1000 Technology Drive, Pittsburgh, PA 15219
645 Russell Street, Batesburg, SC 29006



# HARDWARE INSTALLATION

# MicroLok® II 2/2

# Proprietary Notice



# Important Notice

ASTS USA constantly strives to improve our products and keep our customers apprised of changes in technology. Following the recommendations contained in the attached service manual will provide our customers with optimum operational reliability. The data contained herein purports solely to describe the product, and does not create any warranties.

Within the scope of the attached manual, it is impossible to take into account every eventuality that may arise with technical equipment in service. Please consult an ASTS USA local sales representative in the event of any irregularities with our product.

ASTS USA expressly disclaims liability resulting from any improper handling or use of our equipment, even if these instructions contain no specific indication in this respect. We strongly recommend that only approved ASTS USA spare parts are used as replacements.


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# Revision History

| Revision | Date | Nature of Revision |
|---|---|---|
| 1 | October 2014 | Initial Release |
| 2 | November 2014 | Changed CPU PCB part number in Table 4-2. |

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# 1. GENERAL INFORMATION

## 1.1. INTRODUCTION

This manual provides the basic information necessary to install the MicroLok® II 2/2 system and its peripheral equipment (subject to completion of training by an ASTS USA-approved source). Topics covered include equipment preparation, configuration and mounting, connection of operating power, installation of plug-in boards, and typical printed circuit board external circuit interfaces.

For reference, related MicroLok II 2/2 system manuals include:

- SM-1A1.0001 - System Description
- SM-1A1.0003 - System Startup, Troubleshooting, and Maintenance
- SM-6800D - System Application Logic Programming

ASTS USA provides no shop maintenance procedures for the MicroLok II 2/2 system circuit boards. These boards are not repairable in the field.

## 1.2. R.A.I.L TEAM AND TECHNICAL SUPPORT

The Rapid Action Information Link (RAIL) team created in 1996 serves the technical needs of current and potential ASTS USA customers. Convenient 24-hour access and a rapid resolution to customer problems are the trademarks of this organization. The RAIL team, which is staffed primarily by ASTS USA product and application engineers, is ready to assist and resolve technical issues concerning this or any ASTS USA product.

Direct any questions regarding the contents of this service manual to the RAIL team by telephone at 1-800-652-7276 or through Internet e-mail at railteam@ansaldo-sts.us.

## 1.3. HARDWARE GENERAL DESCRIPTION

The MicroLok II 2/2 system consists of modular cardfile-mounted equipment and external peripheral devices that are used to interface the cardfile circuitry to the tracks and to other associated interlocking control systems. The sections that follow provide an overview of the hardware available for use in the MicroLok II 2/2 system.

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### 1.3.1. Components

The MicroLok II 2/2 interlocking control system is a multi-purpose monitoring and control system designed for railroad and rail mass transit wayside interlocking functions such as switch machine control, track circuit occupancy monitoring. Table 1-1 lists the major components of the MicroLok II 2/2 system that are covered in this manual:

**Table 1-1. MicroLok II 2/2 Major System Components**

| Name | ASTS USA Part No. | Basic Function(s) |
|---|---|---|
| MicroLok II 2/2 cardfile | N16902101 | Houses all plug-in printed circuit boards and an optional local control panel. |
| VCOR relay | N322500-701<br>ASTS USA PN-150B) | Switches power to all cardfile vital output circuits under the control of the MicroLok II 2/2 CPU board. |
| CPU PCB | N17068501 | Provides system vital controlling logic, vital I/O management, external serial communications, application logic execution, internal and external diagnostics, event logging, and a user programming and diagnostics interface. |
| Power Supply/CPS PCB | N16660301<br>N16661203<br>P20B.0100038 | Energizes the VCOR relay under the control of the CPU board. Provides ±12VDC and +5VDC to the cardfile motherboard. |
| CPS Only PCB | N451910-7501 | Energizes the VCOR relay under the control of the CPU board. |
| Standard Vital Output PCB (16 Outputs) | N17060501 (12V)<br>N17060502 (24V) | Controls standard +/- vital outputs (switch machine relay coil or MicroLok II 2/2 isolation module, for example). |
| Vital Input PCB (16 Inputs) | N17061001 (12V)<br>N17061002 (24V)<br>N17061003 (50V)<br>N17061004 (10V)<br>N17061005 (24V AC Immunity) | Receives standard +/- or bi-polar vital inputs (search light mechanism position check, switch machine correspondence, or OS track circuit occupancy, for example). Low and high minimum threshold versions available. |
| Non-Vital I/O PCB | N17061501 | Provides 32 non-vital, non-isolated inputs and 32 non-vital, non-isolated outputs. |
| Ethernet Communication PCB | N17066403 | Allows a MicroLok II 2/2 system to connect directly to an Ethernet network. |
| Synchronization PCB | N17066401 (12V)<br>N17066402 (24V) | Allows two MicroLok II 2/2 units to connect to each other to form a synchronized pair for a seamless redundant application. |
| IN8.OUT8 PCB | N17061601 (12V)<br>N17061602 (24V) | Provides up to eight isolated inputs and eight non-isolated outputs |
| NV.IN32 PCB | N17063701 | Provides 32 non-vital, isolated, inputs |
| NV.OUT32 PCB | N17062701 | Provides 32 non-vital, isolated, outputs |
| Out8.ISO | N17065801 (12V)<br>N17065802 (24V) | Provides eight vital isolated outputs |

### 1.3.2. Cardfile and Plug-In Components

The MicroLok II 2/2 cardfile is designed to house standard 6UX220 Eurocard plug-in printed circuit boards. Most MicroLok II 2/2 printed circuit boards are equipped with integral controls and indications on the board's front panel.

Unused cardfile slots are covered with blank shield panels. These panels come in single slot and multi-slot widths. Each circuit board/panel is secured to the cardfile frame with two slotted-head machine screws. Two extraction levers are provided on each board to make board removal easier. The MicroLok II 2/2 cardfile can be wall or shelf-mounted, and can be easily installed in a standard 19" equipment rack.

External wiring is connected to each circuit board through a 48-pin or 96-pin connector. Each connector attaches directly to the board's upper edge connector at the rear of the card file. Certain connector housings incorporate jumpers that are used to set the electrical address for the associated circuit board. The CPU connector housing has an internal EEPROM that is used to store site-specific configuration data. Even if the CPU board is replaced, the configuration data remains intact within the CPU connector's EEPROM.

The MicroLok II 2/2 cardfile plug-in components covered in this manual are listed in Table 1-1. See service manual SM-1A1.0001 for a detailed description of each circuit board type.

## 1.4. INSTALLING A MICROLOK II 2/2 SYSTEM

**Warning**

> Failure to obtain approved training, and to act in accordance with the procedures and warnings outlined in these manuals, may result in serious personal injury and/or property damage.

In some cases, the entire compliment of equipment may be pre-configured and assembled at the factory. In other cases, board configuration and installation may be done at the installation site. All of these factors are determined mainly by customer preference. Thus, the installation process will differ somewhat from job to job.

Regardless of the specific configuration, there are five basic steps involved in the installation of a MicroLok II 2/2 system. These are:

1. Install the MicroLok II 2/2 cardfile.
2. Install the necessary MicroLok II 2/2 peripheral devices and make the necessary wiring connections between the cardfile and the rails/interlocking equipment.
3. Install the MicroLok II 2/2 printed circuit boards.

4. Make the necessary communications connections between the MicroLok II 2/2 cardfile and other remote train control equipment.

5. Power up, configure, and test the MicroLok II 2/2 system.

Steps 1 through 4 are detailed in this manual. Note that it may not be necessary to perform all of these steps for all MicroLok II 2/2 applications. Step 5 actually includes a number of system checks and configuration procedures. This information is contained in service manual SM-1A1.0003 - MicroLok II 2/2 System Startup, Troubleshooting, and Maintenance.

# 2. CARDFILE AND CIRCUIT BOARD INSTALLATION

## 2.1. Installing the Cardfile

### 2.1.1. Mounting and Environment

The MicroLok II 2/2 cardfile is mounted in a standard 19-inch equipment rack. Keep the cardfile away from sources of excessive heat or battery vapors. Positive ventilation is not required. Cardfile operating temperature limits are -40$^o$ to +70$^o$C. Cardfile mounting dimensions (including rear connectors) are shown in Figure 2-1

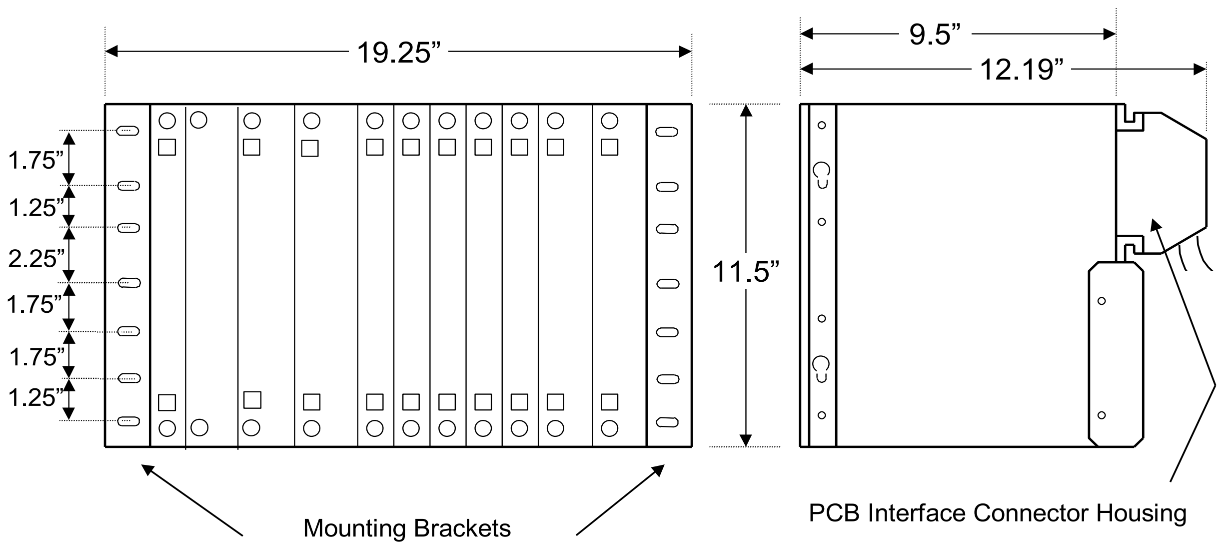



**Figure 2-1. Cardfile Installation Dimensions**

### 2.1.2. General Wiring Practices

MicroLok II 2/2 installations that are wired in the field should be configured to minimize cross talk between wires. Noisy wiring (connections to external equipment) should be separated as much as possible from wires carrying electronic data signals. Cables and wires in general should be kept as short as possible to minimize induced line noise. Low voltage signal wiring should be twisted pairs. Case/house wiring layouts should also be arranged to minimize noise. Switch heater wire runs, track leads, switch machine power wiring and any other noisy wiring should be separated as much as possible from MicroLok II 2/2 wiring, both in the case or house and in outside cable runs. Battery leads should be as short as possible and must be isolated as much as possible from noisy wiring.

Please reference Appendix-A for additional information on proper EMC and EMI wiring techniques.

## 2.2. Power Source

### 2.2.1. Power Supply/CPS PCBs

Power Supply: (nominal input voltage) 12VDC - N16660301 or N16661203

(nominal input voltage) 24VDC - P20B.0100038

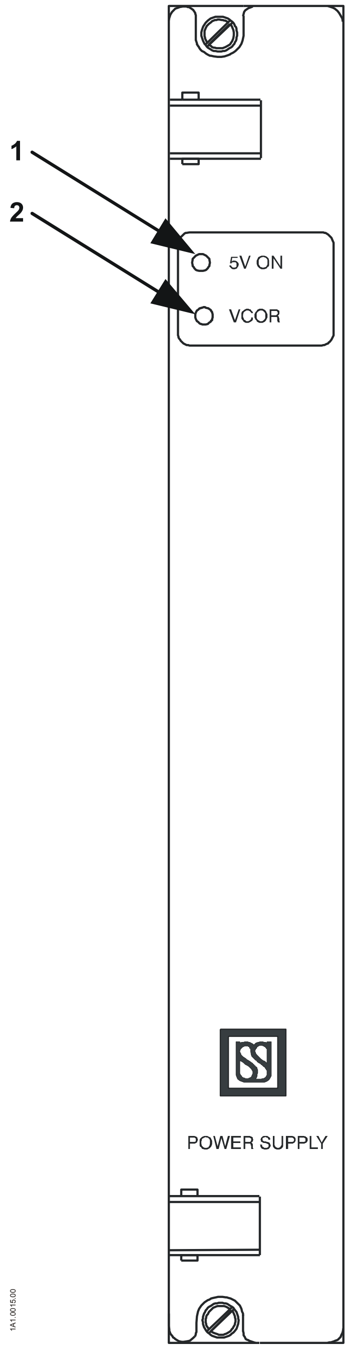



**Figure 2-2. Power Supply PCB Front Panel Detail**

The Power Supply PCB serves a vital role in the fail-safe design of the MicroLok II system.

The power supply PCB performs these functions:

- Produces regulated ±12VDC and +5VDC cardfile power from system battery.
- Conditional Power Supply (CPS) circuit on the PCB generates the VCOR voltage (–9VDC to –14VDC) from the 250Hz CPU signal, to energize the VCOR relay.

Cardfile power is distributed to all system printed circuit boards through the motherboard to the cardfile PCB's 96-pin PCB bottom rear connector.

The +12VDC output of the power supply PCB (See Figure 2-7) is not used as a source for any vital or non-vital outputs. External battery power is used for this purpose.

Current draw on the battery is determined by the application configuration, (number of signal lamps, cab signal carrier frequency, etc.) and can be computed by using the Power Calculation feature of the MicroLok II Development System.

The CPS circuit, located on the power supply PCB, serves a vital role in the fail-safe design of the MicroLok II system. The MicroLok II CPU PCB outputs a 250Hz check signal to the power supply PCB, as long as the diagnostic checks performed continuously by the CPU detect no internal or external system faults. The CPS creates the VCOR voltage directly from the 250Hz signal.

**Table 2-1. Power Supply Indicators**

| REF FIGURE 2-2 | LABEL | DEVICE | PURPOSE |
|---|---|---|---|
| 1 | **5V ON** | LED (Green) | When lit, indicates 5V operating power On to other cardfile PCBs. |
| 2 | **VCOR** | LED (Green) | When lit, indicates conditional power "On" to VCOR relay (CPU diagnostics normal). |

**NOTE**

The VCOR voltage (nominal –9VDC), generated by the CPS, is negative with respect to N12. Refer to Figure 2-3.

Failure of a diagnostic check by the CPU results in the removal of this 250Hz check signal from the power supply PCB and the corresponding loss of VCOR power. Once the VCOR drops all output power is removed from the cardfile vital outputs.

The power supply PCB also outputs ±12VDC and +5VDC to the cardfile motherboard (backplane) via its lower PCB connector. The motherboard distributes the power to the cardfile PCBs. External power, through the VCOR contacts, is used for output power. Figure 2-3 shows an example of MicroLok II power distribution and utilization of the VCOR.

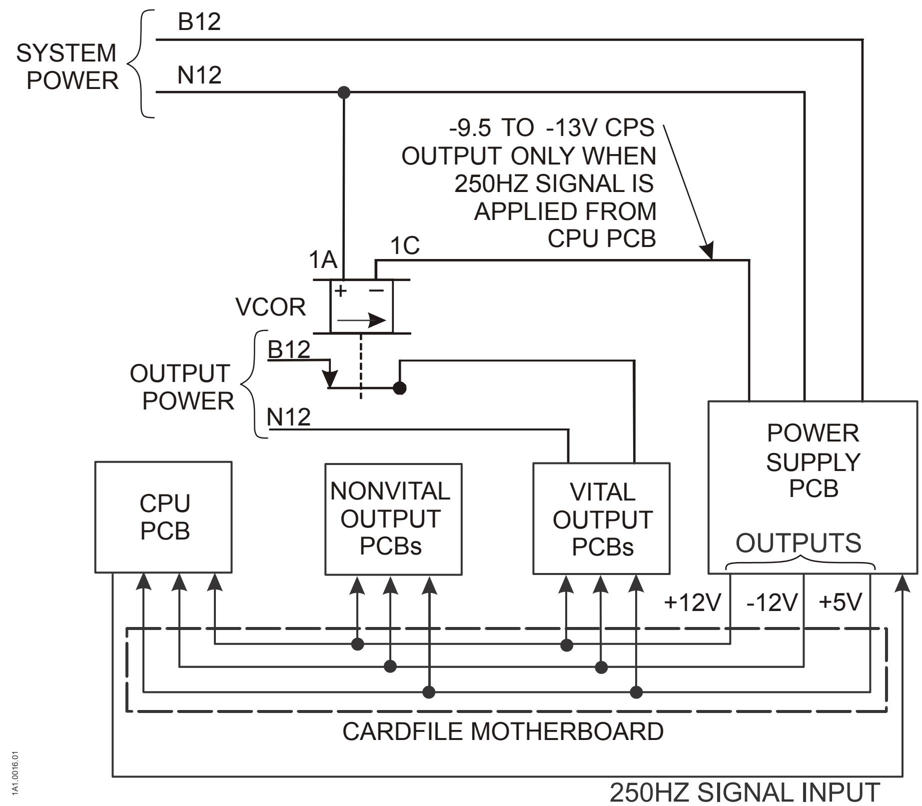



**Figure 2-3. Vital MicroLok II Power Distribution with VCOR**

### Table 2-2. Power Supply/CPS PCBs Specifications

| ASTS USA PART NUMBER | NOMINAL INPUT POWER | + 5VDC OUTPUT | + 12VDC OUTPUT | – 12VDC OUTPUT | ISOLATED OUTPUT | CPS OUTPUT |
|---|---|---|---|---|---|---|
| N16660301 | 9.8VDC to 16.2VDC<br><br>(Auto Off at 9.8VDC, 11.5VDC min for turn-on) | 3 amps | 1 amp | 1 amp | 11.5VDC @ 20ma<br><br>510 Ω load 14VDC unloaded | –13VDC ref to N12 VCOR400 Ω relay* |
| N16661203 | 9.8VDC to 16.2VDC<br><br>(Auto Off at 9.8VDC, 11.5VDC min for turn-on) | 5 amps | 1 amp | 2 amps | 11.5VDC @ 20ma<br><br>510 Ω load 14VDC unloaded | –9.5VDC ref to N12 VCOR400 Ω relay* |
| P20B.0100038 | 9.8VDC to 32VDC<br><br>(Auto Off at 9.8VDC and 32VDC, 11.5VDC min for turn-on) | 5 amps | 1 amp | 2 amps | 11.5VDC @ 20ma<br><br>510 Ω load 14VDC unloaded | –9.5VDC ref to N12 VCOR400 Ω relay* |

* The PN150B relay is used for low output current applications and the PN-150HD is used for high output current applications.

**CAUTION**

While the P20B.0100038 PCB detects overvoltage (above 32VDC) and removes PCB operating voltage to the cardfile; it does **not** disconnect system battery from the Power Supply PCB input. A continuing condition of system battery in excess of 32VDC will damage the Power Supply PCB.

Table 2-3 lists the designation, part number, and rating of fuses used on the power supply PCBs. Refer to Figure 2-4, Figure 2-5, and Figure 2-6 for fuse location.

## Table 2-3. Fuses on the Power Supply PCB

| REF. FIGURE 2-4, FIGURE 2-5, AND FIGURE 2-6 | CIRCUIT APPLICATION | ASTS USA PART NUMBER | DESCRIPTION |
|---|---|---|---|
| F1 | System Battery | J710083* | 7.5 amp, 32 volt |
| | | J7100380027** | 10 amp, 250 volt |
| F2 | Isolated Output | J071190 | 1/2 amp, 250 volt |
| F3 | Conditional Power Supply Circuit | J071075 | 1/8 amp, 250 volt |

* Used on the N16660301 Power Supply PCB.
** Used on the N16661203 and P20B.0100038 Power Supply PCBs.

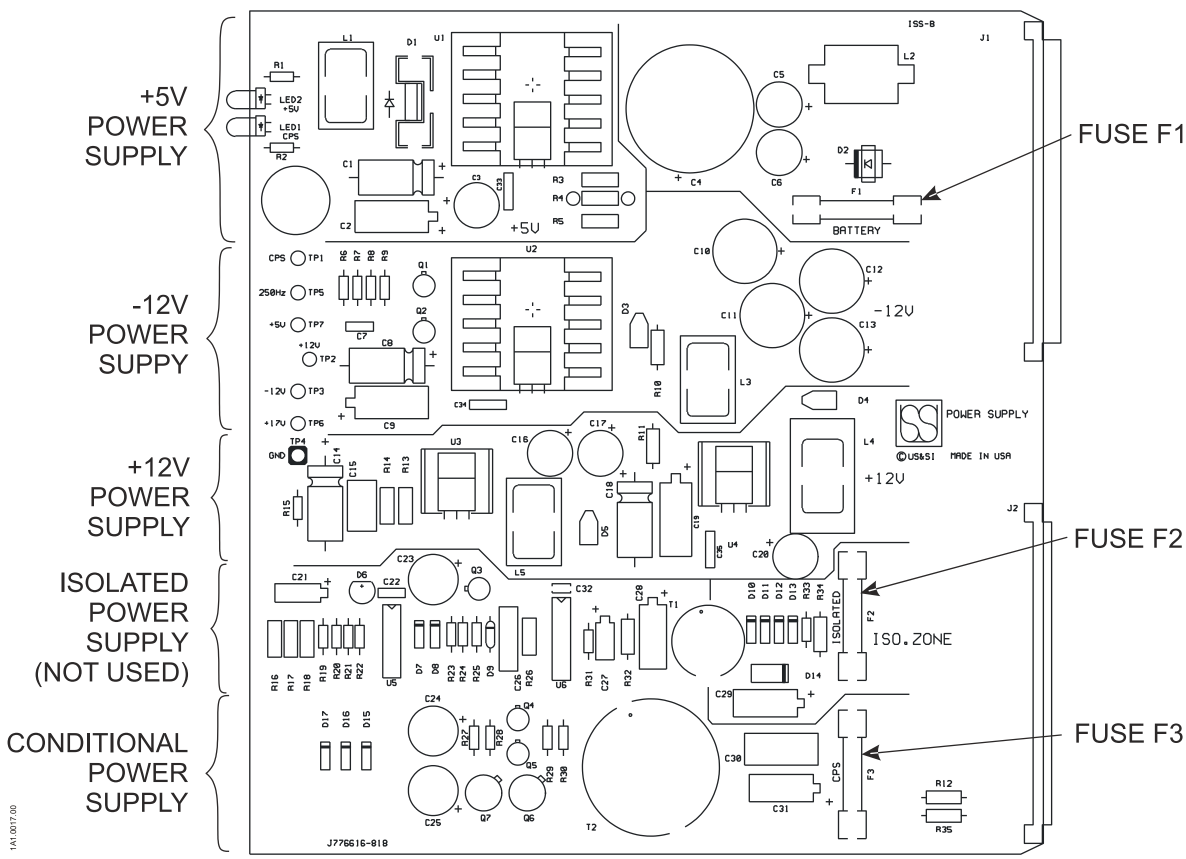



**Figure 2-4. Power Supply PCB Layout (N16660301)**

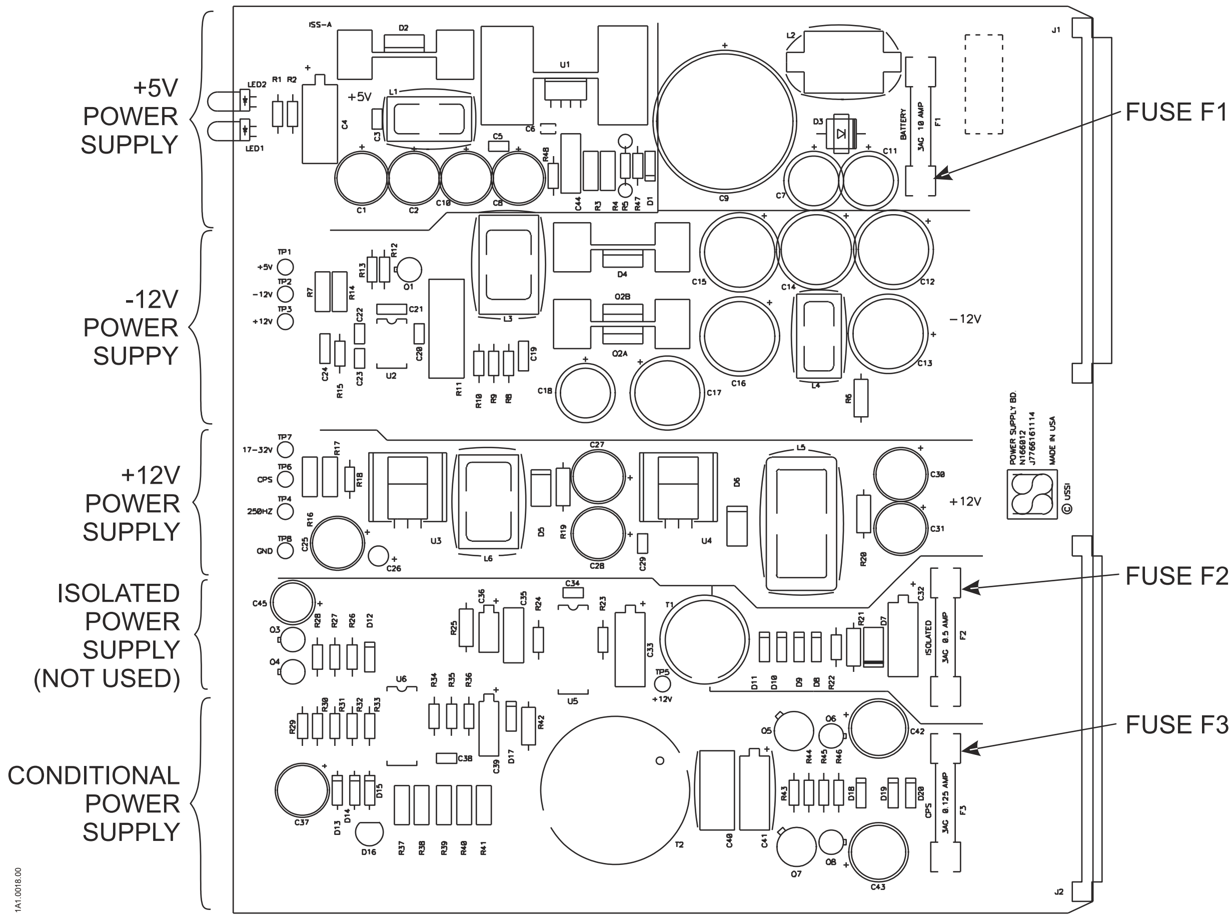



**Figure 2-5. Power Supply PCB Layout (N16661203)**

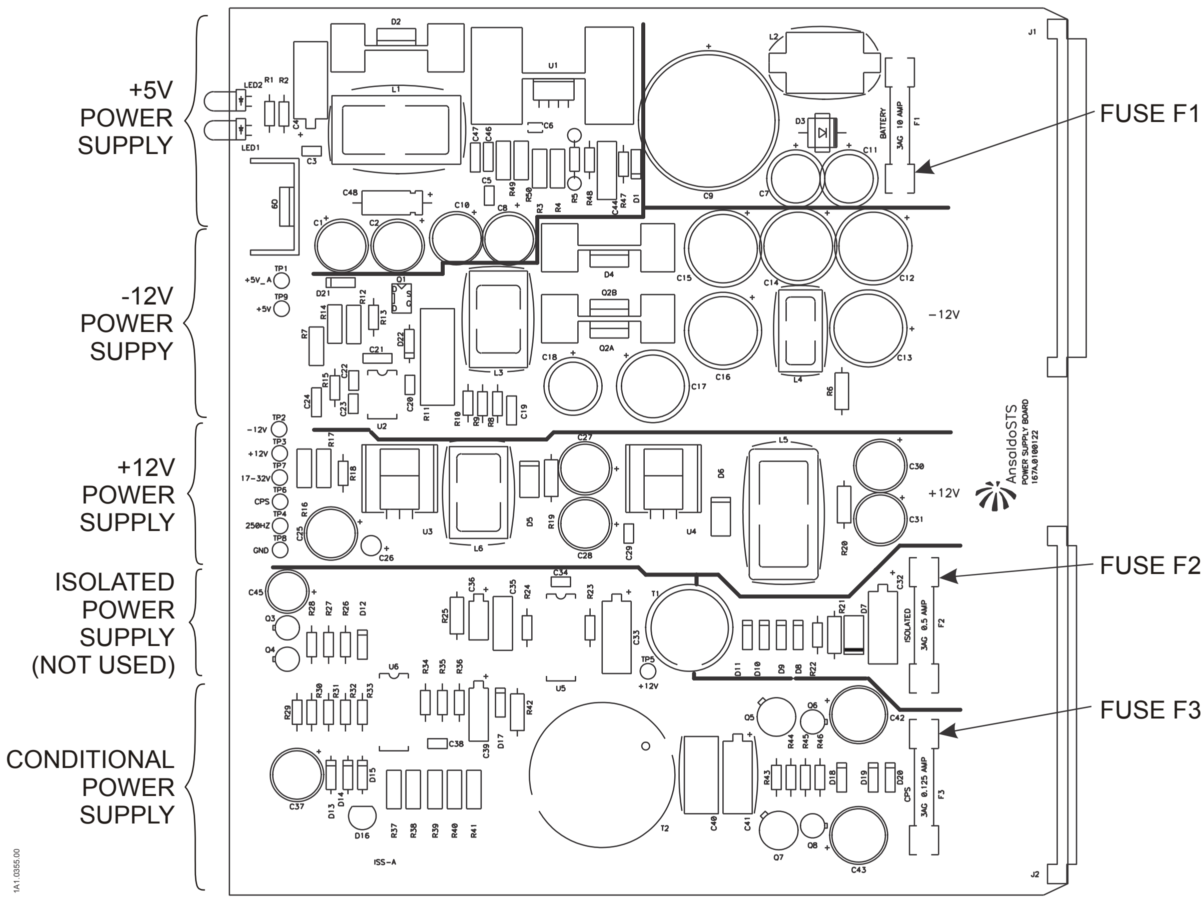
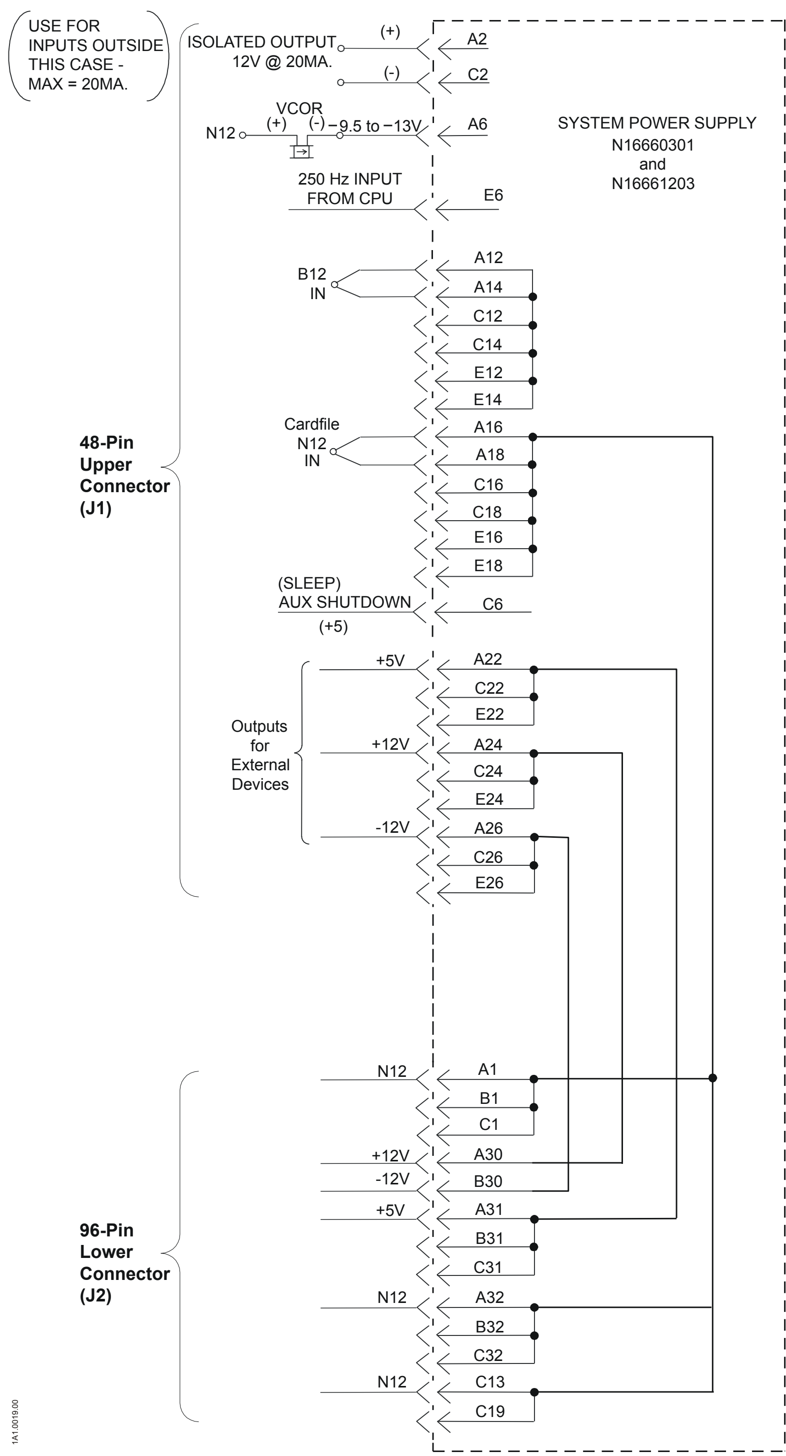



**Figure 2-6. Power Supply PCB Layout (P20B.0100038)**




## Figure 2-7. Power Supply Top and Bottom PCB Connector Pin-Outs

### Table 2-4. Available Power Supply PCB Configurations

| ASTS USA PART NUMBER | 5VDC INTERNAL | 12VDC INTERNAL | INPUT RANGE | FRONT PANEL INCLUDED | ISOLATED POWER SUPPLY CIRCUIT INCLUDED |
|---|---|---|---|---|---|
| N16660301 | +5VDC@ 3A | ±12VDC@ 1A | 9.8VDC – 16.2VDC | YES | YES |
| N16661203 | +5VDC@ 5A | +12VDC@ 1A<br>–12VDC@ 2A | 9.8VDC – 16.2VDC | YES | YES |
| P20B.0100038 | +5VDC@ 5A | +12VDC@ 1A<br>–12VDC@ 2A | 9.8VDC – 32VDC | YES | YES |

**WARNING**

When replacing a power supply PCB, make certain of the PCB type. An old model PCB (N16660301) can be replaced with the new model PCBs (N16661203 or P20B.0100038), but not a new with an old (due to current rating).

<u>A power supply PCB cannot be interchanged with a CPS only PCB.</u>

**NOTE**

A constant voltage type charger is recommended for the batteries supplying MicroLok II system power. The batteries must be capable of providing a minimum voltage of 11.5VDC at system start-up (The system will not turn-on with battery voltage less than 11.5VDC).

### 2.2.2. Conditional Power Supply PCB

CPS only PCB – N451910-7501

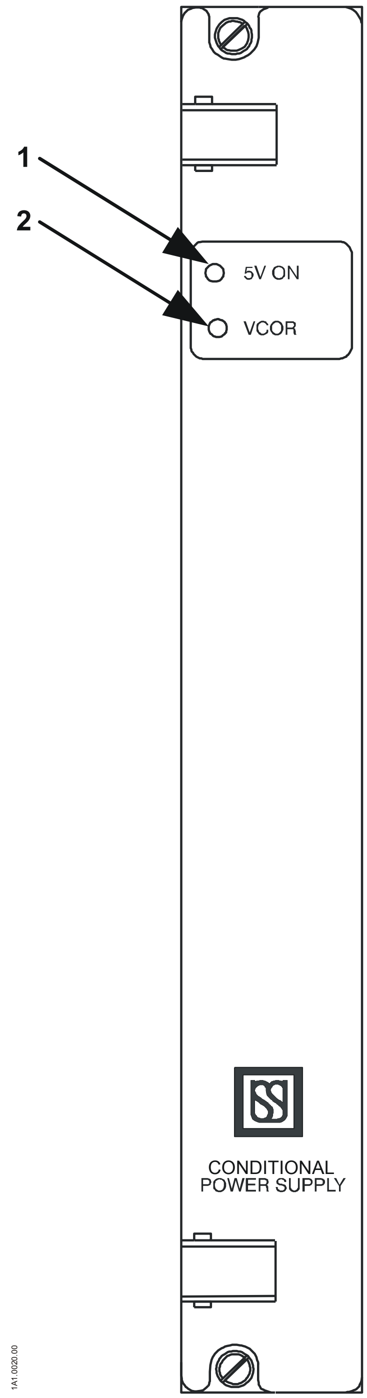



**Figure 2-8. Conditional Power Supply PCB Front Panel Detail**

The Conditional Power Supply (CPS) PCB serves a vital role in the fail-safe design of the MicroLok II system.

The MicroLok II CPU PCB outputs a 250Hz check signal to the power supply PCB, as long as the diagnostic checks performed continuously by the CPU detect no internal or external system faults.

The CPS circuit generates the VCOR voltage (–9VDC to –14VDC) from the 250Hz CPU signal to energize the VCOR relay.

Failure of a diagnostic check by the CPU results in the removal of this check signal from the CPS PCB and the corresponding loss of VCOR power. Once the VCOR drops all output power is removed from the cardfile vital outputs.

External power, switched through the VCOR contacts, is used for system output power. Figure 2-3 shows an example of typical MicroLok II power distribution and utilization of the VCOR.

**Table 2-5. Power Supply Indicators**

| REF FIGURE 2-2 | LABEL | DEVICE | PURPOSE |
|---|---|---|---|
| 1 | **5V ON** | LED (Green) | When lit, indicates 5V operating power from external power supply. |
| 2 | **VCOR** | LED (Green) | When lit, indicates "conditional power On" to VCOR relay (CPU diagnostics normal). |

**NOTE**

The VCOR voltage (nominal –9VDC), generated by the CPS, is negative with respect to N12. Refer to Figure 2-3.

**Table 2-6. Fuse on the Conditional Power Supply PCB**

| DESIGNATION REF. FIGURE 2-9 | CIRCUIT APPLICATION | ASTS USA PART NUMBER | DESCRIPTION |
|---|---|---|---|
| F1 | VCOR Coil Voltage | J071075 | 1/8 amp, 250 volt |

This fuse can blow if there is a problem with the VCOR coil wiring. **There is no indication of this failure**. The front panel LEDs will still be "On," even though the fuse is blown.

The PCB must be removed to check the fuse's condition.

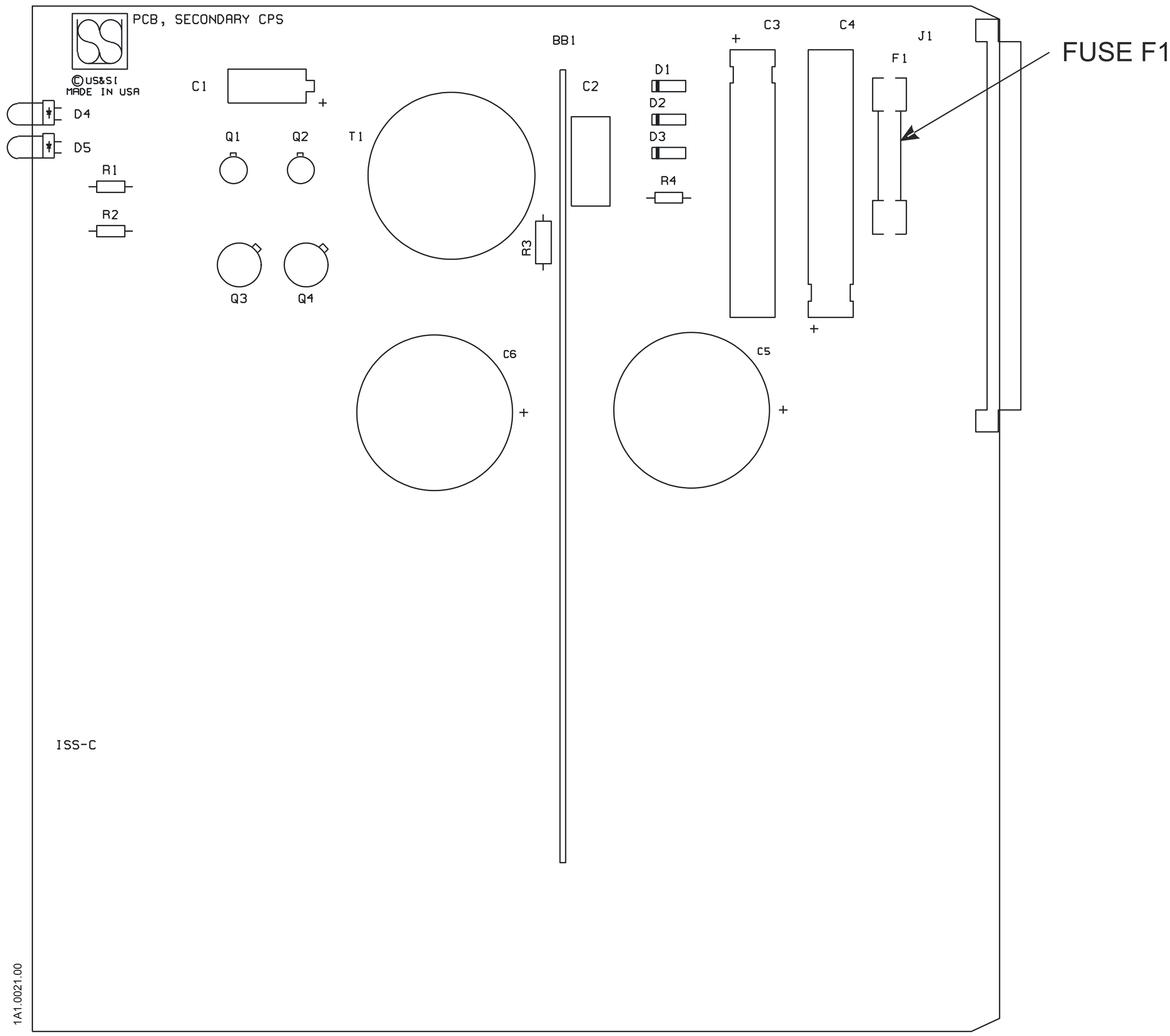
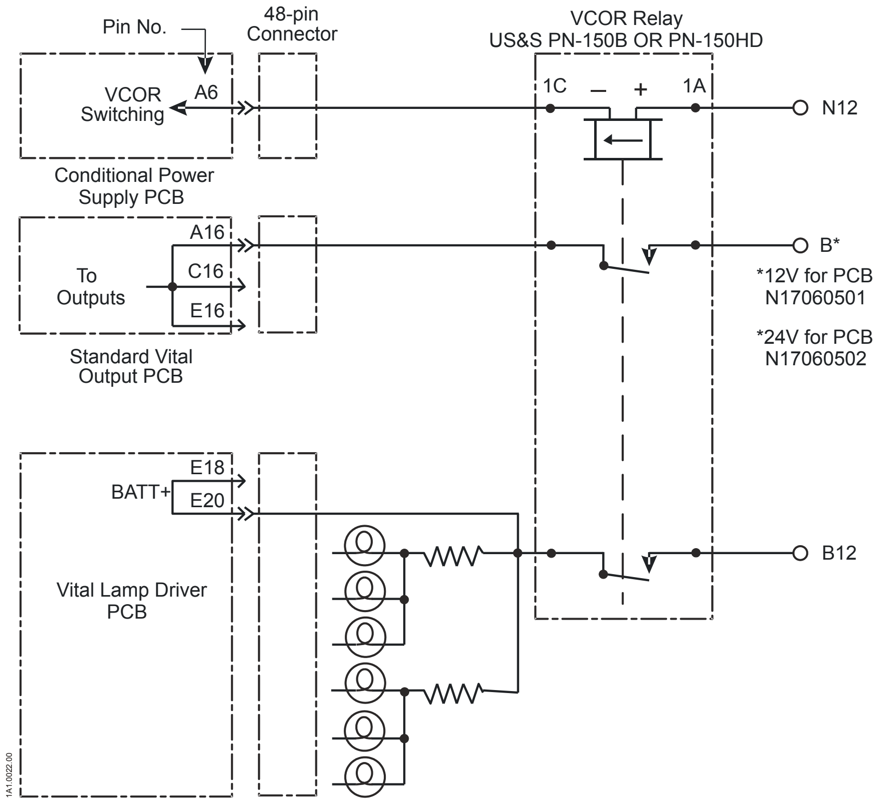



**Figure 2-9. CPS PCB Fuse Location**




## Figure 2-10. Example of CPS, VCOR Vital Output Wiring

*(with conditional power supply PCB)*

*(Example Only)*

## Table 2-7. Conditional Power Supply PCB Specifications

| ASTS USA PART NUMBER | INPUT POWER | + 5V OUTPUT | + 12V OUTPUT | – 12V OUTPUT | ISOLATED OUTPUT | CPS OUTPUT |
|---|---|---|---|---|---|---|
| N451910-7501 | +5V<br>+12V | – – | – – | – – | – – | – 9.5V ref to N12<br>VCOR400 Ω relay* |

* The PN150B relay is used for low output current applications and the PN-150HD is used for high output current applications.

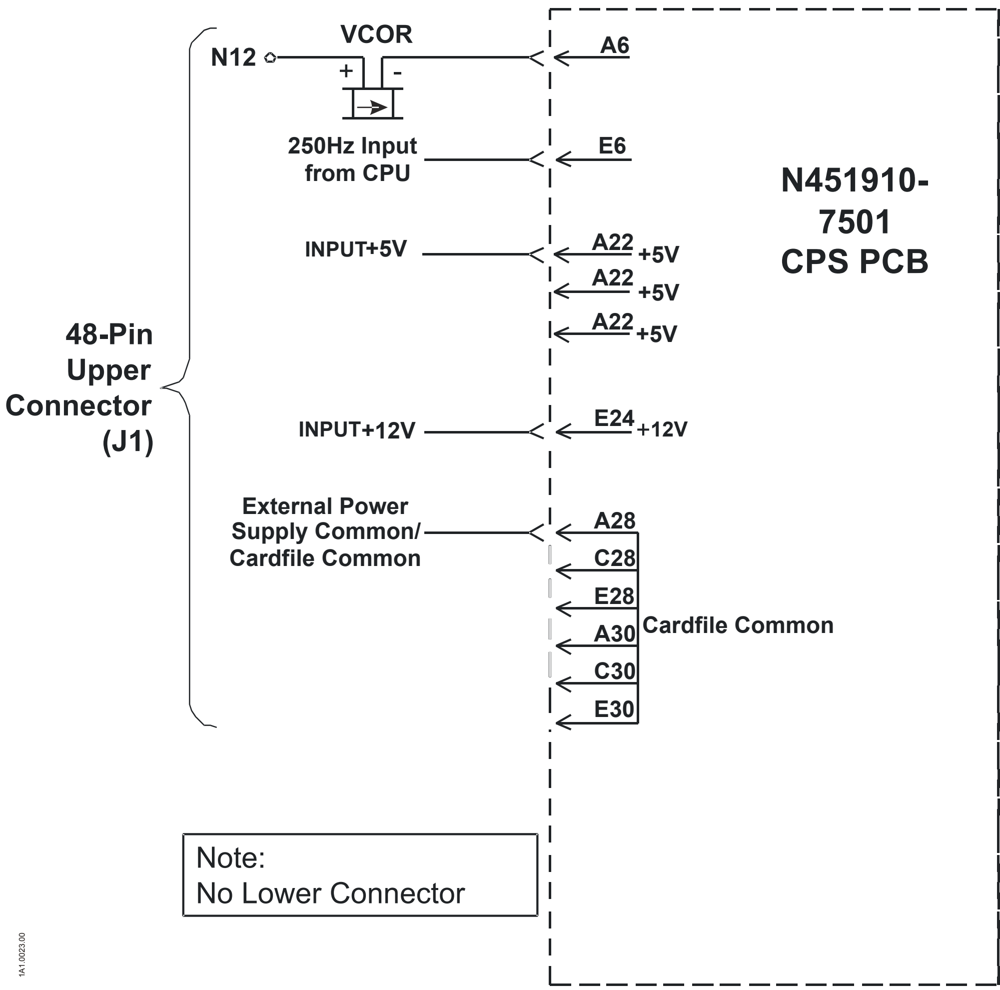



**Figure 2-11. CPS Only PCB Pin-Out**

## NOTE

A constant voltage type charger is recommended for the battery. The battery must be capable of providing a minimum voltage of 11.5VDC at system start-up (The system will not turn-on with battery voltage less than 11.5VDC).

### 2.2.3. Cardfile External Power Supply

Refer to Figure 2-13 for a diagram of typical external power supply connections.

When the power consumption of the cardfile exceeds the rating of the Power Supply PCB, an external power supply must be used to supply the 12VDC and 5VDC required by the cardfile. Two system power supply modules are used to supply power to the MicroLok II cardfile (See Figure 2-13).

When using external power supplies, cage clamp style connections (J20) are provided on the rear of the lower motherboard, behind slot #19. These cage clamp connectors can handle wire from 0.08 – 2.5mm² (#28 – #12) at a maximum of 15 amps per clamp.

Cardfile power is distributed to all system printed circuit boards through the motherboard to the cardfile PCB's 96-pin PCB connector. The +12V power distributed by the motherboard is not used as a source for any vital or non-vital output.

Current draw on the battery is determined by the application configuration, (number of signal lamps, cab signal carrier frequency, etc.) and can be computed by using the Power Calculation feature of the MicroLok II Development System.

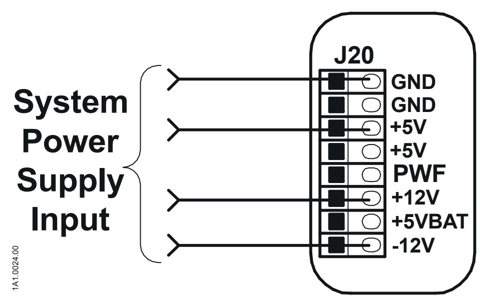



**Figure 2-12. Cardfile Rear J20 External Power Connector**

J20 consist of the following for the power supply connections:

- Two Ground (GND) connections
- Two +5V connections
- One +12V connection
- One –12V connection

PWF (Power Fail) – no connection. Use not implemented at this time.

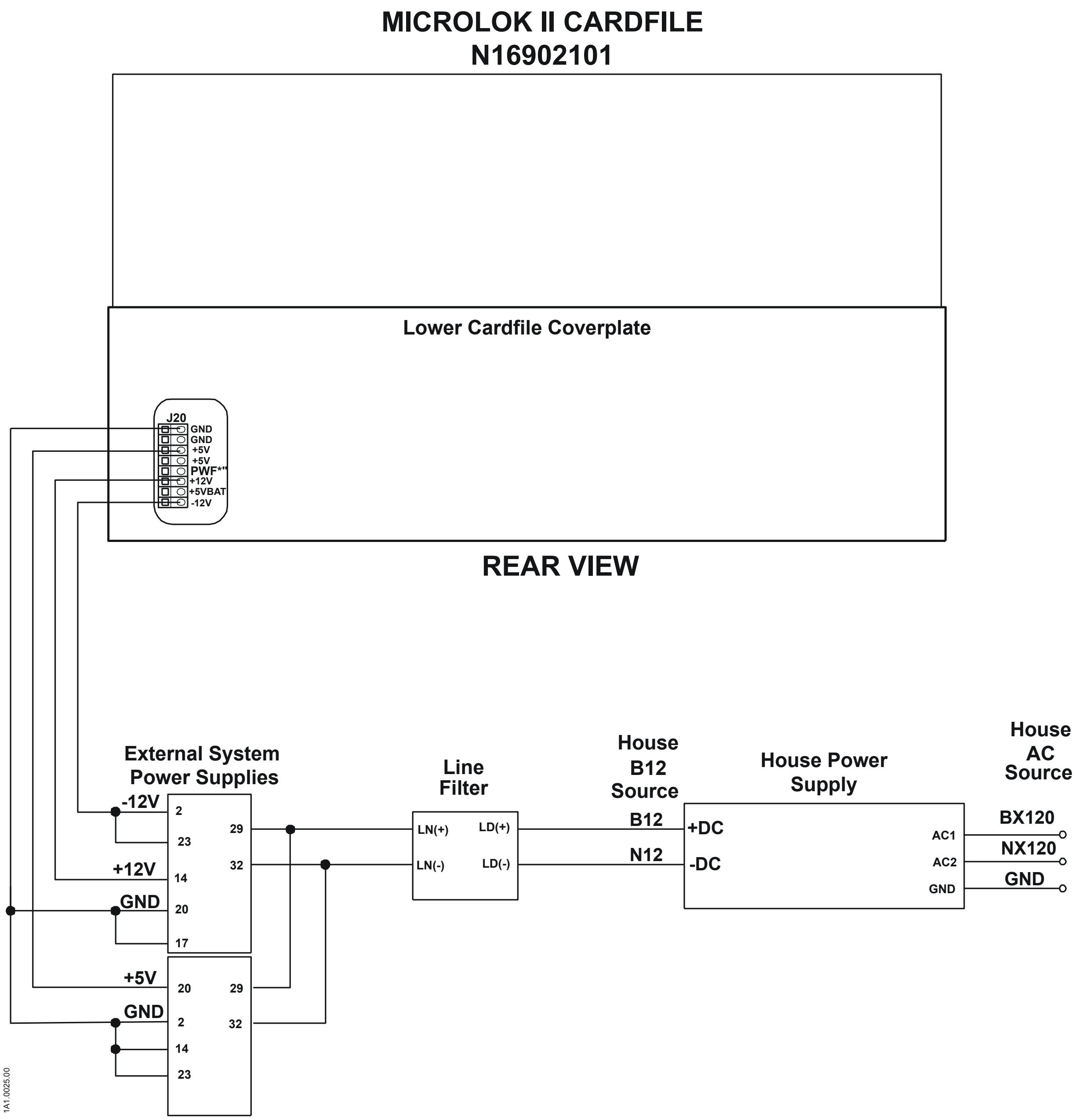



**Figure 2-13. Example External Power Supply to Cardfile Wiring Interface**

In situations where an external power supply is used to power the cardfile and a VCOR relay is needed for vital switching, a CPS only PCB is required to power the relay.

### 2.2.4. Vital Cut-Off Relay (VCOR)

The Vital Cut-Off Relay (VCOR) is used by the MicroLok II system to control power to all vital outputs (See Figure 2-3). System battery B12 passes through the VCOR contacts when the relay is energized (picked). This relay is energized by the conditional output from the CPS PCB in the system cardfile. The MicroLok II CPU PCB controls this fail-safe function. An ASTS USA vital biased relay serves as the VCOR. Dependent on contact current requirements the relays listed in Table 2-8 are used for the VCOR. These relays incorporate a 400 ohm coil and low voltage silver-to-silver contacts.

**Table 2-8. VCOR Contacts and Ratings**

<table>
<tr><th>TYPE<br>PART NUMBER</th><th>CONTACTS</th><th>CONTACT RATING</th><th>COIL RESIST. (OHMS)</th><th>PICKUP AMPS</th><th>PICKUP DC VOLTS</th><th>SYSTEM VOLTAGE</th></tr>
<tr><td rowspan="2">ASTS USA PN-150HD<br>N322505-701</td><td>4FB</td><td>15 amps</td><td rowspan="2">400</td><td rowspan="2">0.0132</td><td rowspan="2">5.3</td><td rowspan="2">10</td></tr>
<tr><td>2FB</td><td>4 amps</td></tr>
<tr><td>ASTS USA PN-150B<br>N322500-701<br>or<br>N322500-801<br>(no front test)</td><td>6FB</td><td>4 amps</td><td>400</td><td>0.0132</td><td>5.3</td><td>10</td></tr>
</table>

**NOTE**

To increase the output current capacity of the relay contacts the following relays can be used as repeaters of the VCOR:

PN-150B (400 or 800 ohm coil)

PN-150HD (400 or 800 ohm coil)

PN-250B (250 ohm coil – 12 volt system)

**CAUTION**

At no time should the operation of an installed VCOR relay be checked by applying +12VDC to the 1C terminal of the coil. This **will** result in damage to the cardfile power supply.

To check relay operation, first remove it from the installation.

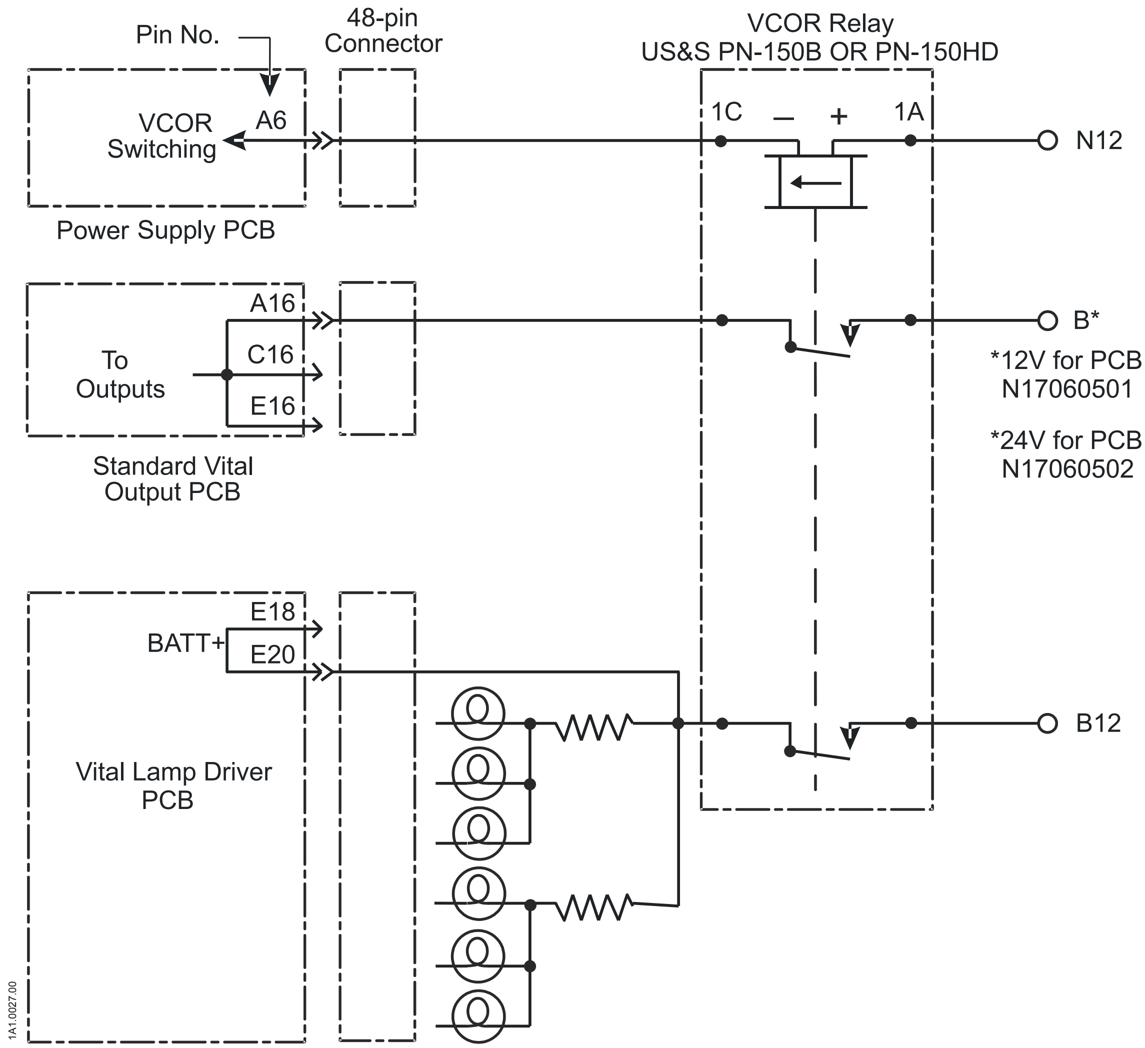



**Figure 2-14. Example of VCOR Vital Output Wiring with Power Supply PCB**

*(shown with incandescent signals)*

*(Example Only)*

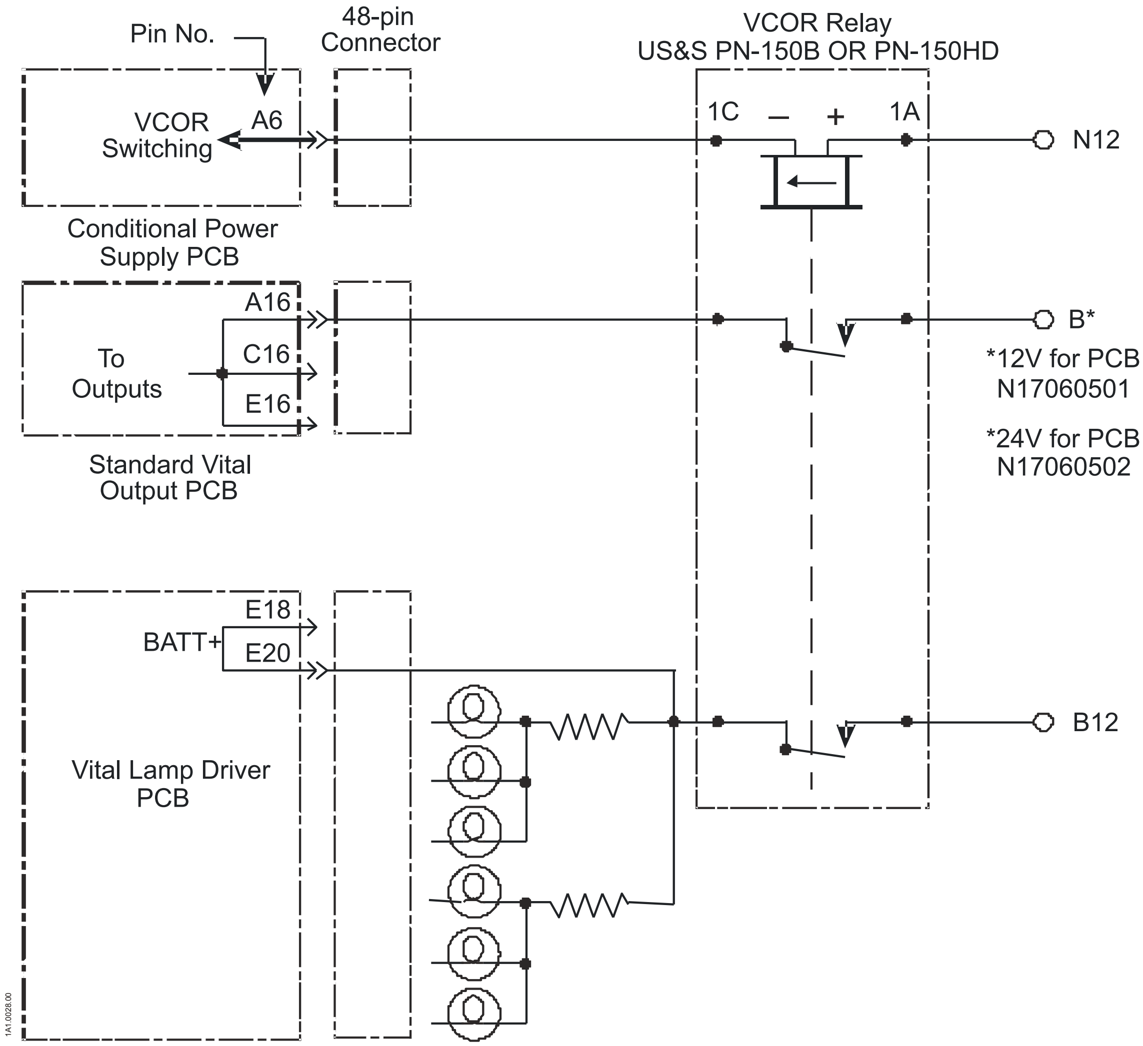



**Figure 2-15. Example of VCOR Vital Output Wiring with CPS PCB**

*(Example Only)*

### 2.2.5. Cardfile Grounding

All MicroLok II 2/2 circuitry is isolated from the MicroLok II 2/2 cardfile chassis. This allows the cardfile to be connected to earth ground for shielding purposes if desired.

For CE-compliant installations, cardfiles must be grounded via the metal cardfile-mounting brackets supplied with all MicroLok II 2/2 units.

The part numbers for these brackets are:

Right: M21050701

Left: M21050702

## 2.3. Installing the MicroLok II 2/2 Cardfile Plug-ins

Installing the MicroLok II 2/2 system cardfile plug-ins is a four-step process. Each of the following steps must be performed for each circuit board to be installed:

- Selecting the appropriate cardfile slot for each circuit board (Section 2.3.1).
- Configuring the cardfile keying plugs for each circuit board (Section 2.3.2).
- Configuring the circuit board jumpers and firmware just prior to installation (Section 2.3.3).
- Install the circuit boards (Section 2.3.4).

### 2.3.1. Circuit Board Arrangement Rules

Observe the following arrangement rules when installing MicroLok II 2/2 printed circuit boards (when applicable) into the card file:

- Any plug-in PCB may be installed in any cardfile slot, with the exception of slot 19 (which cannot be used because there is no corresponding buss connector).

  If the cardfile is going to be full, ASTS USA recommends that the CPU board be installed in slot 18, because it is a double-width PCB that covers the unusable space of slot 19.

- Any two boards can be installed adjacent to one another without concern for EMI or RF effects between the boards. Typically, the boards are grouped according to general function (I/O with I/O and Non-Vital boards with Non-Vital boards, for example).
- All unused slots must be fitted with a blank shield panel so that the entire front face of the cardfile is covered. Available blank panels include:

  Single slot shield panel: N451850-2902

  Double slot shield panel: N451850-2901

- After the full set of PCBs is defined for the application, keying plugs must be installed in the lower motherboard connectors. These plugs prevent insertion of the wrong replacement board for a given slot. Refer to the Section 2.3.2 for keying plug installation procedures.

### 2.3.2. Keying Plug Installation

Each of the MicroLok II 2/2 cardfile slots includes a 12-way female keying guide next to the 96-pin connector. The guide is used to ensure installation of the proper circuit board in each cardfile slot after the complete cardfile board configuration has been determined. Each board is equipped with a corresponding 12-way male keying guide; individual keying tabs are removed at the factory in a specific pattern for the board part number. Prior to installing a board, insert keying plugs (part number J709146-0473) into the corresponding cardfile motherboard keying guide as shown in Figure 2-16 and as listed in Table 2-9.

If it becomes necessary to change the type of board installed in a given slot, the previously installed keying plugs can be removed using a knife or a pair of needle nose pliers.

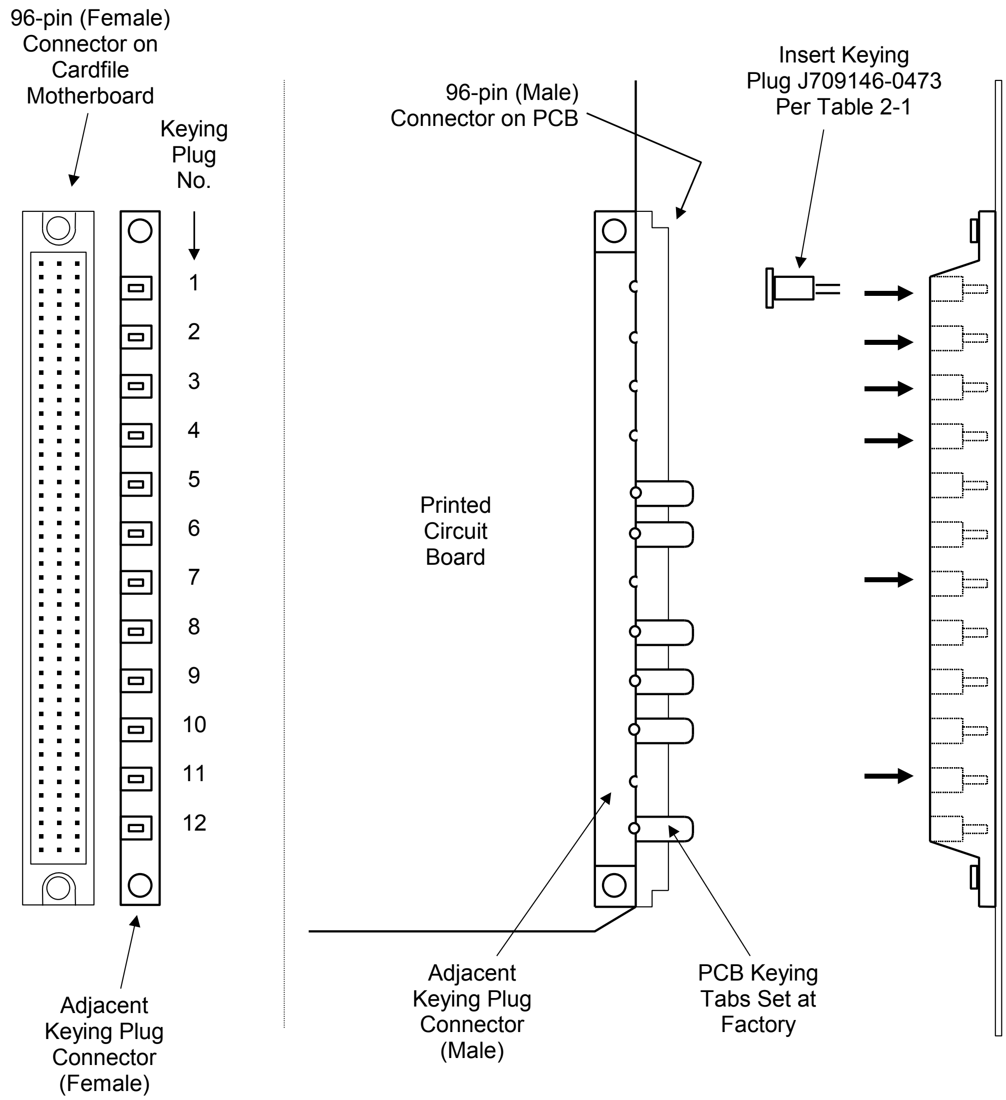



**Figure 2-16. Cardfile Slot Keying Plug Installation**

## Table 2-9. Cardfile Motherboard Keying Plug Locations

| Printed Circuit Board | Part No. | Keying Plug Location (Figure 2-16) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| CPU | N17068501 | X | X | | | X | X | X | | X | | | |
| Power Supply/CPS PCB | N16660301 | X | X | X | | | | | X | X | | | X |
| Power Supply/CPS PCB | N16661203 | X | X | X | | | | | X | X | | | X |
| Power Supply/CPS PCB | P20B.0100038 | X | X | X | | | | | X | X | | | X |
| Standard Vital Output (12V) | N17060501 | X | X | | X | | | | X | X | | X | |
| Standard Vital Output (24V) | N17060502 | X | X | | X | | | | | X | | X | X |
| Vital Input (12V) | N17061001 | X | X | | X | | | | X | X | | | X |
| Vital Input (24V) | N17061002 | X | X | | X | | | | | | X | X | X |
| Vital Input (50V) | N17061003 | X | X | | | | | X | | X | | X | X |
| Vital Input (10V) | N17061004 | X | | X | | X | | X | X | | X | | |
| Vital Input (24V AC Immunity) | N17061005 | X | | X | | X | | X | X | | | X | |
| Non-Vital I/O | N17061501 | X | X | | X | | | | | X | X | X | |
| IN8.OUT8 (12V) | N17061601 | X | X | | X | | | | X | | X | X | |
| IN8.OUT8 (24V) | N17061602 | X | X | | | X | X | X | X | | | | |
| Synchronization (12V) | N17066401 | X | | X | | | X | X | X | | X | | |
| Synchronization (24V) | N17066402 | X | | X | | | X | X | X | | | X | |
| Communication | N17066403 | X | | X | | | X | X | X | | | | X |
| NV.IN32 PCB | N17063701 | X | X | | | | | X | X | | X | X | |
| NV.OUT32 PCB | N17062701 | X | X | | | | X | X | | X | | | X |
| Out8.ISOv(12V) | N17065801 | X | | X | X | | X | X | | | | | X |
| Out8.ISO (24V) | N17065802 | X | | X | X | | X | X | | | | | X |
| CPS | N451910-7501 | No keying plugs | | | | | | | | | | | |

NOTE: "X" Indicates keying plug is to be installed on the motherboard.

### 2.3.3. CPU Board Jumper and DIP Switch Settings

The CPU board contains jumpers and firmware that must be configured before it is installed.

#### 2.3.3.1. Jumper Settings

The CPU PCB includes on-board jumpers (See Figure 2-17). Prior to installing the CPU board in the MicroLok II 2/2 cardfile, the jumpers listed in Table 2-10 should be checked to make certain they are in their proper positions. JP2, JP4 and JP5 must have their shorting blocks in the 2-3 position for proper system resets. All other jumpers are for factory use only and must not be moved.

**Table 2-10. CPU PCB Jumper Settings**

| JUMPER | POSITION |
|---|---|
| JP1 | Not Installed |
| JP2 | 2-3 |
| JP3 | 2-3 |
| JP4 | 2-3 |
| JP5 | 2-3 |
| JP6 | Soldered (+5V to WD_IN) |

#### 2.3.3.2. CPU DIP Switches

The CPU PCB includes an on-board eight-position DIP (dual inline package) switch (See Figure 2-17). Rocker 1 is used for selecting the IP address. Rockers 2 through 7 are for factory use only and must be left in the off position. See SM-1A1.0003 for additional information.

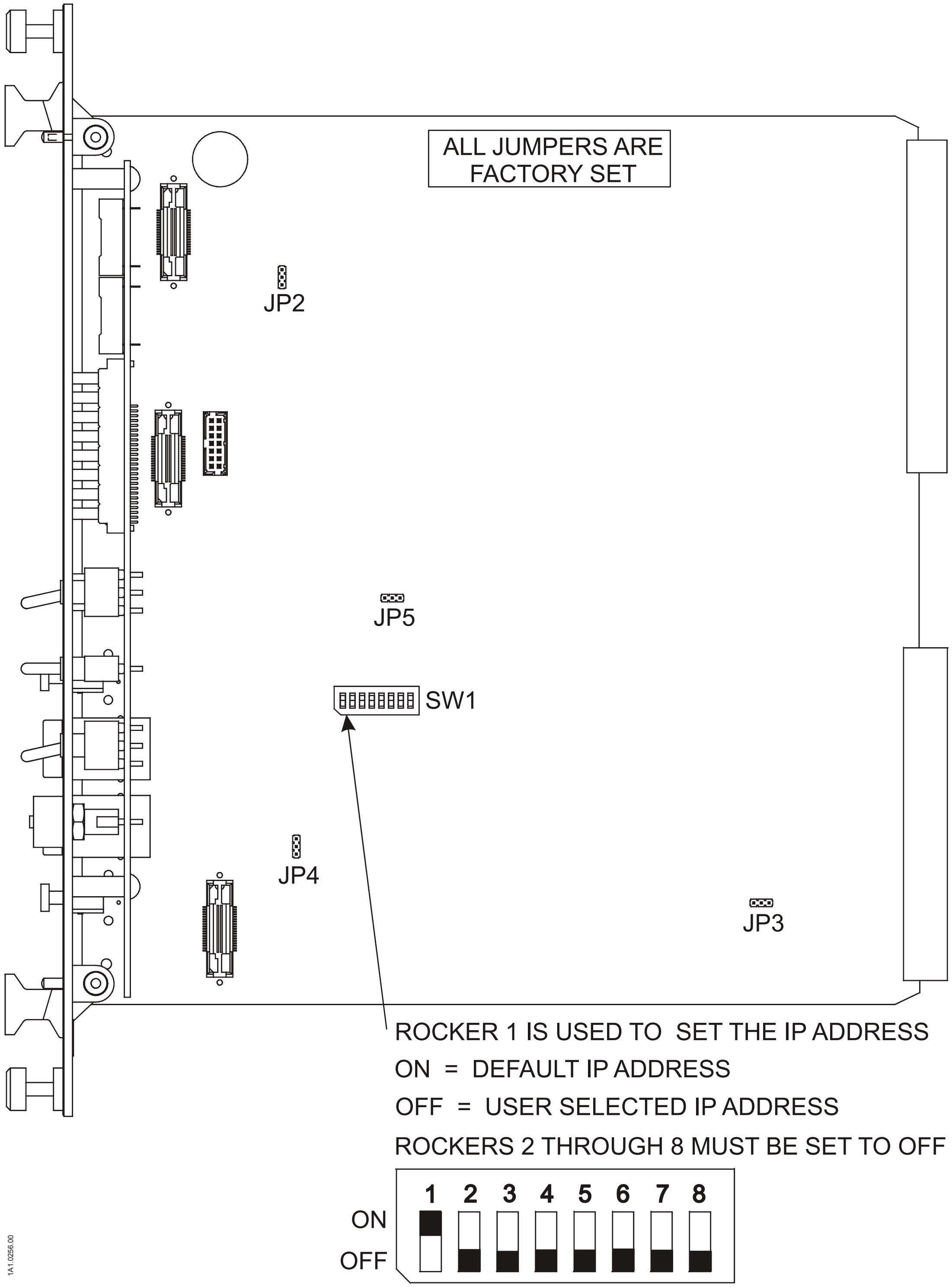



**Figure 2-17. CPU PCB Jumper Positions and Settings (N17068501)**

### 2.3.4. Installing MicroLok II 2/2 Circuit Boards

***ASTS USA REQUIRES that power is removed from the cardfile before removing or installing circuit boards.***

Use the following the procedure to install the MicroLok II 2/2 plug-in circuit boards:

1. ASTS USA provides stickers with each MicroLok II 2/2 system that are used to identify the type of circuit board installed in each cardfile slot. Obtain the proper sticker for the board to be installed. Attach the sticker to the inside bottom surface of the cardfile. Make certain that the arrow on the sticker points toward the appropriate card slot.
2. Hold the circuit board to be installed vertically in front of the cardfile.
3. Insert the board upper and lower edges into the plastic card guides inside the cardfile.

**CAUTION**

> When installing any MicroLok II 2/2 circuit board into the card file, do not attempt to force the board into the slot. Damage to the circuit board and motherboard 96-pin connectors may result. If resistance is encountered when installing a board, gently rock the board to engage the male and female connectors. If the board still cannot be fully inserted into the card slot, remove the board from the cardfile and attempt to determine the source of the resistance.

4. Gently push the board into the cardfile until the board and cardfile 96-pin connectors are fully engaged. If the board has an integral front panel, make certain that the rear face of the front panel is flush against the front of the cardfile.
5. If the board has an integral front panel, secure the board into position using the two retaining screws attached to the front panel.

## 2.4. PCB Connector Assembly and Cardfile Address Setting

### 2.4.1. General

**NOTE**

> Refer to Section 3 for MicroLok II 2/2 printed circuit board interfaces to external circuits.

Individual MicroLok II 2/2 circuit boards are interfaced (as applicable) to external circuits using connector/cable assemblies with a 48-pin or 96-pin female connector housing that attaches directly to the matching connector on the applicable circuit board. All boards except the 96-pin non-vital I/O PCB (N17061501) use the 48-pin connector. Each connector housing is secured to the cardfile backplane with two small machine screws. (See Figure 2-18.) The complete connector/cable assemblies may be assembled to order by ASTS USA, or assembled by the user.

The connector cable assemblies provide discrete wiring for all available I/O points on each PCB. As shown in Figure 2-18, wire bundles are routed through a protective sleeve on one of the two wiring openings of the connector housing. For most applications, the cable assemblies utilize only one cable opening on the connector housing. However, non-vital I/O PCB N17061501 may need to use both openings to accommodate the full set of 32 input and 32 output wires.

For some MicroLok II 2/2 circuit boards, the connector housing also includes an Address Select PCB with six two-position jumpers used to set the cardfile electrical address of the associated board. These addresses are defined in the MicroLok II 2/2 vital application logic. The jumper settings must exactly match the values set in the application program to ensure normal system operation. The following circuit boards do not require a cardfile bus address and do not have jumpers included with the connector housing:

- CPU board
- CPS board

ASTS USA provides stickers with each MicroLok II 2/2 system that depict individual connector jumpers. After each jumper has been attached to the associated cardfile connector, affix a sticker to the cardfile frame directly below the connector. Use a pen or indelible marker to mark each jumper position on the sticker.

An EEPROM is included within the special connector housing used for the CPU board. This chip holds site-specific configuration data and allows the CPU to be changed while keeping the chip programming intact.

### 2.4.2. Connector/Cable Assembly Construction Notes

User assembly of the MicroLok II 2/2 connector/cable requires the parts and tools listed in Table 2-11.

**Table 2-11. MicroLok II 2/2 PC Board Connector Components and Tools**

| Fig. 2-11 Item | Description | ASTS USA Part No. | Comments/Vendor Part No. |
|---|---|---|---|
| 1 | connector housing assembly<br>48-pin<br>96-pin | J709146-1105<br>J709146-1104 | Used on all PCBs except N17061501.<br>Used with non-vital I/O PCB N17061501. |
| 2 | connector receptacle<br>48-pin<br>96-pin | J709146-0452<br>J709146-0922 | -- |
| 3 | receptacle mounting screw | J525400-0001 | Mounts both 48-pin or 96-pin receptacle. |
| 4 | guide<br>48-pin<br>96-pin | J709146-1106<br>J709146-1107 | -- |
| 5 | wire crimp contact<br>48-pin, #16 to #20 wire<br>48-pin, #20 to #26 wire<br>96-pin, #20 to #28 wire | J709146-0453<br>J709146-0853<br>J709146-0921 | Harting 09-06-000-8482<br>Harting 09-06-000-8481<br>Harting 09-06-000-8484 |
| -- | crimp tool, for:<br>48-pin, #16 to #20 wire<br>48-pin, #20 to #26 wire<br>96-pin, #20 to #28 wire | -- | Harting tool 09-99-000-0077<br>Harting tool 09-00-000-0076<br>Harting tool 09-00-000-0075 |
| -- | extraction tool, for:<br>48-pin, #16 to #20 wire<br>48-pin, #20 to #26 wire<br>96-pin, #20 to #28 wire | -- | Harting tool 09-99-000-0087<br>(Contact ASTS USA)<br>Harting tool 09-99-000-0101 |
| -- | insertion tool, for:<br>48-pin, #16 to #20 wire<br>48-pin, #20 to #26 wire<br>96-pin, #20 to #28 wire | -- | (Contact ASTS USA)<br>(Contact ASTS USA)<br>Harting tool 09-99-000-0100 |
| -- | locator tool, for:<br>48-pin, #16 to #20 wire<br>48-pin, #20 to #26 wire<br>96-pin, #20 to #28 wire | -- | Harting tool 09-99-000-0086<br>(Contact ASTS USA)<br>Harting tool 09-99-000-0099 |
| 6 | Address Select PCB<br>48-pin housing<br>96-pin housing | N17003101<br>N17003301 | Used to set cardfile slot address on selected PCBs.<br>N17003101 replaces N17002002<br>N17003301 replaces N17002101 |
| 7 | EEPROM PCB<br>48-pin housing | N17002001 | Used to hold the EEPROM for site-specific configuration. |
| Figure 2–20 | connector housing assembly | N39908001 | Used with Communication PCB (N17066403). |
| Figure 2–21 | connector housing assembly | N39908001 | Used with Synchronization PCBs (N17066401 and N17066402). |

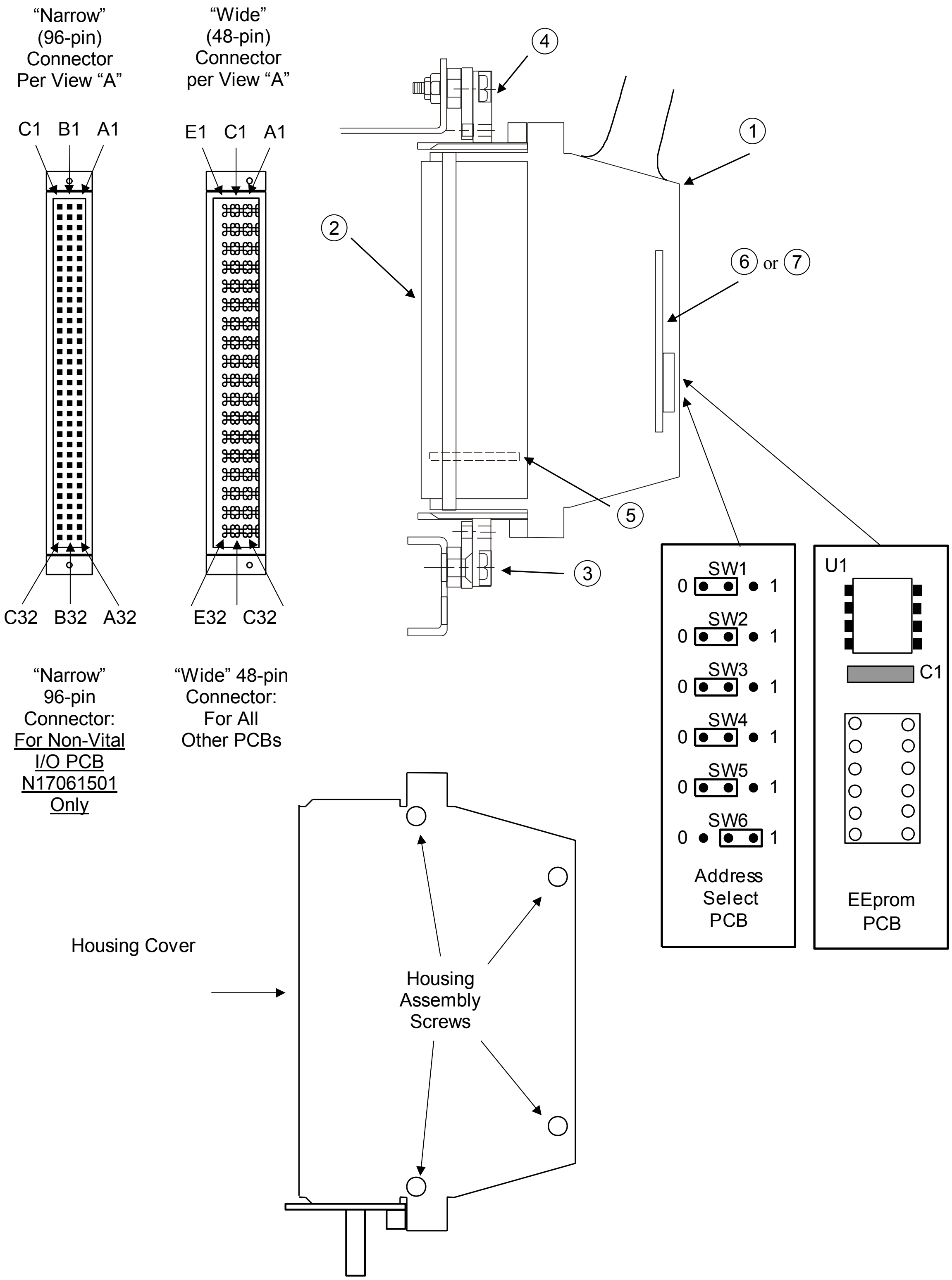



**Figure 2-18. PCB Wiring Connector Mounting and Integral Address Switch Board**

## 2.5. Circuit Board Connections to External Circuits

The configuration of the external wiring to each MicroLok II 2/2 printed circuit board depends entirely on the board type and the selected application. The sections that follow detail the specific connection requirements for each type of MicroLok II 2/2 circuit board.

### 2.5.1. CPU Board

The CPU board contains the central controlling logic and diagnostic monitoring for the MicroLok II 2/2 system. Four communication ports are used for communicating with external systems. (See Figure 2-19.) A USB port enables the connection of a laptop PC for software maintenance, diagnostics, and data log downloading.

The four general purpose ports can be used for vital and non-vital serial communications with other MicroLok II 2/2 systems, modems for central office communication, or AF-902 or AF-904 systems. For installations where the MicroLok II 2/2 system is communicating with another vital system in the same house or case, the maximum serial cable length is 50 feet (15 meters). A modem is required for cables longer than 50 ft. (15 meters). The modem must support an RS-485 link or an RS-485 to RS-232 converter is required. The modem must operate with two signals: TXD, RXD, and a COMMON. Section 3.2 discusses the connecting of MicroLok II 2/2 to external serial devices. Typical equipment used for conversion, isolation and transmission are discussed in Section 3.2.2.

The CPU board also may communicate with an EEPROM contained in the 48-way connector housing that is contained in the CPU's upper rear connector to the rear of the cardfile. This EEPROM is located on a circuit board N17002001 shown on the top left of Figure 2-19. This EEPROM stores any site-specific information and will stay with the wiring hardness even if the CPU board or the cardfile is changed.

Whether the EEPROM is used to store information is dependent on the way the application has been written. The EEPROM is written to during the configuration of the MicroLok II 2/2 unit using the Maintenance Tool and only read during the power-up sequence or after a reset. The contents of the EEPROM will not change unless the configuration tool is run again and will be read as long as the executive or application software has not been revised. If any of the data was revised, the unit will run off of the default setting of the application program until the unit has been reconfigured using the Maintenance Tool.

Use of the Maintenance Tool for configuration is described in SM-1A1.0003.

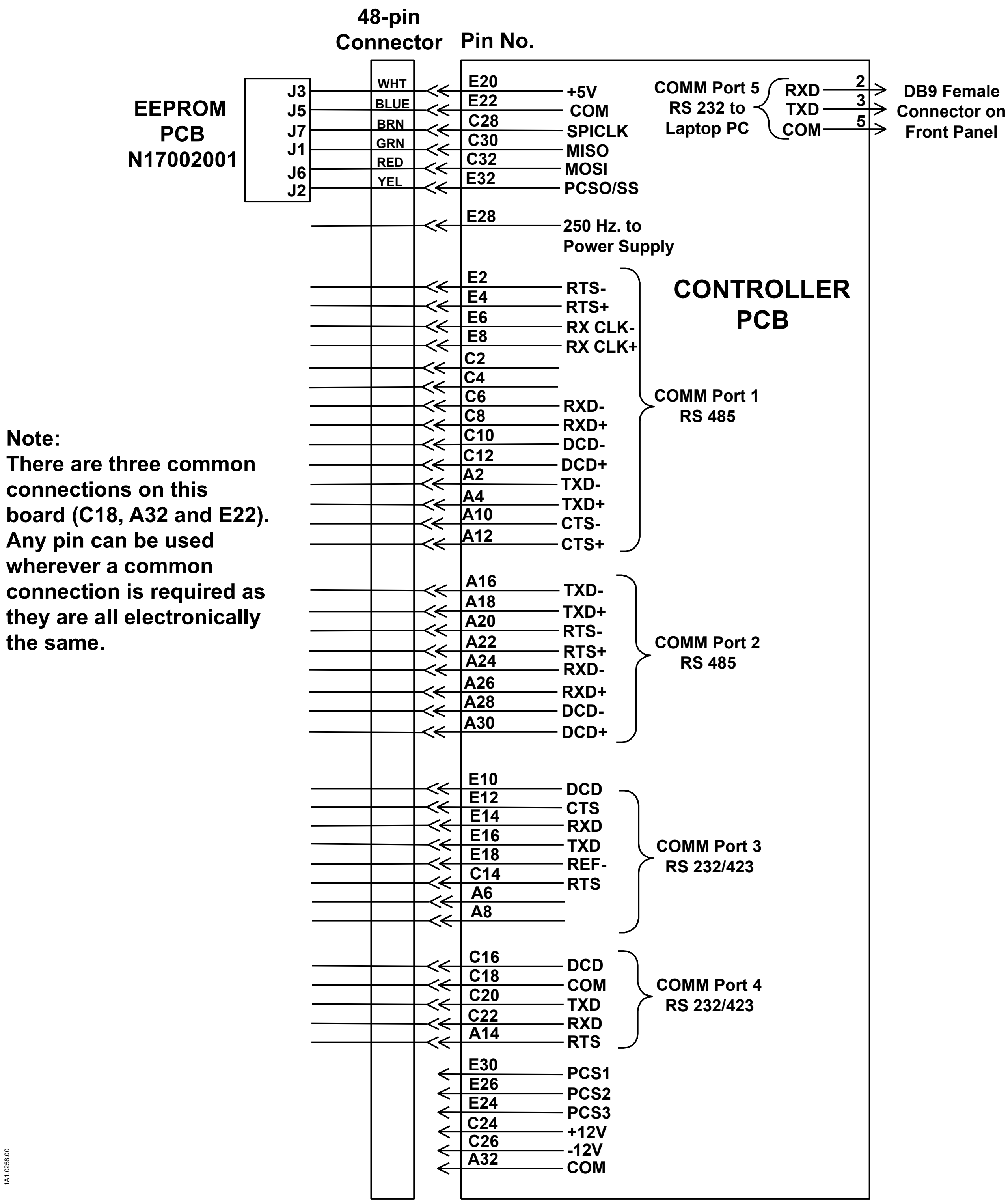



**Figure 2-19. CPU PCB - Basic Interface Wiring**

## 2.5.2. Ethernet Communication PCB

The Communication PCB interfaces through an external board connector (ASTS USA Part Number N39908001). See Figure 2–20. The connector contains address selection jumpers (SW2, SW3, and SW4) and two RJ45 jacks (ETH1 and ETH2) for the Ethernet ports. This allows a standard Ethernet cable to be plugged directly into the back of the MicroLok II cardfile.

Refer to ASTS USA service manual SM1D1.0026 for additional Communication PCB information.

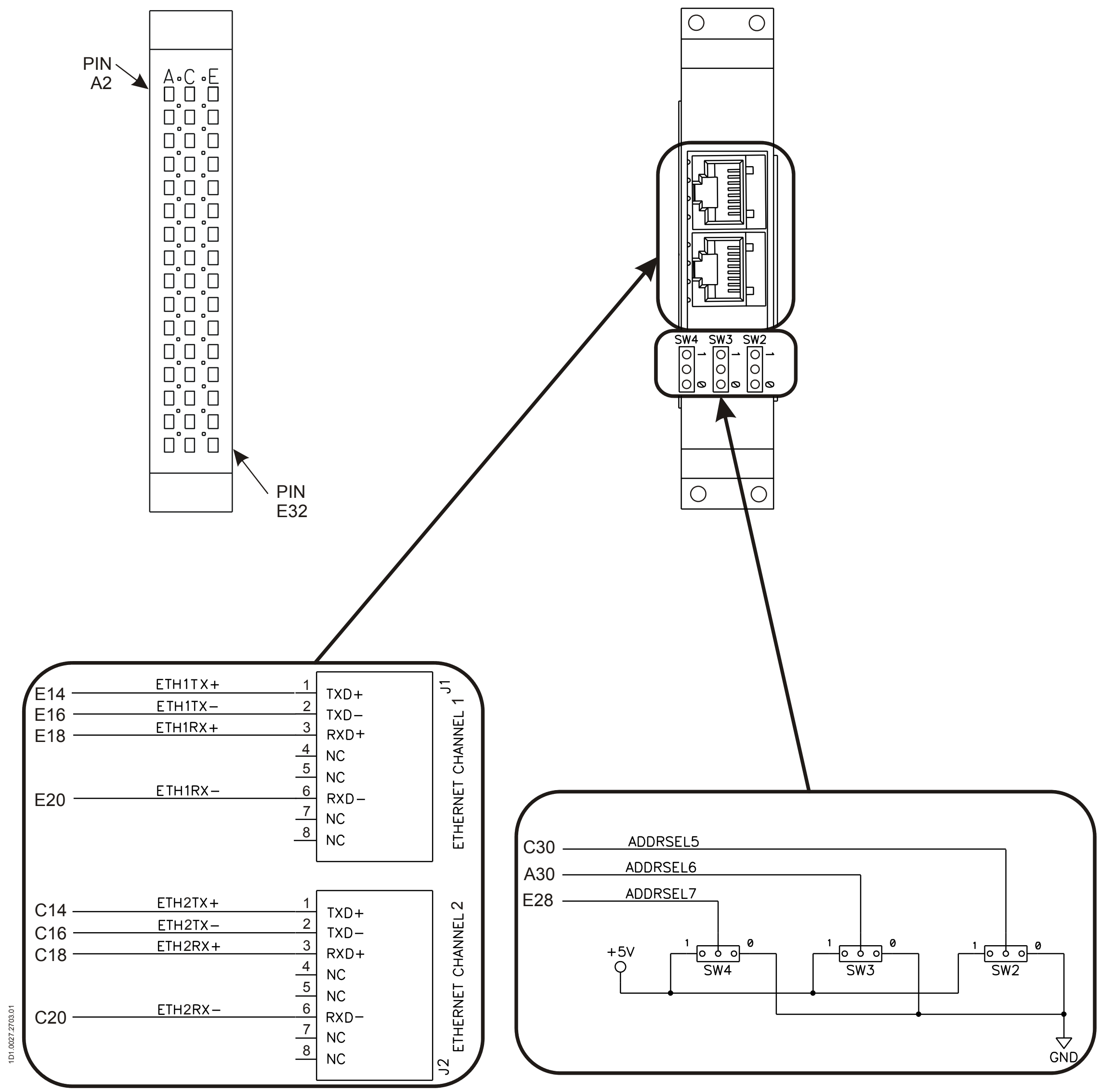



**Figure 2–20. Communication PCB Connector**

### 2.5.3. Synchronization PCB

The Synchronization PCB interfaces through an external board connector ASTS USA Part Number N39908001. See Figure 2–21. The connector contains address selection jumpers (SW2, SW3, and SW4) and two RJ45 jacks (ETH1 and ETH2) for the Ethernet ports. This allows a standard Ethernet cable to be plugged directly into the back of the MicroLok II cardfile. I/O cables can also be wired to the screw terminals of connectors J2 and J3.

**NOTE**

Only Ethernet Channel 1 can be used for the synchronization application.

**NOTE**

The jumper positions of the Address Selection jumpers (SW2, SW3, and SW4 shown in Figure 2–20) are determined by the software application. The settings can be found in the MicroLok II compiler's .mll list file.

Typical Synchronization PCB wiring between two MicroLok II units is shown in Figure 2–22.

Refer to ASTS USA service manual SM1D1.0027 for additional Synchronization PCB information.

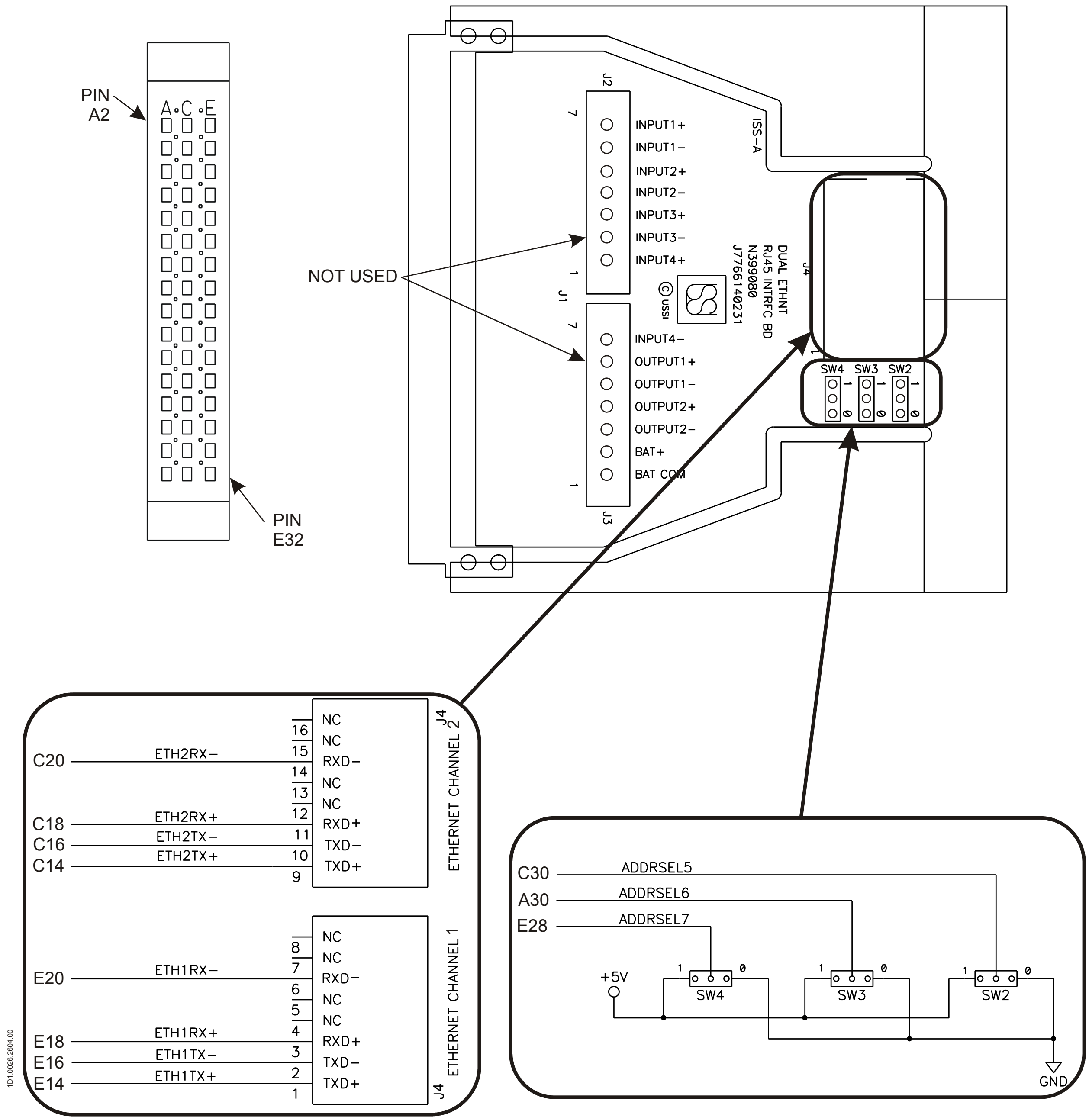



**Figure 2–21. Synchronization PCB Connector (part number N39908001)**

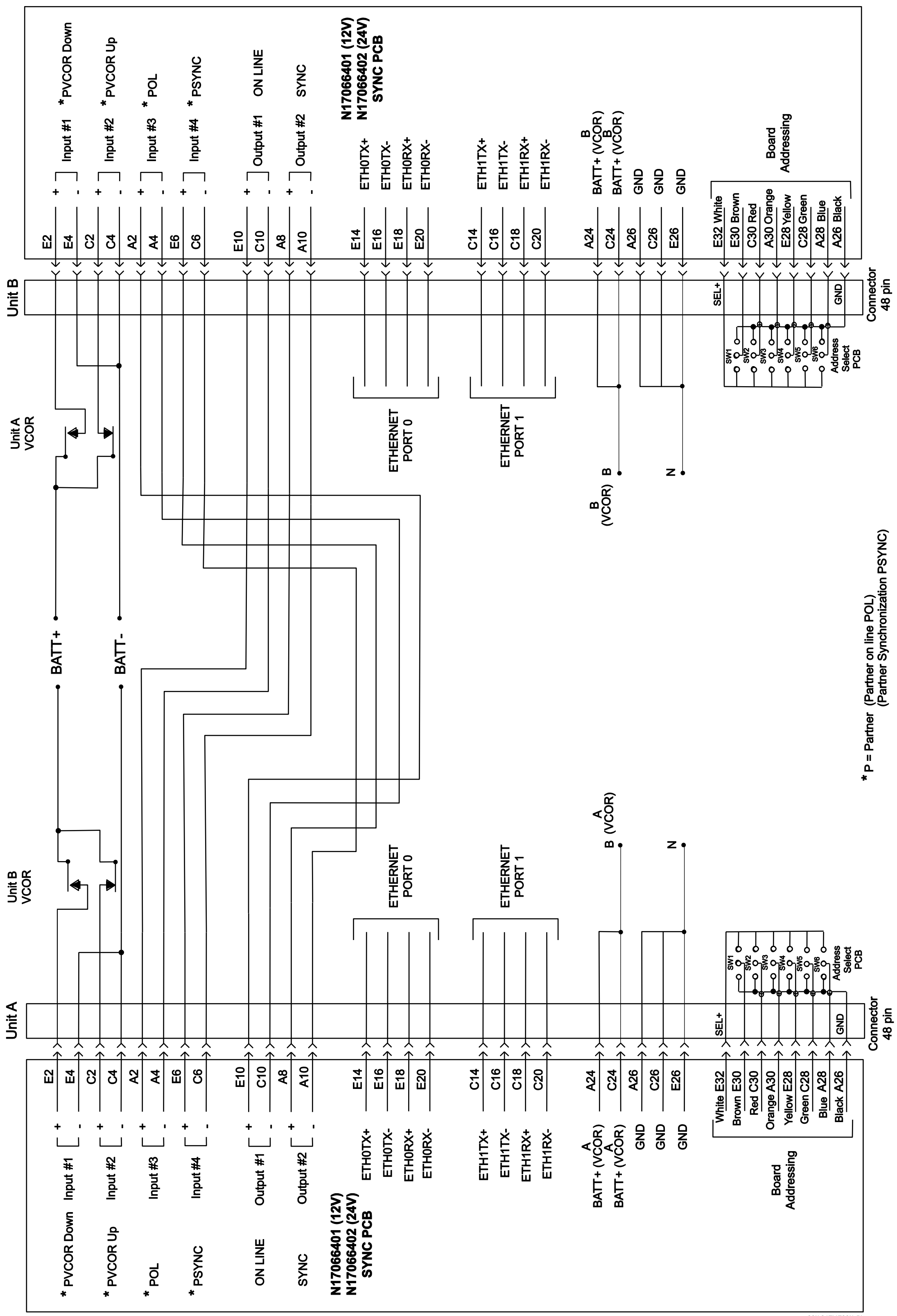



**Figure 2–22. Typical Synchronization PCB Interface Wiring**

### 2.5.4. IN8.OUT8 PCB

Field wiring is done via the top board connector. Each of the eight isolated individual vital inputs has two input connections (+, –) for field equipment.

Inputs can be wired in a BiPolar configuration. Note that in Figure 2-24 input 7 is "On" and input 8 is “Off" for the polarity indicated. For the reverse polarity, input 7 is "Off" and input 8 is "On". A typical vital BiPolar input block diagram is shown in Figure 2-23.

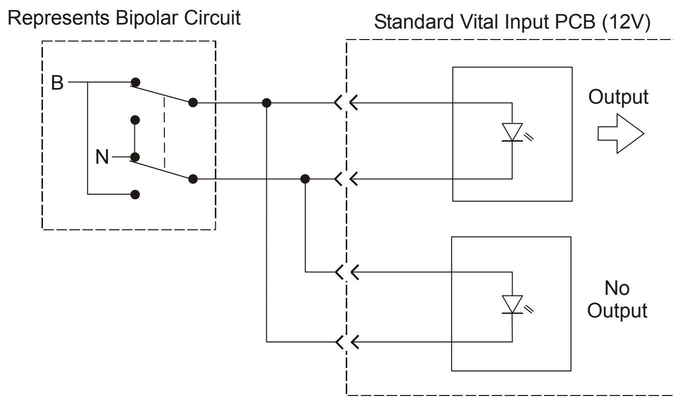



**Figure 2-23. Typical Vital BiPolar Input Block Diagram**

Refer to Figure 2-24 for PCB pin-out information and Figure 2-25 for PCB top connector pin configuration.

PCB 48-pin top connectors are typically wired by ASTS USA per project specifications. A typical connector/cable assembly for the IN8.OUT8 PCB is ASTS USA Part Number N50739601 (20 foot), which provides wiring for the eight inputs and outputs (See Figure 2-25).

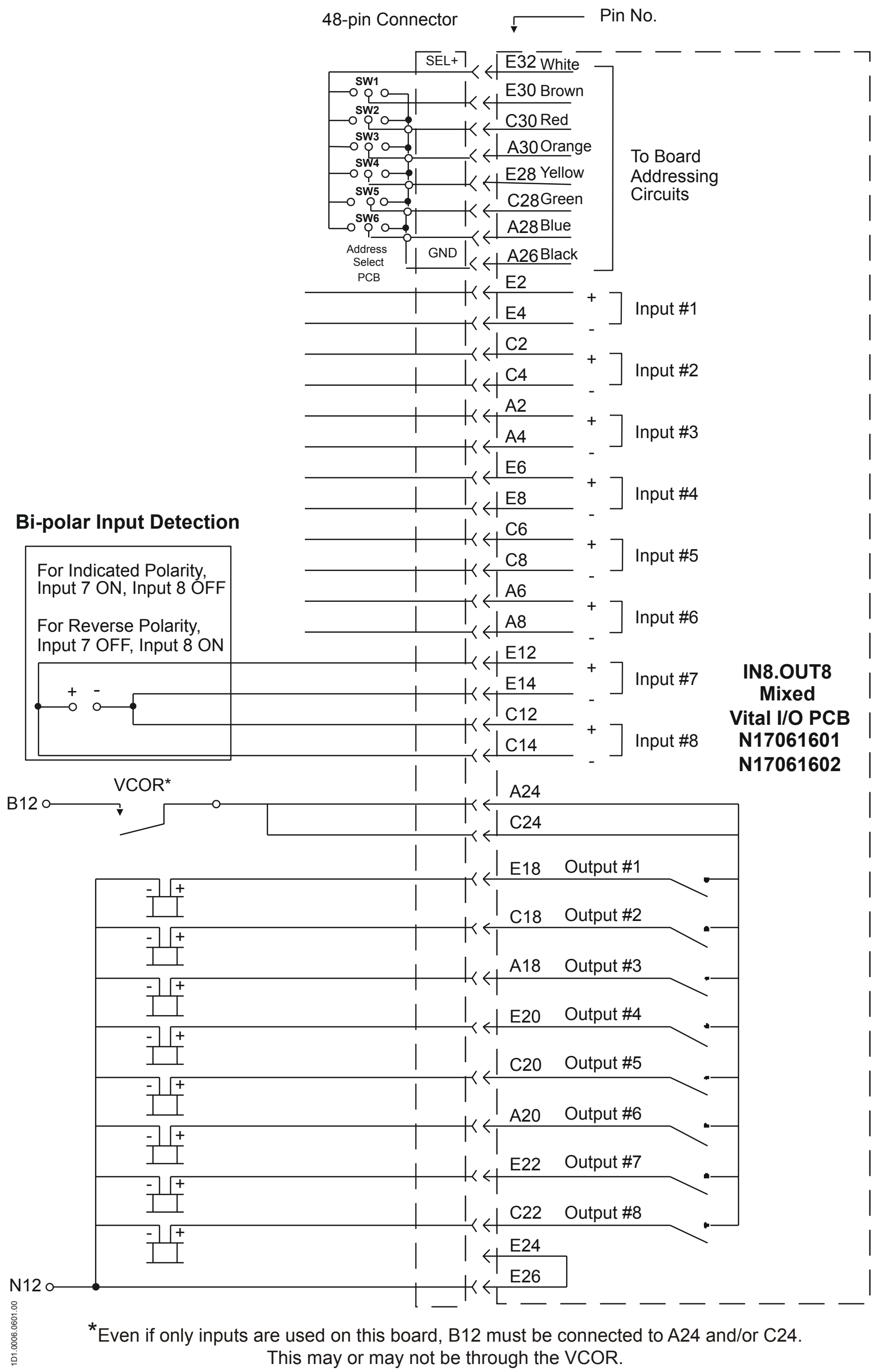



**Figure 2-24. Mixed Vital I/O PCB - Basic Interface Wiring**

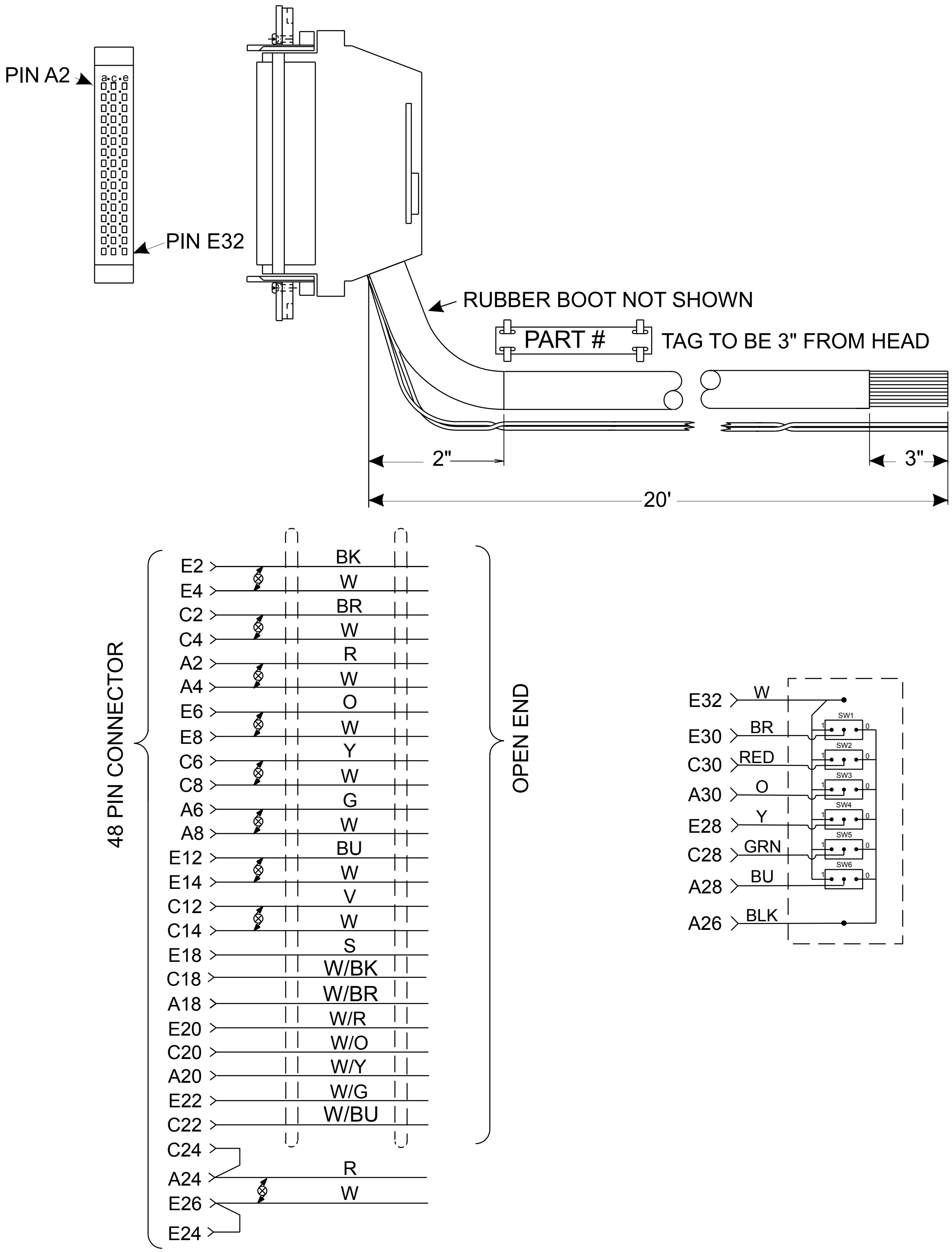



**Figure 2-25. Typical Input Top Connector**

### 2.5.5. Vital Input PCB

The vital input PCB can accept up to 16 isolated inputs. The specifications for this board are listed in Table 2-12.

**Table 2-12. Vital Input PCB Specifications**

| ASTS USA Part No. | Nom. Input Voltage | Min. Voltage to Ensure ON State | Voltage to Ensure OFF State | Max. Sustained Input Voltage |
|---|---|---|---|---|
| N17061001 | 12V | 9.8V | 7.0V or less | 16.2V |

There are no power connections required through the upper connector. When wiring a vital input PCB to a relay contact circuit contained in the same house as the MicroLok II 2/2 cardfile, the signal battery may be used as the energy source to activate the inputs. Terminals designated (-) may be connected to battery N12 and B12 switched over relay contacts.

When wiring a vital input PCB to a relay contact circuit outside the MicroLok II 2/2 house, use the isolated source that is part of the power supply. This is consistent with the practice of confining signal battery to the case in which the MicroLok II 2/2 unit is housed.

As shown in Figure 2-26, inputs can also be wired in a bi-polar configuration.

#### 2.5.5.1. Noise Protection

- ASTS USA recommends the use of twisted pair wiring (two-three turns per foot) for all input to minimize possible noise.
- ASTS USA recommends the separation of “clean” and noisy wiring. Ideally, all inputs are gathered in a bundle, all outputs are gathered in a bundle, and power wiring is gathered in a bundle. Each of these bundles is physically separated from other house wiring. It is particularly important to maintain this physical separation from high-current wiring.

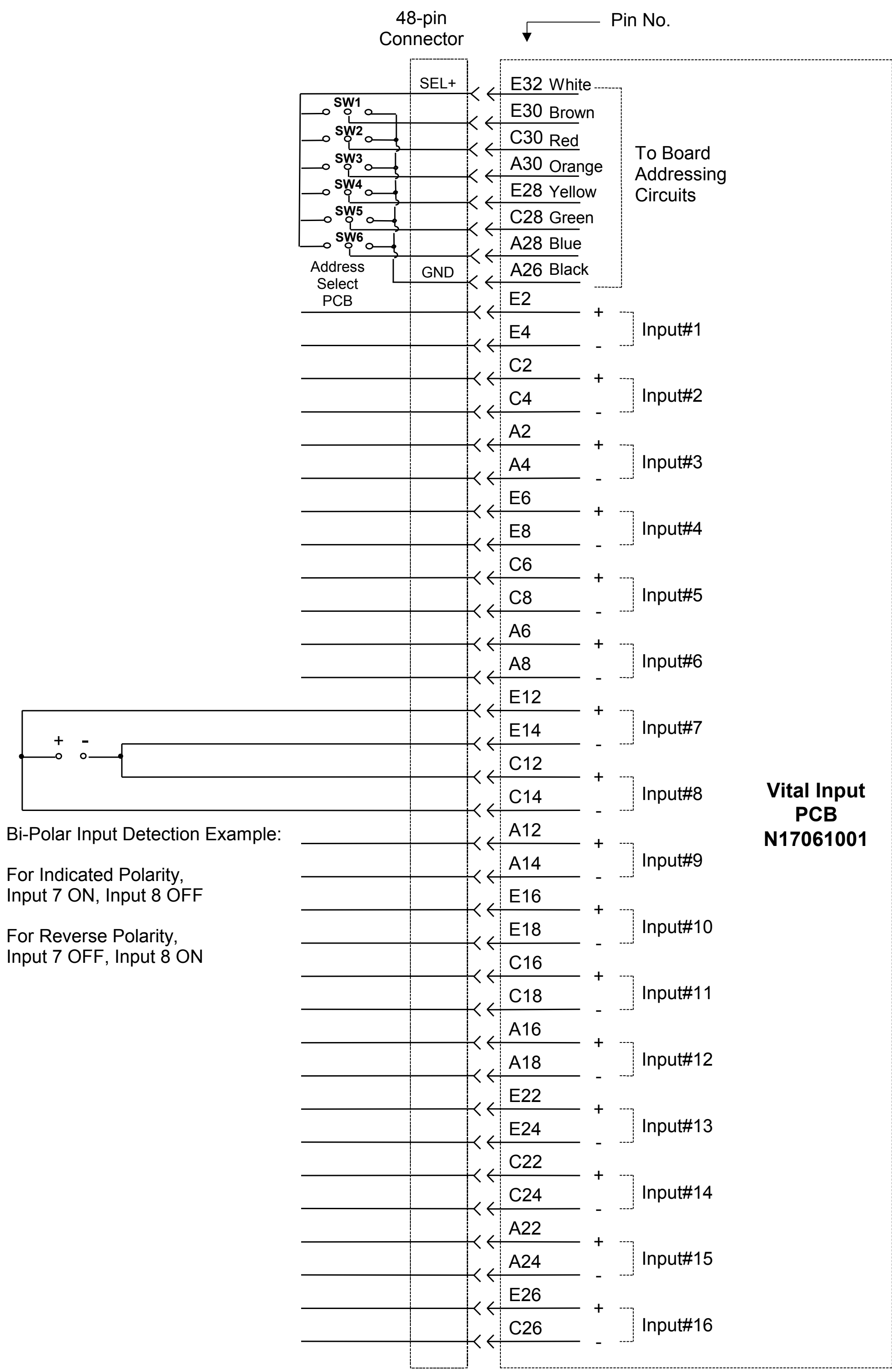



**Figure 2-26. Vital Input PCB - Basic Interface Wiring**

### 2.5.6. Standard Vital Output PCB

The standard vital output PCB provides up to 16 outputs. The specifications for this board are listed in Table 2-13.

**Table 2-13. Standard Vital Output PCB Specifications**

| ASTS USA Part No. | Voltage $V_{BATT}$ Range | Load Resistance Range | Max. OFF Voltage | Min. ON Voltage |
|---|---|---|---|---|
| N17060501 | 12V | 50 Ω - ∞ | 0.75V | $V_{BATT}$ - 1V |

Outputs are controlled by “high side” software-controlled switches. Loads should be connected from outputs to battery negative. The high side switch is used to connect battery (+) to the output.

Each output is protected with a polyswitch, which acts like a circuit breaker. When the overcurrent trip point is reached (approximately 0.75A), the polyswitch switches to a high impedance. The switch resets to its normal low impedance when the additional load or short is removed. A short to battery (-) will trip the polyswitch and cause the VCOR relay to drop, but will not cause any damage. A short to battery (+) will not cause any damage, but since this condition is equivalent to a false output, the MicroLok II 2/2 CPU will cause the VCOR relay to drop. Figure 2-27 shows the suggested wiring connections for the standard vital output PCBs.

There are multiple connecting points available for both the B12 and N12 connections. A single contact can handle up to 3 amps of load current. If the anticipated load current exceeds 3 amps, use additional connecting points for the B12 and N12 feeds (one point for each additional 3 amps).

#### 2.5.6.1. Noise Protection

**Relay Coil Snubs**

Relay snubs are intended to dissipate large electromagnetic surges from the coil inductance and to prevent these surges from interfering with normal operation of the MicroLok II 2/2 system. It is recommended that all relays being driven by MicroLok II 2/2 be snubbed to prevent unwanted monitor errors. This is particularly true where the coil load to the MicroLok II 2/2 relay driver is being broken by a series contact.

Relay snubs can also be installed on other relays that are not directly controlled by MicroLok II 2/2 outputs, but may be contributing to possible noise due to their close proximity to the MicroLok II 2/2 wiring.

ASTS USA recommends the use of TransZorb (J792736-0002) for relay snubbing. They will have minimal effect on relay timing.

Resistors are also suitable relay snubs. When using a resistor loading of the MicroLok II 2/2 output an effect on timing (relay drop away) must be considered.

Diodes can also be used as snubs but:

- They will definitely increase relay drop time.
- They may cause contact burning in some circuits.

**WARNING**

Do not use diodes or any devices that could function as a diode in ac or dc electrified territory; otherwise, voltage induced by the device could cause a relay to remain falsely energized.

## Twisted Wire

ASTS USA recommends the use of twisted pair wiring (2 to 3 turns per foot) for all relay loads to minimize possible noise. This should be done wherever possible on all I/O wiring.

## Wire Separation

ASTS USA recommends the physical separation of clean and noisy wiring. Ideally, all outputs are gathered in a bundle, inputs are gathered in a bundle, and power wiring is gathered in a bundle. Each of these bundles is physically separated from each other (6 inches preferred) and all bundles are physically separated from other house wiring. It is particularly important to maintain this physical separation from high-current noisy wiring.

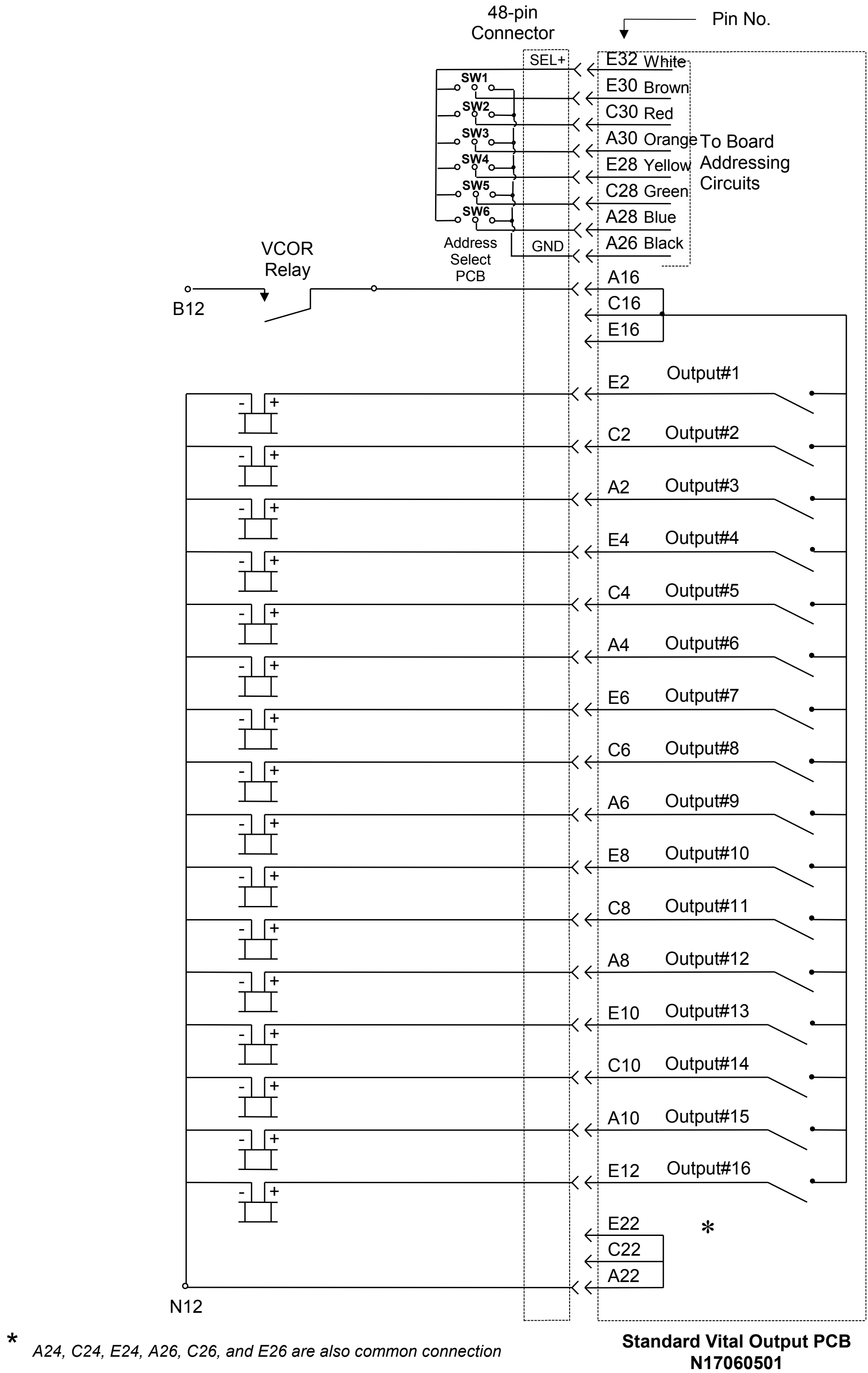



**Figure 2-27. Standard Vital Output PCB - Basic Interface Wiring**

### 2.5.7. Non-Vital I/O PCB

The non-vital NV.IN32.OUT32, I/O PCB (N17061501) connects each of its 32 inputs and outputs to a 96-pin connector mounted on the rear of the board. Specifications for the board are listed in Table 2-14.

**Table 2-14. Non-Vital NV.IN32.OUT32 I/O PCB Specifications**

| ASTS USA Part No. | Input and Output Voltage Range | Externally Available Inputs | Externally Available Outputs | Current Rating On Outputs |
|---|---|---|---|---|
| N17061501 | 4.5 to 32.4VDC | 32 | 32 | Outputs 1-30: 0.25A (polyswitch-protected)<br>Outputs 31, 32: 2.0A (Protected by a 5.0A, 3AG, 250 Volt fuse) |

Figure 2-28 on the next page shows the generic interface wiring for the board.

**WARNING**

Pins C16 through C29 are common connector pins for the outputs. They must be connected to the common of the B12 supply. Otherwise, damage to the printed circuit board will occur.

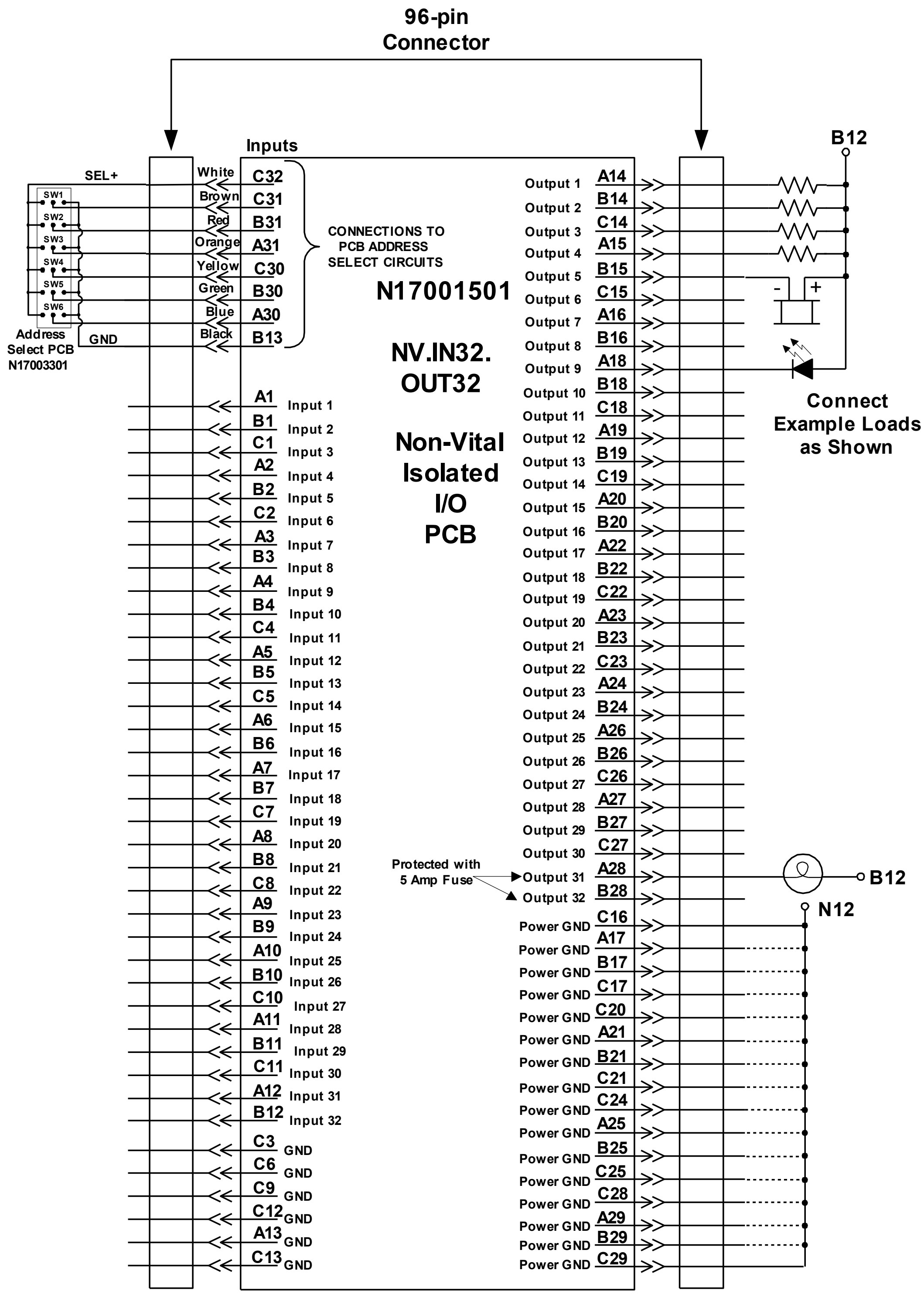



Figure 2-28. Standard Non-Vital Output PCB - Basic Interface Wiring

In Figure 2-28 on the previous page, pins C16 – C29 are common connector pins for the outputs. They must be connected to the common of the B12 supply. The number of required common returns depends on the number of outputs activated.

The general guidelines are:

- Outputs 31 and 32 are intended for high current; add a return for each used.
- For each of the other outputs, add one return for every eight outputs used.

## 2.5.8. Vital Isolated Output PCB (OUT8.ISO)

OUT8.ISO – Eight Vital Isolated Outputs – N17065801 (12V)
N17065802 (24V)

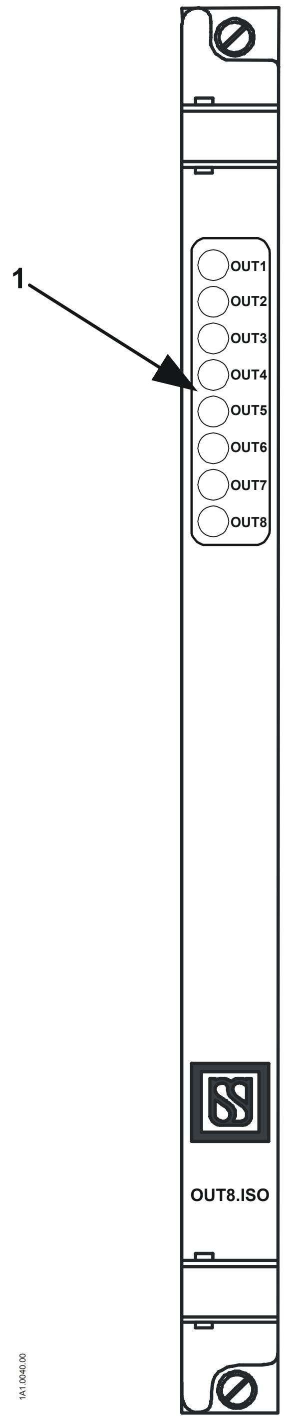



**Figure 2-29. OUT8.ISO PCB Front Panel**

Controls eight normal or four BiPolar vital isolated outputs (switch machine, relay coil, or BiPolar drive for example).

The vital isolated output PCB provides eight vital isolated outputs for double break control of relays and BiPolar relays. Each output provides a + and a – connection that is isolated from the house battery and other outputs.

The outputs are jumper selectable (JP1 – JP8) to drive normal vital relays or outputs can be combined to drive BiPolar relays.

Always verify that jumpers JP1 – JP8 are in the correct position before installation and applying power.

Output voltage is dependent on two factors, battery voltage and load resistance.

**Table 2-15. Vital Isolated Output PCB Indicators**

| REF FIGURE 2-29 | LABEL | DEVICE | PURPOSE |
|---|---|---|---|
| 1 | **OUT1 – OUT8** | LEDs (Yellow) | Monitor state of vital outputs 1 through 8. When lit, indicates respective output is turned On. |

**Table 2-16. OUT8.ISO Output Specifications**

| VITAL OUT8.ISO PRINTED CIRCUIT BOARDS | | | | |
|---|---|---|---|---|
| OUTPUT SPECIFICATIONS | | | | |
| **ASTS USA PART NO.** | **VOLTAGE $V_{BATT}$ RANGE** | **LOAD RESISTANCE RANGE** | **MAX. OFF VOLTAGE** | **MIN. ON VOLTAGE** |
| N17065801 | 11.5V | 50 Ω | 0.75V | ≈11.50V |
| N17065801 | 12.5V | 400 Ω | 0.75V | ≈12.50V |
| N17065802 | 24V | 100 Ω | 1.5V | ≈23V |
| N17065802 | 24V | 800 Ω | 1.5V | ≈24V |

## NOTE

Pairs of LEDs will flash briefly in sequence (top to bottom) during operation as the PCB performs the output tests.

**WARNING**

Jumpers JP1 through JP8 must be in the proper configuration. Otherwise, damage to the printed circuit board will occur.

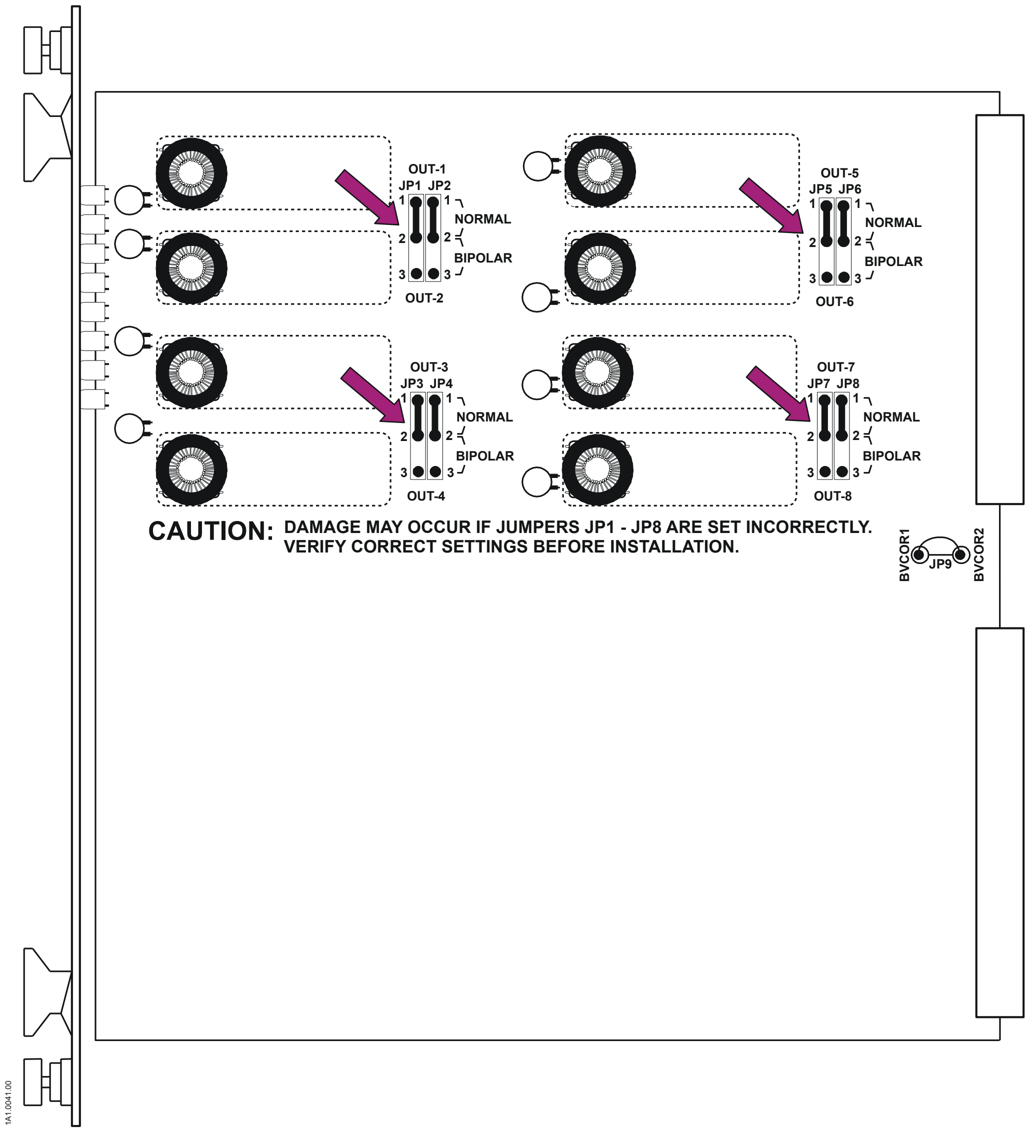



**Figure 2-30. OUT8.ISO PCB Jumper Location**

*(For NORMAL or BIPOLAR output selection)*

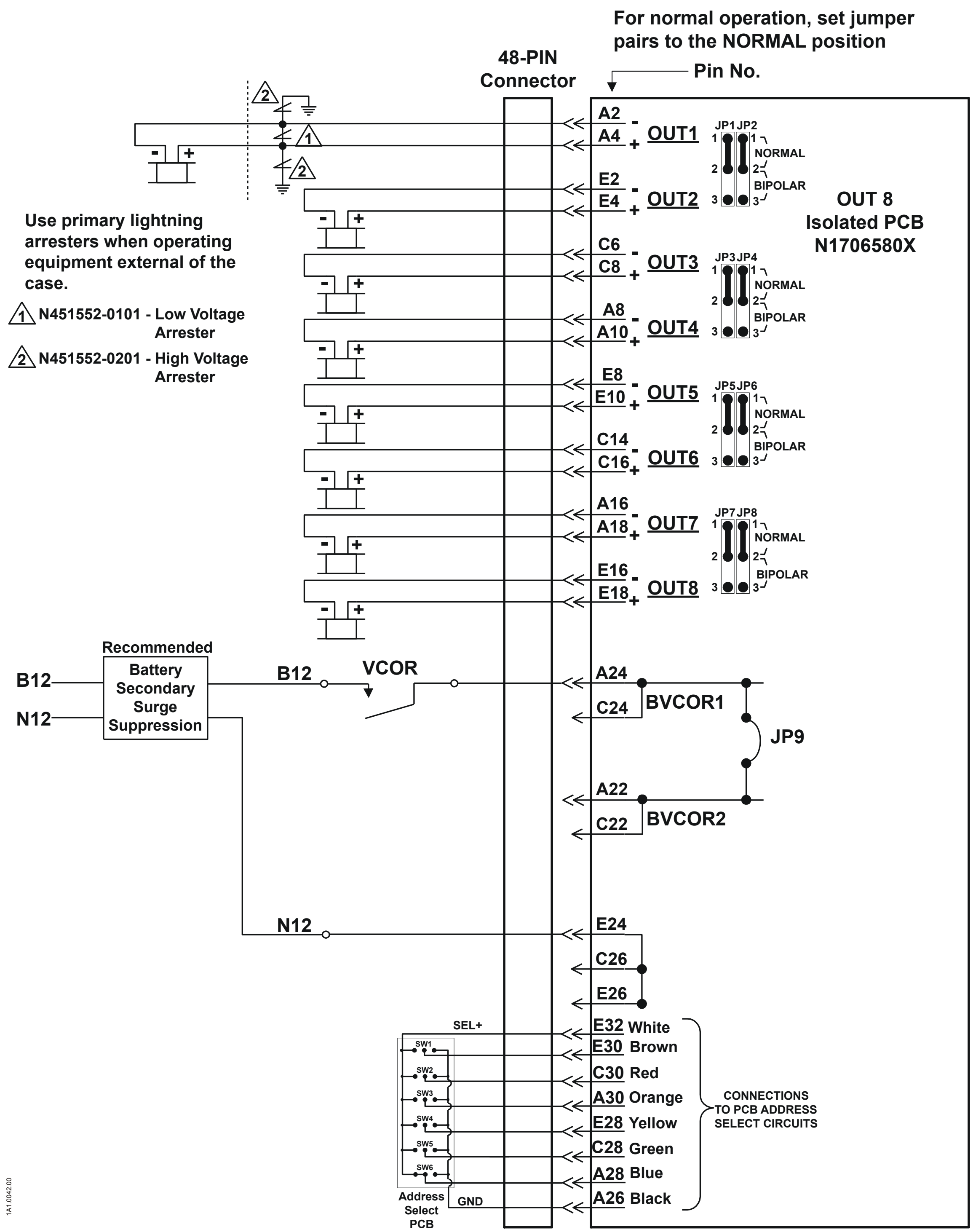



**Figure 2-31. Example Interface for Normal Operation with Same Battery**

*(BVCOR1 and BVCOR2 using the Same Battery)*

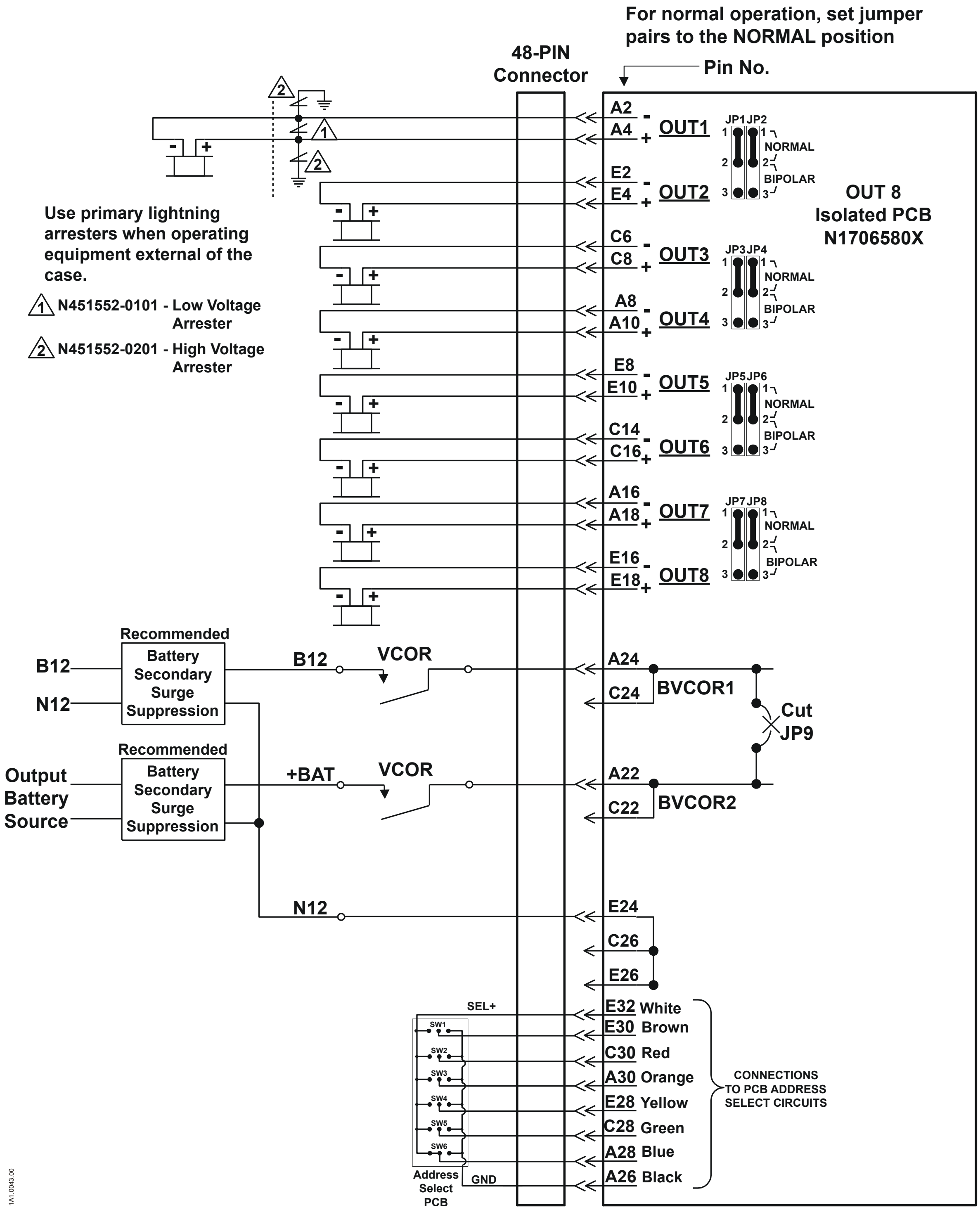



**Figure 2-32. Example Interface for Normal Operation with Separate Batteries**

*(BVCOR1 and BVCOR2 using Separate Batteries)*

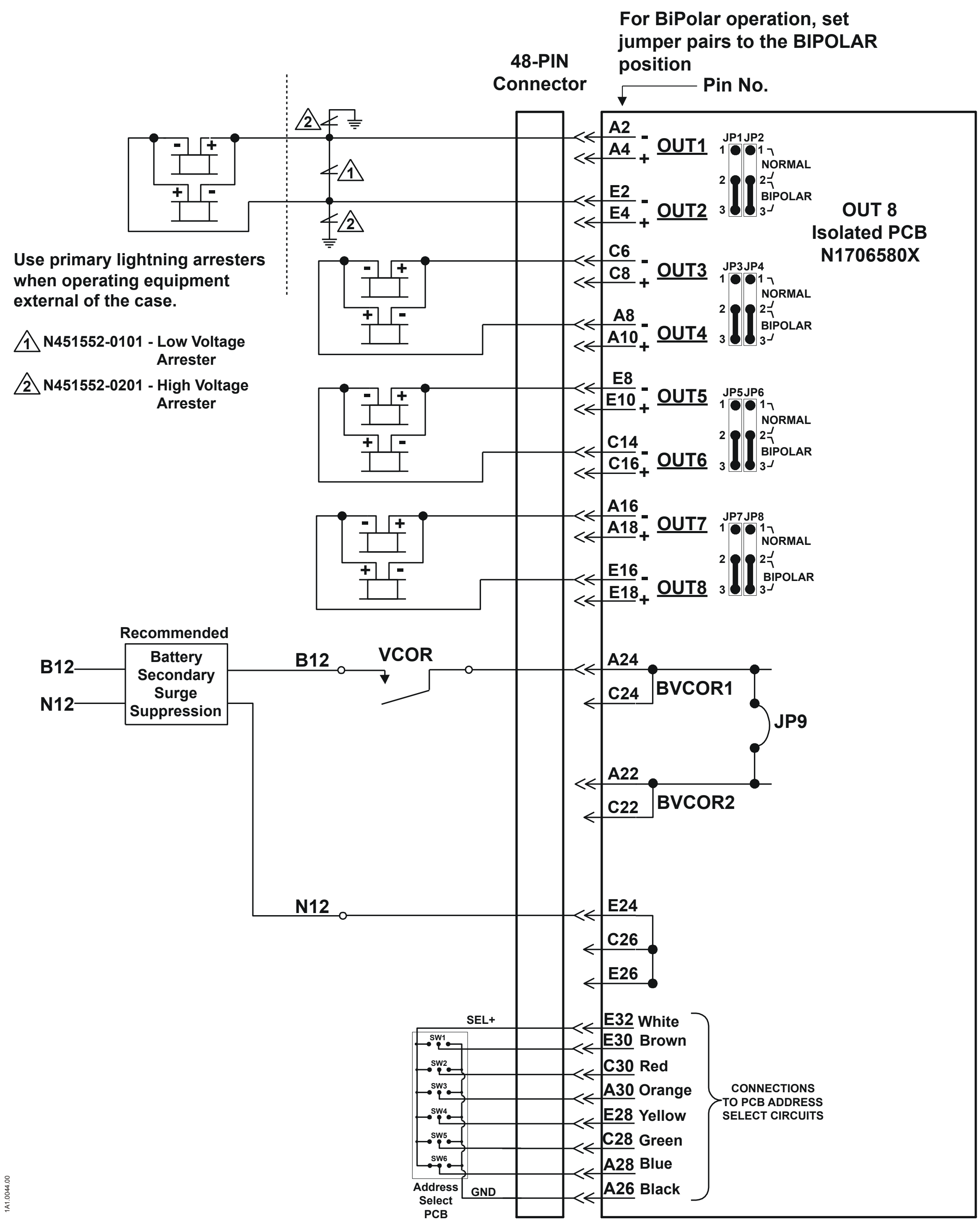



**Figure 2-33. Example Interface for BiPolar Operation with Same Battery**

*(BVCOR1 and BVCOR2 using the Same Battery)*

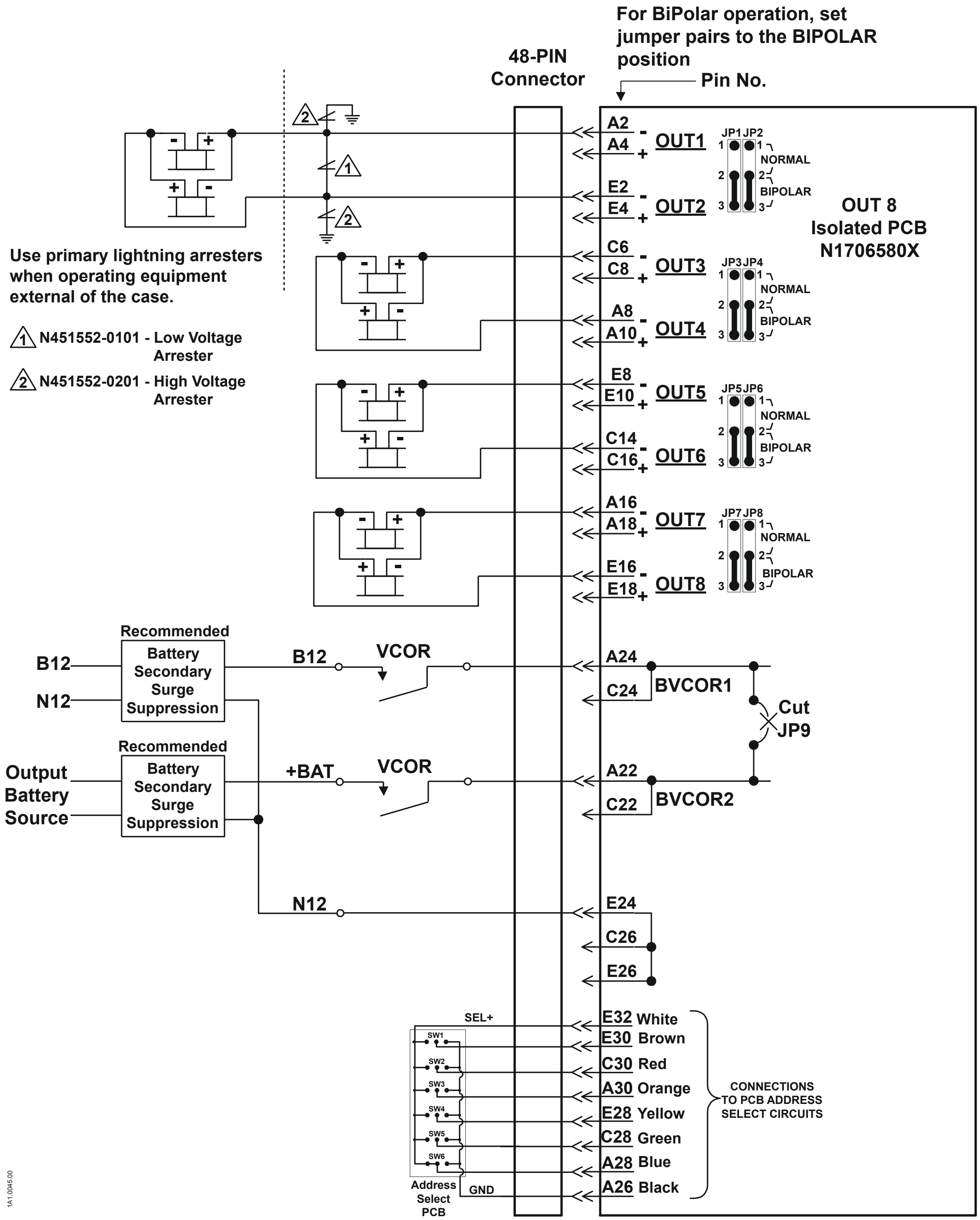



**Figure 2-34. Example Interface for BiPolar Operation with Separate Batteries**

*(BVCOR1 and BVCOR2 using Separate Batteries)*

## 2.5.9. MicroLok II Non-Vital PCBs

NV.IN32 Non-Vital 32 Isolated Inputs – N17063701

NV.OUT32 Non-Vital 32 Isolated Outputs – N17062701

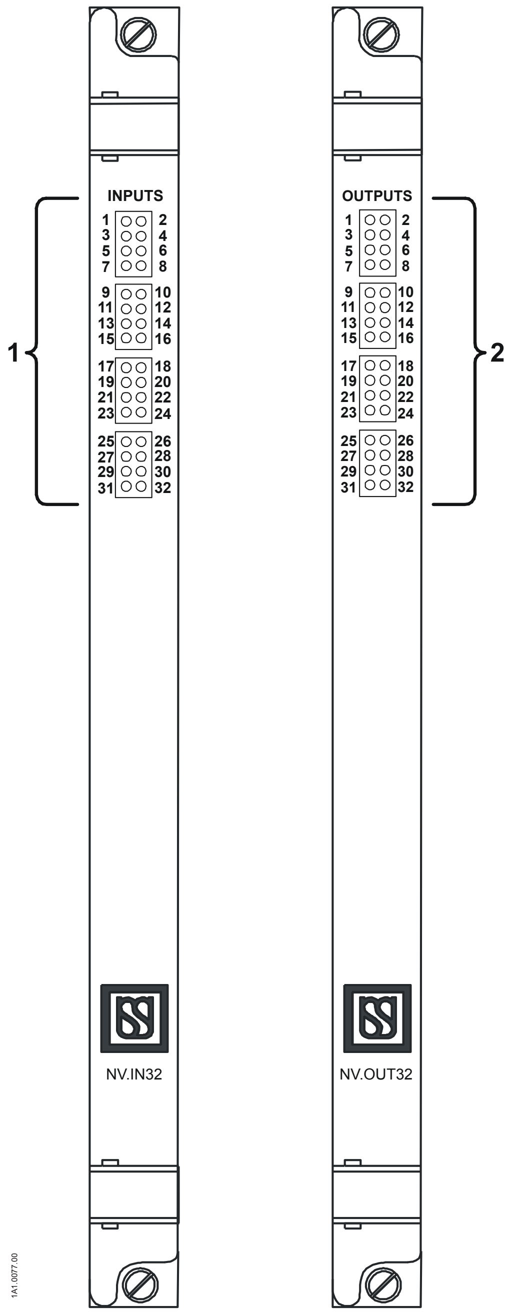



**Figure 2-35. NV.IN32 and NV.OUT32 PCB Front Panel Detail**

### 2.5.10. Non-Vital Output PCB (NV.OUT32)

The NV.OUT32 PCB provides 32 isolated, outputs for control of external devices such as indicators and relays.

The outputs are divided into two groups of eight outputs and one group of sixteen outputs, each group having a separate bussed common (negative DC) reference output. Refer to Table 2-18 for output specifications.

Isolation allows switching power from sources isolated from the MicroLok II power supply battery. Outputs are designed to operate at battery voltages between 9.5 and 35VDC.

Outputs switch positive battery and are capable of supplying up to 0.5 amps. Nominal voltage drop per output is load dependent and usually less than 2.5 volts.

The PCB employs PolySwitches to protect the output circuitry. A PolySwitch functions like a circuit breaker. When the over-current trip point (about 0.75 amp) is exceeded, the device switches to high impedance. The PolySwitch returns to low impedance when the overload or short circuit condition is removed.

**Table 2-17. Non-Vital I/O PCB Indicators**

| REF FIGURE 2-35 | LABEL | DEVICE | PURPOSE |
|---|---|---|---|
| 1 | **INPUTS 1-32** | LEDs (Green) | Monitors states of non-vital inputs 1-32. When LED is lit, respective input is On. |
| 2 | **OUTPUTS (SWITCHED TO N12) 1-32** | LEDs (Yellow) | Monitors states of non-vital outputs 1-32. When LED is lit, respective output is On. |

**Table 2-18. Non-Vital I/O PCB Specifications**

| ASTS USA PART NO. | INPUT AND OUTPUT VOLTAGE RANGE | EXTERNALLY AVAILABLE INPUTS | EXTERNALLY AVAILABLE OUTPUTS | CURRENT RATING ON OUTPUTS |
|---|---|---|---|---|
| N17062701 | 9.5 to 35VDC | 0 | 32 | Outputs 1-32: 0.5AMPS |
| N17063701 | 6.0 to 35VDC | 32 | 0 | n/a |

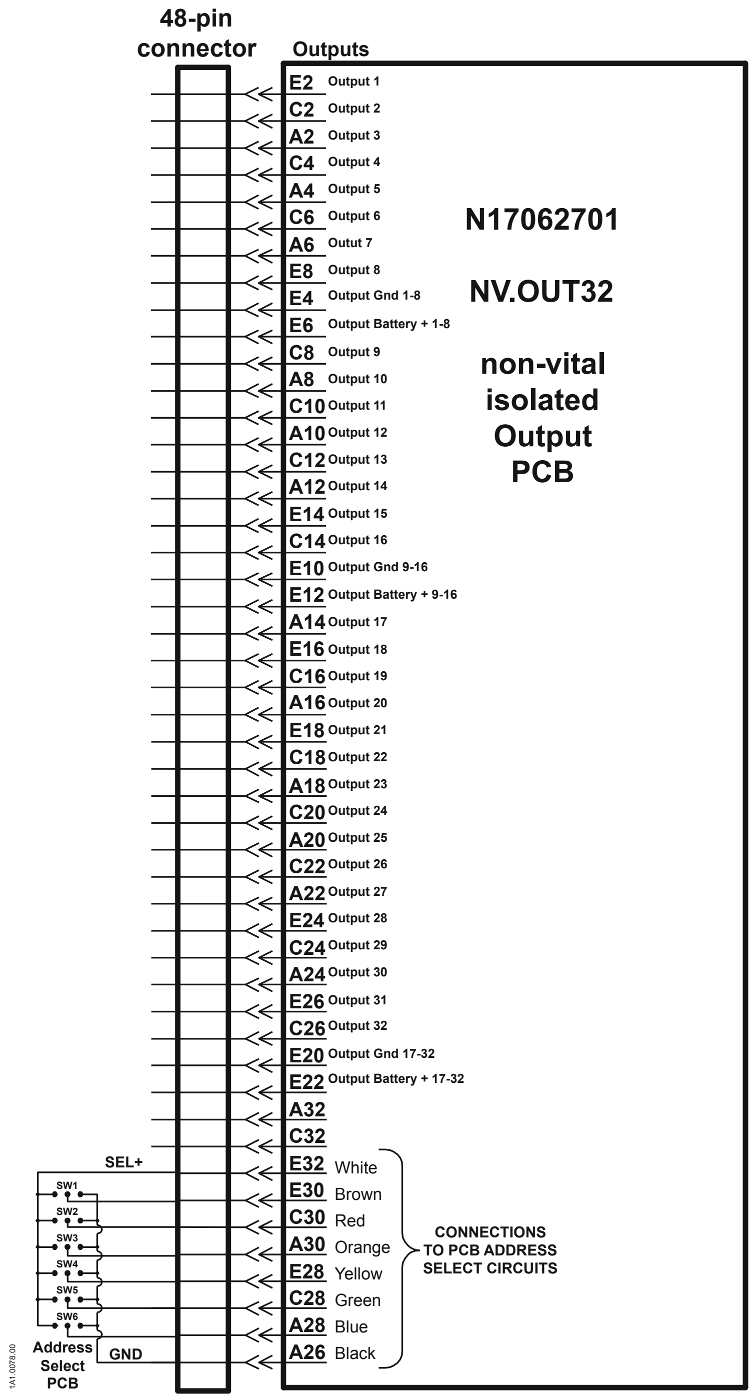



Figure 2-36. Non-Vital OUT.32 PCB Basic Interface Wiring

### 2.5.11. Non-Vital Input PCB (NV.IN32)

The non-vital input PCBs (NV.IN32) in the MicroLok II system generate and monitor the status of non-vital discrete inputs. Examples of non-vital inputs include controlled inputs from alarms, sensors, and the Local Control Panel. Refer to Table 2-17 for PCB front panel indications.

The PCB provides 32 isolated external inputs. Isolation allows switching power from sources isolated from the MicroLok II power supply. The 32 inputs are divided into two groups of eight inputs and one group of sixteen inputs, each group having a separate bussed common (negative DC) reference input. External input voltages between 6 and 35VDC represent logical "1." Refer to Table 2-18 for input specifications.

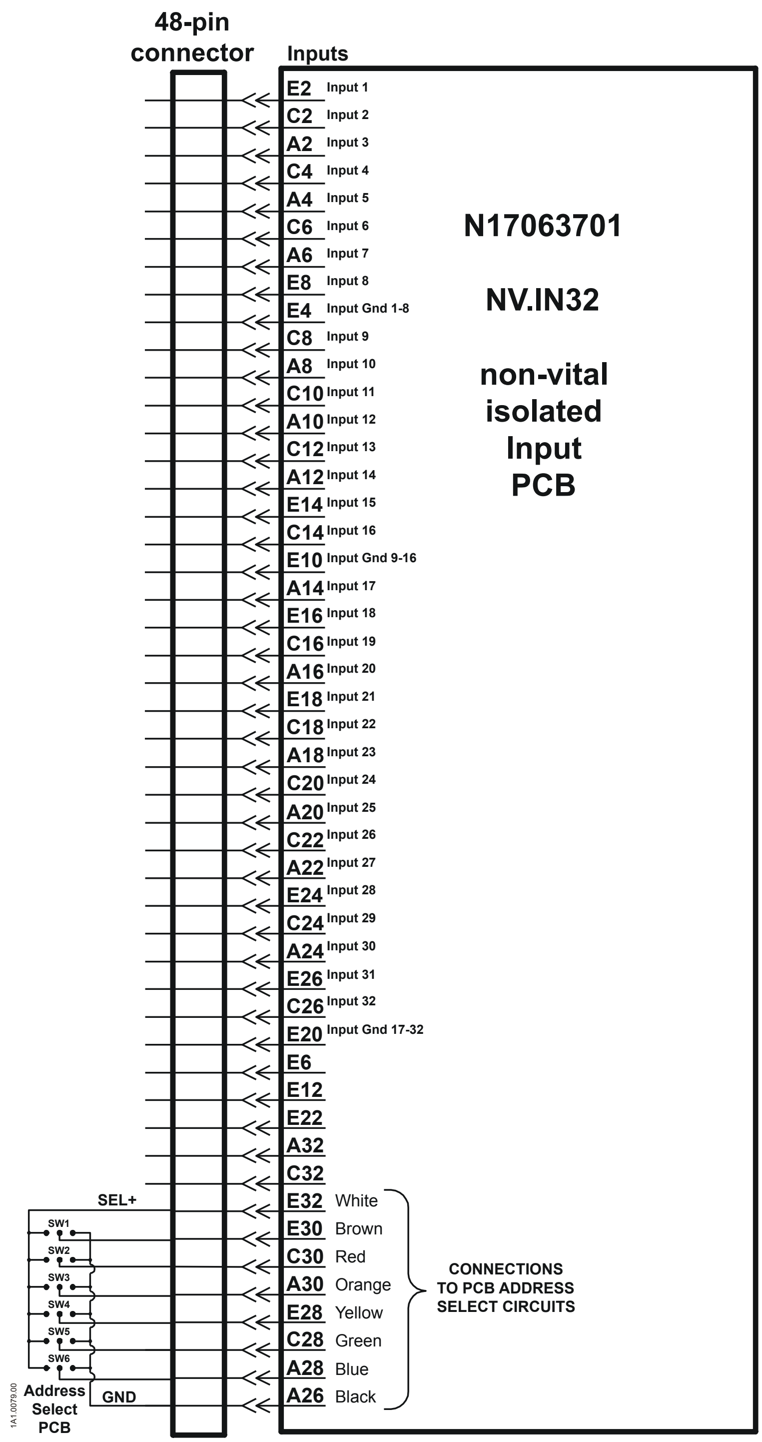



Figure 2-37. Non-Vital IN.32 PCB Basic Interface Wiring

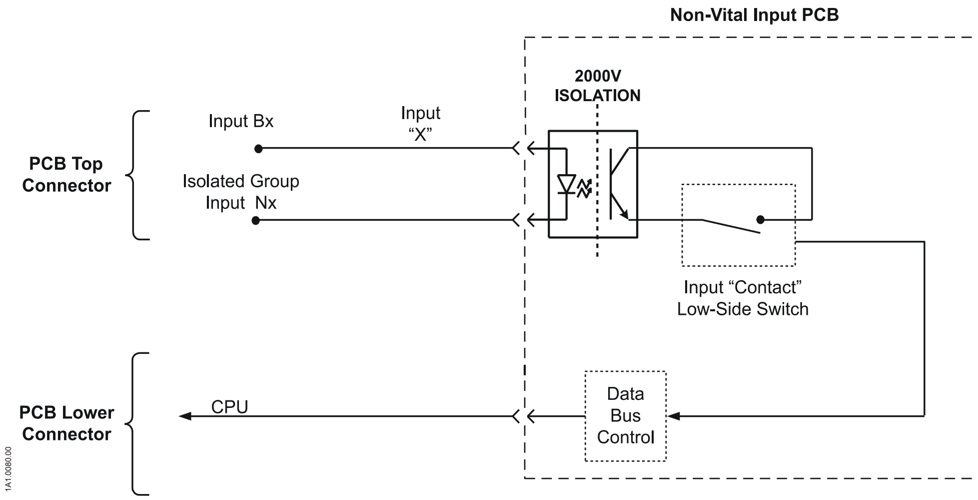



**Figure 2-38. Example Non-Vital Isolated Input Block Diagram**

*(Example Only)*

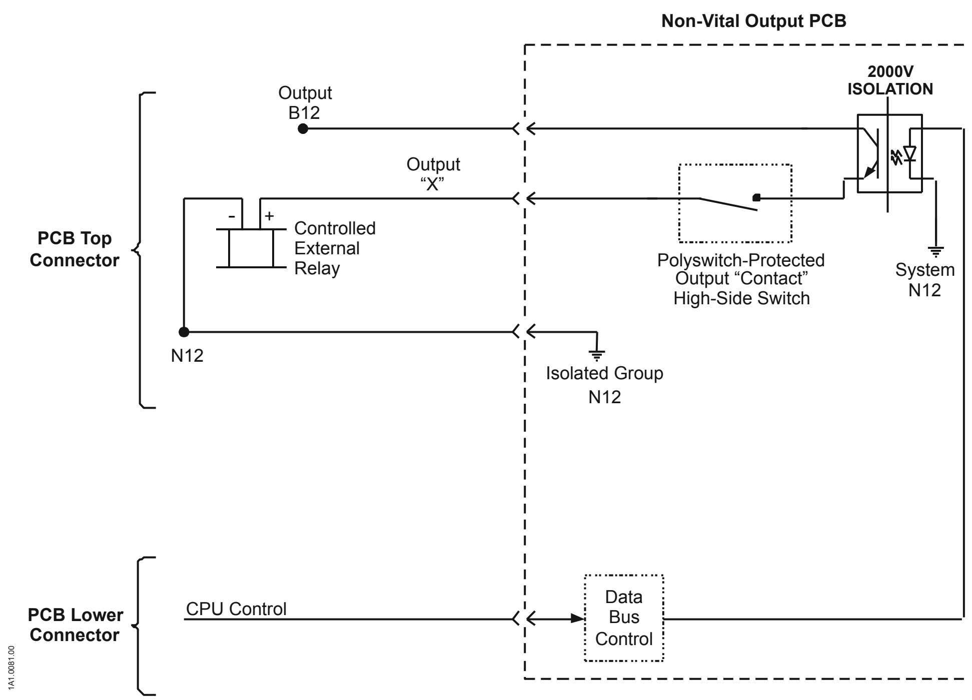



**Figure 2-39. Example Non-Vital Isolated Output Block Diagram**

*(Example Only)*

## 2.5.12. Address Select Jumper Settings

On the PCBs that use them, the address select jumpers are used for board addressing. The jumper settings are automatically determined by the compiler when the application program is written. This information is clearly defined and available to the user in the list file (.mll), which is one product of compiling an application text file (.ml2). If this file is unavailable, the user can determine the jumper settings by following the instructions below. By far the best way to determine the jumper settings, however, is to use the list file.

The jumper settings for each board are determined by the order in which the boards are defined in the application. The jumper settings *do not* depend on the order the boards happen to appear in the cardfile. If the application program and list file are both unavailable, then the order can also be found by looking at the configuration menu in the MicroLok II 2/2 Development System. The buttons for the board listing in the configuration window are in the same order, from left to right, as they are in the application. See SM-1A1.0003 for additional information.

The boards used in the MicroLok II 2/2 system are eight-bit boards. The following table shows how the jumpers are set in accordance with the way they appear in the application. (Board 1 being the first board listed and board 16 being the last board listed in the application.)

**NOTE**

Each jumper may be set to either a "0" or "1" position.

**Table 2-19. Board Order Jumper Selection**

| Board Order (as defined in the application program) | Jumper Selection | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 | 0 | 0 | 1 |
| 3 | 0 | 0 | 1 | 0 | 0 | 1 |
| 4 | 0 | 1 | 1 | 0 | 0 | 1 |
| 5 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 0 | 1 | 0 | 1 |
| 7 | 0 | 0 | 1 | 1 | 0 | 1 |
| 8 | 0 | 1 | 1 | 1 | 0 | 1 |
| 9 | 0 | 0 | 0 | 0 | 1 | 1 |
| 10 | 0 | 1 | 0 | 0 | 1 | 1 |
| 11 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 1 | 1 | 0 | 1 | 1 |
| 13 | 0 | 0 | 0 | 1 | 1 | 1 |
| 14 | 0 | 1 | 0 | 1 | 1 | 1 |
| 15 | 0 | 0 | 1 | 1 | 1 | 1 |
| 16 | 0 | 1 | 1 | 1 | 1 | 1 |

For example, for the first board, jumpers 1 through 5 are set to "0," while jumper 6 is set to "1." The second board will have jumpers 2 and 6 set to "1" with the rest at "0," and so on.

As an example, Table 2-20 was formed using the table above.

**Table 2-20. Board List Example**

| Boards | Settings | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| IN16 | 0 | 0 | 0 | 0 | 0 | 1 |
| IN16 | 0 | 1 | 0 | 0 | 0 | 1 |
| IN16 | 0 | 0 | 1 | 0 | 0 | 1 |
| NV IN32 OUT 32 | 0 | 1 | 1 | 0 | 0 | 1 |
| OUT 16 | 0 | 0 | 0 | 1 | 0 | 1 |
| OUT 16 | 0 | 1 | 0 | 1 | 0 | 1 |

It is assumed that the application software defines the boards as they are shown above, i.e., Board #1 is an IN16 board, etc. It is the order in which they are defined in the application program that determines the board number, not the relative position in the cardfile.

# 3. INSTALLING MICROLOK II 2/2 SYSTEM PERIPHERAL DEVICES

## 3.1. Vital Cut-Off Relay (VCOR) Installation and Wiring

The VCOR controls power to all MicroLok II vital outputs under the control of the MicroLok II 2/2 CPU board. Power for the relay coil is supplied by the cardfile CPS. A ASTS USA PN-150B relay (part number N322500-701) is used for all VCOR installations. The components required to rack-mount the relay are listed in Table 3-1.

**Table 3-1. Rack-Mount Components**

| Item | ASTS USA Part No. |
|---|---|
| PN-150B relay | N322500-701 |
| Relay mounting base | N451376-0302 |
| Contact springs for #14 - #16 wire | M451142-2702 |
| Relay mounting bars (2 required) | M451837-0303 |

Double battery and return paths are wired to the relay to eliminate voltage drops. Use #14 wire for connections between the cardfile and the relay. Also, use parallel contacts of the VCOR where possible. Figure 3-1 shows the wiring between the MicroLok II 2/2 cardfile and the VCOR for the various types of vital output boards.

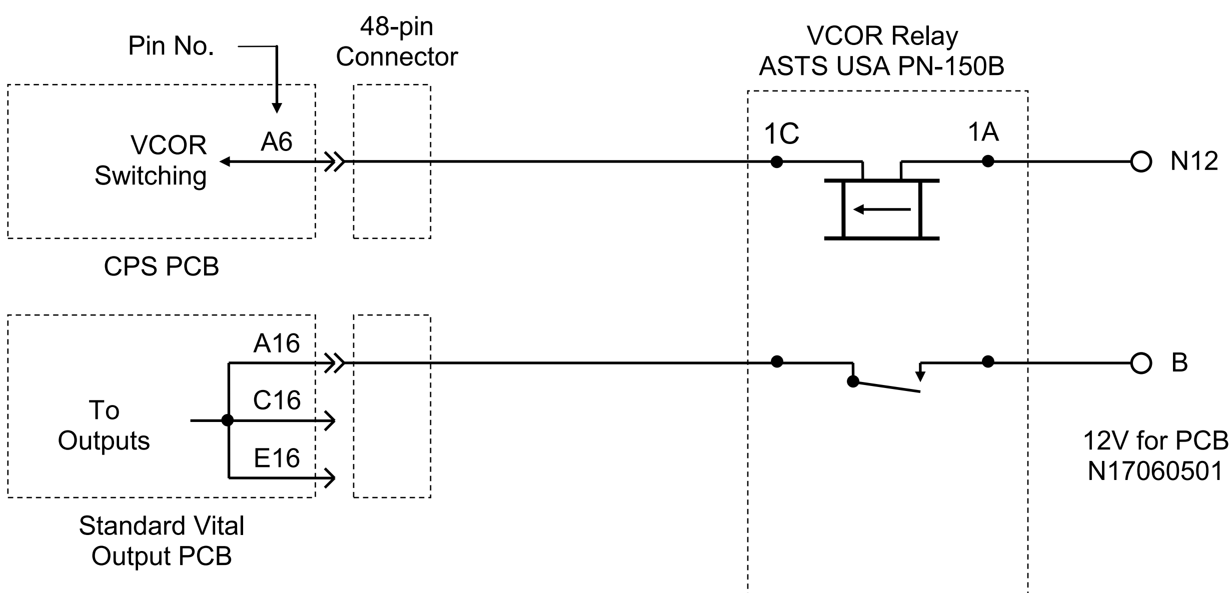



**Figure 3-1. VCOR Relay Wiring**

## 3.2. Connecting MicroLok II 2/2 to External Serial Devices

The MicroLok II 2/2 controller board has four independent serial ports. The MicroLok II 2/2 application program determines the function of each of these ports. Each port may be designated as a MicroLok PEER. The function of serial ports may be designated in any combination.

The four serial ports support three different hardware interface standards. Ports 1 and 2 support an RS-485 hardware interface while port 3 supports an RS-423 interface and port 4 supports an RS-232 interface. These standards (RS-485, RS-423, and RS-232) define only the characteristics of the hardware interface. They define characteristics such as interface voltage levels, whether signals are balanced or unbalanced with respect to signal common, and whether or not outputs can be set to a high impedance state for compatibility with multi-drop communication circuits.

Typically, the RS-485 serial ports are reserved for direct, local connections between two or more RS-485 capable units located in the same equipment facility and powered by the same vital battery power supply. The RS-485 ports utilize balanced signal drivers and receivers that offer a high degree of immunity to ambient electrical noise. In addition, RS-485 serial ports may be connected directly to a multi-drop, hard-wired, serial communication circuit without the use of external signal processing hardware (signal splitters, etc.). The allowable length of the communication circuit is essentially unlimited as long as no part of the circuit leaves the equipment room or signal house where it originates. (MicroLok II 2/2 RS-485 circuits cannot be run between signal houses without serial communication circuit isolation hardware.)

RS-423 and RS-232 serial ports are most easily connected to common serial devices and commercially available modems. The RS-423 port may be used in simple, short distance, multi-drop applications while the RS-232 port may be used only in short distance point-to-point applications. Short distance, in this case, means less than 50 ft. (15 meters).

### 3.2.1.1. Connecting to RS-485 Serial Ports

Serial ports 1 and 2 are the RS-485 serial ports.

Each RS-485 port signal is transported by a twisted pair of wires labeled as XXX- and XXX+ (TXD- and TXD+, for example). Outputs labeled with a (-) always connect to inputs labeled (-) or (A). Outputs labeled with a (+) always connect to inputs labeled (+) or (B). Differential voltage between (-) and (+) conductors of a pair is typically 1.5 to 5 volts with the (-) conductor negative with respect to the (+) conductor when the signal is not asserted. (For data lines TXD and RXD, the quiescent or unasserted state is identified as the MARK state.) **In addition, the signal commons (COM) for all ports on an RS-485 communication link must be connected together to equalize potential between signal commons for the connected units.**

When two MicroLok II 2/2 units powered by the same battery are serially connected, the connection of serial commons is made through negative battery and does not have to be made through the serial cable. Note that COM cannot be connected to frame or earth ground as it is directly connected through the MicroLok II 2/2 power supply to negative vital battery. RS-485 ports should be interconnected using *only* twisted pair cable with an over-all shield. For best performance, the interconnecting cables should not contain extra, unused pairs. Any unused pairs should be connected together at both ends of the cable and connected to signal common (COM) for best noise immunity.

If connected, the shield should be connected to frame ground at one end of the cable only. On the units at each end of the communication circuit, 120 ohm, ½ watt external load resistors should be placed across the TXD transmitters and across the RXD receivers. Any units in between should simply “bridge” the circuit using a bridging “stub” which is as short as possible.

#### 3.2.1.2. Connecting to RS-423 Serial Ports

Serial port 3 is the RS-423 serial port. Serial port 3 supports TXD output signals and RXD, input signals. RTS, DCD, CTS, and Data Clock signals including transmit clock (TXC) which may be either an input or an output and receive clock (RXC) which is an input are present but are not currently supported by the MicroLok II 2/2 executive. These signals should not be connected. These signals may be supported in a future release of the MicroLok II 2/2 executive.

In an RS-423 interface, outputs are referenced to signal common (COM) while inputs have their own independent common, receive common (RXCOM). Signal outputs are connected to signal inputs by a single wire as they are in the RS-232 interface but COM on each end is connected to RXCOM on the other end. As this connection of commons does not equalize potential between the signal commons (COM) of the two connected units, an additional connection must be made between COM terminals on the connected units. The quiescent or inactive state for all signals is between –3.6 and –6 volts. (For data lines TXD and RXD, the quiescent state is the MARK state.). The active state for all signals is between +3.6 and +6 volts. RS-423 ports should be interconnected using only multi-conductor cable with an over-all shield. The cable should not contain any twisted pairs.

The serial port commons (COM) should be connected using one of the conductors in the cable (*not* the shield). For best performance, interconnecting cables should not contain extra wires. Extra wires should be connected together and connected to COM at both ends for best noise immunity. Note that COM cannot be connected to frame or earth ground as it is directly connected through the MicroLok II 2/2 power supply to negative vital battery. The cable shield should be connected to frame ground at one end of the cable only. If CTS is not used, it must be forced to its unasserted state. To permanently force an input to its unasserted state, the input should be connected to -12V. To force an input to its asserted state, the input should be connected to +12V.

RS-423 ports may be connected to RS-232 ports by strapping COM and RXCOM terminals together on the RS-423 end and connecting signals as described under the RS-232 connection scheme below.

#### 3.2.1.3. Connecting to RS-232 Serial Ports

Serial port 4 is the RS-232 serial port. Serial port 4 supports TXD output signals and RXD input signals. Each RS-232 signal is transported by a single wire and is referenced to signal common

(COM). When any RS-232 signal is not asserted the voltage level for that signal is between –3 and –15 volts. (For data lines TXD and RXD, the quiescent or unasserted state is the MARK state.). The asserted state for all signals is between +3 and +15 volts. RS-232 ports should be interconnected using only multi-conductor cable with an over-all shield. The cable should not contain any twisted pairs. The serial port signal commons (COM) should be interconnected using one of the conductors in the cable (NOT the shield). For best performance, interconnecting cables should not contain extra wires. Extra wires should be connected together and connected to COM at both ends for best noise immunity. If connected, the cable shield should be connected to frame ground at one end of the cable only. The length of interconnecting cables should be limited to 50 ft. (15 meters) or less. If it is necessary to permanently force an input to its unasserted state, the input should be connected to -12V. To force an input to its asserted state, the input should be connected to +12V.

### 3.2.2. Isolation of Serial Port Signal Common

Application engineers should note that the serial commons for all MicroLok II 2/2 serial ports are connected directly to negative vital battery *and* to each other. This means that anything connected to any serial port signal common *is also connected to negative vital battery.* Furthermore, anything connected to the serial common of any equipment that is directly connected to any MicroLok II 2/2 serial port is connected to negative vital battery through MicroLok II 2/2. This imposes serious restrictions on the characteristics of the devices that can be *directly connected* MicroLok II 2/2 serial ports. It should be noted, for example, that most commercial data modems connect their serial common to earth ground in some way, either directly or through a low resistance. It should also be noted that most data radios connect their serial common directly to their antenna ground. Both of these conditions create a problem since they introduce a connection between negative vital battery and earth ground. (Vital battery is required to float with respect to ground.) This effectively means that devices like these *must* be connected to MicroLok II 2/2 through a serial line isolator which provides a high level of isolation between the signal commons of MicroLok II 2/2 and serial devices such as modems and data radios.

Isolation between serial signal commons is also necessary when serially connecting MicroLok II 2/2 units that are powered by different batteries. As these battery power supplies are considered vital and are required to float with respect to ground, significant potential differences can develop between the battery negatives. These potential differences can wind up being equalized by the connection between serial commons. This situation poses a threat both to communication circuit reliability and the electrical integrity of the connected MicroLok II 2/2 units. In addition, interconnection of battery commons by any means is not a recommended practice. This situation, too, can be remedied by introducing a serial line isolator in the serial line between the MicroLok II 2/2 units.

It is strongly recommended that all MicroLok II 2/2 units *not* connected to the same battery power supply be interconnected serially using communication devices that provide serial common isolation. Furthermore, care must be exercised to insure that devices that *are* serially connected directly to a MicroLok II 2/2 unit *do not* have serial connections to devices that might ground serial common.

### 3.2.3. Physical Connections to Serial Ports

**Table 3-2. Physical Connections to Serial Ports**

| SIGNAL | PORT 1 RS-485 | PORT 2 RS-485 | PORT 3 RS-423 | PORT 4 RS-232 |
|---|---|---|---|---|
| **NOTE** DCD, RTS, CTS, and RXREF are reserved for future use. Do Not connect these signals. | | | | |
| TXD- | A2 | A16 | E16 | C20 |
| TXD+ | A4 | A18 | | |
| RXD- | C6 | A24 | E14 | C22 |
| RXD+ | C8 | A26 | | |
| RTS- | E2 | A20 | C14 | A14 |
| RTS+ | E4 | A22 | | |
| CTS- | A10 | | E12 | |
| CTS+ | A12 | | | |
| DCD- | C10 | A28 | E10 | C16 |
| DCD+ | C12 | A30 | | |
| RXREF | | | E18 | |
| COM (0V) | A32 | A32 | C18 | E22 |
| +12V | C24 | C24 | C24 | C24 |
| -12V | C26 | C26 | C26 | C26 |

### 3.2.4. Configuring MICROLOK II 2/2 Serial Ports

All four MicroLok II 2/2 serial ports have many configuration options. These are made available to accommodate most requirements that might be encountered in modern communication equipment. Most of the available options are not intended to be used in the “typical” MicroLok II 2/2 installation. In most typical installations, only one port configuration should be used for Genisys protocol.

For additional information about serial port configuration options, refer to SM-6800D, "System Application Logic Programming."

#### 3.2.4.1. Serial Port Configuration for Operation on a Direct Wire, Point-to-Point, Communication Circuit

MicroLok II 2/2 serial ports 1 and 2 are designed to operate on a direct wire, multi-drop communication circuit. This causes transmit data (TXD) drivers to assume a high impedance state whenever these ports are not actively placing data on the communication circuit. This configuration may not be acceptable for most point-to-point communication circuits as external biasing resistors may be required on inputs to which TXD is connected to positively hold those inputs in an unasserted state when TXD drivers go to their high impedance state. This problem can be overcome without the use of external biasing resistors by setting the point-to-point serial port configuration parameter to 1 (POINT.POINT: 1;). This causes TXD outputs to actively drive the inputs to which they are connected at all times.

Note that for ports designated as master ports, this need not be done. The default configuration of all master ports is point-to-point. Note also that serial port 4 is capable only of point-to-point operation regardless of its designated function and the value of the POINT.POINT parameter for port 4.

# 4. INSTALLATION PARTS LIST

## 4.1. MAJOR SYSTEM ASSEMBLIES

**Table 4-1. Major System Assemblies**

| Item/Description | ASTS USA Part No. | Comments |
|---|---|---|
| System Cardfile | N16902101 | Empty enclosure without field-replaceable components (PCBs and panels).<br>Reference Section 4.2 for components. |
| VCOR Relay | N322500-701 | ASTS USA PN-150B.<br>Reference Section 4.3 for installation parts. |
| External Melcher Power Supply | J725709-0292 - +5V<br>AM2003-9<br>J725709-0293 - +/-12V<br>AM2332-9 | Regulates and protects external power input; conditions and converts the battery input voltage to the various voltage levels required for cardfile circuitry operation. |

## 4.2. MAJOR CARDFILE COMPONENTS

### 4.2.1. Plug-In Printed Circuit Boards and Front Panels

**Table 4-2. Plug-In Circuit Boards and Front Panels**

| Item/Description | ASTS USA Part No. | Comments |
|---|---|---|
| CPU PCB | N17068501 | -- |
| Standard Vital Output PCBs | N17060501 (12V)<br>N17060502 (24V) | 16 outputs at 12V |
| Vital Input PCBs | N17061001 (12V)<br>N17061002 (24V)<br>N17061003 (50V)<br>N17061004 (10V)<br>N17061005 (24V AC Immunity) | 16 inputs at 12V |
| Non-Vital I/O PCB | N17061501 | IN32.OUT32 |
| 1-Wide Blank Front Panel | N451850-2902 | -- |
| 2-Wide Blank Front Panel | N451850-2901 | -- |
| Cps Only PCB | N451910-7501 | With front plate |
| Power Supply/CPS PCB | N16660301<br>N16661203<br>P20B.0100038 | ±12VDC and +5VDC outputs |
| Ethernet Communication PCB | N17066403 | -- |
| Synchronization PCB | N17066401 (12V)<br>N17066402 (24V) | -- |
| In8.Out8 PCB | N17061601 (12V)<br>N17061602 (24V) | 8 isolated inputs and 8 non-isolated outputs |
| Nv.In32 PCB | N17063701 | 32 non-vital isolated inputs |
| Nv.Out32 PCB | N17062701 | 32 non-vital isolated outputs |
| Out8.ISO | N17065801 (12V)<br>N17065802 (24V) | 8 vital isolated outputs |

### 4.2.2. PCB Interface Cable Assembly Components and Tools

**Table 4-3. PCB Interface Cable Assembly Components and Tools**

| Item/Description | ASTS USA Part No. | Comments |
|---|---|---|
| 48-Pin Connector Assembly | J709146-1105 | Used with all PCBs except N17061501. |
| 96-Pin Connector Assembly | J709146-1104 | Used with non-vital I/O PCB N17061501. |
| 48-Pin Connector Receptacle | J709146-0452 | -- |
| 96-Pin Connector Receptacle | J709146-0922 | -- |
| Receptacle Mounting Screw | J525400-0001 | 48-pin or 96-pin receptacle |
| 48-Pin Guide | J709146-1106 | -- |
| 96-Pin Guide | J709146-1107 | -- |
| Wire Crimp Contacts | J709146-0453 | 48-pin, #16-#20, (Harting # 09-06-000-8482) |
| | J709146-0853 | 48-pin, #20-#26 (Harting # 09-06-000-8481) |
| | J709146-0921 | 96-pin, #20-#28 (Harting # 09-06-000-8484) |
| Address Select PSB | N17003101 | 48-pin housing (replaces N17002002) |
| | N17003301 | 96-pin housing (replaces N17002101) |
| EEPROM PCB | N17002001 | CPU PCB connector assembly only. |
| Crimp Tools | | 48-pin, #16-#20 (Harting # 09-99-000-0077) |
| | | 48-pin, #20-#26 (Harting # 09-00-000-0076) |
| | | 96-pin, #20-#28 (Harting # 09-00-000-0075) |
| Extraction Tools | Contact ASTS USA | 48-pin, #16-#20 (Harting # 09-99-000-0087) |
| | | 48-pin, #20-#26 Wire |
| | | 96-pin, #20-#28 (Harting # 09-99-000-0101) |
| Insertion Tools | Contact ASTS USA<br>Contact ASTS USA | 48-pin, #16-#20 |
| | | 48-pin, #20-#26 |
| | | 96-pin, #20-#28 (Harting # 09-99-000-0100) |
| Locator Tools | Contact ASTS USA<br>Contact ASTS USA | 48-pin, #16-#20 (Harting tool 09-99-000-0086) |
| | | 48-pin, #20-#26 |
| | | 96-pin, #20-#28 (Harting tool 09-99-000-0099) |
| Connector Housing Assembly | N39908001 | Used with Communication PCB (N17066403).<br>Used with Synchronization PCBs (N17066401 and N17066402). |

### 4.2.3. Miscellaneous Cardfile Installation Parts

**Table 4-4. Miscellaneous Cardfile Installation Parts**

| Item/Description | ASTS USA Part Number | Comments |
|---|---|---|
| PCB Keying Plug | J709146-0473 | Reference Section 2.3.2 for installation. |
| R.H. Cardfile Mounting Bracket | M21050701 | Included with cardfile. |
| L.H. Cardfile Mounting Bracket | M21050702 | Included with cardfile. |

## 4.3. MISCELLANEOUS UNIT INSTALLATION HARDWARE

**Table 4-5. Miscellaneous Unit Installation Hardware**

| Item/Description | ASTS USA Part Number | Comments |
|---|---|---|
| VCOR RELAY MOUNTING PARTS | | Reference Section 3.1. |
| PN-150B RELAY | N322500-701 | 1 required |
| RELAY MOUNTING BASE | N451376-0302 | 1 required |
| RELAY MOUNTING BARS | M451837-0303 | 2 required |
| CONTACT SPRINGS | M451142-2702 | #14 - #16 wire |
| TRANZORB | J792736-0002 | 1.5KE39A TransZorb used for snubbing external relay driven from the MicroLok II 2/2 unit. |

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# APPENDIX-A. ELECTROMAGNETIC COMPATIBILITY

## A.1. Purpose

The purpose of this appendix is to define the overall generic guidelines and related installation practices associated with the EMC grounding techniques, cable routing procedures and noise suppression devices to be utilized by Ansaldo STS US and its subcontractors, to aid in the assurance of EMC compatibility of the MicroLok 2/2 equipment and associated installation supplied.

## A.2. General

Effective cable routing within pieces of equipment and within an overall system is one of the most technically effective and cost efficient methods of controlling Electromagnetic Interference (EMI) and assuring Electromagnetic Compatibility (EMC). While a cable's purpose is to provide a path for a specific source (i.e. AC Power, Digital Signals, etc.), incorrect installation and placement can lead to cables becoming "harmful carriers" of EMI interference. A wire (cable) carrying a current has associated magnetic and electric fields and accordingly, can effectively be an antenna and therefore a potential radiating source of EMI. Figure A-1 shows how a radiating cable can couple EMI to an adjacent cable. It also shows how radiating fields from known radiating sources can also be coupled to cables.

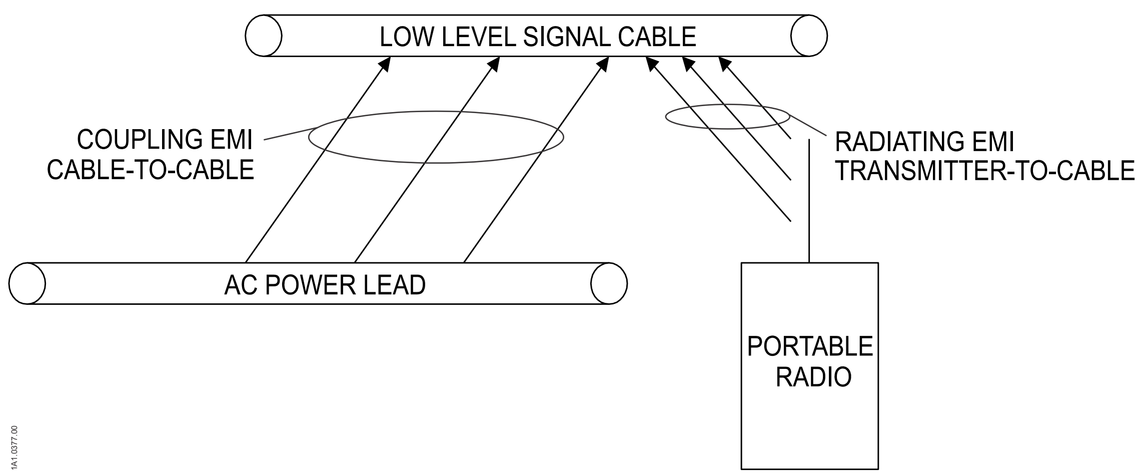


**Figure A-1. How a Cable Can Become a "Harmful Carrier" of EMI**

Effective cable routing can minimize the chances of cables becoming "harmful carriers" by providing two results:

1. Eliminating or reducing EMI interference from coupling from one cable to another.

2. Eliminating or reducing EMI interference from coupling from a source of EMI (i.e. arcing, motor brush noise, radio transmissions, etc.) onto a cable.

## A.3. Cable Categories

The first step to effective cable routing is the proper categorizing of all cabling based on their function. For the purposes of this contract cables shall be categorized into one of three basic categories:

Category #1 - AC Power Cables

Category #2 - DC Power and Control Cables

Category #3 - Signal and Network Cables

These categories have traditionally been chosen based on the typical characteristics, including EMI considerations of each type. AC Power Cables tend to be carrying higher voltages and currents and tend to be susceptible to surges and sags in the voltage and current levels they carry. These cables can create magnetic fields and can also be carrying other abnormalities from the power grid, such as the effects of lightning strikes. DC Power and Control Cables can also carry high level voltages and currents as well as transients related to control activities. Also because of the control nature of this category, one also needs to be more concerned about the susceptibility of this cabling. The final category of Signal and Network Cables tend to be made up of cables which will be carrying low level signals, either analog or digital. While this group can be the source of some EMI, by far the greater concern is the potential for harmful EMI being coupled onto this category.

Once a group of cabling has been categorized it is suggested that it is "grouped" and routed by category. This practice should be followed both, when routing cables within a specific piece of equipment or interconnecting different pieces of equipment within a system.

The following are recommended industry guidelines for the routing of categorized cables:

- Category #1 (AC Power Leads) – These cables should be routed along frame members and on the bottom of a machine/equipment. The purpose of this practice is to utilize the characteristics of the frame members to both shield and absorb any EMI radiating from the cables.

- Category #2 (DC Power & Control Leads) - These cables should also be routed along frame members or sheet metal plates within equipment enclosures. However, these cables should be separated from Category #1 cables and should not be hung "open space" fashion in any equipment enclosure or cabinet. As with the Category #1 cables, the frame members and sheet metal plates act to shield and absorb any EMI radiated from these cables.

- Category #3 (Signal & Network Cables) - These cables should be routed and separated as far as is possible from both Category #1 and #2 cables. As a general rule, when no shielding is available, these internal cabinet cables should be spaced a minimum of 1 inch from Category #1 cables for every 3 feet of a possible parallel run. It should be noted that for extreme low level signal cables this separation should be even greater, increasing to 10 inches for every 3 feet of parallel run. Conduits are also recommended for Category #3 cables as well.

- At enclosure or cabinet entry holes, separate locations for each category of cables should be utilized whenever possible.

**NOTE**

In the event of higher than expected disturbances that are proven to be related to electromagnetic interference coupling on cabling leading to or from ASTS supplied equipment, it is recommended to install a ferrite (ASTS Part Number N16927901) approximately 12 inches from the unit experiencing the disturbance. Testing has also shown that by using this ferrite in conjunction with a common mode filter (ASTS part number N451552-1001) on the system inputs, greatly reduces noise and increases the noise immunity in known problematic areas.

## A.4. Cable Selection

While not directly associated with “cable routing”, “cable selection” must be considered in any EMC compliant design. Clearly, the appropriate use of such cabling types as coaxial, twisted pairs and shielded twisted pairs enhances the overall EMC compliance of any individual piece of equipment and overall systems. Typical types of wiring and cabling for each of the basic cable routing categories are as follows:

- Category #1 (AC Power Leads) - Typical wire types for this category are balanced pairs for single phase or balanced three phase leads. The next best alternative to balanced pairs would be to group all of this cable together. Shielded cable is seldom used for this category.

- Category #2 (DC Power and Control Leads) - Balanced pairs, twisted pairs (both single and three phase) and single wire are used in this category. Shielded cable is seldom used for this category.

- Category #3 (Signal and Network Cables) - A wide variety of leads and cabling can be used in this category, including: twisted pairs, shielded twisted pairs, shielded and coax, and fiber type cables.

## A.5. Grounding Techniques

The purpose of grounding is to electrically interconnect conductive or charged objects in order to minimize the potential differences between them. This is important to achieve both from an

EMC control and safety standpoint. From the EMC control perspective proper grounding techniques provide:

- A low resistance path to dissipate energy (to ensure the proper operation of suppression devices such as RF filters).
- A common reference level, insuring against multiple ground potentials (which may cause unwanted ground loops).

In addition to those affects, proper grounding significantly impacts safety by providing:

- A low resistance path to earth. This provides a fault return path between the fault and the source to lessen the voltage hazard until a fuse/circuit breaker opens.
- A low resistance path between electrical equipment and nearby metallic objects to minimize shock hazards.
- A path to “bleed-off” static charges.
- A preferred path for lightning strikes to earth.
- A common reference plane of low relative impedance between electronic devices, circuits or systems.

## A.6. Types of Grounding Systems

In their most basic form, there are two simple ground systems which are utilized in most applications. They are the Single-Point Ground System and the Multi-Point Ground System. Figure A-2 and Figure A-3 represent these systems. When possible, the single point system shall be used since it is a better approach in minimizing ground loops. The intent is to eliminate ground loops which can cause conductive noise coupling through common impedances. This can increase the potential for radiated and conducted emissions and susceptibility problems due to effective loop antennas being formed by an improperly installed ground system.

The physical distance between equipment sometimes dictates that long ground leads are required to implement a single point ground system. These long leads present high impedances at radio frequencies due to the lead length inductance. In instances where the grounding of radio frequencies is of greater concern than the avoidance of ground loops, multiple point grounding should be implemented. When multiple point grounding is required, it becomes more critical that the difference in ground potential between each ground connection point is as small as possible. This grounding system is most often used when grounding a system which involves many pieces of equipment.

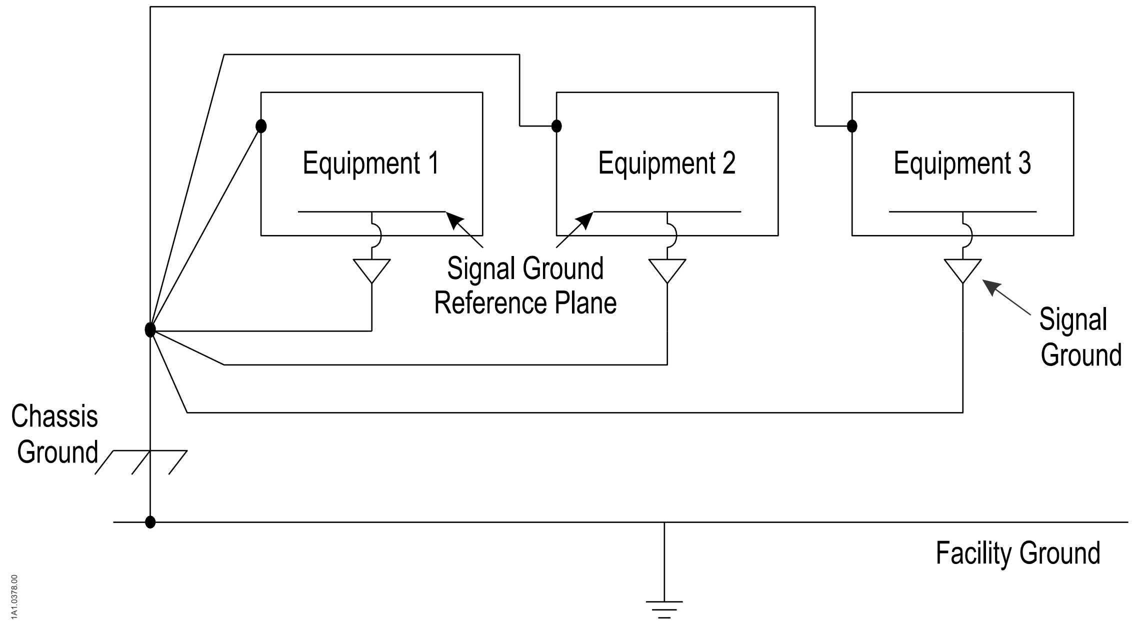


**Figure A-2. Single Point Ground System**

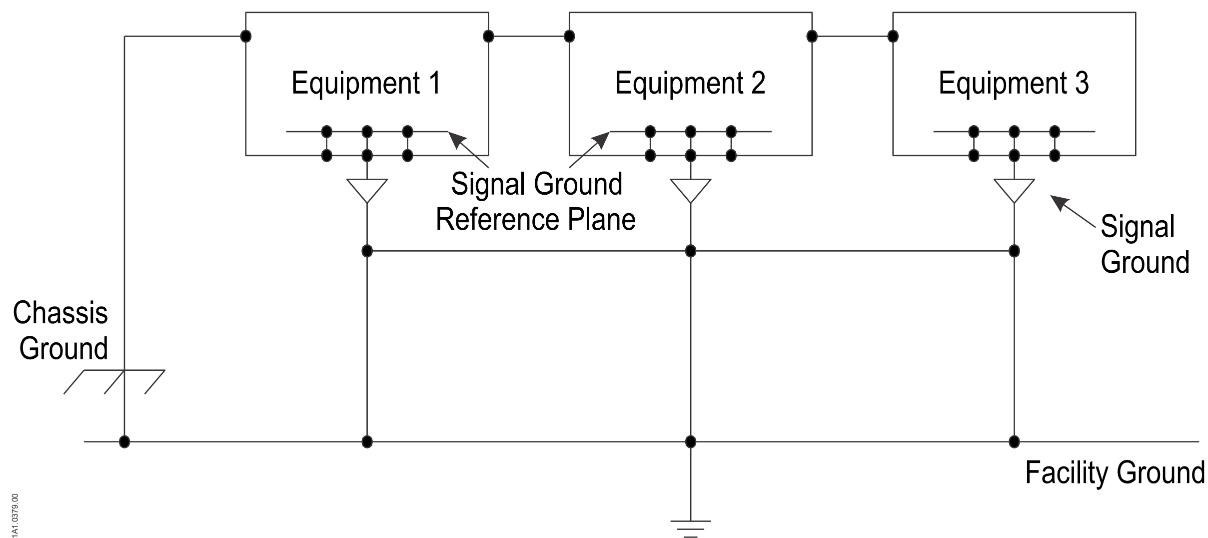


**Figure A-3. Multi-Point Ground System**

## A.7. General Guidelines for Effective Grounding

The following are general guidelines, which should be followed to ensure proper grounding for enhanced EMC compliance:

1. Keep all ground wires as short as possible.
2. Never run supply and return leads in separately or in separate shields.

3. Always follow the grounding installation instructions supplied by equipment.

4. All ground surfaces should be clean bare metal surfaces.

5. Properly compress all RF gaskets and locking hardware.

6. If the ground point and system utilizes different metals be sure to consider the impact and make certain that regularly scheduled maintenance procedures are in place to inspect such points for corrosion.

7. When possible, weld mating ground surfaces.

8. It is advisable to maintain separate ground systems within the equipment cabinet or rack for signal returns, signal shield returns, power system returns, and chassis and case ground. They can all be tied together at a single ground reference point (cabinet or rack ground stud to relay room copper detail).

## A.8. Conclusions

Proper cable routing is essential to an effective EMC Compliance Program. Accordingly, procedures should be followed on all projects which will ensure that proper cable routing has been accomplished. The procedures that should be followed, as defined in this document, are a combination of established installation practices and proven EMC industry guidelines. Steps such as drawing and design review, factory inspections and site visits for installation inspections should be utilized to ensure compliance with the procedures set forth.

The grounding of systems is a complex task. In order to minimize EMI, while meeting other requirements for safety and lightning protection, grounding must be implemented correctly. Many factors, including operating system requirements, location, and installation practices, all impact the grounding techniques that can be used and all can impact the overall effectiveness of the ground system, especially as it relates to EMI control.

**End of Manual**