MC-4020-ET
REMOTE STATION
MINE COMMUNICATIONS UNIT
MANUAL

Manual Part Number 180-0568
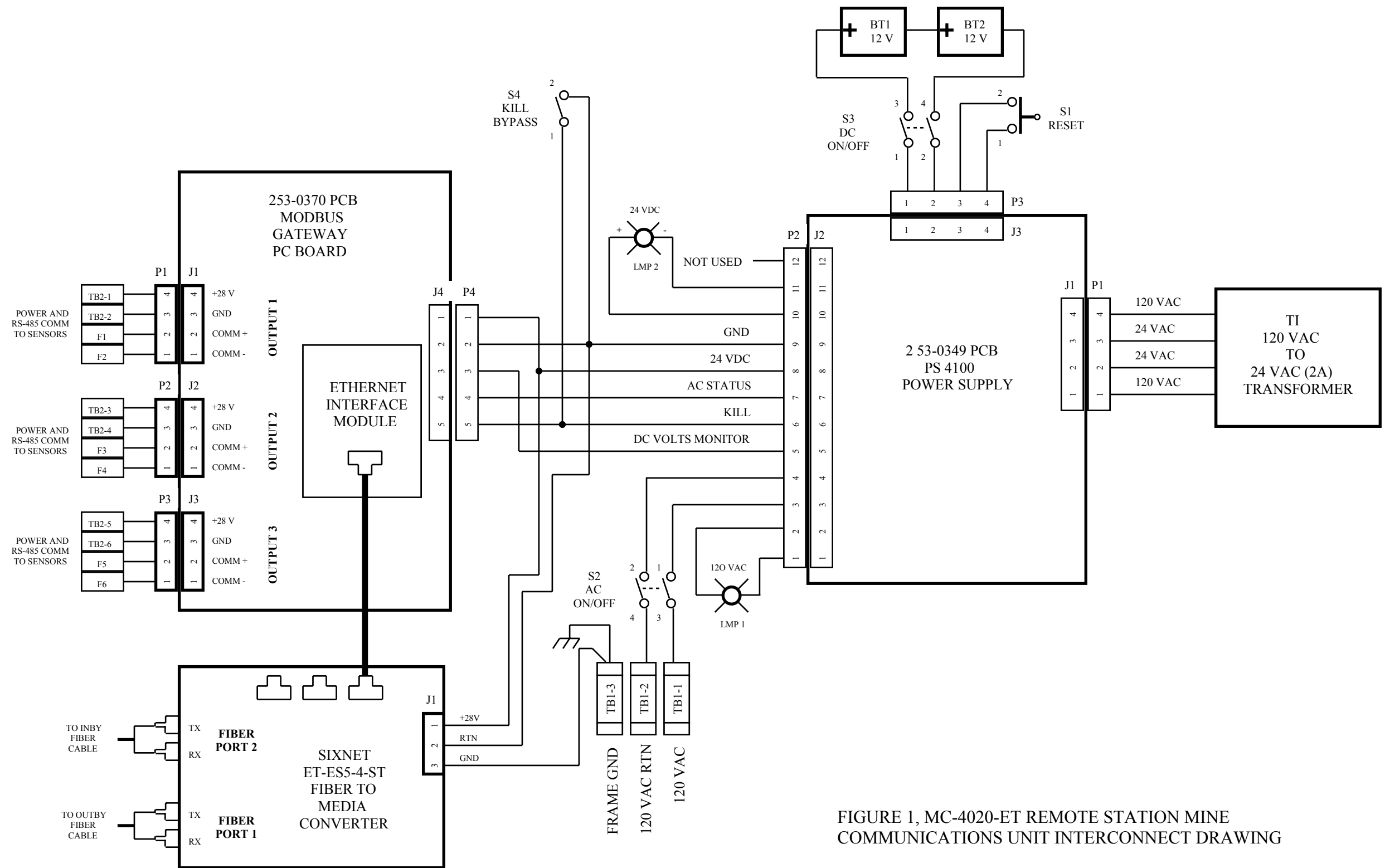
December 7, 2006

FIGURE 1, MC-4020-ET REMOTE STATION MINE
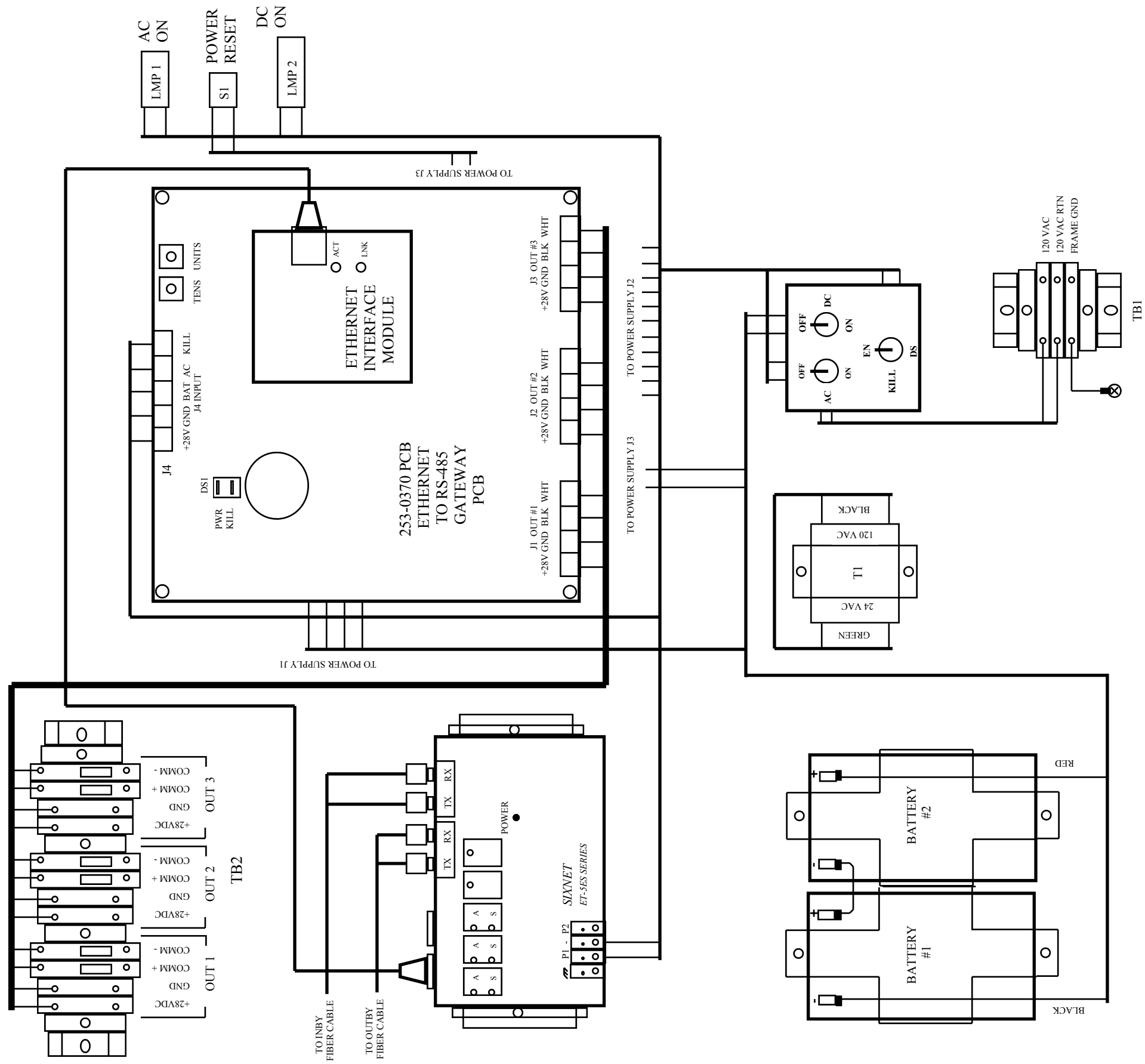COMMUNICATIONS UNIT INTERCONNECT DRAWING

FIGURE 2, MC-4020-ET REMOTE STATION MINE COMMUNICATIOSIONS
UNIT SHOWING THE ETHERNET PCB CONNECTIONS
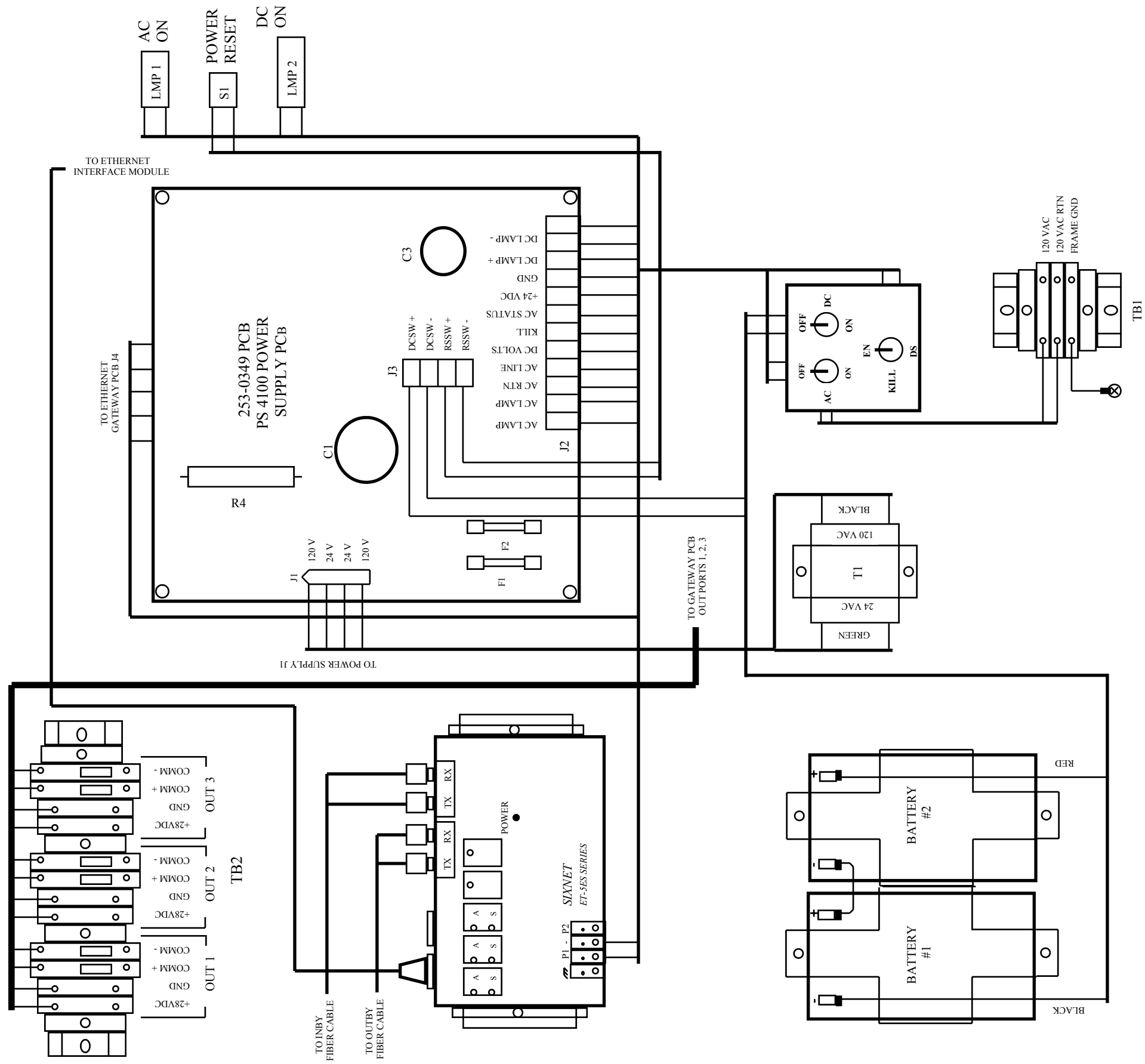
FIGURE 3, MC-4020-ET REMOTE STATION MINE COMMUNICATIIONS
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1. INTRODUCTION

1.0. General

The American Mine Research MC-4020-ET Remote Station Mine Communications Unit provides the user with a means of connecting to a fiber optic cable and communicating with Modbus protocol sensors and remotes. The MC-4020-ET unit uses the AMR Ethernet to Modbus Gateway PC board to convert Ethernet Modbus TCP/IP commands into Modbus Protocol commands to poll sensors, repeaters and remotes using three RS-485 output ports. The output ports are monitored and may be controlled from the Master Station to isolate and troubleshoot the monitoring system.

The MC-4020-ET is AC powered with a power supply PC board provide DC to sensors and other monitoring devices. The power supply also charges standby batteries in the event of loss of AC power. The backup batteries will provide a minimum of 4 hours of operation.

1.1. Features

The features of the MC-4020-ET Remote Station Mine Communications Unit are summarized below:

1.1.1. Power

- 120 VAC @ 0.2 amperes with fully charged battery and no devices connected to the Gateway output ports.
- A 120 VAC to 24 VAC @ 2 amperes transformer provides power to the Power Supply PC board.
- AC and DC power ON/OFF switches and indicators.
- Power may be remotely removed "Killed" from the Master Station.
- A Kill Enable/Disable switch to allow selection of the "Kill" feature.
- Momentary push-button Power Reset switch.

1.1.2. Battery Backup

- Two sealed rechargeable lead-acid 12 volt, 7 amp-hour batteries connected in series provide a minimum of four hours of operation in the event AC power is interrupted.
- The Power Supply PC board provides "fast" and "trickle" charging of the two batteries. A completely discharged set of batteries will require a minimum of 7 hours to fully recharge..

1. INTRODUCTION (cont.)

1.1.3. Power Supply (253-0349) PC Board

- 3/4 amp fused 120 VAC and 120 VAC Return.
- 27 VDC @ 1 amperes available to recharge the batteries.
- 24 VDC @ 1 amperes available to power the Gateway PC board and to power the three Gateway output ports.
- Outputs to illuminate AC and DC power indicators.
- AC power ON/OFF digital status output to the Gateway PC board.
- 0 to 3 VDC analog voltage output to the Gateway PC board.
- "Kill" digital input from the Gateway PC board.

1.1.4. Gateway (253-0370) PC Board

- 15 VDC to 28 VDC powered.
- Allows Modbus Master Station operator to remove 28 VDC power from and/or disable communications to the output ports.
- 19.2 Kbaud rate.
- BCD Switch Addressable from 1-99.
- Transmit and Receive LEDs on all ports simplifies troubleshooting.
- Biased and terminated output ports.
- Comm Output Port Transceiver devices fault protected to +/- 60 VDC.
- Output port communication chips in sockets.
- Gateway removes power from comm output if port current exceeds 400 milliamperes and the DS1 PWR switch is ON.
- Kill Remote if the DS1 Kill Enable switch is ON.
- Gateway Analog Data available at Modbus Master Station
  - 1) Comm Line bias voltages for three ports.
  - 2) Comm Line data peak voltages for three ports.
  - 3) Communication errors for three ports.
  - 4) DC voltage value powering the Gateway PC board.
  - 5) Current drain for each of the three output ports.
- Gateway Digital Data available at Modbus 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 Modbus remote.
  - 4) Comm port short circuit current trip enable/disable selection.
  - 5) Battery Status Input.

1. INTRODUCTION (cont.)

- Gateway Controls available at Modbus 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.

1.1.5. Sixnet 5 Port Media Converter

- 10 to 30 VDC @ 6 watts.
- LED power indicator.
- Two full/half duplex , 100 Base FX fiber ports.
- Three 10/100 Base T(x) Auto-detection shielded RJ45 ports.
- Communication "Activity" and "Link" LEDs for each port.

2. SPECIFICATIONS

2.1. Enclosure

- Size, 22 in. x 18 in. x 8 in. (outside dimensions).
- Dual, snap latch hinged cover.
- NEMA Type 4, 4X, 12 construction.
- Molded fiberglass reinforced polyester construction.
- Closed cell neoprene cord encased gasket.

2.2. Transformer

- Size, 2 5/8 in. x 4 in. x 2 3/8 in.
- 120 VAC primary.
- 24 VAC @ 2 amperes secondary.
- 1500 VRMS insulation test.

2.3. Battery

- Quantity, 2 each.
- Size each battery, 3.8 in. x 6 in. x 2.6 in.
- Voltage, 12 VDC
- Current capacity, 7 amp-hours.

2.4. Power Supply PC Board (253-0349)

- Size, 6 in. x 6 in.
- Fuses, 2 each, 250 volt @ 3/4 amperes.
- Input Voltage, 120 VAC and 24 VAC.
- Output Power to Gateway, 24 VDC @ 1 amperes.
- Output Power to Batteries, 27 VDC @ 1 amperes.
- Digital Status Output, AC Voltage ON/OFF.
- Battery Monitor Voltage Output, 0 to 3 VDC.
- Kill Power Input, 100 milliampere current sink.
- Indicator, AC Power ON/OFF.
- Indicator, DC Power ON/OFF.

2. SPECIFICATIONS (cont.)

2.5. Gateway PC Board (253-0370)

- PCB Size, 6 in.x 6 in.
- 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 , 400 milliamperes.
- Input Port: Ethernet
- Output Ports: Three 2-Wire RS-485

2.6. Sixnet 5 Port Media Converter (253-0370)

- Size, 4.7 in.x 3.2 in. x 2.1 in..
- Power, +10VDC to +30VDC @ 6 watts.
- Fiber Ports:
  Quantity, 2 each.
  Connectors, ST.
  Speed, 100 Mbps (Half Duplex), 200 Mbps (Full Duplex).
  Ethernet Compliance, 100 BaseFX.
  Speed, 100 Mbps (Half Duplex), 200 Mbps (Full Duplex).
- Copper Ports:
  Quantity, 3 each.
  Connectors, Shielded RJ45.
  Support Type, 10/100 BaseT(x) with Auto-polarity Tx/Rx detect and correct.
  Speed, Auto-detection 10 Mbps (Half Duplex), 200 Mbps (Full Duplex).
  Isolation, 1500 Volts RMS.

3. INSTALLATION

The MC-4020-ET Remote Station Mine Communications Unit is completely
assembled and ready for service. The user simply connects 120 VAC power, installs
the fiber optic cable and connects the RS-485 copper cable. The following
instructions provide details for installation and setup of the MC-4020-ET Remote
Unit.
Note 1: Use Figure 1, MC-4020-ET Remote Station Mine Communications
Unit Interconnect Drawing; Figure 2, MC-4020-ET Remote Station Mine
Communications Unit Showing the Ethernet PCB Connections; and
Figure 3, MC-4020-ET Remote Station Mine Communications Unit Showing
the Power Supply PCB Connections as an aid in making connections.

Note 2: Use Manual part number 180-0653 for information concerning the operation
of the MC-4070 Modbus Gateway.

3.1. AC Power

Connect 120 VAC power to TB1.

3.2. Fiber Optic Cable

1) Connect the Outby fiber optic Tx and Rx cables to the Sixnet Media Converter.
left side fiber optic port.
2) Connect the Inby fiber optic Tx and Rx cables to the Sixnet Media Converter.
right side fiber optic port.

3.3. Copper Wire RS-485 Output Port Cables

The MC-4020-ET Remote will supply 24 VDC and RS-485 communications to
three strings of Modbus protocol devices. The DC current draw from each port is
monitored by the Gateway PC board. The Gateway will remove DC power from
the any port when the current draw by a string of devices attached to that port is
greater than 400 milliamperes.
The Master Station will be signaled that the DC power has been removed.
However, it is recommended that the sum of the current draws from the three ports
be less than 750 milliamperes.

The Gateway PC board also monitors the condition of the RS-485 communication
wires to the Modbus device string. Should the two COMM wires short together or
make contact with the 24 VDC or GND wires, the Gateway PC board will interrupt
communications to the Output port and signal the Master Station.

3. INSTALLATION (cont.)

Each string of Modbus devices is connected to the MC-4020-ET Remote using a two twisted-shield pair cable. One twisted pair provides 24 VDC power to the device string. The second pair provides the RS-485 communications to the devices. Use TB2-OUT1, TB2-OUT2 and TB2-OUT2 to make connections to the Inby string of Modbus devices. Note that the RS-485 COMM + and COMM– lines are fuse protected.

1) Connect the Inby cable +28 VDC wire to TB2-OUT1 28V terminal.
2) Connect the Inby cable GND wire to TB2-OUT1 GND terminal.
3) Connect the Inby cable COMM (+) wire to TB2-OUT1 COMM (+) terminal.
4) Connect the Inby cable COMM (-) wire to TB2-OUT1 COMM (-)terminal.

If the TB2-OUT2 port and/or TB2-OUT2 port is also to be used, then repeat steps 1 through 4 above for each port.

3.4. Setup Connections

Before applying power to the MC-4020-ET Remote unit, insure the following connects are made as shown in Figures 2 and 3.

1) The Sixnet Media Converter ethernet port RJ45 connector is cable connected to the Gateway PC board Ethernet Interface Module.
2) The wires to both battery wires are connected.
3) +28 VDC and GND are connected to the Sixnet Media Converter.
4) Connectors J1, J2 and J3 are connected to the PS4100 Power Supply PC board.
5) Connectors J1, J2, J3 and J4 are connected to the Ethernet Gateway PC board.

3.5. Power ON

1) Place the AC and DC Power ON switches to the ON position.
2) The AC Power ON lamp should be ON.
3) Place the Kill Enable/Disable switch to the Enable position.
4) Push and hold (one second) the Power ON Reset switch.
5) The DC Power ON lamp should be ON.
6) The Sixnet Media Converter Power ON LED should be ON.
7) The Sixnet Media Converter fiber ports and RJ45 port ACTivity LEDs should be blinking if the Master Station is polling Modbus devices.
8) Measure 24 VDC between pins 1 and 2 on each Gateway output port.
9) Place the Gateway PC board DS1 PWR switch to ON to allow the Gateway to automatically remove power from the OUT ports when the current draw exceeds 400 milliamperes.

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3. INSTALLATION (cont.)

10) Place the Gateway PC board DS1 KILL switch to ON to allow the Gateway to automatically remove power from the MC-4020-ET Remote when receiving a Master Station command.

. 11) If the Gateway IP address has **not** been set proceed to step 3.6.

12) If the Gateway IP address has been set and the Master is polling devices connected to the Gateway output ports, the Gateway output ports TX LED will blink and the port RX LED will blink assuming the Modbus device in connected to that particular port.

3.6. Setting The Ethernet Gateway IP Address.

Note: If the Remote Unit User Ethernet Gateway IP address has already been set it is not necessary to perform the following procedure.

The Gateway IP address must be set before it can be used to poll Modbus devices. It is more convenient to set the IP address while the remote unit is located outside the mine near the Master Station PC. The Ethernet Gateway IP address may be set as follows:

1) Set the address switches (BS1 and BS2) to 00.

2) Recycle power in the remote unit. Insure the processor LNK and ACT LEDs are ON.

3) Use a web browser and type the DEFAULT Gateway IP address (130.1.0.216) and hit enter.

4) The Gateway Web Page will appear. Follow the Gateway web page instructions to enter the desired Gateway address.

5) After the new Gateway address has been set, turn the remote unit power OFF and set the Modbus Gateway address to a non-zero number. Turn the remote unit power ON (with a non-zero Gateway Modbus address) the new IP address is saved.

Remote Station Power Suppy

+24 VDC

GND

BAT STAT IN
AC STAT IN
KILL OUT

SET ADDRESS

DS1

PWR
  OFF — DISABLE
  ON — ENABLE
KILL
  OFF —DISABLE
  ON — ENABLE

Ethernet Cable

Activity LED

Link LED

CABLES SAME AS PORT 3

POWER

DATA

OUTPUT CABLE

SHIELD TO GROUND

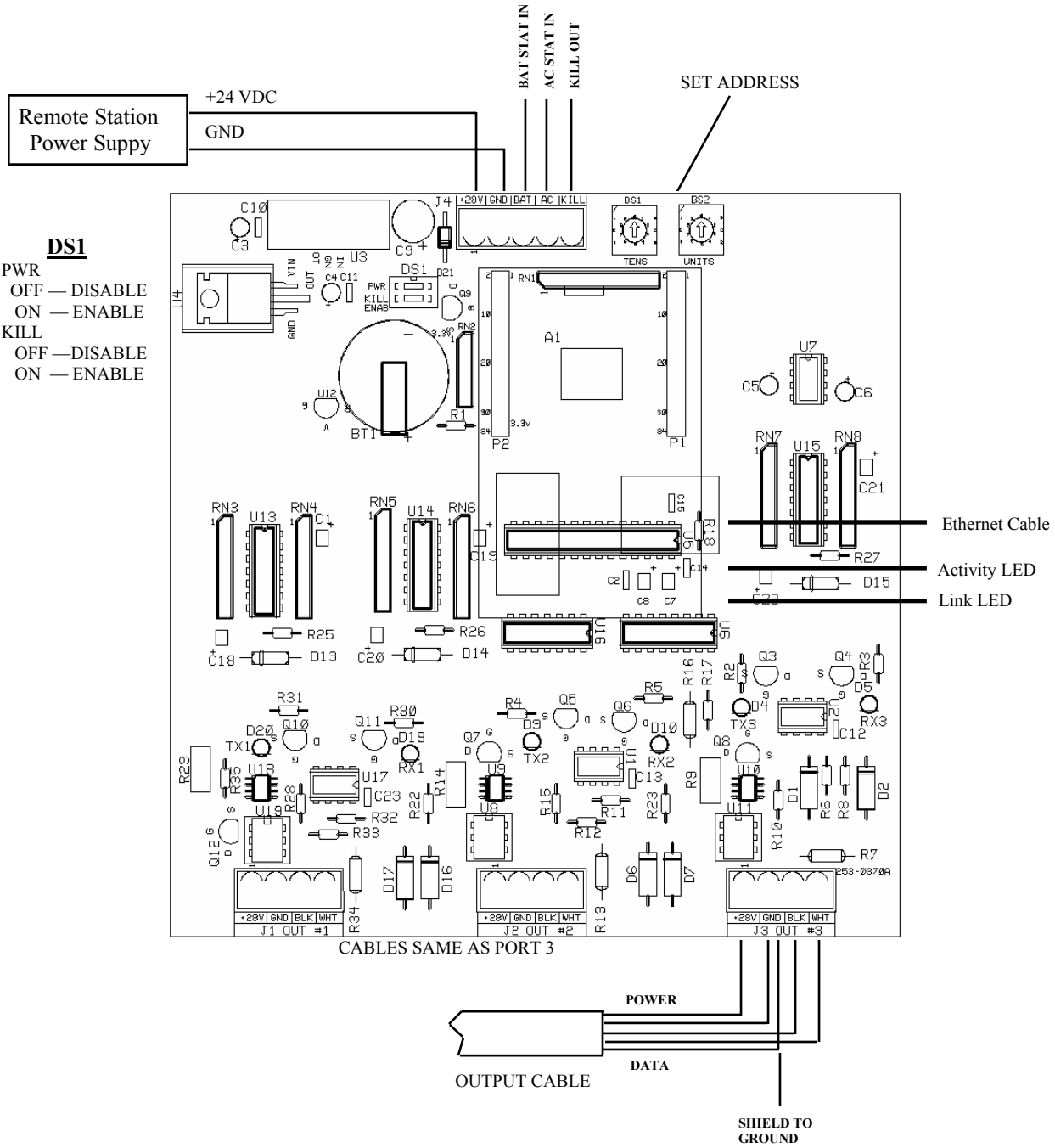FIGURE 4, ETHERNET GATEWAY PC BOARD

4. TROUBLESHOOTING

4.1. Getting Power To The MC-4020-ET Remote Unit

1) Insure that the Remote Unit is installed properly according to the manual installation section 3.
2) Insure that 120 VAC is supplied to the Remote Unit TB1, the AC Power ON switch is ON and the AC lamp is ON.
3) Insure that the voltage output measured across both batteries is greater than 22 VDC and the DC Power ON switch is ON
4) Verify that the DC Power ON lamp turns ON when the Power ON Reset switch is momentarily pressed. If the DC Power ON lamp comes ON and then turns OFF when the Power ON Reset switch is released, place the Kill Enable/Disable switch to Disable and repeat step 4 again.
5) If the DC Power ON lamp stays ON, the Master Station has commanded the Remote power OFF and placing the Kill switch to Disable bypasses the Master Station command to Kill power to the Remote. Be sure to place the Kill Enable/Disable switch to Enable once the Master Station has commanded the Remote power to ON.
6) After the DC Power ON lamp comes ON and stays ON, verify the following conditions:
    a) The Sixnet Media Converter power ON LED is ON;
    b) The voltage measured across both batteries is either increasing (which means the batteries are being charged) or the battery voltage is greater than 27 VDC (which means the batteries are fully charged). This confirms the 253-0349 Power Supply PC board battery changing circuitry is functional.
    c) Measure 24 VDC between pins 1 and 2 of J4 on the 253-0370 Gateway PC board. This confirms the 253-0349 Power Supply PC board 24 VDC power supply circuitry is functional.
    d) The Gateway Ethernet Interface Module ACTivity LED should blink every 10 seconds even though there may not be an ethernet connection.
    e) Confirm the presence of 24 VDC at pins 1 and 2 of each Gateway PC board OUT port connectors. If the voltage is not present at all of the port connectors, remove the plug from that port to eliminate the possibility of a cable short and measure the port pins again. NOTE: The Gateway PC board will remove power from the OUT port if the DS1 (POWER) switch is ON and the current draw is greater than 400 milliamperes. If the voltage is still not available at the port, either the power has been commanded OFF from the Master Station or the port power control IC has failed. In the event the Gateway does remove 24 VDC from the output port, it will notify the Master Station.

4. TROUBLESHOOTING (cont.)

4.2. Sixnet Media Converter

1) Confirm 24 VDC is connected to P1 and (-) of the Sixnet module power connector and the Power LED is ON.
2) Confirm that the Outby Tx/Rx and the Inby Tx/Rx fiber optic cables are connected to the module fiber ports. If there is ethernet ACTivity on the fiber cable, the port ACT LEDs should blink.
3) Confirm that one of the Sixnet Media Converter module RJ45 ethernet ports is connected to the 253-0370 Ethernet Gateway PC board. The ACTivity LED associated with that RJ45 port should blink in unison with the fiber port ACTivity LED.

4.3. 253-0370 Ethernet Gateway PC board

1) Insure that the Gateway PC board is installed properly according to the Installation (Section 3) of this manual.
2) Insure that the Gateway PC board has 24 VDC at connector J4-1 and J4-2.
3) Confirm the presence of 24 VDC at pins 1 and 2 of each Gateway PC board OUT port connectors. If the voltage is not present at all of the port connectors, remove the plug from that port to eliminate the possibility of a cable short and measure the port pins again.
NOTE: The Gateway PC board will remove power from the OUT port if the DS1 (POWER) switch is ON and the current draw is greater than 400 milliamperes. If the voltage is still not available at the port, either the power has been commanded OFF from the Master Station or the port power control IC has failed. In the event the Gateway does remove 24 VDC from the output port, it will notify the Master Station.
4) Verify the Ethernet cable is connected, the processor LNK (green LED) is ON and the processor ACT (yellow LED) is blinking.
5) When the Gateway receives Modbus TCP/IP requests it sends a request to the three output ports causing the TX LEDs to blink.
6) If a sensor or remote connected to the Output Port responds to the request for data, the corresponding RX LED will blink and the TXIN LED will blink.
7) If a sensor or remote fails to respond to request, move the port output cable to another port to test if the port has failed.

4. TROUBLESHOOTING (cont.)

8) The Gateway PC board monitors each OUT port COMM (+) and COMM (−) line for abnormal (wires shorted to each other or wire/s shorted to 24 VDC or to GND) conditions. If a short condition exits, the Gateway PC board will disable communication to that port until the short condition is removed. The Gateway PC board will notify the Master Station that communications with the port has been disabled.
9) If a sensor or remote fails to respond to request, move the port output cable to another port.

4.4. Using The Master Station

1) If a particular branch of the monitoring system is experiencing communications problems, use the Analog, Digital and Control data returned from the Gateway to determine the problem source.
2) Observe the Control Channel Status and insure the Port is enabled and Power is ON.
3) Use the Digital Channel Status to observe the Port Short and Port Open states.
4) Use the Digital Channels Status to confirm AC Power ON and Battery Status.
5) Use the Analog Channels Data to verify the Power Supply voltage is between 15 VDC and 28 VDC.
6) Use the Analog Channels Data to verify the Port Bias voltage is between 0.15 VDC and 0.45 VDC.
7) Use the Analog Channels Data to verify the Port Level voltage is greater than 0.5 VDC.
8) Use the Analog Channels Data to verify the Port Draw current is consistent with the devices being powered from the port.
9) Use the Analog Channels Data to verify the Port Errors is not excessive.

5. REPLACEMENT PARTS

Part Number	Description
253-0370	Ethernet Gateway PC Board
253-0349	PS4100 Power Supply PC Board
310-0189	Sixnet Media Converter
275-0002	Recharageable 12V, 7 AH, Battery
130-0007	Transformer
050-0001	Power ON Reset Switch
065-0008	120 VAC Power ON LED
065-0011	24 VDC Power ON LED
160-0061	TB2 Comm Fuse
310-0160	Rabbit Core Processor Module

BT1 12 V   BT2 12 V

S3 DC ON/OFF
S1 RESET

S4 KILL BYPASS

253-0370 PCB
MODBUS GATEWAY PC BOARD

P1 J1
TB2-1 +28 V
TB2-2 GND
F1 COMM +
F2 COMM −
OUTPUT 1

POWER AND RS-485 COMM TO SENSORS

P2 J2
TB2-3 +28 V
TB2-4 GND
F3 COMM +
F4 COMM −
OUTPUT 2

POWER AND RS-485 COMM TO SENSORS

P3 J3
TB2-5 +28 V
TB2-6 GND
F5 COMM +
F6 COMM −
OUTPUT 3

POWER AND RS-485 COMM TO SENSORS

ETHERNET INTERFACE MODULE

J4 P4

24 VDC
LMP 2
NOT USED

P2 J2
GND
24 VDC
AC STATUS
KILL
DC VOLTS MONITOR

P3
J3

2 53-0349 PCB
PS 4100
POWER SUPPLY

J1 P1
120 VAC
24 VAC
24 VAC
120 VAC

TI
120 VAC TO 24 VAC (2A) TRANSFORMER

S2 AC ON/OFF

120 VAC
LMP 1

TB1-3 FRAME GND
TB1-2 120 VAC RTN
TB1-1 120 VAC

J1
+28V
RTN
GND

SIXNET ET-ES5-4-ST FIBER TO MEDIA CONVERTER

TO INBY FIBER CABLE
TX
RX
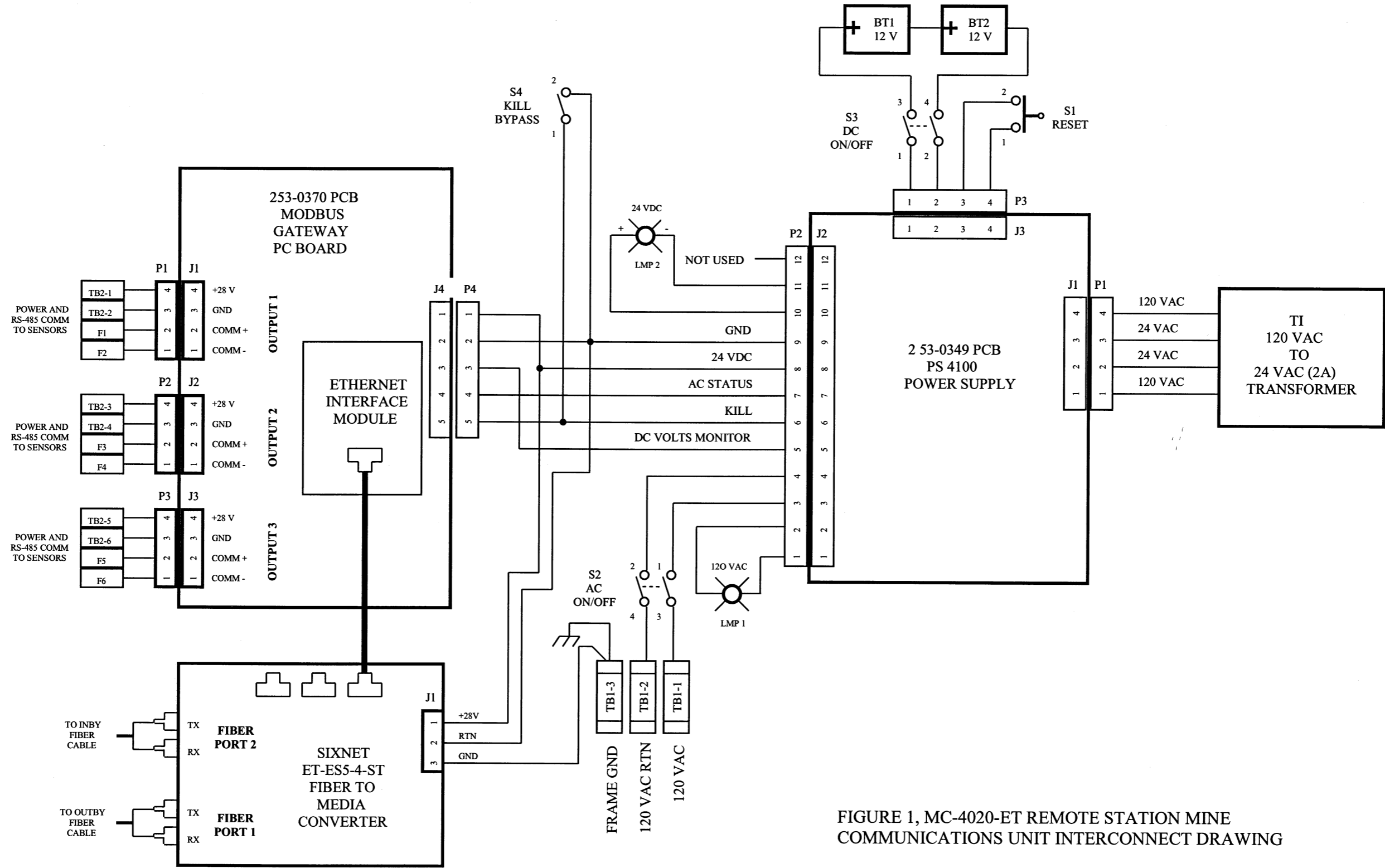FIBER PORT 2

TO OUTBY FIBER CABLE
TX
RX
FIBER PORT 1

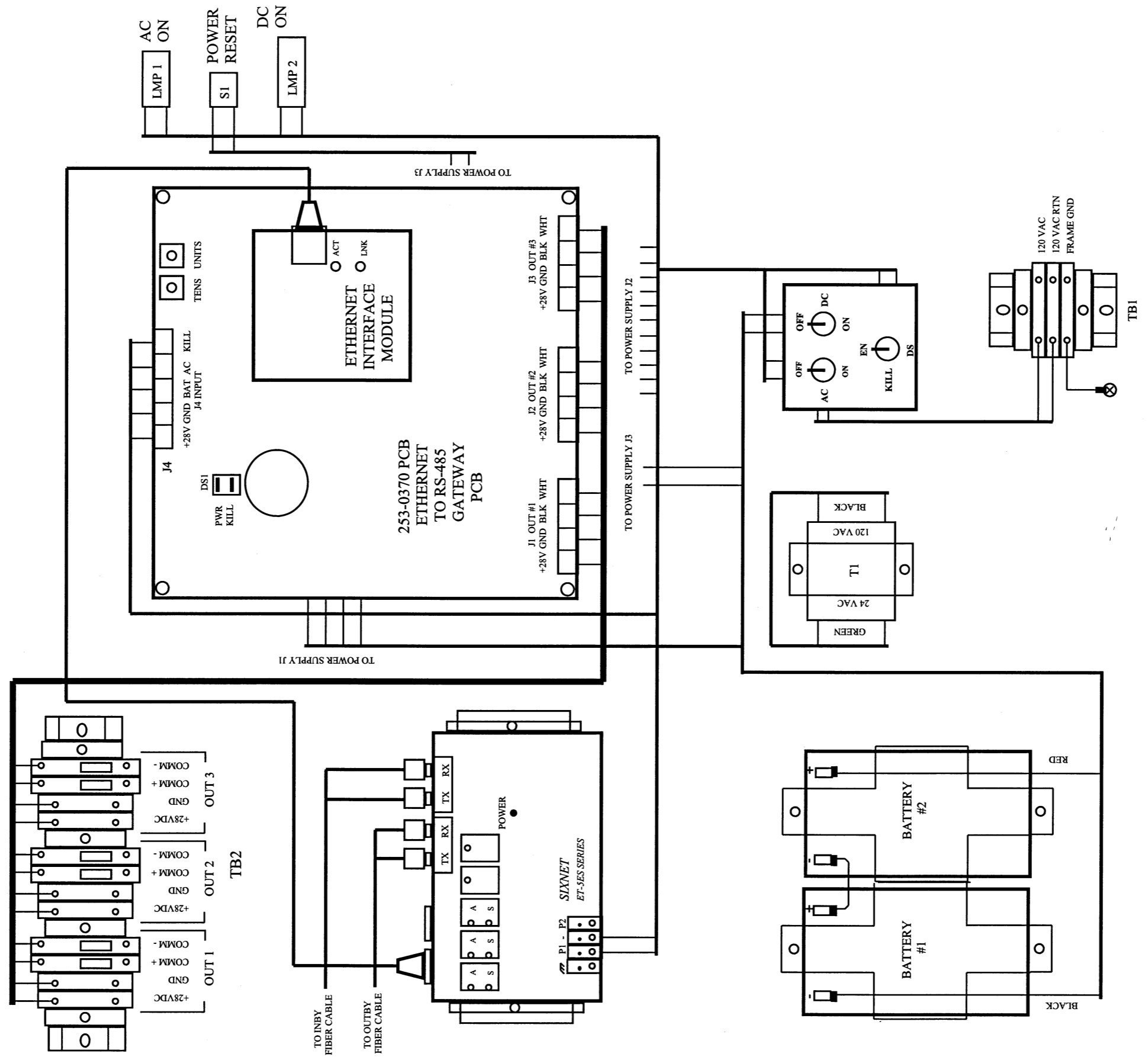FIGURE 1, MC-4020-ET REMOTE STATION MINE COMMUNICATIONS UNIT INTERCONNECT DRAWING

FIGURE 2, MC-4020-ET REMOTE STATION MINE COMMUNICATIOSIONS
UNIT SHOWING THE ETHERNET PCB CONNECTIONS

FIGURE 3, MC-4020-ET REMOTE STATION MINE COMMUNICATIONS
UNIT SHOWING THE POWER SUPPLY PCB CONNECTIONS