POWER MONITORING' options (Section 2.C)..
- ☐ Connect the data line to the input and enable and connect as many output lines as necessary (Section 2.B).
- ☐ Connect sensors and monitored points (Section 2.D).
- ☐ Connect power and press the 'RESET' button (Section 2.B)

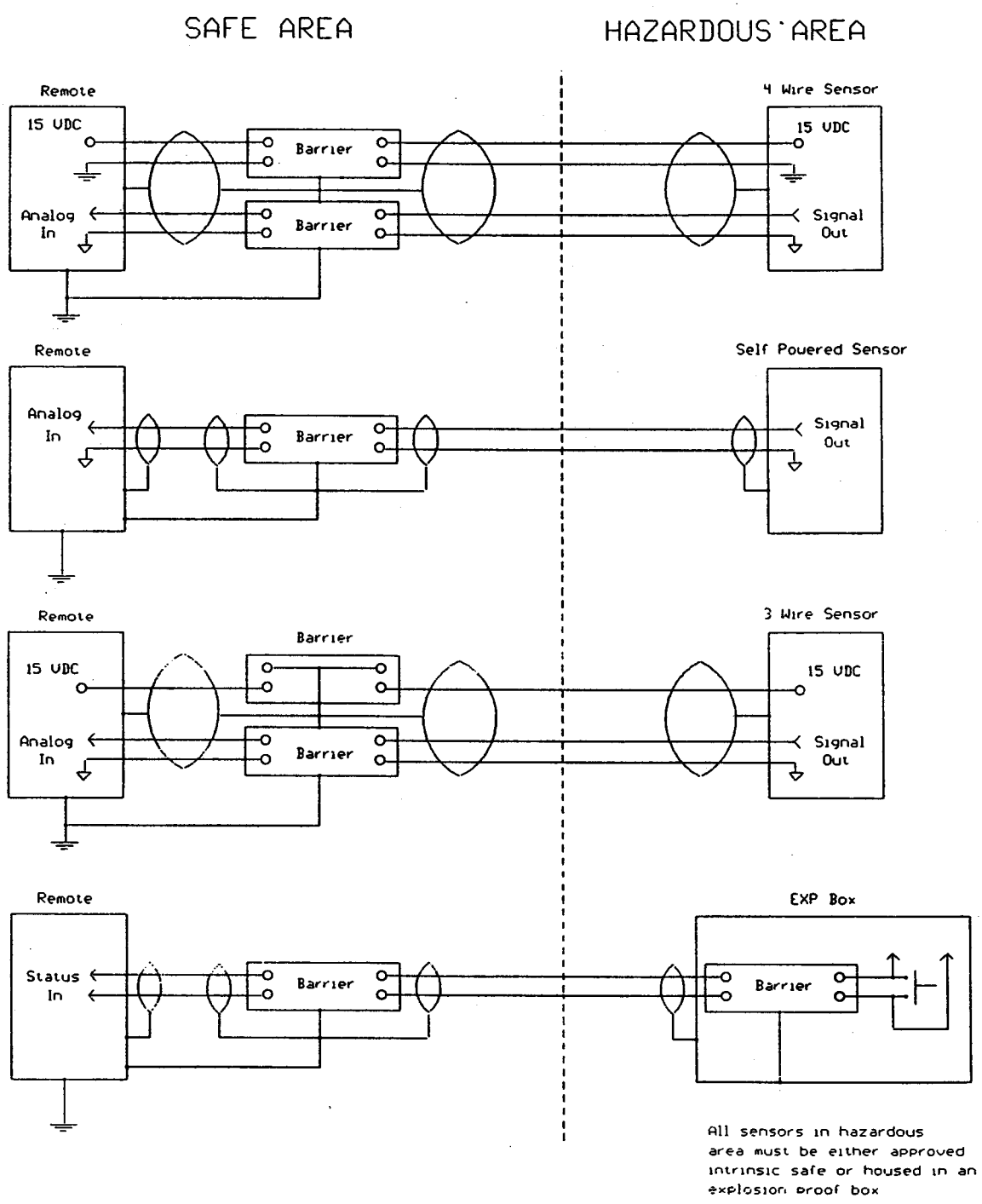
4 Installation of Barriers

Barriers are normally installed in a safe area and connected to the sensor in a hazardous location. No explosion-proof housings are needed, although it is recommended that they be installed in a protective enclosure. Units install singly, in any position or can be grouped on a common, earth-grounded plate, with mounting tabs to provide electrical grounding. Grounding techniques for Remotes and barriers are employed using no less capacity than a No. 12AWG wire.

Barriers or barrier enclosures are attached to the Blue Remotes and are so labeled that barrier outputs identify the type of sensor to which the barrier cable is connected, i.e., CO sensor, CH4 sensor, anemometer.

Figure 13 shows how to connect the various barriers with the various sensors. Refer to MC-4000 System Installation Checklist in the MC-4000 System Installation Manual for further information on the use of barriers. Also refer to the barrier manufacturers information.

Figure 13, Barrier Installation



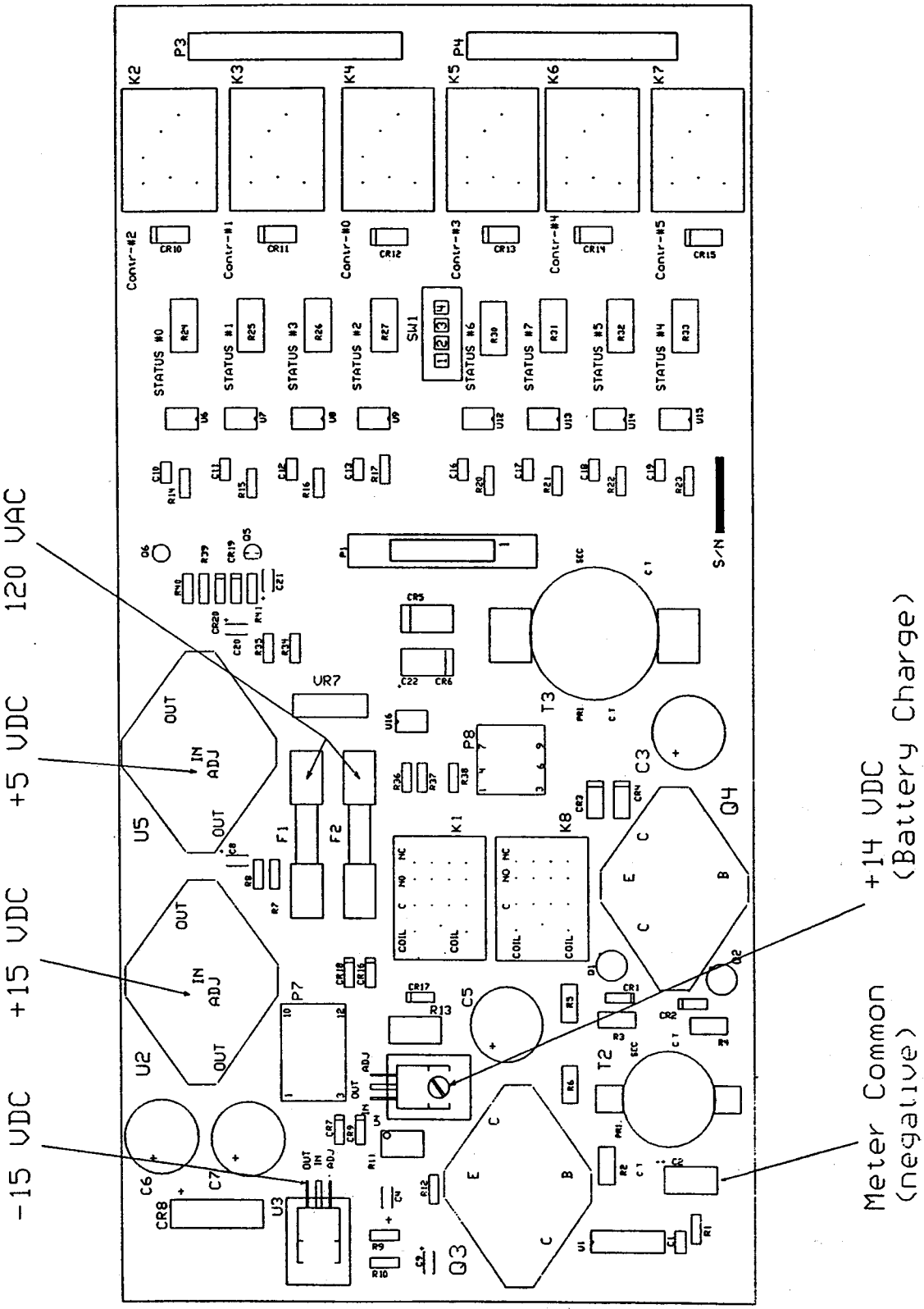
5 Troubleshooting

The MC-4020 has 3 PC boards that can be easily replaced if necessary (Figure 1). The top board in the enclosure, called Power Supply/Interface PCB, contains the +15VDC, -5VDC, +5VDC, and battery charging regulators. It also contains the status input isolators and the control relays. The power supply can be checked with a VOM (volt-ohm meter). Refer to Figure 14 for check points and voltages. If any of these voltages are not correct, the board should be replaced.

The board in the bottom left hand corner of the PCB compartment is the Repeater/Splitter Card. If the unit is not communicating, use the following checklist to determine the source of the problem.

- **Are the communications LED's flashing (ensure that they are enabled)?** If not, check to see if the unit is properly powered. If the unit is powered and the power supply board checks out, then check the communications line to ensure that the unit has a good connection to the rest of the system (replace the fuses if necessary). If all of the above checks out, replace the Repeater/Splitter Card.
- **The communications LED's are flashing but the unit is not replying.** Check the address and baud rate switches. Please note, the address set for this unit must be configured and enabled on the MC-4010 Master Station. If the above checks out, replace the Repeater/Splitter Card.

Figure 14, Power Supply Board (Part #253-0089D)



6 Replacement Parts

Part Number	Description
253-0089	Power Supply
253-0211	Repeater/Splitter Card
253-0207	I/O Card
275-0002	Rechargeable Battery, 12 Volt
253-0206	Strobe PCB
195-0101	Ribbon Cable, 20 Conductor
	Power Supply to I/O Card
195-0069	Control and Status Cable
195-0111	Analog Cable
195-0099	Transformer and Wiring Harness
125-0058	Strobe Lens, Amber
037-0012	Sonalert
065-0008	LED, 120 VAC
050-0005	Switch, Reset
081-0133	Enclosure
165-0009	Fuse Block, Data Line