

PiC409/49

USER'S MANUAL

For PiCs Utilizing the PiCTurbo Processor

Giddings & Lewis

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SECTION 1 - INTRODUCTION

1.1 THE G&L PiC

The G&L PiC (Programmable industrial Computer) is an industrial grade computer that is capable of carrying out sophisticated control functions, such as multiple-axis motion control and master/slave control. A PiC consists of at least one PiC rack (each rack including a power supply), a PiCTurbo Processor, and additional modules as required by the needs of the application. Essential system-control software is provided as firmware on the PiCTurbo Processor. The PiC follows a user-written program called a Ladder Diagram Network, or LDN. Creating the LDN is covered in the PiC409/49 Programming Manual.

Required PiC System Components:

The procedures in this manual require that the following items be available.

1. A master rack including the necessary power supply.
2. The PiCTurbo Processor.
3. Additional modules as required by the application.
4. An IBM or IBM-compatible personal computer.
5. A copy of G&L's GLLADD software, version 2.0 or later.
6. A GLLADD cable.

The **master rack** is the metal framework into which the PiC modules are inserted. Up to seven extension racks can be in a system in addition to the master rack.

The **power supply** provides the power necessary for system operation. Each PiC rack has a power supply installed at the G&L factory.

The **PiCTurbo Processor** contains the

"brains" of the PiC. The hardware and software on this module enable the PiC to perform its control functions.

Beyond the required PiCTurbo Processor, it is up to the user to decide what **additional modules** to include in a PiC control system. I/O modules are normally a part of every system. In addition, modules are available that provide features such as extended communications capabilities, the ability to use a video display, the ability to use servo feedback, etc.

An **IBM or IBM-compatible personal computer** must be used to communicate with and program the PiC. The following is a list of the types of PC's that can be used:

1. IBM monochrome and CGA in IBM PC and IBM AT. (GLLADD, the software needed for communication, will not run on the PS2 machines.)
2. Zenith laptops.
3. Compaq monochrome portables and Deskpros.

In cases where a G&L Software Solution is used with a PiC, another type of programming device may be used in addition to the IBM-compatible PC. For instance, in the case of PiCMotion, a Fluke Touch Control Screen or a Termiflex Programming Pendant can be used.

A copy of **GLLADD software** (available from G&L) is required to allow communications between the PiC and the personal computer. The user interacts with the PiC through a series of menus. An overview of the PiC menus is shown in Table 1-1.

The **GLLADD cable** links the personal computer to the Terminal socket on the PiCTurbo Processor faceplate. The cable can be purchased from G&L, or user-fabricated as shown in Appendix B of the GLLADD Manual.

<u>Menu/Function</u>	<u>Source of Information</u>

Available from the Aux 1 menu:

1. Run LDN.....	Section 6.3
The PiC Run Mode	
2. Program LDN.....	Programming Manual
Used to create the LDN. Also used in Runtime initialization procedures.	
3. Load into PiC Memory.....	Section 6.6
Loads LDN or data file into PiC memory.	
4. Verify PiC Memory.....	Section 6.5
Compares LDN or data file on disk with that in PiC memory.	
5. Record from PiC Memory.....	Section 6.4
Records an LDN from PiC memory onto computer disk.	
6. Aux Two	
Provides access to more functions.	
7. Aux Three	
Used by G&L for internal diagnostics. Not a user-accessible function.	
8. Change Authorization.....	Section 6.7
Used to change the authorization code required to access PiC functions.	

**Table 1-1.A Overview of the PiC Menus
(continued on next page)**

Menu/Function	Source of Information

Available from the Aux 2 menu:

1. Message Formatter.....	Programming Manual
Allows user to create and arrange messages in PiC memory.	
2. Terminal Baud Rate.....	Section 6.8
Used to change baud rate for the Terminal port on the PiCTurbo Processor faceplate.	
System Memory Configuration.....	Section 6.9
Used to enable or disable write protection for available bank(s) of user memory.	
3. Call Routine Installer.....	Programming Manual
4. Bank Select	Section 6.10
5. Variable, CR or I/O Table Back-Up.....	Section 6.11
6. Diagnostics.....	Section 7

Table 1-1.B Overview of the PiC Menus

PiC Communications

Communications between the PiC and the outside world centers around the PiCTurbo Processor. This module contains hardware and firmware that is essential for PiC operation. In addition, the LDN is stored in user memory on the PiCTurbo Processor. The user communicates with the

PiCTurbo Processor through the use of GLLADD software in an IBM-compatible personal computer. The PiCTurbo communicates with the application through the use of appropriate I/O modules. Figure 1-1 shows the communication links that exist between PiC components and typical I/O.

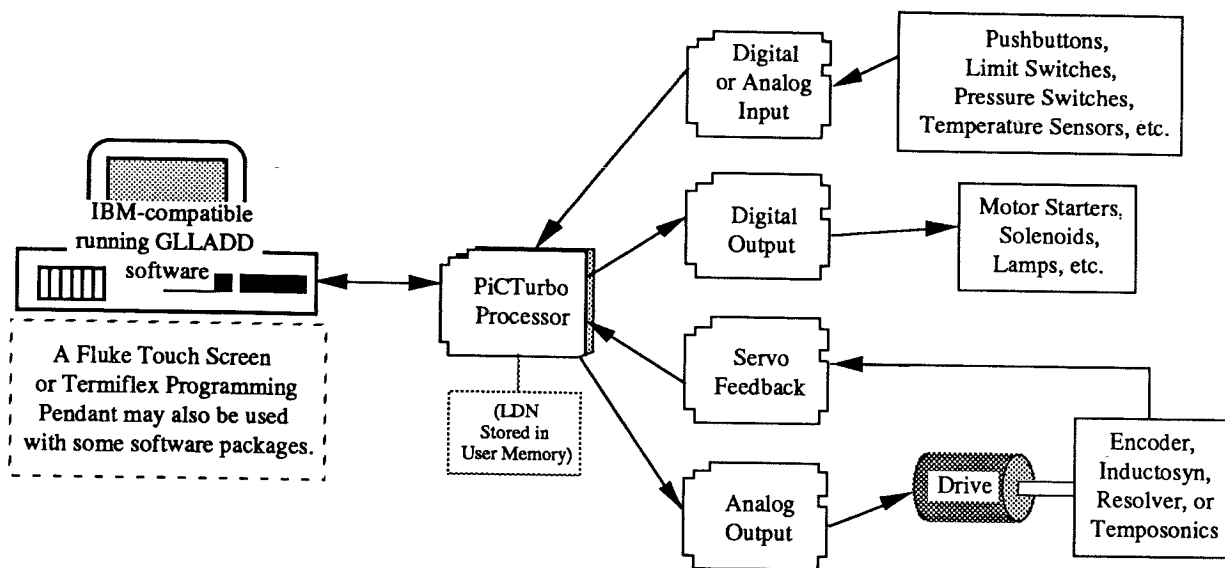


Figure 1-1 PiC and I/O Communication

1.2 THE PiC409/49 USER'S MANUAL

The PiC409/49 User's Manual provides the information necessary to get a PiC control system up and running. Proper installation, operation, and maintenance of the Giddings & Lewis PiC (both the 409 and the 49) are covered. The sections are presented in the sequence in which they should be read and followed. Information on programming the PiC is provided in the PiC409/49 Programming Manual.

NOTE

This manual is designed for use with a PiC that utilizes a PiCTurbo Processor. **This manual does not provide the information necessary to use a PiC system that does not contain the PiCTurbo Processor.** That information is in the standard version of the PiC409/ Family User's and Programming manuals.

User's Manual Contents

The following list indicates the sections contained in this manual and their contents:

1. Introduction
Provides general information regarding the PiC and the contents of the User's Manual.
2. Installation Wiring Guide
Contains instructions on getting the PiC rack or racks ready to have modules inserted into them. Covers connecting power to each rack, configuring racks, and mounting them.
3. PiC Modules
Introduces the PiC modules and explains proper care and use of them.
4. PiCTurbo Processor
Introduces the PiCTurbo Processor and its functions.
5. System Start-Up
Explains the final hardware setup and how to access the PiC menu system.
6. User Functions
Covers a number of functions that are

available through the PiC menus.

7. Diagnostics

Explains the use of the Diagnostics menu.

8. Appendixes

Provide documentation on PiC modules, recommended power supplies, wiring for obsolete racks, and GLLADD cable wiring. A glossary is also contained in this section.

1.3 SAFETY CONSIDERATIONS

All information presented within this manual should be read and thoroughly understood prior to installing, operating or troubleshooting the PiC to ensure safe operation and optimum equipment performance. Observe all federal, state and local safety standards that are pertinent to this piece of equipment.

CAUTION, IMPORTANT and NOTE blocks are found throughout this manual. The following examples illustrate how these items appear and the definition of each.

CAUTION

Installation, operating and maintenance procedures, practices, etc., which will result in injury to personnel or loss of life if not carefully followed.

IMPORTANT

Installation, operating and maintenance procedures, practices, etc., which will result in damage to equipment if not carefully followed.

NOTE

Installation, operating and maintenance procedures, practices, etc., which are essential to emphasize.

1.4 ORDERING PARTS

When ordering replacement parts, the following information is necessary to ensure that the proper part is sent and that shipment takes place as quickly as possible.

1. If the part has a serial number, specify the serial number of the part.
2. Include the part number and a description of the part.
3. Provide a customer P.O. number. A P.O. number is required even if the part being ordered is under warranty.
4. Specify the desired method of shipping.
5. Know the name and shipping address of the person and company to receive the part.



SECTION 2 - INSTALLATION WIRING GUIDE

2.1 INTRODUCTION

This section guides the user through readying the PiC rack for operation. The following topics are explained:

1. The differences between a PiC49 rack and a PiC409 rack.
2. How to configure a PiC409 rack.
3. How to interconnect master and extension racks.
4. How to wire power to a rack.
5. Shielding and noise considerations.
6. Rack mounting procedures.

2.2 UNPACKING THE PiC

The Programmable industrial Computer (PiC) and its associated hardware have been tested and carefully packed before shipment. When the equipment is received, the packing material should be removed and the equipment carefully inspected for damage. If any damage is discovered, notify both the carrier and the factory so that corrective action can be taken.

Check the contents of the shipment against the packing slip for accuracy. In each shipping box containing a PiC rack, you should find the following:

1. The PiC rack. The appropriate PiC power supply is installed in the rack.
2. A power cord. The power cord comes properly connected at the power supply end.
3. PiC manuals.

Do NOT remove any printed circuit boards (PiC modules) from their anti-static bags at this time. Procedures for handling modules are covered in Section 3.

2.3 THE PiC RACK

The metal framework that PiC modules are inserted into is referred to as the PiC rack. The module sockets in the rear of the rack are connected to the backplane, which is sometimes called the motherboard. The backplane interconnects the PiC modules with a power source and allows logic level communication between the modules.

The PiC rack is available in a PiC49 version or a PiC409 version. The PiC49 rack contains one nest (row of slots for modules) and is non-expandable. The PiC409 rack contains two vertically stacked nests and is expandable, which means it contains circuitry that allows up to eight racks to be interlinked.

Master Racks and Extension Racks

The PiC409 rack is designed to allow up to eight racks to be linked together in a single control system. Only one rack can contain a PiCTurbo Processor. That rack is the master rack. The racks are user-configured to identify the master rack and to give each extension rack a unique identifier number. If your control system consists of one rack, that rack must be configured as the master rack.

Up to seven extension racks may be connected to the master rack to provide additional slots for PiC modules. Only AC input and output modules, DC input and output modules, and the Scan Monitor Module will function in an extension rack.

2.4 CONFIGURING A PiC409 MASTER RACK

To configure a PiC409 master rack, you carry out the following:

1. Set a rotary switch to designate the master rack.

2. Place a jumper to indicate the quantity of extension racks in the system, which selects the quantity of control relays available.

PiCTurbo control relay memory is configured to match these settings through software.

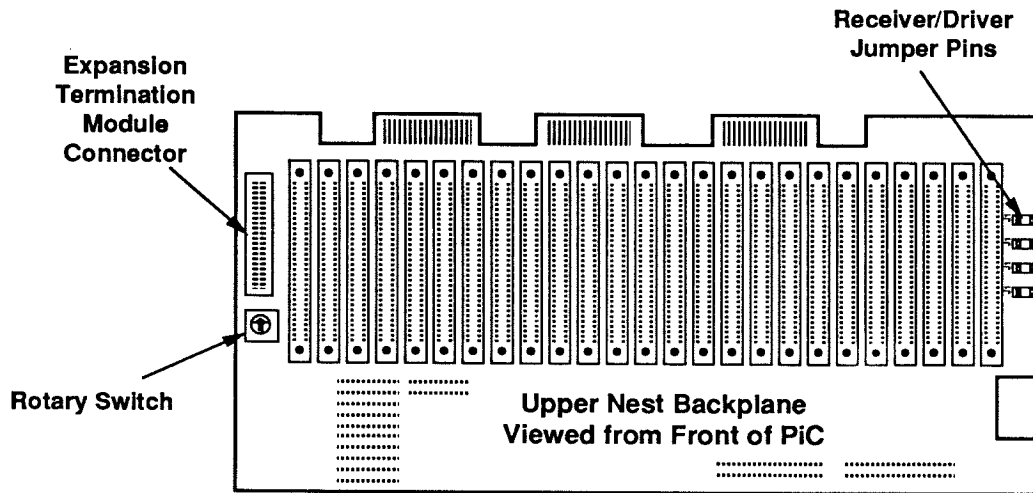
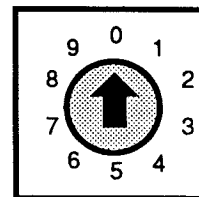


Figure 2-1 PiC409 Backplane

NOTE

Prior to December of 1985, G&L Electronics sold PiC409 racks (master rack p/n 503-15697-00, extension rack p/n 503-15699-00) that require configuration procedures that differ from those found in this section. For these procedures, refer to Appendix C. Procedures for interconnecting current-style and the previous-style racks are also found in that appendix.

switch to position zero (0), as shown in Figure 2-2. This designates the rack as the master rack.



PiC409 master rack designation.

Figure 2-2 Rotary Switch Setting for Master Rack

Designating the Master Rack

In each PiC409 control system, one rack and only one rack must be configured as the master rack. If you have only one rack in your system, define that rack as the master rack. To designate a rack as the master rack perform the following:

1. Locate the rotary switch that is to the left of the first slot on the upper nest motherboard (looking into the rack from the front). This is shown in Figure 2-1.
2. Use a small, flat blade screwdriver to set the

Setting the Jumper in a Master Rack

A number of sets of jumper pins (two pins each set) are found to the right of the last slot in the upper nest of each 409 rack (see Figure 2-1). The upper four sets (each labeled J1) are used in this procedure. The jumper that is provided must be placed on the correct set of pins to indicate the quantity of extension racks in a system, and thus select the quantity of control relays available for programming.

A control relay is one of the elements used in creating an LDN. Blocks of PiC memory are reserved for the I/O addresses for each extension rack. The memory reserved for I/O addresses can be used for control relays instead if the racks the I/O addresses are dedicated to are not present.

If there are no extension racks being used in a system, a total of 3,792 control relays are available. If one to three extension racks are in a system, 3,024 control relays are available. If four to seven extension racks are in a system, 2,000 control relays are available.

Figure 2-3 shows the jumper options for a master rack. You select an option by placing the jumper over the appropriate set of jumper pins, as shown in Figure 2-4. When the rack arrives from the factory, the jumper will reside on one of the sets of pins. Refer to Table 2-1 to determine which jumper position to use for your system.

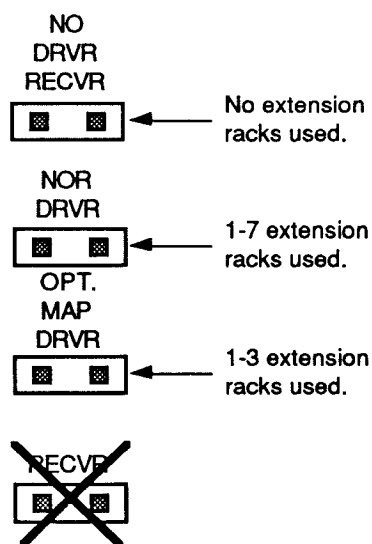


Figure 2-3 Master Rack Jumper Options

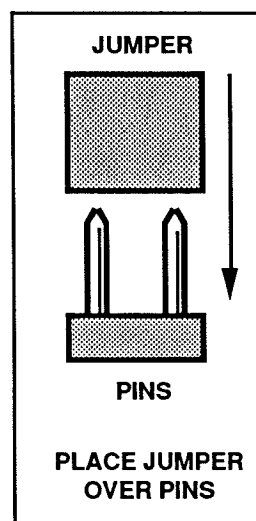


Figure 2-4 Jumper Placement on Pins

Control Relays Available	Extension Racks Present	Jumper Position
3,972	none	NO DRV R RECVR
3,024	1 - 3	OPT MAP DRV R
2,000	1 - 7	NOR DRV R

Table 2-1 Master Rack Jumper Settings

2.5 CONFIGURING PiC409 EXTENSION RACKS

To configure PiC409 extension racks, you carry out the following:

1. Set a rotary switch on each extension rack to assign each rack a unique identification number.
2. Place a jumper on each extension rack to define that rack as an extension rack.
3. Install an Expansion Termination Module in the last extension rack in the system.

Assigning Extension Rack Numbers

To assign an identification number to an extension rack, set the rotary switch on the upper nest motherboard to one of the positions shown in Table 2-2. Each rack must be assigned a different identification number. The identification number allows the PiC to determine the source or destination of data.

Extension Rack Number	Rotary Switch Position
1st Extension	1
2nd Extension	2
3rd Extension	3
4th Extension	4
5th Extension	5
6th Extension	6
7th Extension	7

Table 2-2 Extension Rack Identification Numbers



Figure 2-5 Extension Rack Jumper Position

Setting the Jumper in an Extension Rack

This procedure uses the upper four sets of jumper pins found to the right of the last slot in the upper

nest of each 409 rack (see Figure 2-1). Place the provided jumper on the last of these sets of pins (labeled RECV). The jumper position for an extension rack is shown in Figure 2-5.

Expansion Termination Module

The racks in a multi-rack system are connected together in daisy-chain fashion. The last extension rack in the series must be terminated with an Expansion Termination Module, shown in Figure 2-6. This module is not for use in any other rack in the control system.

Insert the module into the connector to the left of the first slot in the upper nest (see Figure 2-1). The module is keyed to prevent incorrect insertion. Removal is simply a matter of inserting your finger into the hole and pulling the module out.

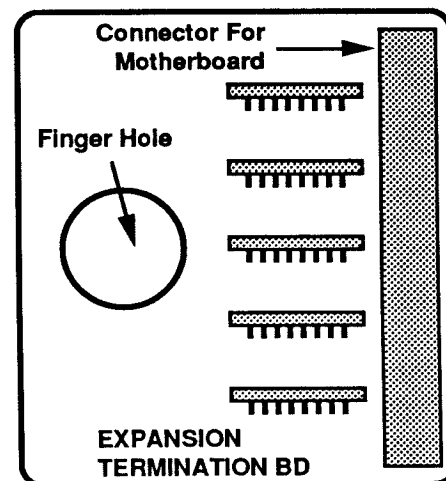


Figure 2-6 Expansion Termination Module

2.6 INTERCONNECTING MASTER AND EXTENSION RACKS

Racks in a multi-rack system are interconnected in daisy-chain fashion using flat 40-conductor cables. Cables in various lengths are available from the G&L factory. Short cables should be used to connect racks that are stacked vertically. Longer cables are used to connect racks mounted

side-by-side.

Three card-edge type connectors are at the top of each upper nest backplane (see Figure 2-7). Looking at the backplane from the front of the rack, the driver card edge is on the right side. The center and left connectors are receiver card edges used for extension racks.

To link together racks in a multi-rack system, perform the following:

1. On the master rack, attach one end of a ribbon cable to the card edge labeled DRIVER.
2. Attach the other end of the cable to either of the card edges labeled RECEIVER on the first extension rack.
3. To connect more extension racks, connect a ribbon cable from the RECEIVER card edge on one rack to the RECEIVER card edge on the backplane in the next rack.

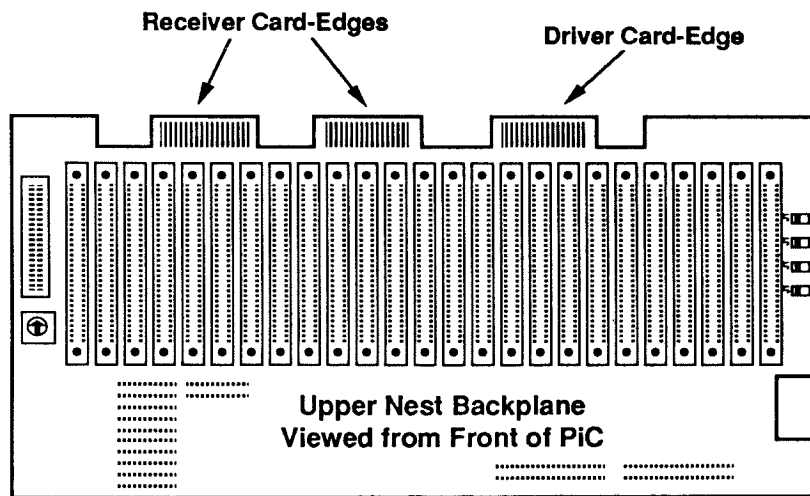


Figure 2-7 Card Edge Connectors on PiC409 Backplane

Only the master rack has a cable connected to the DRIVER connector. The last extension rack in the series will have a cable attached to only one of the RECEIVER connectors. This is the rack that must contain an Expansion Termination Module.

IMPORTANT

Keep the interconnecting cables away from all other wiring to prevent electrical interference.

2.7 CONFIGURING A PiC49 RACK

These racks are non-expandable and require no special configuration by the user.

2.8 PRIMARY AC POWER

All PiC systems (409 and 49) should be isolated from incoming AC lines through the use of a control transformer (to isolate grounds) and a noise filter. G&L specifies a .5 KVA or larger control transformer and an Islatrol® filter model I-115/U (G&L Part Number 401-53038-00). Figures 2-8 and 2-13 show typical connections for a control transformer and noise filter.

Islatrol is a registered trademark of Control Concepts Corporation.

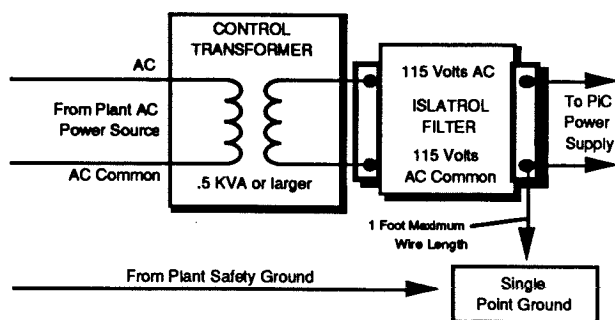


Figure 2-8 Control Transformer and Islatrol Filter

Mount these items in the PiC cabinet with the master rack. The Islatrol filter must be no further than one foot from the single point ground which must also be in the same cabinet.

If the quality of the line voltage is inadequate (sags or surges outside $\pm 10\%$ windows), the PiC power supplies should be isolated by the use of a motor generator set.

IMPORTANT

To ensure proper grounding, most ground connections are made at the system's single point ground. This includes the grounding of the AC power for the PiC racks. The single point ground is described in detail in Section 2.12. Before doing any wiring, read that section and install a single point ground tie block within one foot of the Islatrol filter output.

2.9 MAIN DISCONNECT SWITCH

The following should all originate from a main disconnect switch:

1. Primary 115 Volt AC power from the control transformer and filter to the PiC Power Supply.
2. The user-furnished DC power supply and the AC power supplied to the AC I/O modules. (DC and AC I/O modules require that the user furnish the power for the

module.)

A main disconnect switch ensures that electrical power to all PiC system devices will be removed if power to the PiC is intentionally or unintentionally eliminated.

2.10 PiC409 RACK AC POWER CONNECTIONS

NOTE

Where local wiring codes and standards do not agree with the recommended wiring colors and gauges in this section, the wiring codes and standards take precedent in all cases. It is the user's responsibility to determine what the local wiring codes and standards are.

PiC409 racks have a built-in power supply. Depending on the type of power supply that was specified when your rack was ordered, your rack will have either a ten-terminal or an eight-terminal barrier strip for the power connections. The power cord included with the PiC409 rack is already properly connected to the barrier strip. However, the procedure for connecting a power cord to the barrier strip is included in this section in case you ever have to make those connections in the future.

The power cord enclosed with the PiC409 rack contains the correct gauges and colors of wire for supplying power to the power supply. The power cord consists of shielded four-conductor cable. The black, white and green wires are #16 and the white/green wire is #10.

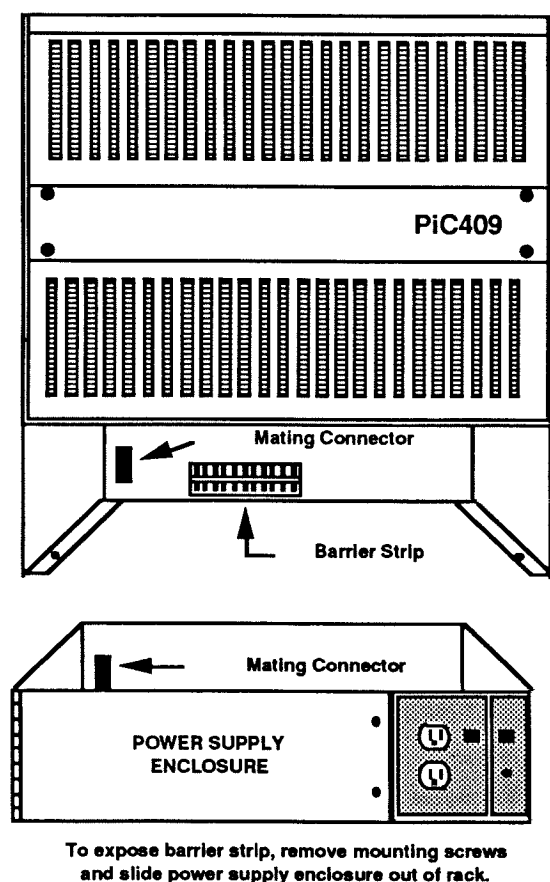


Figure 2-9 PiC409 Power Supply Enclosure Removal

To gain access to the barrier strip, remove the two screws under the power supply enclosure and slide the enclosure out of the rack (see Figure 2-9). Figure 2-10 illustrates the wiring for the ten-terminal barrier strip. Use the following steps to connect AC power to the PiC409 power supply.

1. Connect the #10 white/green wire from terminal 1 to the single point ground.
2. Use the green conductor in the power cable to connect terminal 2 on the barrier strip to the single point ground.
3. Use the white conductor in the power cable to connect terminal 3 to the 115 volt AC Common connection on the Islatrol filter.
4. Use the black conductor to connect terminal 4 to the 115 volt AC connection on the Islatrol filter.
5. Connect one end of the shield drain wire to

the single point ground. Leave the other end of the shield drain wire unconnected.

6. Connect a #10 white wire (not provided) from the 115 volt AC Common connection on the Islatrol filter to the single point ground in your PiC cabinet. This wire must not exceed one foot in length.

No additional power wiring is required. Slide the power supply enclosure back into its original position and secure it with the two screws you removed earlier.

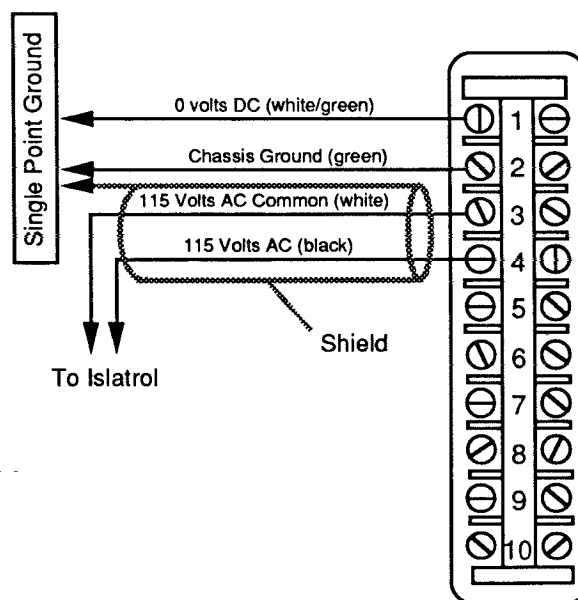


Figure 2-10 Eight or Ten Terminal Strip Wiring

2.11 PiC49 RACK AC POWER CONNECTIONS

PiC49 racks have a built-in power supply. Located in the back of the power supply compartment is a six-terminal barrier strip. The power cord included with the PiC49 rack is already properly connected to the barrier strip. However, the procedure for connecting a power cord to the barrier strip is included in this section in case you ever have to make those connections in the future.

The power cord enclosed with the PiC49 rack contains the correct gauges and colors of wire for

supplying power to the power supply. The power cord consists of shielded four-conductor cable. The black, white and green wires are #16 and the white/green wire is #10.

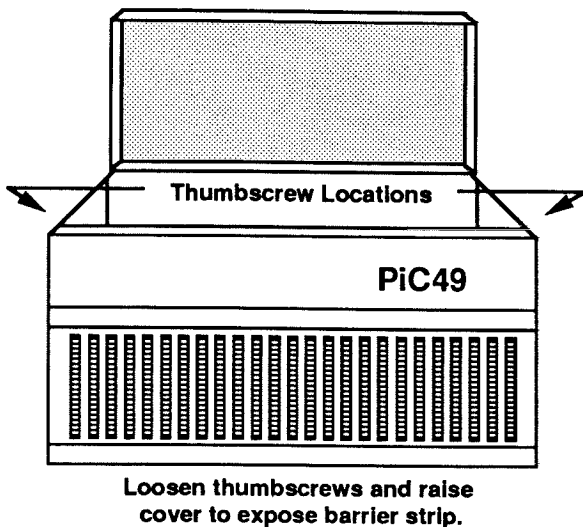


Figure 2-11 Opening the PiC49 Power Supply Compartment

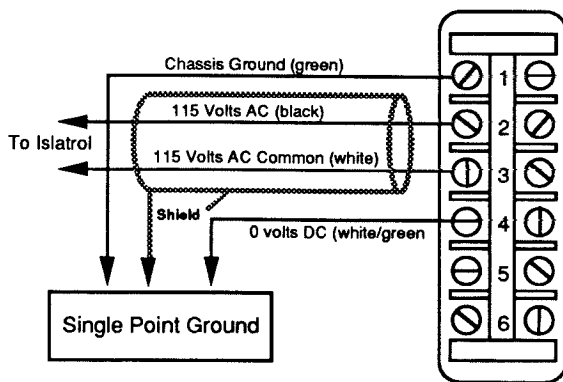


Figure 2-12 Six Terminal Strip Wiring

To gain access to the barrier strip, loosen the two thumbscrews at the top of the rack (see Figure 2-11) and raise the top cover. Figure 2-12 illustrates the wiring for the six-terminal barrier strip. Use the following steps to connect AC power to the PiC49 power supply.

1. Use the green conductor in the power cable

to connect terminal 1 on the barrier strip to the single point ground.

2. Use the black conductor to connect terminal 2 to the 115 volt AC connection on the Islatrol filter.
3. Use the white conductor to connect terminal 3 to the 115 volt AC Common connection on the Islatrol filter.
4. Connect the #10 white/green wire from terminal 4 to the single point ground.
5. Connect one end of the shield drain wire to the single point ground. Leave the other end of the shield drain wire unconnected.
6. Connect a #10 (not provided) white wire from the 115 volt AC Common connection on the Islatrol filter to the single point ground in your PiC cabinet.. This wire must not exceed one foot in length.

No additional power wiring is required. Close the top cover and secure it by tightening the thumbscrews.

IMPORTANT

As with any type of computer equipment, proper grounding, shielding and noise suppression are essential for reliable operation of the PiC. Following the instructions presented in this section will eliminate many of the interference problems that typically exist in industrial environments. Failure to follow these instructions may result in incorrect data which can affect the reliability of the system.

If you have difficulty meeting these requirements or if problems occur despite your efforts, please consult G&L Electronics.

NOTE

The remainder of this section applies to both the PiC49 and the PiC409.

2.12 SINGLE POINT GROUND

A single point ground is required for proper grounding. This should be a tie block located in the PiC cabinet, which also contains the control transformer, the Islatrol filter and the master rack.

The single point ground tie block should be made of brass or copper. It must be welded or bolted securely to the inside of your PiC cabinet no farther than one foot from the Islatrol filter. Fasten this tie block using the following guidelines:

1. The single point ground must be located no further than one foot from the Islatrol filter, and as close as possible to the PiC.
2. Scrape the paint off of the panel in the PiC cabinet where the block is to be fastened. This assures good electrical contact with the cabinet.
3. Use star washers directly on the panel when bolting the block. This also helps to provide good electrical contact.

Ground Paths

The following items should be connected at the single point ground.

1. DC Common (use #10 white wire with green stripe that is part of the provided power cord). This is the 0 volts DC bus.
2. 115 volts AC, 1 phase common output of the Islatrol filter (use #10 white wire that is part of the provided power cord).
3. Chassis ground terminal on the PiC barrier strip (use #16 green wire that is part of the provided power cord).
4. Plant safety ground (consult local wiring codes for proper wire to use).
5. The shield drain wire for the 115 volt power cable between the Islatrol filter and the PiC power supply. Connect only the end of the shield located closest to the control transformer.
6. DC common from the power supply used for the 24 or 15 volt DC I/O modules (use #16 white/green conductor).

7. The chassis ground terminal on any extension racks (use a minimum #16 green conductor).
8. The single point grounds from remote or slave PiCs used as part of the same system (use #10 conductor).
9. The chassis of any machine, motor drive or other equipment connected to the PiC (use #16 green conductor).
10. The chassis ground for additional power supplies.
11. The chassis of any remote extension rack.
12. Peripheral components such as control transformers, personal computers, etc.

Refer to Figure 2-13 and Figure 2-14 when making ground connections.

IMPORTANT

Wherever possible, all connections to the single point ground, including DC common, chassis ground, and AC common should be routed separately to the single point ground. These ground paths should only be connected together at the single point ground block.

The following grounding recommendations should also be observed:

1. All equipment housings, frames, panels and doors should be grounded to the PiC cabinet. Hinges are not acceptable as ground connections unless stainless steel or brass metal is used as a hinge rod.
2. The chassis of the master rack and any extension racks in the same PiC cabinet should be attached to the PiC cabinet by the use of star washers.

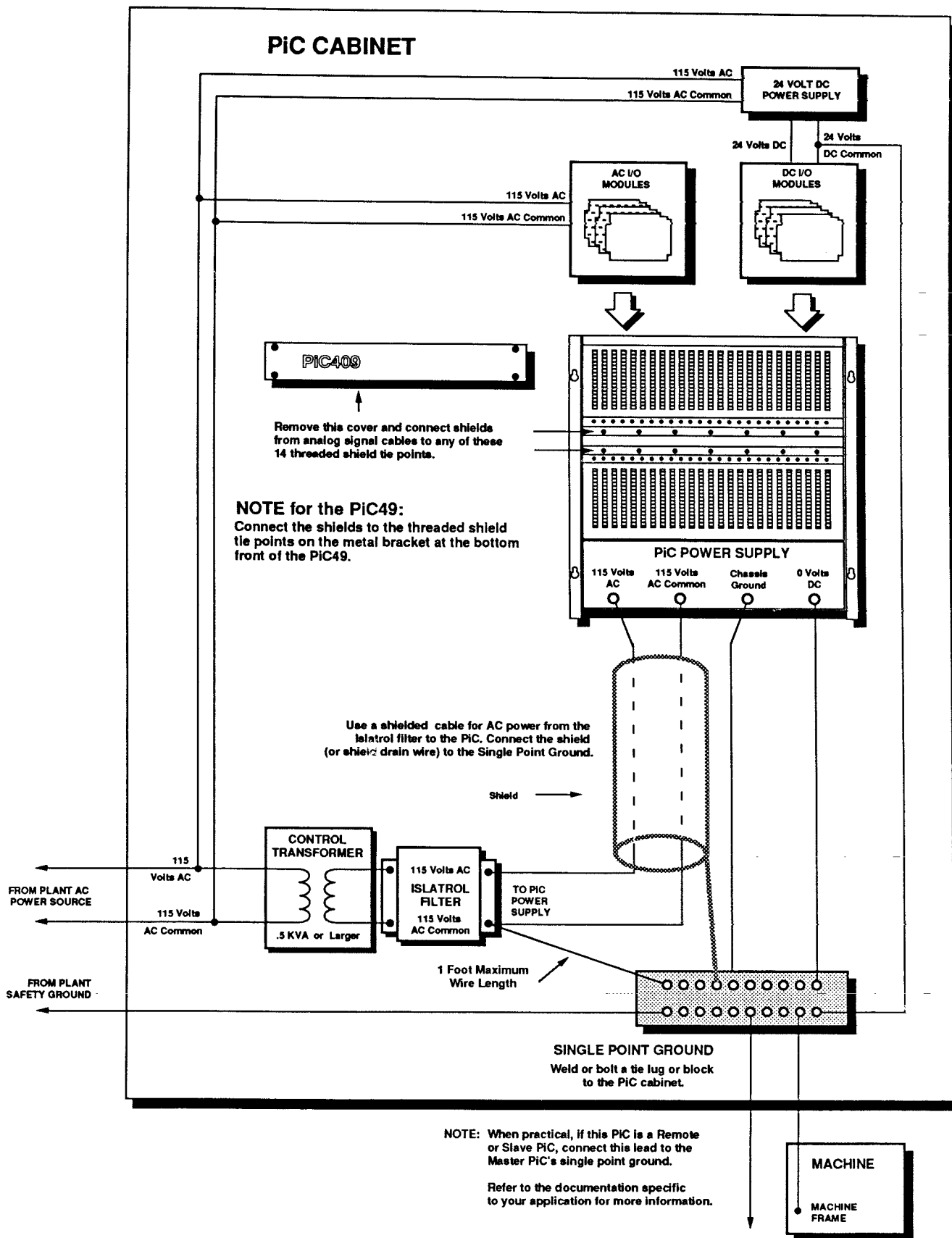
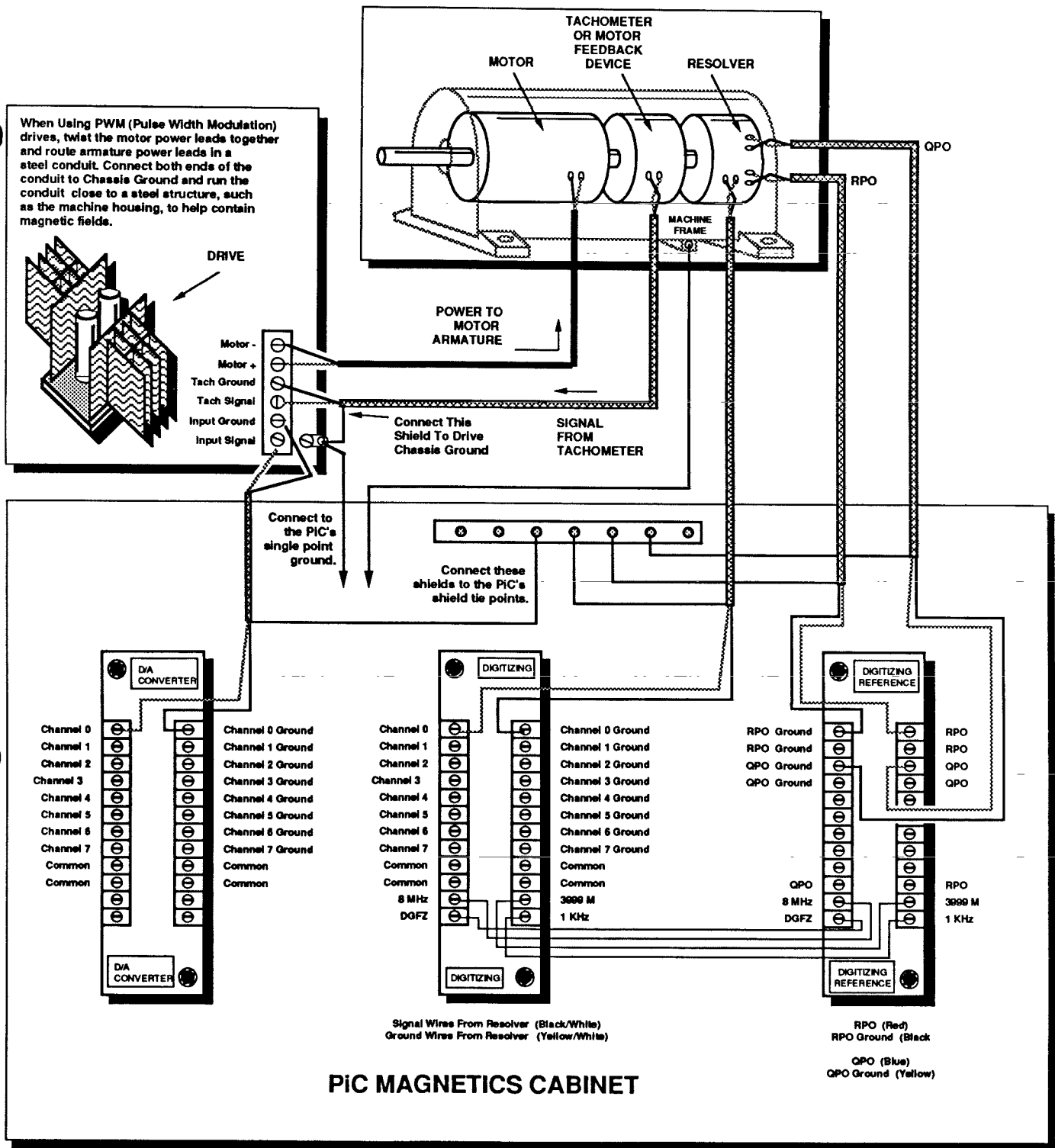
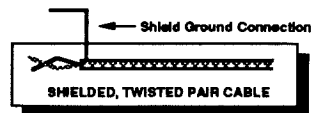


Figure 2-13 Typical Single Point Ground Connections



IMPORTANT!

Keep ALL analog signal leads from Resolvers, Tachometers, D/A Module, etc. physically separated from the motor leads, 24V wiring, and AC wiring.



Use shielded, twisted pair cables for these signal leads. Ground the shields as indicated in the illustration.

Figure 2-14 Typical Connections for Analog Cable Shields

Grounding Methods

1. Panels may be grounded with enclosure studs provided any paint is removed from the stud flange and around each hole on both sides of the panel. Star washers should be inserted between the panel and the hold-down nut. This is the most desirable method.
2. Ring lugged washers may be used provided the paint is removed from the panel and star washers are used directly on the panel surface.
3. Grounding straps may be used provided any paint is removed from both termination ends, and star washers are used between the strap and hold-down bolts.

2.13 SHIELDING AND NOISE

Electrical noise is an unwanted signal, commonly introduced into signal wires through electrostatic (capacitive) coupling, magnetic (inductive) coupling, and/or resistive coupling. Noise coupling is reduced through the use of shielded wire, twisted pair wire, coaxial cables, proper grounding practices and by separating noise-sensitive wires from noise-generating wires.

Some of the signals associated with a PiC are:

1. 115 Volt AC wiring, such as connections to solid state relays, starter/relay coils, solenoid valves, transformers, video monitors and other peripheral devices. These signals generally create noise that interferes with other signals.
2. 24 volt DC wiring to display lights and machine devices such as limit switches, pressure switches and float switches.
3. Analog signals (AC or DC) to feedback devices such as sliders, scales and resolvers. These are low level signals which are very noise susceptible.

To prevent these signals from interfering with one another, the following routing methods must be followed.

1. Within the PiC cabinet, power wiring (115 volts AC) should be separated from DC

wiring, analog wiring, and wiring carrying low-level signals. Do not run AC and DC cables side by side.

2. When running cables outside of the enclosure, use separate cables for each type of signal. NEVER MIX AC, DC LOW-LEVEL DIGITAL, OR ANALOG SIGNALS IN THE SAME CABLE OR CONDUIT.

G&L recommends that a minimum distance of four inches separate wiring carrying these types of signals. Longer wire runs require greater separation.

3. Analog signals (for encoders, resolvers, scales, sliders, etc.) should be routed in shielded cables. The shields for these cables should be grounded as indicated in the subsection *Grounding Cable Shields* and as shown in Figure 2-14.
4. Motor leads, especially those from PWM drives, should be twisted together whenever possible and separated as far as possible from analog signals.

IMPORTANT

Devices creating large amounts of electromagnetic interference (such as arc welding equipment) or cables for such equipment should be separated from the PiC by a minimum distance of 10 feet while the device is in operation.

Grounding Cable Shields

All cable shields, with the exception of the shields for the power leads described in the next paragraph, should terminate at the PiC shield tie points on the master rack. **UNDER NO CIRCUMSTANCES SHOULD THE SHIELD DRAIN WIRE BE USED AS A SIGNAL WIRE OR CURRENT CARRYING CONDUCTOR.**

Cables that are a source of radiation, such as power leads for a high frequency welder or PWM (pulse width modulation) motor, should be twisted together and shielded with a continuous iron or steel conductor (foil wrap or conduit). Ground the shields at both ends of the cable to the

equipment the cable is connected to .

2.14 SIGNAL ISOLATION

All analog signals connected to the PiC should be referenced to the PiC single point ground. If this is not possible, an analog isolator is required between the signal lines and the PiC. Motor drives with differential inputs that use the same single point ground do not require analog isolation. Interfaces to other devices may require analog isolation.

2.15 TRANSIENT SIGNAL SUPPRESSION

All AC or DC lines to external inductive devices (such as motors, relays, and solenoids) that are controlled from the PiC should be equipped with electrical arc suppression. Specifically, the following recommendations should be followed:

1. All motors should be arc suppressed at the motor starters as shown in Figure 2-15.
2. 115 volt AC coils, solenoids, etc. have to be suppressed if a contact is placed between the coil and the AC Output Module. This is shown in Figure 2-16.
3. Direct current (DC) outputs should be suppressed by use of a diode (see Figure 2-16). If dropout time is critical in an application, a metal oxide varistor (MOV) should be used for DC output arc suppression in place of the diode. The metal oxide varistor should be rated at 30V.

IMPORTANT

Arc suppression on DC outputs to inductive devices is essential to avoid long-range damage to DC output modules.

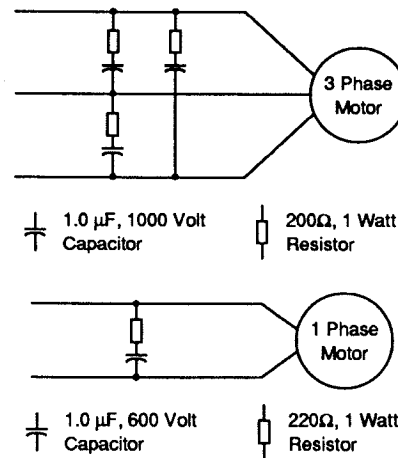


Figure 2-15 AC Motor Arc Suppression

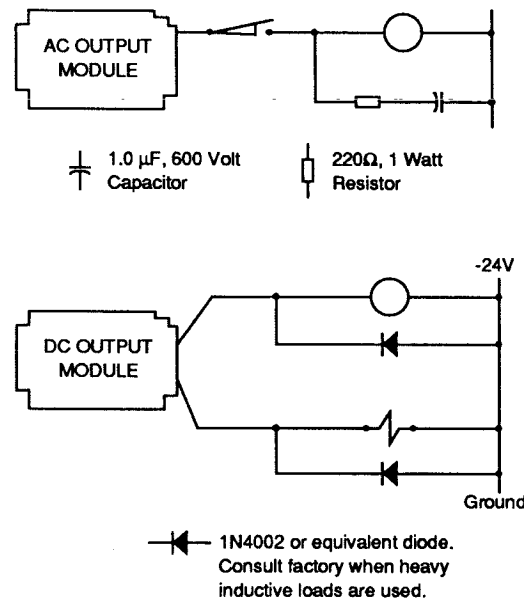


Figure 2-16 Device Arc Suppression

2.16 MOUNTING THE PiC RACK

G&L PiC racks should be mounted on a rigid, vertical surface, protected from corrosive or explosive atmospheres and conductive fluids and particles. A NEMA 12 enclosure is strongly recommended. Mounting dimensions for the PiC racks are supplied in Figure 2-17.

The PiC racks are cooled by convective air flow. Do not place auxiliary devices in a position where

these devices would impede the free air flow over the PiC or power supply. The operating environment must be kept within the following limits:

Operating Temperature: 7° to 55° C, 45° to 130° F.

Relative Humidity: 15% to 95%, Non-condensing.

If the temperatures in the cabinet are expected to exceed 55° C (130° F), fans, heat exchangers, or an air conditioner should be used. If you have difficulty meeting any of these requirements, please consult the G&L Electronics factory.

A fan assembly that mounts to the bottom of PiC409 racks is available from G&L, part number 502-03451-00.

IMPORTANT

Failure to observe these requirements may result in short circuits and the subsequent failure of the system.

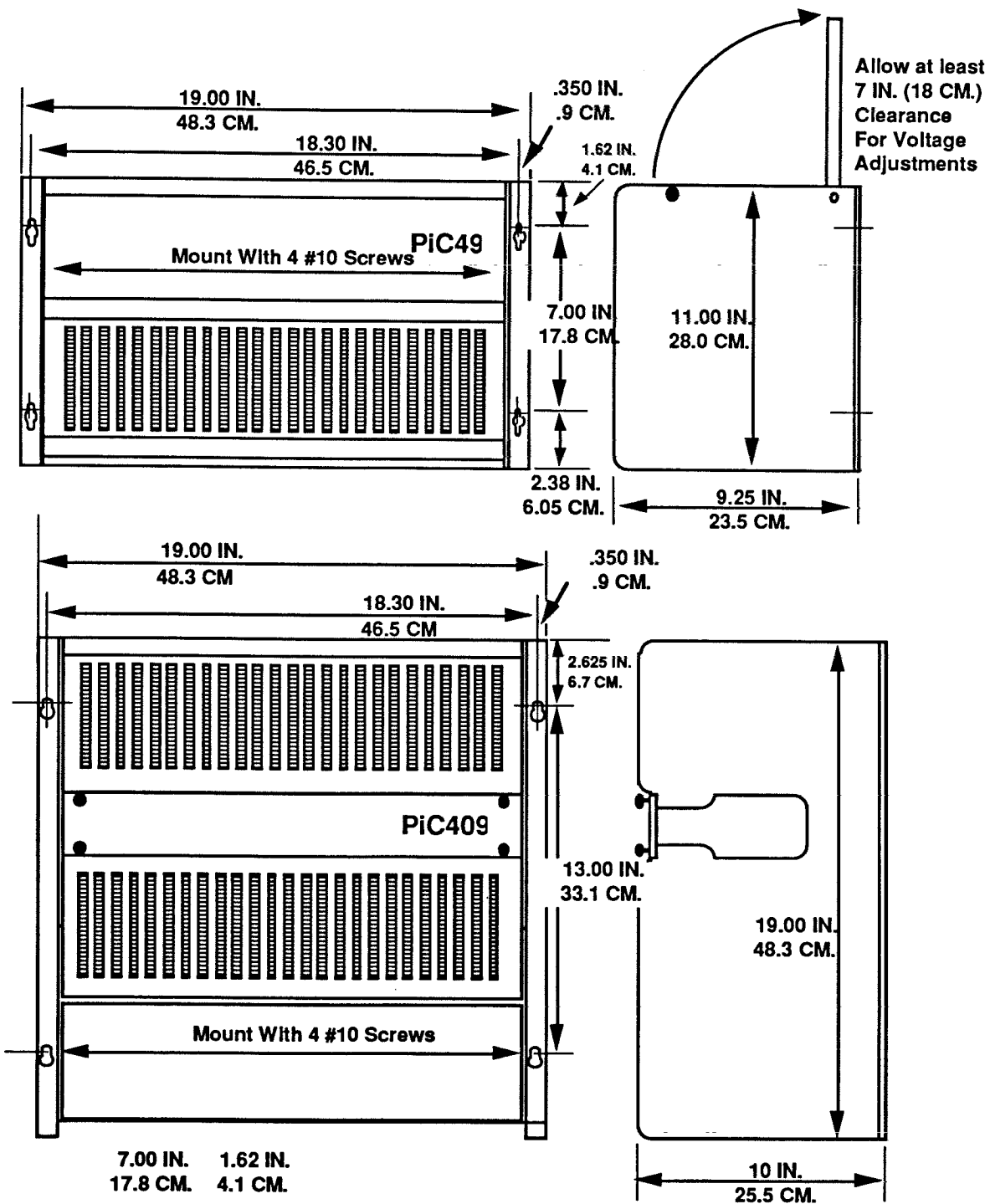


Figure 2-17 PiC Rack Dimensions



SECTION 3 - PiC MODULES

3.1 INTRODUCTION

This section introduces the PiC module and describes how to properly handle, configure, and install modules. Actual installation of the modules a system contains will vary from application to application. The procedures in this section apply to modules in general.

NOTE

For technical information on each PiC module, refer to Appendix A of the User's Manual.

The PiC Module

PiC modules are printed circuit boards that contain the components necessary to provide the PiC with specific capabilities. A PiC module is placed into the system by sliding the rear edge into the PiC rack until it extends into a socket on the backplane. The modules are keyed to prevent incorrect insertion.

Setting Switches and Jumpers

Some modules require that switches and/or jumpers on the module be set by the user before the module is inserted into the PiC rack. A common instance in which switches are set involves defining an address (location in PiC memory). When a PiC module does not have a fixed address, the user defines the module address by setting an address switch.

Jumpers are typically used to activate or deactivate options on a module. From a hardware perspective, jumpers complete a circuit. When a jumper is "out", the circuit is open, and therefore not effective. When a jumper is "in", the circuit is closed, and thus effective.

Refer to the write-up in Appendix A for each module you are using to determine whether or not the module contains any switches or jumpers that must be set. An example module showing jumpers and switches is shown in Figure 3-1. The switches are labeled "SW" and the jumpers are labeled "J".

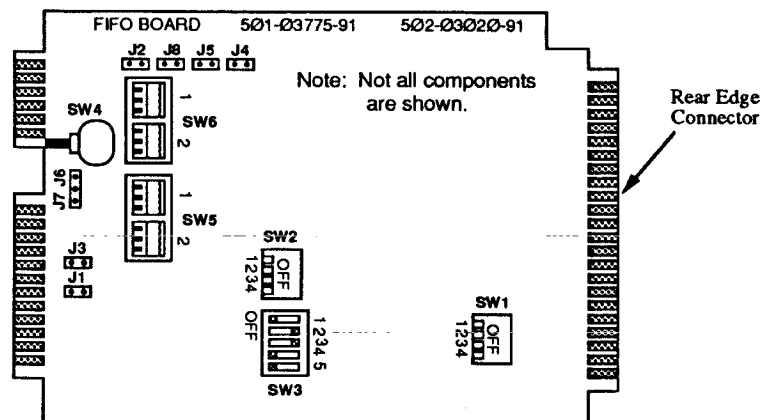


Figure 3-1 Example Module Illustration

Faceplates and Card Edge Connectors

When wiring connections are made directly to a module, the module will have a front edge connector in addition to the rear edge connector that inserts into the PiC. Connections are made to a front edge connector via a faceplate or card edge connector that is affixed to the front edge of the module (see Figure 3-2).

Faceplates are a convenient means of wiring to a module. They use screw-type wiring terminals and provide a place where information about each connection can be written. The connection points are typically identified on the faceplate. Each module using a faceplate requires three slots in the rack; one slot for the module to slide into, and one empty slot on either side to accommodate the faceplate.

Card edge connectors are more economical than faceplates, but lack some of the convenience. Wiring to a card edge connector is accomplished by crimping a pin onto the wire and inserting the pin into the card edge connector in the appropriate location. A module using a card edge connector requires one slot only.

Wiring diagrams for each module are provided in the module's write-up in Appendix A. Wiring to a faceplate or card edge connector is normally done before it is installed onto the PiC Module.

Required Modules

The PiCTurbo Processor is a required part of every PiC control system. Other than that, the modules your system will utilize depends on your application. In virtually all cases, I/O modules will be used in the control system.

The functions of the PiCTurbo Processor are covered in Section 4.

Worksheets

Included at the end of this section are a number of worksheets that assist in documenting the layout of your control system. The worksheets are explained in detail in following sections. Use these worksheets to document the layout of your system. Keeping such a record can assist in the installation, start-up and troubleshooting of the PiC control.

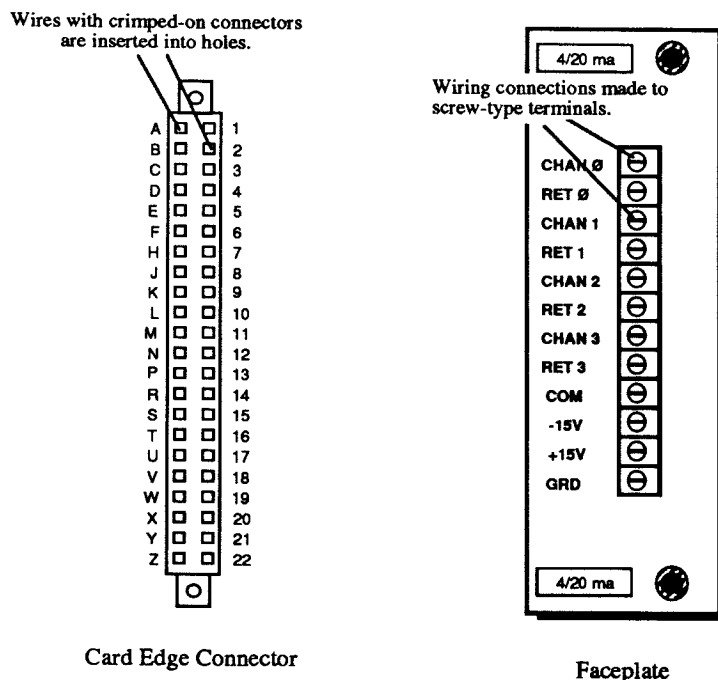


Figure 3-2 Card Edge Connector and Faceplate

3.2 HANDLING PiC MODULES

G&L Electronics makes every effort to ensure that each PiC module will provide reliable operation when used within its rated tolerances. However, the end user can follow certain practices that will avoid shortening the useful lifetime of a module. Follow the practices in this section to avoid accidentally damaging a PiC module.

IMPORTANT

It is essential that you observe the following precautions whenever handling any PiC module. Read and understand each precaution before handling any PiC Module.

1. **Ensure that power to the rack is off before inserting or removing PiC modules, edge connectors, and faceplates.** Failure to remove power may result in permanent damage to the module.
 2. Wear a grounded wrist strap whenever handling the PiC modules. PiC modules contain sensitive components that can be damaged by electrostatic discharge.
 3. Handle PiC modules by their edges. Avoid touching the etched conductors or gold edge tabs. Oil from contact with skin will cause the edge connectors to slowly accumulate dirt, which may eventually result in a bad electrical connection.
 4. When inserting a module into a rack, use only your hands to slide the module in, and exert only enough pressure to insert the rear edge into the backplane.
 5. Always use a module removal tool (available from G&L) to remove a PiC module.
 6. Do not remove a PiC module from its conductive bag until the module is ready to be inserted into the nest.
 7. When a PiC module must be laid flat and it is not in its conductive bag, lay the module on a non-conductive surface.
-

3.3 INSERTING MODULES

PiC modules are inserted into the PiC in the following way:

1. Locate the module that is to be installed and remove it from its protective package.
2. If applicable, configure the switches and/or jumpers on the module. If the module being installed is an I/O Module, refer to the I/O Module Worksheet at the end of this section for switch setting and jumper placement information.
3. Insert the module into the nest slot specified on the Module Placement Worksheet. Each module has a notch in one corner to ensure that they can only be inserted in the correct manner. Modules are inserted in the following way:
 - A. Place the top and bottom edges of the module in the guides for the desired slot. The components should be on the right side of the module.
 - B. Slide the module towards the back of the PiC until the rear edge is flush against the backplane socket.
 - C. Apply pressure against the front edge of the module until the rear edge is fully seated in the backplane socket.
4. If applicable, place the front edge connector or faceplate onto the front edge of the module.

Worksheets are provided at the end of this section to allow the final hardware placement to be documented. Documenting the hardware placement will assist in the installation, start-up, and troubleshooting of the PiC system.

3.4 MODULE PLACEMENT

Any type of PiC module, after being properly addressed, will operate in any slot in the master rack. However, the following recommendations and restrictions should be considered when deciding where to locate PiC modules:

1. Only AC input and output modules, DC input and output modules and the Scan Monitor Module may be inserted into extension racks.
2. Modules installed with the optional faceplate require an empty slot on both sides of the module.
3. Certain modules require a vacant slot to the right of the slot the module is inserted in because of the size of the components on these modules. The Instruction Sheet for each module (located in Appendix A) indicates if the module needs two slots.
4. Separate the AC, DC, and analog modules into groups within the rack(s). Insert the AC modules as far away from the PiCTurbo Processor as possible. For instance, if the PiCTurbo Processor is inserted in slot four of the upper nest, the AC modules should be inserted into the opposite side of the lower nest. If an extension rack is used, insert the AC modules into the extension rack.
5. If a Scan Monitor Module is used, insert it into the slot after the last module in the last nest, furthest from the PiCTurbo Processor.

3.5 INPUT/OUTPUT (I/O) MODULES

An I/O module is any PiC module that is addressed within the boundaries shown in the IO Addresses column in Table 3-1. I/O modules include AC and DC input and output modules and special purpose modules supported by the G&L Call Routines.

Addressing I/O Modules

Each input and output that the PiC monitors corresponds to an address. The address defines a location in PiC memory. Each I/O address is represented by a four-digit number. The first digit of the I/O address indicates the rack where the corresponding I/O module is located. The rack-indicating digit is always one greater than the actual rack number, as shown in Table 3-1.

<u>Rack Number</u>	<u>First Digit of Address</u>
1	2
2	3
3	4
↓	↓
8	9

Table 3-1 Rack/Address Relationship

The last three digits of the I/O address represent the individual addresses within each rack. Table 3-2 shows the addresses available to each rack.

<u>Rack Name</u>	<u>PiC Addresses</u>	<u>Max. I/O per Rack</u>
master rack	2000-2255	256
1st extension	3000-3255	256
2nd extension	4000-4255	256
3rd extension	5000-5255	256
4th extension	6000-6255	256
5th extension	7000-7255	256
6th extension	8000-8255	256
7th extension	9000-9255	256

Table 3-2 Rack I/O Addresses

When an address is defined, that address and following addresses equal to the number of I/O addresses occupied by the module must be reserved for use only by that module. No other module can be addressed within the defined block of addresses. For instance, if an I/O module that occupies eight addresses is addressed at 2200, that reserves addresses 2200-2207 for that module only.

Refer to the I/O module write-ups located in Appendix A to determine what starting addresses are available to each I/O module. The write-ups also describe how to set the address switches for each module to the desired starting address.

IMPORTANT

I/O modules require a block of addresses beginning with the module's starting address. An I/O module may not be addressed within the block of addresses reserved for another I/O module.

I/O Module Worksheets

The I/O Module Worksheets should be completed to ensure that the addresses assigned to each I/O module do not overlap. Some I/O modules have fixed addresses (these are not user-definable). Ensure that the addresses assigned to these I/O are also recorded in the worksheets. If your PiC system contains more than one rack, a copy of the I/O Module Worksheets should be made and filled out for each rack. Keep the the completed worksheets for future reference to facilitate module insertion and replacement, I/O module expansion, I/O device troubleshooting, etc.

The rack address (2-9) should be entered in the area provided in the top line of each I/O Module Worksheet. The rack address is the first digit of the I/O address. The rack address is represented by the "X" digit of each address in the Address column.

The I/O Module Worksheets have five columns, which should be filled in as follows:

1. Enter the name of the I/O module that is being assigned to the indicated address in the **Module Name** column.
2. The **Address** column lists 256 addresses. The last 16 addresses (X240-X255) are not available for use in the master rack (X = rack address). The starting addresses are in increments of four because four is the least number of I/O addresses that an I/O module can occupy. Remember, each I/O module can only be assigned to a starting address that is listed as being available in the I/O module's write-up in Appendix A.

3. Enter the function of the I/O module in the **Address Description** column. For example, if a particular address on an input module is wired to a plus direction overtravel limit switch, "plus overtravel limit switch" should be placed in the Address Description column adjacent to the address.

The addresses assigned to some special purpose modules may not have an external reference. The Digitizing Reference Module, for instance, occupies four I/O addresses. The functions of these addresses are internal to the PiC. Therefore, a description of the individual I/O addresses occupied by the Digitizing Reference Module would not be entered in the Address Description column.

4. Indicate the address switch settings that correspond to the starting address in the **Address Switches** column. Darken the side (ON or OFF) of the address switches to be depressed. Address switches that are not used on a particular I/O module may be ignored. Some I/O modules with fixed addresses will not have address switches.
5. Enter the setting or position of switches or jumpers found on the module in the **Miscellaneous Switches and Jumpers** column.

3.6 MODULE PLACEMENT WORKSHEET

The Module Placement Worksheet should be completed to assign a nest and slot number to all PiC modules in each rack. Complete the I/O Module Addressing Worksheet first so the address of each I/O module will be known. If your PiC system contains more than one rack, copies of the Module Placement Worksheet should be made and filled out for each rack. The completed worksheet(s) should be retained for future reference to facilitate module insertion and replacement, troubleshooting, etc. An example filled-out Module Placement Worksheet is included that shows recommended module placement.

Referring to the Module Placement Worksheet, enter the rack address (2-9) in the area provided. Rack address 2 is the master rack, rack address 3 is the first extension rack, rack address 4 is the second extension rack, etc.

If your rack has only one nest (as in a PiC49), use the upper nest area on the worksheet. The slot numbers corresponding to the upper and lower nest slots are shown between the two nests. Enter the name of the module to be inserted into each slot and the corresponding address (if applicable) in the two boxes adjacent to each slot number. Vacant rows in the nest indicate that a module should not be inserted into that slot.

When assigning a slot or slots to a module, ensure that adequate space is allotted for each module.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers	
	X000		1 2 3 4 5 6 7 8 ON OFF		
	X001				
	X002				
	X003				
	X004		1 2 3 4 5 6 7 8 ON OFF		
	X005				
	X006				
	X007				
	X008		1 2 3 4 5 6 7 8 ON OFF		
	X009				
	X010				
	X011				
	X012		1 2 3 4 5 6 7 8 ON OFF		
	X013				
	X014				
	X015				
	X016		1 2 3 4 5 6 7 8 ON OFF		
	X017				
	X018				
	X019				
	X020		1 2 3 4 5 6 7 8 ON OFF		
	X021				
	X022				
	X023				
	X024		1 2 3 4 5 6 7 8 ON OFF		
	X025				
	X026				
	X027				
	X028		1 2 3 4 5 6 7 8 ON OFF		
	X029				
	X030				
	X031				

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X032		1 2 3 4 5 6 7 8 ON OFF	
	X033			
	X034			
	X035			
	X036		1 2 3 4 5 6 7 8 ON OFF	
	X037			
	X038			
	X039			
	X040		1 2 3 4 5 6 7 8 ON OFF	
	X041			
	X042			
	X043			
	X044		1 2 3 4 5 6 7 8 ON OFF	
	X045			
	X046			
	X047			
	X048		1 2 3 4 5 6 7 8 ON OFF	
	X049			
	X050			
	X051			
	X052		1 2 3 4 5 6 7 8 ON OFF	
	X053			
	X054			
	X055			
	X056		1 2 3 4 5 6 7 8 ON OFF	
	X057			
	X058			
	X059			
	X060		1 2 3 4 5 6 7 8 ON OFF	
	X061			
	X062			
	X063			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X064		1 2 3 4 5 6 7 8 ON OFF	
	X065			
	X066			
	X067			
	X068		1 2 3 4 5 6 7 8 ON OFF	
	X069			
	X070			
	X071			
	X072		1 2 3 4 5 6 7 8 ON OFF	
	X073			
	X074			
	X075			
	X076		1 2 3 4 5 6 7 8 ON OFF	
	X077			
	X078			
	X079			
	X080		1 2 3 4 5 6 7 8 ON OFF	
	X081			
	X082			
	X083			
	X084		1 2 3 4 5 6 7 8 ON OFF	
	X085			
	X086			
	X087			
	X088		1 2 3 4 5 6 7 8 ON OFF	
	X089			
	X090			
	X091			
	X092		1 2 3 4 5 6 7 8 ON OFF	
	X093			
	X094			
	X095			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X096		1 2 3 4 5 6 7 8 ON OFF	
	X097			
	X098			
	X099			
	X100		1 2 3 4 5 6 7 8 ON OFF	
	X101			
	X102			
	X103			
	X104		1 2 3 4 5 6 7 8 ON OFF	
	X105			
	X106			
	X107			
	X108		1 2 3 4 5 6 7 8 ON OFF	
	X109			
	X110			
	X111			
	X112		1 2 3 4 5 6 7 8 ON OFF	
	X113			
	X114			
	X115			
	X116		1 2 3 4 5 6 7 8 ON OFF	
	X117			
	X118			
	X119			
	X120		1 2 3 4 5 6 7 8 ON OFF	
	X121			
	X122			
	X123			
	X124		1 2 3 4 5 6 7 8 ON OFF	
	X125			
	X126			
	X127			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X128		1 2 3 4 5 6 7 8 ON OFF	
	X129			
	X130			
	X131			
	X132		1 2 3 4 5 6 7 8 ON OFF	
	X133			
	X134			
	X135			
	X136		1 2 3 4 5 6 7 8 ON OFF	
	X137			
	X138			
	X139			
	X140		1 2 3 4 5 6 7 8 ON OFF	
	X141			
	X142			
	X143			
	X144		1 2 3 4 5 6 7 8 ON OFF	
	X145			
	X146			
	X147			
	X148		1 2 3 4 5 6 7 8 ON OFF	
	X149			
	X150			
	X151			
	X152		1 2 3 4 5 6 7 8 ON OFF	
	X153			
	X154			
	X155			
	X156		1 2 3 4 5 6 7 8 ON OFF	
	X157			
	X158			
	X159			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X160		1 2 3 4 5 6 7 8 ON OFF	
	X161			
	X162			
	X163			
	X164		1 2 3 4 5 6 7 8 ON OFF	
	X165			
	X166			
	X167			
	X168		1 2 3 4 5 6 7 8 ON OFF	
	X169			
	X170			
	X171			
	X172		1 2 3 4 5 6 7 8 ON OFF	
	X173			
	X174			
	X175			
	X176		1 2 3 4 5 6 7 8 ON OFF	
	X177			
	X178			
	X179			
	X180		1 2 3 4 5 6 7 8 ON OFF	
	X181			
	X182			
	X183			
	X184		1 2 3 4 5 6 7 8 ON OFF	
	X185			
	X186			
	X187			
	X188		1 2 3 4 5 6 7 8 ON OFF	
	X189			
	X190			
	X191			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X192		1 2 3 4 5 6 7 8 ON OFF	
	X193			
	X194			
	X195			
	X196		1 2 3 4 5 6 7 8 ON OFF	
	X197			
	X198			
	X199			
	X200		1 2 3 4 5 6 7 8 ON OFF	
	X201			
	X202			
	X203			
	X204		1 2 3 4 5 6 7 8 ON OFF	
	X205			
	X206			
	X207			
	X208		1 2 3 4 5 6 7 8 ON OFF	
	X209			
	X210			
	X211			
	X212		1 2 3 4 5 6 7 8 ON OFF	
	X213			
	X214			
	X215			
	X216		1 2 3 4 5 6 7 8 ON OFF	
	X217			
	X218			
	X219			
	X220		1 2 3 4 5 6 7 8 ON OFF	
	X221			
	X222			
	X223			

*Darken side of switch (ON or OFF) to be depressed.

I/O Module Addressing Worksheet - Rack Address (2-9) : _____

Module Name	Address	Address Description	Address Switches*	Misc. Switches & Jumpers
	X224		1 2 3 4 5 6 7 8 ON OFF	
	X225			
	X226			
	X227			
	X228		1 2 3 4 5 6 7 8 ON OFF	
	X229			
	X230			
	X231			
	X232		1 2 3 4 5 6 7 8 ON OFF	
	X233			
	X234			
	X235			
	X236		1 2 3 4 5 6 7 8 ON OFF	
	X237			
	X238			
	X239			
	X240		1 2 3 4 5 6 7 8 ON OFF	
	X241			
	X242			
	X243			
	X244		1 2 3 4 5 6 7 8 ON OFF	
	X245			
	X246			
	X247			
	X248		1 2 3 4 5 6 7 8 ON OFF	
	X249			
	X250			
	X251			
	X252		1 2 3 4 5 6 7 8 ON OFF	
	X253			
	X254			
	X255			

*Darken side of switch (ON or OFF) to be depressed. _____

Lower Nest

Upper Nest

Module Name	Address	Slot Number	Module Name	Address
		1	PiCTurbo Processor	
RS-232C*	#2236	2	PiCTurbo Processor	
		3	PiCTurbo Processor	
		4		
		5		
		6		
		7		
		8		
		9	D/A Converter	#2212
		10		
		11		
		12	Digitizing Reference*	#2176
		13		
		14		
		15	μProc. Digitizing*	#2180
DC Input	#2000	16		
DC Input	#2016	17		
DC Output	#2008	18	μProc. Digitizing*	#2184
DC Output	#2024	19		
AC Input	#2032	20		
AC Input	#2040	21	μProc. Digitizing*	#2188
AC Output	#2048	22		
AC Output	#2056	23	Video Memory	#2232
		24		
Scan Monitor		25	Video Interface	#2228

*Requires three slots if a faceplate is used.

Example Filled-Out Module Placement Worksheet

Lower Nest**Upper Nest**

Module Name	Address	Slot Number	Module Name	Address
		1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		
		13		
		14		
		15		
		16		
		17		
		18		
		19		
		20		
		21		
		22		
		23		
		24		
		25		

Module Placement Worksheet

SECTION 4 - PiCTURBO PROCESSOR

4.1 INTRODUCTION

This section introduces the PiCTurbo Processor and discusses the hardware functions and user-serviceable parts of the PiCTurbo. Each of the LEDs, switches and sockets on the PiCTurbo Processor are explained, as well as battery removal and installation and the adjustment of the power supply voltages.

The PiCTurbo Processor

The PiCTurbo consists of two printed circuit boards (containing related hardware and firmware) and a faceplate. One of the printed circuit boards has a rear-edge connector that inserts into the backplane of the PiC. The module is constructed as a single unit. The only part of the PiCTurbo Processor that is user-serviceable is the on-board battery.

NOTE

The faceplate on the PiCTurbo Processor is an integral part of the module. Do not attempt to remove the PiCTurbo faceplate under any circumstances.

Prior to the development of the PiCTurbo Processor, eight separate modules were required to perform the functions provided by the PiCTurbo Processor alone. The following modules are replaced by a single PiCTurbo Processor:

1. CPU Module
2. Programmer's Console Module
3. PC Support Module
4. Compiler Module
5. Call Routines on EPROM Module (when purchased as an option)
6. FPA Module

7. RS-232 Module

8. Up to four banks of 36/40K CMOS memory.

In addition, the PiC control panel that was an integral part of previous PiC controls is no longer present.

The PiCTurbo Processor simplifies system setup because it doesn't require the user to set any address switches or jumpers. It provides more room for modules in the main rack, since it only occupies three slots, and it provides a faster processing time, which means a significant reduction in scan time. It also provides increased reliability, since the number of parts that could fail has been reduced considerably.

The PiCTurbo Processor requires three slots in the PiC rack (using slots 1-3 is recommended). If the next module to be inserted into the rack does not have a faceplate, that module may be inserted into the next slot (slot 4). If the next module does have a faceplate, that module would need to be inserted into slot 5.

4.2 PiCTURBO PROCESSOR HARDWARE

The PiCTurbo Processor contains a number of components that provide information about the condition of the control system and also provide the user with the capability to initiate certain functions. Please refer to Figure 4-1 for the location of the components described in this section.

Voltage Monitor LEDs

The three sets of amber LEDs (uppermost on the faceplate) are Voltage Monitor LEDs. The PiC power supply provides three voltages: -15V DC, +15V DC, and +5V DC. Each voltage has two LEDs on the PiCTurbo Processor, one to indicate an over-voltage condition and one to indicate an under-voltage condition. When a Voltage Monitor LED illuminates, it means that the

corresponding voltage is more than 5% out of tolerance.

If one of the Voltage Monitor LEDs illuminates, adjust the appropriate voltage as explained in Section 4.5.

Status LEDs

The set of red LEDs are the Status LEDs. Status LED 1 illuminates to indicate a hardware failure on the PiCTurbo Processor. Status LED 2 illuminates to indicate a checksum error (which means there is a problem with the user LDN).

If Status LED 1 illuminates (other than during start-up diagnostics, explained in Section 4.3), remove the PiCTurbo Processor and put in a replacement PiCTurbo. Call the G&L factory for instructions on what your options are for repair or replacement. These will vary according to whether or not the module is still under warranty.

If Status LED 2 illuminates, reload your LDN. If that doesn't extinguish Status LED 2, examine your LDN to make certain it was properly programmed.

Power LED

The green Power LED illuminates to indicate that the +5V DC and the $\pm 15V$ DC from the power supply are present and within tolerance. If the PiC is not receiving power, or if one of the power supply voltages is out of tolerance, the Power LED extinguishes.

Scan LED

The green Scan LED illuminates to indicate that the LDN is being scanned. The Scan LED only illuminates when the PiC is in the Run Mode, since that is the only time the LDN is scanned. If the LED is not illuminated, it means that the LDN is either not being scanned, or that the scan time exceeds 100 milliseconds. If the PiC is in the Run Mode and the Scan LED is not illuminated, it indicates that a programming error or hardware failure is preventing the PiC from completing its scan of the LDN.

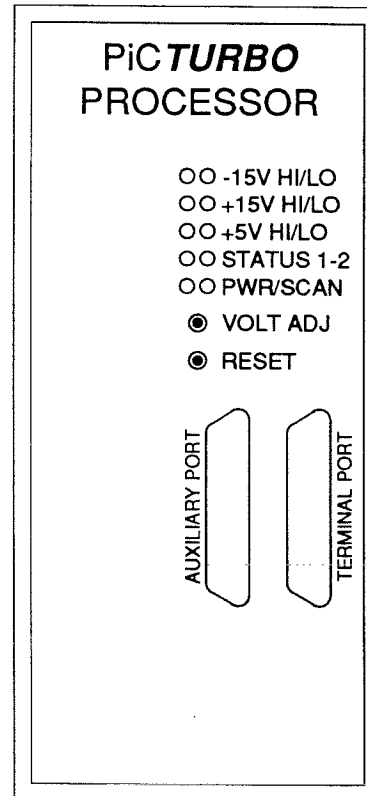


Figure 4-1 PiCTurbo Processor Faceplate

Voltage Adjust Push Button

The Voltage Adjust push button narrows the tolerance for the three voltages from the power supply to $\pm 1.0\%$. This allows the voltages to be precisely adjusted. The use of the Voltage Adjust push button is explained further in Section 4.5.

Reset Push Button

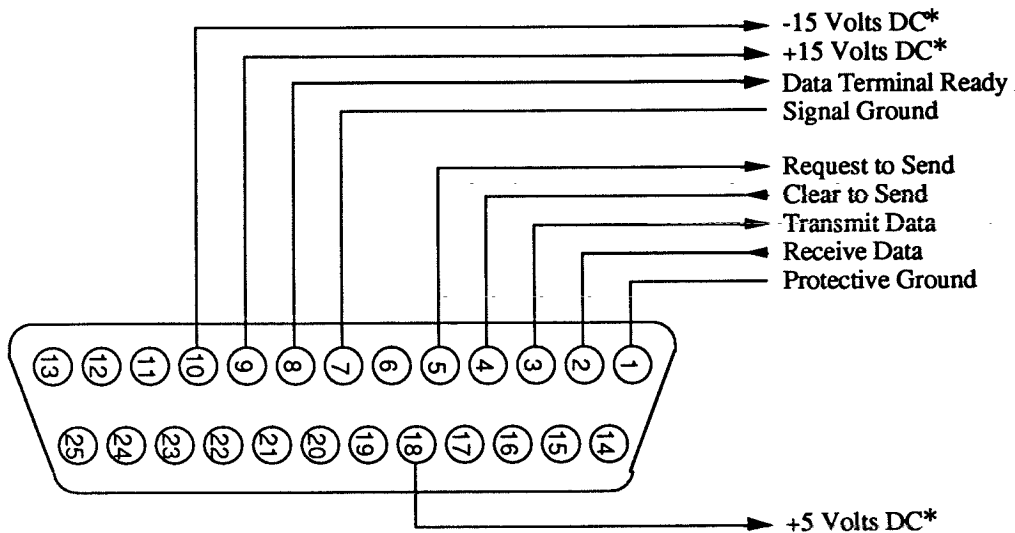
Pressing the Reset push button has the same effect as removing and then reapplying power to the PiC. Whatever mode is currently active is aborted and the PiC goes through its power-up sequence. Start-up diagnostics are carried out by the PiCTurbo and the PiC menus start at the level where the user authorization code is requested (providing an auto-start LDN isn't in user memory). A reset is automatically initiated by an out of tolerance power supply.

IMPORTANT

The Reset push button should never be pressed while the PiC is controlling a machine or process. Injury to personnel and/or damage to machinery may result if this is done. The correct method for exiting the Run mode when the PiC is carrying out its control function is explained in Section 6.3 of this manual.

Terminal Port

The Terminal Port allows the user to connect a personal computer to the PiC. Figure 4-2 shows the pin functions on the Terminal Port socket.



with
cable
Jim H
had to
jumper
4-8

* These power connections are provided for interface to communication devices only (e.g. PiC programming pendant, RS232 to RS422 converters, etc.). Do not use these connections for machine interfaces such as I/O modules, encoders, etc.

Figure 4-2 Terminal and Auxiliary Socket Pin-Out Diagram

Auxiliary Port

The Auxiliary Port allows the user to connect an auxiliary interface device to the PiC, such as a Fluke Touch Control Screen or a Termiflex Hand-Held Programming Pendant. Figure 4-2 shows the functions of the pins on the Auxiliary Port socket.

With the Fluke Touch Control Screen, the user can fabricate a cable following the pinout shown below.

Touch Screen	PiCTurbo
25-Pin Female Connector	Auxiliary Port
25-Pin Male Connector	25-Pin Male Connector
2..... to.....	2
3..... to.....	3
19..... to.....	4
5..... to.....	5
7..... to.....	7

4.3 START-UP DIAGNOSTICS

When power is applied to the PiCTurbo Processor, or when a reset is initiated, the PiCTurbo carries out a series of internal diagnostic tests on the module-mounted hardware. The sequence LED indications is as follows:

1. The green Power LED illuminates when power is applied (or a reset initiated).
2. The Power LED extinguishes and red Status LED 1 illuminates while a series of hardware tests are carried out.
3. Status LED 1 extinguishes and the Power LED illuminates and remains illuminated. If user memory does not contain an auto-start LDN, the PiCTurbo Processor is now ready for use.

If Status LED 1 remains illuminated after approximately ten seconds, the PiCTurbo Processor has suffered a hardware failure. Remove the PiCTurbo Processor and put in a replacement PiCTurbo. Call the G&L factory for instructions on what your options are for repair or replacement.

4. If an auto-start LDN is in user memory, Status LED 2 will flash for approximately ten seconds before LDN scanning begins.

4.4 BATTERY REMOVAL AND INSTALLATION

Mounted in a holder on the PiCTurbo Processor is a Panasonic® Lithium BR-2/3 3V battery, or equivalent (G&L part no. 401-52446-00). This battery protects against the loss of data stored in user memory RAM should the PiC lose power. A capacitor on the PiCTurbo Processor continues providing memory back-up protection even while the battery is absent. You have safely thirty minutes in which to replace the battery.

The battery should last approximately ten years with the PiCTurbo base unit and four years with the memory expansion option, but it is a good idea to test it periodically to make certain is supplying the required voltage. To test the battery, follow the procedure in Section 7.7.

IMPORTANT

Make certain you have read and understand the instructions for handling PiC modules in Section 3 before removing the PiCTurbo Processor. These instructions must be followed to ensure that you do not accidentally damage the module.

Battery Removal

1. Remove power from the PiC.
2. Remove any cables connected to the PiCTurbo Processor faceplate sockets and remove the PiCTurbo from the PiC rack.
3. Lay the PiCTurbo Processor down on a non-conductive surface so that the battery is facing up (see Figure 4-3)
4. Insert a non-conductive blade where indicated and gently pry the battery out.

Battery Installation

1. Look at the signs (+ and -) molded into the battery holder for an indication of how the battery must be oriented. Position the battery properly above its holder.
2. Gently press the battery into its holder.
3. Following the precautions outlined in Section 3, replace the PiCTurbo Processor in its position in the main rack.
4. Replace any cables that were connected to the PiCTurbo faceplate sockets.
5. Apply power to the PiC.

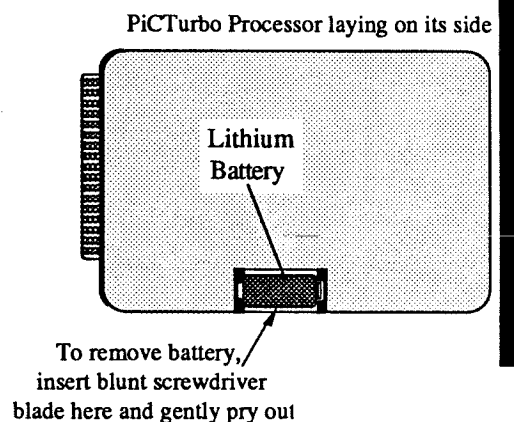


Figure 4-3 PiCTurbo Processor Battery Location

4.5 ADJUSTING POWER SUPPLY VOLTAGES

When any of the three power supply voltages exceeds a $\pm 5\%$ tolerance, the related Voltage Monitor LED will illuminate. This indicates that the out of tolerance power supply requires adjustment.

To adjust a power supply voltage perform the following procedures:

1. Determine which of the power supply voltages is out of tolerance (refer to the explanation of the Voltage Monitor LEDs in Section 4.2 if you are unfamiliar with the LEDs).

2. Remove the other modules from the nest so that only the PiCTurbo Processor remains in the nest.

3. Access the power supply.

With a PiC409 rack, you must remove the two screws that secure the door to the power supply compartment and swing the door open. The power supply swings out with the door.

With a PiC49 rack, you must remove two thumbscrews on either side at the top of the rack. Then lift up on the front edge of the top to expose the power supply.

6. When both Voltage Monitor LEDs for the voltage being adjusted extinguish, press the Voltage Adjust push button and hold it in. If any of the LEDs illuminate, adjust the appropriate pot(s) with the Voltage Adjust push button depressed until the LED(s) extinguish.

7. Insert the other modules into the nest and check to see if the voltages are still within tolerance. If not, repeat steps 4-6.

8. Return the power supply compartment to its normal position.

With a PiC409 rack, swing the door to the power supply compartment closed and replace the screws that secure it.

With a PiC49 rack, close the top of the rack and replace the two thumbscrews that hold it in position.

CAUTION

Do not allow the screwdriver used in adjusting the power supply potentiometers to come in contact with anything but the potentiometers.

4. Using a small screwdriver with an insulated handle, slowly turn the adjustment pot(s) for the voltages(s) you wish to adjust. Refer to Appendix B for illustrations showing the locations of the power supply adjustment pots.
5. If the direction you are turning the adjustment screw does not extinguish the Voltage Monitor LED, turn the screw in the opposite direction.

SECTION 5 - SYSTEM START-UP

5.1 INTRODUCTION

This section explains the steps required to get the PiC ready to have a program loaded into it. A short section on troubleshooting is included in case the system doesn't function properly at start-up. Make certain you have read and understood the sections before this one before attempting any of the procedures in this section.

5.2 START-UP

This procedure is meant to be followed when the PiC control is first started up.

Preliminaries

The start-up procedures assume a basic knowledge of GLLADD software. If you need more information on GLLADD, please refer to the GLLADD manual.

The following items are required to carry out the start-up procedure:

1. PiC with power connected to it.
2. The PiCTurbo Processor and all other modules that are to be used in your control system.
3. Faceplates or card edge connectors for all modules requiring them.
4. An IBM or IBM-compatible personal computer.
5. A copy of G&L's GLLADD software.
6. A GLLADD cable. This can be purchased from G&L, or user-fabricated as shown in Appendix B of the GLLADD Manual. It must be sufficiently long to extend from the PiC to the personal computer being used.

IMPORTANT

Section 3 contains detailed instructions on how to handle and insert PiC modules. Read and follow those instructions before inserting any PiC modules.

NOTE

Prior to following the procedures in this section, the PiC rack must be configured, wired, and mounted as explained in Section 2.

Initial Start-Up Procedure

If at any time your PiC system does not appear to be functioning as it was designed to, please refer to Section 5.3, *Troubleshooting* for assistance.

1. Make certain that power to the PiC is OFF. Do not apply power to the PiC until directed to do so.
2. Remove the PiCTurbo Processor from its protective wrap and insert the module into slots one and two in the upper nest of your rack.
2. Apply power to the PiC. The PiCTurbo Processor will carry out its start-up diagnostics as explained in Section 4.3.
3. If any of the amber Voltage Monitor LEDs are illuminated, refer to Section 4.5 and adjust the power supplies. If everything is functioning properly, only the green Power LED will be illuminated at this point after the approximately ten seconds that the start-up diagnostics requires.
4. Remove power from the PiC.
5. Select the next module to be installed and remove it from its protective package. Set the switches and/or jumpers as indicated on

the I/O Module Worksheet. Consult the Module Placement Worksheet and insert the module into the nest in the indicated slot.

6. If applicable, make wiring connections to the faceplate or edge connector and install it onto the module. Wiring diagrams for each module are included in the write-up for the module in Appendix A.
7. Repeat Steps 5 and 6 for each module that is to be inserted into the PiC.
8. Apply power to the PiC.
9. Re-adjust the power supplies, if necessary.

NOTE

The PiC has a default baud rate of 9600 baud for communications between the PiC and the personal computer. Therefore, in order to establish communications with the PiC upon initial power up, you must set your personal computer to communicate at 9600 baud.

-
10. Connect the GLLADD cable from serial communications port 1 of the personal computer to the Terminal Port on the PiCTurbo Processor faceplate.
 11. Bring up the GLLADD main menu.
 12. Press function key F5. Information will be displayed under the line "PiC Remote Control Mode". This information applies to PiCs that do not use a PiCTurbo Processor. Disregard the information and press any key. The following will be displayed:

PLEASE ENTER THE SYSTEM'S DEFAULT
AUTHORIZATION CODE

13. Press the space bar. This is the factory-programmed default authorization code. The following will be displayed:

TO DEFINE YOUR AUTHORIZATION CODE,
ENTER 1-9 CHARACTERS
FOLLOWED BY A CARRIAGE RETURN.
REMEMBER, THE CODE IS NOT
SHOWN ON THE SCREEN, EACH TIME A
CHARACTER IS ACCEPTED
A "*" IS DISPLAYED

IMPORTANT

Keep a copy of your user authorization code in a safe place. If you forget the code and haven't kept a copy somewhere, you can remove the battery from the PiC to clear your code from memory, but this will destroy all battery-backed data in memory, including LDN data. For instructions on how to remove the PiC battery, see Section 4.4.

-
14. Enter a suitable code from one to nine characters long and press Return. The code can contain any combination of letters, numbers or spaces.

When you enter each character of your code, an asterisk will be displayed to acknowledge your entry without revealing the code on screen.

When you press the carriage return key, the PiC will store your authorization code in battery-backed RAM and display the Aux 1 Mode. In the future, no one will be able to gain access to the Aux 1 Menu without entering the defined user authorization code. If the authorization requirement is disabled during a work session, the PiC will restore the requirement upon power up.

The Aux 1 menu is shown in Figure 5.1.

ACTIVE BANK 1
WRITE PROTECTION: BANK 1 OFF: BANK 2 OFF: BANK 3 OFF: BANK 4 OFF:
MOTION COPROCESSOR RESIDENT

PiCTURBO AUX. 1 MODE SELECT MENU VER. 1.0

1. RUN LDN.
2. PROGRAM LDN.
3. LOAD INTO PIC MEMORY.
4. VERIFY PIC MEMORY.
5. RECORD FROM PIC MEMORY.
6. AUX TWO.
7. AUX THREE.
8. CHANGE AUTHORIZATION.

TO MAKE YOUR SELECTION, ENTER THE NUMBER
AND CARRIAGE RETURN. TO RETURN TO THE AUX 1 MENU FROM ANY
MODE ENTER "CONTROL Q".

CHOICE?

Figure 5.1 Aux 1 Menu

At this point you are ready to load a program into user memory and place the PiC into the Run Mode. These functions, and the other functions available through the Aux 1 menu, are explained in Section 6. Please refer to that section and carry out the function(s) that you want to perform at this time.

5.3 TROUBLESHOOTING

This section explains basic troubleshooting procedures. If at any time your PiC does not operate correctly, refer to this section and follow the applicable troubleshooting suggestions.

Power Supply

1. No AC Power

Check customer disconnect. Check AC at power supply screw terminals. Check rack circuit breakers.

2. No DC Power

Check for loose connections in power supply wiring. Determine if power supply is providing DC power. Replace power supply if defective.

3. Power Supply checks OK, LEDs on PiCTurbo Processor inactive.

Check if power supply is properly seated. Check wiring to backplane terminal strip.

4. One or more Voltage Monitor LEDs on.

Adjust power supply as explained in Section 4.4 until LEDs are out. Upgrade to larger power supply if necessary, or reduce load. Replace power supply if defective.

PiCTurbo Processor

Refer to Section 4.

Peripheral Devices

1. Cannot load program into PiC memory from disk.

Check baud rate settings. Check GLLADD cable.



SECTION 6 - USER FUNCTIONS

6.1 INTRODUCTION

This section explains the functions that can be carried out once the Aux 1 menu is displayed. Functions that pertain exclusively to programming an LDN are covered in the Programming Manual. The Diagnostics procedures are covered in a separate section (Section 7) due to the length of the procedures involved.

NOTE

Getting a printout of the LDN is a GLLADD function. To print the LDN, refer to Section 5 of the GLLADD Manual, *Listing a Documented LDN*.

6.2 DISPLAYING THE AUX 1 MENU

There are two basic methods to display the Aux 1 menu. The first method is for those who are familiar with the various PiC menus and are already using them. The second method is for those who are displaying the Aux 1 menu from the GLLADD level and are unfamiliar with the process.

Method One

If you are already using the various menus, you can display the Aux 1 menu from another menu by pressing "CTRL-Q".

Method Two

1. Ensure that the GLLADD cable is connected from serial communications port 1 on the personal computer to the Terminal socket on the PiCTurbo Processor faceplate.
2. Bring up the GLLADD main menu (it has the heading "G&L PiC Ladder Development System). Refer to the GLLADD manual if you are unfamiliar with GLLADD.
3. Press function key F5. Information will be

displayed under the line "PiC Remote Control Mode". This information applies to PiCs that do not use a PiCTurbo Processor. Disregard the information and press any key.

4. Answer the prompts regarding the user authorization code entry. The G&L-defined user authorization code is a space bar entry (press the space bar). If the user authorization code has been redefined, consult the appropriate personnel at your facility to determine what the code is. When the code is correctly entered, the Aux 1 menu will be displayed.

6.3 THE RUN MODE

When the Run mode is entered, the LDN will assume control of the system the PiC is connected to. This section explains how to enter the Run mode and how to safely exit the Run mode once you are in it.

Entering the Run Mode

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

1. Enter a "1" and press Return. The PiC will display the following message:

PLEASE CONFIRM YOUR CHOICE TO ENTER
THE RUN MODE BY ENTERING A 1.

If you've changed your mind, press any key except the "1" key.

2. To enter the Run mode, enter a "1" and press Return. If an LDN has been properly entered and saved in PiC memory, the PiC will enter the Run mode.

RTD is a Call Routine that is included on every PiCTurbo (see Section 6 of the Programmer's Manual). If RTD is not included in the LDN, the screen does not display anything indicating that the PiC has entered the Run mode.

If RTD is included in the LDN, the LDN will be displayed.

If a valid LDN does not reside in user memory, the following message will be displayed:

INVALID LADDER DIAGRAM. CHECK FOR:
1. LDN CHECKSUM ERROR.
2. CALLS REQUIRED BY LADDER NOT FOUND.
3. CALL CHECKSUM ERROR.
ENTER ANY KEY TO RECALL MENU.

If this is displayed, do the following:

1. Determine if an LDN checksum exists by entering the Program mode. If an LDN checksum exists, a message stating that will be displayed near the ">>..." prompt. 2. If there is no LDN checksum, reinstall the Call Routines. During the reinstallation process, a message will be displayed pertaining to a Call Routine checksum error if one existed. After taking the corrective action, enter the Run mode.

Exiting the Run Mode

The following procedures begin with the PiC in the Run mode. There are actually four possibilities for exiting the Run mode, explained below.

CAUTION

Before exiting the Run mode, ensure that the PiC-controlled process or machine is at a point in its operation when control can be safely removed. Injury to personnel and damage to machinery may result if this is not done.

If the PiC is not controlling a process or machine, press the Reset push button on the PiCTurbo Processor faceplate.

If RTD is active, simultaneously press "CTRL" and "Q" on the keyboard.

If RTD is not active and the LDN is not configured to auto-start, remove power at a central power switch (cutting off power from both the controlled machine and the PiC), and then reapply power.

If RTD is not active and the LDN is configured to auto-start, remove power at a central power switch (cutting off power from both the controlled machine and the PiC), reapply power, and while Status LED 2 on the PiCTurbo Processor is flashing, simultaneously press "CTRL" and "Q" on the keyboard. Status LED 2 will flash for approximately ten seconds when power is reapplied. During this time the auto-start LDN is not active.

IMPORTANT

You cannot re-enter the Aux 1 mode from the Run mode by pressing CTRL-Q unless Real Time Debug (RTD) has been installed and is working in the LDN being run. If these conditions are not met, power must be removed from and then reapplied to the PiC and one of the start-up procedures must be followed to enter Aux 1.

To avoid this inconvenience, always include RTD in every LDN you use.

The alternative is to press the Reset button on the PiCTurbo Processor faceplate, but that should only be performed if the PiC is not controlling a machine or process. Otherwise injury to personnel and/or damage to machinery may result.

6.4 RECORDING FROM PIC MEMORY ONTO DISK

This procedure allows you to record an LDN from user memory in the PiC onto a computer diskette. Recording data files such as the I/O Module Address table, non-volatile variables, and retentive relays is explained in Section 6.11. The following procedure requires the Aux 1 menu to be displayed. Displaying the Aux 1 menu is explained in Section 6.2.

This procedure assumes that drive B of the personal computer has been defined as the working drive. If this is not the case, substitute your working drive where drive B is specified.

1. With the GLLADD disk in drive A, insert a formatted disk into drive B to receive the recorded LDN or data file.
2. With the Aux 1 menu displayed, enter a "5" and press Return to select the Record function. The following message will be displayed:

Enter the filename (<F9> for help, <Alt><F10> to abort):

3. Enter the name you wish the LDN to be stored under and press Return. The following will be displayed:

Please indicate whether this is a Ladder, or Data file (L/D)?

4. Enter an "L" for LDN. The data file option is not active in this menu.

The LDN will be recorded onto the disk in drive B. If the operation was a success, the following will be displayed:

RECORD OPERATION STATUS: GOOD
ENTER ANY KEY TO RECALL MENU.

6.5 VERIFYING A LOAD/RECORD OPERATION

This procedure makes a byte-for-byte comparison between a specified LDN or data file on disk and an LDN or data file that is in PiC memory. Data files include the I/O Module Address table, non-volatile variables, and retentive relays. The following procedure requires the Aux 1 menu to be displayed. Displaying the Aux 1 menu is explained in Section 6.2.

This procedure assumes that drive B of the personal computer has been defined as the working drive. If this is not the case, substitute your working drive where drive B is specified.

1. With the GLLADD disk in drive A, insert the disk that contains the LDN or data file that is being verified into drive B.

2. With the Aux 1 menu displayed, enter a "4" and press Return to select the Verify function. The following message will be displayed:

Enter the filename (<F9> for help, <Alt><F10> to abort):

3. Enter the name of the file on the disk in drive B that you wish to verify and press Return. The following will be displayed:

Please indicate whether this is a Ladder, Call or Data file (L,C,D)?

4. Enter an "L" if an LDN is being verified, or enter a "D" if a data file is being verified. The Call option is not active in this menu.
The specified LDN or data file will be verified with the contents of user memory. If the operation was a success, the following will be displayed:

VERIFY OPERATION STATUS: GOOD
ENTER ANY KEY TO RECALL MENU.

6.6 LOADING INTO PiC MEMORY

This procedure allows you to load a specified LDN or data file from disk into PiC memory. Data files include the I/O Module Address table, non-volatile variables, and retentive relays.

NOTE

If the contents of non-volatile variables or status of retentive control relays is being loaded, make certain that the PiC has been configured via the Runtime initialization process to allow for at least the same number of non-volatile variables and retentive relays. Otherwise, the data will be lost again when power to the PiC is removed.

The following procedure requires the Aux 1 menu to be displayed. Displaying the Aux 1 menu is explained in Section 6.2.

This procedure assumes that drive B of the

personal computer has been defined as the working drive. If this is not the case, substitute your working drive where drive B is specified.

1. With the GLLADD disk in drive A, insert the disk that contains the LDN or data file that is being loaded into drive B.
2. With the Aux 1 menu displayed, enter a "3" and press Return to select the Load function. The following message will be displayed:

Enter the filename (<F9> for help, <Alt><F10> to abort):

3. Enter the name of the file on the disk in drive B that you wish to load into PiC memory and press Return. The following will be displayed:

Please indicate whether this is a Ladder, Call or Data file (L,C,D)?

4. Enter an "L" if an LDN is being loaded, or enter a "D" if a data file is being loaded. The Call option is not active in this menu.

The specified LDN or data file will be loaded into user memory. If the operation was a success, the following will be displayed:

LOAD OPERATION STATUS: GOOD
ENTER ANY KEY TO RECALL MENU.

6.7 MODIFYING THE USER AUTHORIZATION CODE

As a security measure, a user authorization code (password) is required before the Aux 1 menu can be displayed. To enter the factory-installed user authorization code, simply press the space bar entry. The authorization code is redefined by the user during the initial start-up procedure, as explained in Section 5.

After a user authorization code is defined, it can be modified from the Aux 1 menu in three ways. It can be redefined, or it can be disabled, or it can be enabled. The ability to disable the requirement for the authorization code is provided for the user's convenience. It allows the various functions to be worked on without the frequent need to enter the password.

If you disable the user authorization code requirement and forget to enable it again, the

requirement will automatically be reenabled when the PiC is powered up next.

Redefining the User Authorization Code

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

1. With the Aux 1 menu displayed, enter an "8" to select the Change Authorization option and press Return. The PiC will prompt you to enter the current user authorization code. After this is done, the following menu is displayed:

1. CHANGE THE AUTHORIZATION CODE.
2. CODE NOT REQUIRED FOR ENTRY TO THE AUX1 MENU,
3. CODE REQUIRED FOR ENTRY TO THE AUX1 MENU.

TO MAKE YOUR SELECTION, ENTER THE NUMBER AND CARRIAGE RETURN.

CHOICE?

2. Select Item 1 by entering a "1" and pressing Return. The PiC will display the following message:

PLEASE CONFIRM YOUR CHOICE TO CHANGE THE AUTHORIZATION CODE BY ENTERING A 1.

3. If you've changed your mind, press any key except the "1" key. To proceed with changing the authorization code, press "1" key and Return. The PiC will display the following message:

TO DEFINE YOUR AUTHORIZATION CODE, ENTER 1-9 CHARACTERS FOLLOWED BY A CARRIAGE RETURN. REMEMBER, THE CODE IS NOT SHOWN ON THE SCREEN, EACH TIME A CHARACTER IS ACCEPTED A "*" IS DISPLAYED.

4. Enter the desired user authorization code and press Return. The code can contain any combination of letters, numbers or spaces.

When you enter each character of your code, an asterisk will be displayed to acknowledge

your entry without revealing the code on screen.

When you press the Return key, the PiC will store your authorization code in battery-backed RAM and display the following message:

THE NEW CODE HAS BEEN ACCEPTED.
ENTER ANY KEY TO RETURN TO THE AUX1 MENU.

5. Press any key. The PiC will prompt you to enter your user authorization code. After you do this, the Aux 1 Menu will be displayed.

Unless the authorization code requirement is disabled, no will be able to gain access to the PiC Aux 1 Menu without entering the defined code.

Disabling the Authorization Requirement

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

1. With the Aux 1 menu displayed, enter an "8" to select the Change Authorization option and press Return. The PiC will prompt you to enter the current user authorization code. After this is done, the following menu is displayed:

1. CHANGE THE AUTHORIZATION CODE.
2. CODE NOT REQUIRED FOR ENTRY TO THE AUX1 MENU,
3. CODE REQUIRED FOR ENTRY TO THE AUX1 MENU.

TO MAKE YOUR SELECTION, ENTER THE NUMBER AND CARRIAGE RETURN.

CHOICE?

2. Select Item 2 by entering a "2" and pressing Return. The PiC will display the following message:

PLEASE CONFIRM YOUR CHOICE TO PERMIT ENTRY TO THE AUX 1 MENU SELECT WITHOUT AN AUTHORIZATION CODE BY ENTERING A 2.

3. If you've changed your mind, press any key except the "2" key. To proceed with changing the authorization code, press "2" key and Return. The PiC will display the following message:

AN AUTHORIZATION CODE IS NOT REQUIRED TO ENTER THE AUX1 MENU. THIS IS ACTIVE UNTIL A POWER DOWN. ENTER ANY KEY TO RETURN.

Enabling the Authorization Requirement

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

1. With the Aux 1 menu displayed, enter an "8" to select the Change Authorization option and press Return. The PiC will prompt you to enter the current user authorization code. After this is done, the following menu is displayed:

1. CHANGE THE AUTHORIZATION CODE.
2. CODE NOT REQUIRED FOR ENTRY TO THE AUX1 MENU,
3. CODE REQUIRED FOR ENTRY TO THE AUX1 MENU.

TO MAKE YOUR SELECTION, ENTER THE NUMBER AND CARRIAGE RETURN.

CHOICE?

2. Select Item 3 by entering a "3" and pressing Return. The PiC will display the following message:

PLEASE CONFIRM YOUR CHOICE TO REQUIRE AN AUTHORIZATION CODE BY ENTERING A 3.

3. If you've changed your mind, press any key except the "3" key. To proceed with changing the authorization code, press the "3" key and Return. The PiC will display the following message:

AN AUTHORIZATION CODE IS REQUIRED TO ENTER THE AUX1 MENU. THIS IS ACTIVE UNTIL A POWER DOWN. ENTER ANY KEY TO RETURN.

To enable the PiC authorization requirement, select Item 8 on the Aux 1 Menu. In response, the PiC will prompt you to enter your user authorization code. After you do this, the following menu will be displayed:

1. CHANGE THE AUTHORIZATION CODE,
2. CODE NOT REQUIRED FOR ENTRY TO THE AUX1 MENU,
3. CODE REQUIRED FOR ENTRY TO THE AUX1 MENU.

TO MAKE YOUR SELECTION, ENTER THE
NUMBER
AND CARRIAGE RETURN.

CHOICE?

Select Item 3 by entering a "3", followed by a carriage return. In response, the PiC will display the following message:

PLEASE CONFIRM YOUR CHOICE TO
REQUIRE AN AUTHORIZATION CODE BY
ENTERING A 3.

If you've changed your mind, press any key except the "3" key. But to proceed with enabling the authorization requirement, press the "3" key and press Return. In response, the PiC will display the following message:

AN AUTHORIZATION CODE IS REQUIRED.
ENTER ANY KEY TO RETURN TO THE AUX1
MENU..

Press any key. The PiC will prompt you to enter your user authorization code. After you do this, the Aux 1 Menu will be displayed. Until the authorization requirement is disabled, no one will be able to gain access to the Aux 1 Menu without entering the user authorization code.

6.8 CHANGING THE TERMINAL PORT BAUD RATE

This procedure allows you to change the baud rate for the Terminal socket on the PiCTurbo Processor faceplate. The Auxiliary socket is controlled through the software package it is used with. The Terminal socket baud rate controls communications between the PiC and the personal computer in use.

Any changes you make in the Terminal socket baud rate setting will be retained in battery-backed memory. The changed setting will remain in effect until replaced by another setting or until the PiC battery is removed. If the PiC runs an LDN that includes a setting for the Terminal baud rate, that baud rate will replace the baud rate stored in battery-backed memory.

This procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

NOTE

The PiC has a default baud rate of 9600 baud for communications between the PiC and the personal computer. Therefore, in order to establish communications with the PiC upon initial power up, you must set your personal computer to communicate at 9600 baud also.

1. With the Aux 1 menu displayed, enter a "6" and press Return to display the Aux 2 menu. The PiC will display the following menu:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM
MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I\O TABLE BACK-
UP
- 6 - DIAGNOSTICS

SELECT (1-6)

2. Enter a "2" and press Return. The following will be displayed:

TERMINAL BAUD RATE AND MEMORY CONFIGURATION

1. TERMINAL BAUD RATE.
2. BANK 1 WRITE PROTECTION.
3. BANK 2 WRITE PROTECTION.
4. BANK 3 WRITE PROTECTION.
5. BANK 4 WRITE PROTECTION.

SELECT (1-5) .

3. Enter a "1" and press Return. The following will be displayed:

ENTER THE MENU NUMBER FOR THE
TERMINAL BAUD RATE

1. 300
2. 1200
3. 2400
4. 4800
5. 9600

SELECT (1-5) .

4. Enter the number corresponding to the baud rate you wish to select and press Return. The following will be displayed:

WHEN THE BAUD RATE IS CHANGED THE
PIC WILL SAVE THE SELECTED VALUE IN
BATTERY BACKED MEMORY. NOTE THE
RATE SELECTED IN THE PROGRAM MODE
INIT. WILL TAKE PRIORITY FOR AUTO
START LDN'S.

PLEASE CONFIRM THE PIC TERMINAL BAUD
RATE CHANGE
'Y' OR 'N' .

5. If you've changed your mind and don't want the baud rate selection you just made, press the "N" key. Otherwise press the "Y" key. The following will be displayed:

PLEASE CHANGE TERMINAL TO NEW BAUD
RATE. AFTER CHANGING THE BAUD RATE
OF THE TERMINAL PRESS ENTER.

6. Make certain the baud rate of the personal computer agrees with the baud rate you just selected for the PiC. When they agree, press Enter (or Return), the following message will be displayed:

COMMUNICATIONS ESTABLISHED AT NEW
BAUD RATE.

PRESS CONTROL Q TO RETURN TO AUX1
MENU.

If this message doesn't appear, check to see if the PiC and the communications device are set to the same baud rate. Since you can't reset the PiC baud rate until communications have been re-established, you'll need to change your computer's baud rate until it agrees with the PiC baud rate.

If you're no longer sure what the PiC baud rate is, try setting your computer to all of the baud rates between 300 and 9600, one after another, pressing the Return key after each setting is established. When your computer's baud rate finally matches the PiC baud rate, you'll see the message about communications being established and you'll be able to start the process over again.

6.9 CONFIGURING SYSTEM MEMORY

This procedure allows you to enable/disable write-protection on the banks of PiC memory. When write-protection is enabled, that bank cannot have new data enter into it. If you attempt to add to an LDN in a write-protected bank, you will receive an error message. You can tell if a bank is write-protected by checking the Aux 1 menu. At the top there is a line that begins "WRITE PROTECTION:". The write-protection (on or off) for each bank is indicated.

Any changes you make in the write protection selections are retained in battery backed memory. A selection remains in effect until replaced by another selection or until the PiC battery is removed. The procedure in this selection is analogous to setting a switch on the PiCTurbo Processor. The write protection applies to the PiCTurbo. It does not become part of the LDN. If the PiC runs an LDN that includes a write protection selection that differs from that currently selected for the PiCTurbo, the LDN write protection overrides that defined for the PiCTurbo Processor.

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

1. With the Aux 1 menu displayed, enter a "6" and press Return to display the Aux 2 menu. The PiC will display the following menu:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I/O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

2. Enter a "2" and press Return. The following will be displayed:

TERMINAL BAUD RATE AND MEMORY CONFIGURATION

- 1. TERMINAL BAUD RATE.
- 2. BANK 1 WRITE PROTECTION.
- 3. BANK 2 WRITE PROTECTION.
- 4. BANK 3 WRITE PROTECTION.
- 5. BANK 4 WRITE PROTECTION.

SELECT (1-5) .

3. Enter the number (2-5) of the bank you wish to write-protect and press Return. The following will be displayed:

WRITE PROTECT BANK X (Y OR N) .

"X" will be the number of the bank being write-protected.

4. Press "Y" if you wish to enable the write-protection for the indicated bank. Press "N" if you wish to disable it. The display will scroll to allow you to write-protect another bank. When you wish to return to the Aux 1 menu, press Control-Q.

6.10 BANK SELECT

This procedure allows you to select which bank of memory will be active. The bank of memory that is currently active is indicated in the first line of the Aux 1 menu. This procedure only applies to PiCTurbo Processors that include the multiple bank feature. Once a bank is activated, you can do all the normal LDN-related procedures, such as entering or loading an LDN, recording it, editing it, etc.

1. With the Aux 1 menu displayed, enter a "6" and press Return to display the Aux 2 menu. The following will be displayed:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION.
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR, OR I/O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

2. With the Aux 2 menu displayed, Enter a "4" and press Return to select Bank Select. The following information will be displayed:

ENTER THE NUMBER, FROM 1-4, OF THE BANK YOU WANT TO ACTIVATE.

3. Type in the number of the bank you wish to activate. The following information will be displayed:

BANK X IS NOW ACTIVE. ENTER CNTRL Q TO RETURN TO AUX1 MENU.

"X" designates the bank number selected. That bank will remain active until another bank is selected or until the Run mode is entered. The Run mode defaults to Bank 1.

When the Run mode is exited you will be in whatever bank is currently active as determined by how bank selection is set up in the LDN.

6.11 VARIABLE, CONTROL RELAY, OR I/O TABLE BACK-UP

This procedure allows the status of retentive control relays and non-volatile variables to be backed up onto computer disk. It also allows the I/O Table (explained in Section 7) to be backed up on disk.

When an LDN is recorded onto disk the status of retentive control relays and the contents of non-volatile variables are not recorded. Their existence is recorded, but not the specific status and contents. In order to obtain a permanent record of this data, it must be backed up using the procedure in this section.

The following procedure begins with the Aux 1 menu displayed. Displaying the Aux 1 menu is explained in Section 6.2.

This procedure assumes that drive B of the personal computer has been defined as the working drive. If this is not the case, substitute your working drive where drive B is specified.

1. Insert a formatted computer disk into drive B of the personal computer connected to the PiC. The backed-up data will be recorded onto this disk.
2. With the Aux 1 menu displayed, enter a "6" and press Return to display the Aux 2 menu. The following will be displayed:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I\O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

3. Enter a "5" and press Return. The following will be displayed:

VARIABLE, CR, OR I\O TABLE BACKUP MENU

- 1 - NON-VOLATILE VARIABLE BACKUP
- 2 - NON-VOLATILE CR BACKUP
- 3 - I\O MODULE ADDRESS DETECT TABLE BACKUP

TO LOAD NON-VOLATILE VARIABLES, CR'S, OR THE I\O MODULE TABLE USE THE LOAD MODE OF AUX1.

SELECT (1-3)

4. Type in the number of the backup you wish to perform and press Return. The following will be displayed:

Enter the filename (<F9> for help, <Alt><F10> to abort):

5. Type in the name you want to store the data under and press Return. The following will be displayed:

Please indicate whether this is a Ladder, or Data file (L/D)?

6. Enter a "D". After a short pause, the following will be displayed:

VARIABLES RECORDED, AUTO VERIFY IN PROGRESS
Enter the filename (<F9> for help, <Alt><F10> to abort):

7. Enter in the filename defined in Step 4 and press Return. The following will be displayed:

Please indicate whether this is a Ladder, Call, or Data file (L,C,D)?

8. Enter a "D". After a short pause, the following will be displayed:

GOOD

CTRL Q TO EXIT.
ENTER ANY KEY TO START OVER.

9. Either continue backing up data or exit from the Backup Menu by pressing "CTRL-Q" to

return to the Aux 1 Menu.

NOTE

Before loading the data pertaining to retentive relays or non-volatile variables back into the PiC, make certain that PiC memory is set up to contain at least the same number of retentive relays or non-volatile variables. This number is defined via Runtime initialization (see Section 2 of the Programmer's Manual).

SECTION 7 - DIAGNOSTICS

7.1 INTRODUCTION

The PiC Diagnostics allow the user to perform the following functions:

1. Verify the condition of user memory.
2. Verify the condition of the area of memory dedicated to control relay data.
3. Verify the condition of the PiCTurbo Processor.
4. Determine if the I/O modules can be found at their indicated addresses.
5. Test the condition of the battery.

The PiC Diagnostics are especially helpful in locating intermittent problems, since the diagnostics can be started and allowed to run continuously. When the intermittent failure occurs, the PiC Diagnostics can assist in identifying the source of the problem.

The PiC Diagnostics are available from the Aux 2 Menu, which is accessed from the Aux 1 menu. Refer to Section 6.2 if you need help displaying the Aux 1 menu.

Required Components

To perform these procedures, you must have the following components available.

1. A functional PiC.
2. A GLLADD cable.
3. An IBM or IBM-compatible personal computer with two disk drives.
4. A copy of G&L's GLLADD software.
5. A Resistor Termination Module for each PiC that contains I/O modules that are going to undergo the I/O Module Address Detect Test. The Resistor Termination Module must be inserted into the rack before the test is carried out. Immediately after the test, the Resistor Termination Module should be removed.

7.2 DISPLAYING THE DIAGNOSTICS MENU

1. With the Aux 1 menu displayed, enter a "6" and press Return to display the Aux 2 Menu. The following will be displayed:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION.
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR, OR I/O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

2. Enter a "6" and press Return. The following will be displayed:

DIAGNOSTIC MENU

- 1 - USER MEMORY DIAGNOSTIC
- 2 - CONTROL RELAY MEMORY DIAGNOSTIC
- 3 - POWER ON DIAGNOSTICS
- 4 - EXECUTE I/O MODULE ADDRESS DETECT
- 5 - BATTERY TEST

SELECT (1-5)

At this point, refer to the part of this section that covers the diagnostics procedure you wish to follow. The diagnostics procedures are explained in the following order:

Section	Subject
7.3	User Memory Diagnostics
7.4	Control Relay Memory Diagnostics
7.5	Power-On Diagnostics
7.6	I/O Module Address Detect Test
7.7	Battery Test

Table 7.1 Diagnostics by Section

7.3 USER MEMORY DIAGNOSTIC

The User Memory Diagnostic checks the condition of user memory by writing to that area of memory and then reading it to determine if data is being recorded accurately.

WARNING

If the user memory diagnostic is interrupted by a power loss, the contents of user memory may be lost. Therefore, make certain the contents of user memory have been recorded onto computer disk before the user memory diagnostic is run.

The following procedure explains how to carry out the User Memory Diagnostic.

1. With the Diagnostic Menu displayed, enter a "1" and press Return. The following will be displayed:

```
WARNING!!! DO NOT EXECUTE THE USER
MEMORY DIAGNOSTIC UNLESS THE LADDER
IS SAVED
IF THE TEST IS STOPPED BY A POWER
LOSS OR RESET, INVALID MEMORY MAY
RESULT
ENTER THE NUMBER OF THE HIGHEST BANK
TO TEST FOR EXAMPLE, IF YOU ENTER A
4, THE TEST IS DONE ON BANKS 1, 2,
3, AND 4
```

```
SELECT (1-4)
```

2. After making certain that the LDN is saved in some form, enter the number of the highest bank to be tested and press Return. The amount of memory in each bank to be tested will be displayed. The following information will also be displayed.

```
IF THE AMOUNT OF MEMORY IN EACH BANK
IS NOT CORRECT, REPLACE THE TURBO
MODULE
```

```
IF THE AMOUNT OF MEMORY IN EACH BANK
IS CORRECT, ENTER A CARRIAGE RETURN
TO START TEST
```

3. Press Return to start the User Memory Diagnostic. The results of the diagnostic test will be displayed in relation to each bank tested.

Example display for a user memory bank that passed diagnostics:

```
BANK 1 OK
```

Example display for a user memory bank that failed diagnostics:

```
MEMORY FAILURE AT $XXXX
```

"XXXX" is a hexadecimal address (the \$ indicates that it is in hex) indicating the location of the memory failure. If a memory failure is indicated, the PiCTurbo Processor needs to be replaced.

4. Press CTRL-Q to stop the User Memory Diagnostic test and return to the Aux 1 Menu.

7.4 CONTROL RELAY MEMORY DIAGNOSTIC

The Control Relay Memory Diagnostic checks the condition of control relay memory by writing to a user-specified area of control relay memory and then reading it to determine if data is being recorded accurately. The following procedure explains how to carry out the Control Relay Memory Diagnostic.

1. With the Diagnostic Menu displayed, enter a "2" and press Return. The following will be displayed:

```
CONTROL RELAY MEMORY DIAGNOSTIC
```

```
CR0 TO CR9255
```

2. The Control Relay Memory Diagnostic will be performed and the results of the diagnostic test will be displayed.

Example display for control relay memory that passed diagnostics:

```
SINGLE BIT MEMORY OK.
```

Example display for bit memory that failed diagnostics:

SINGLE BIT MEMORY FAILURE AT \$XXXX

"XXXX" is a hexadecimal address (the \$ indicates that it is in hex) indicating the location of the control relay memory failure. If a control relay memory failure is indicated, the PiCTurbo Processor needs to be replaced.

4. Press CTRL-Q to stop the Control Relay Memory Diagnostic test and return to the Aux 1 Menu.

7.5 EXECUTING POWER-ON DIAGNOSTICS

The Power-On Diagnostics check the condition of the PiCTurbo Processor. The main advantage of the Power-On Diagnostics over the normal PiC start-up diagnostics is that these diagnostics are run continuously, providing a means of verifying an intermittent problem. The following procedure explains how to carry out the Power-On Diagnostics.

1. With the Diagnostic Menu displayed, enter a "3" and press Return. The following will be displayed:

POWER ON DIAGNOSTICS

ENTER CR TO START, ESC TO STOP

The CR in this prompt refers to a Carriage Return (the Return key). If ESC is pressed to stop the test, you must then press CTRL-Q to return to the Aux 1 Menu. A step can be saved by simply pressing CTRL-Q initially, which both stops the test and displays the Aux 1 menu.

2. Press Return. The Power-On Diagnostics will be continuously performed and the results of the diagnostic test will be displayed.

Example display for a Power-On Diagnostics Test that found no errors:

NO ERRORS FOUND IN POWER UP

DIAGNOSTICS

ESC TO EXIT THE TEST

Example display for a Power-On Diagnostics Test that found an error:

INVALID SEGMENT- BAD LABEL OR
CHECKSUM ERROR. SEGMENT = \$10
HARDWARE FAILURE.

If an error is found during the Power-On Diagnostics, the PiCTurbo Processor must be replaced.

If ESC is pressed to stop the test, you must then press CTRL-Q to return to the Aux 1 Menu. A step can be saved by pressing CTRL-Q initially, which both stops the test and displays the Aux 1 Menu. There is a slight delay between when CTRL-Q is pressed and the Aux 1 Menu is displayed.

7.6 THE I/O MODULE ADDRESS DETECT TEST

General

The I/O Module Address Test allows the user to verify that I/O modules are in the PiC at their intended memory address locations. The procedure consists of the following steps:

1. When first performing the test, the user initializes the I/O Module Table and then types in a list of the I/O modules that are present in the PiC and the address for each I/O Module.
2. When the I/O module address information has been entered into the table, the user commands the PiC to do an I/O Module Address Test.

The PiC then attempts to locate each I/O module at the address the user entered for it. If an I/O module cannot be found at the address entered for it, the PiC indicates this.

I/O Module Definition

The following PiC modules are defined as I/O modules.

1. AC or DC Output Module.
2. AC or DC Input Module.
3. TTL Module.
4. Video Interface Module.
5. Video Memory Module.
6. D/A Converter Module.
7. Data Acquisition Module.
8. RS-232 Module.
9. Encoder Module.
10. Digitizing Reference Module.
11. μ Processor Digitizing Module.
12. Step Rate Position Counter Module.
13. Programmable Timer Module.
14. FIFO Module.
15. 4 to 20 mA Output Module.
16. FPA Processor Module.

Required Hardware

A Resistor Termination Module (part number 502-02881-10) must be present in each rack that contains I/O modules to be tested. The Resistor Termination Module can be inserted into any slot in the PiC rack. This module should be removed immediately after the test.

Accessing the I/O Module Address Detect Test

1. With the Diagnostic Menu displayed, enter a "4" and press Return. The Main Menu of the I/O Module Address Test will be displayed. This menu is as follows:

I/O MODULE ADDRESS DETECT MENU

- 1 - INITIALIZE OR DELETE TABLE DATA
- 2 - ADD A MODULE TO THE TABLE
- 3 - DISPLAY MODULES IN THE TABLE
- 4 - DELETE A MODULE FROM THE TABLE
- 5 - TEST MODULE ADDRESSING

USE AUX1 MENU TO LOAD TABLE DATA

USE AUX2 MENU TO RECORD TABLE DATA

SELECT (1-5)

Each option has its own menu that guides the user through related operations. To select an option, enter the number associated with the option and press the Return key. When an option is selected, its menu will be displayed and all related functions will be active.

NOTE

To display the I/O Module Address Detect Menu from any its submenus, press the ESCAPE key.

Initializing the I/O Module Address Table

This option initializes the I/O Module Address Table, allowing data to be typed in. Initializing the table erases existing information in the table. This option is selected the first time an I/O Module Address Table is typed in or when an existing table is to be deleted.

1. With the I/O Module Address Detect Menu displayed, enter a "1" and press Return. The following will be displayed:

```
INITIALIZE I/O MODULE DATA TABLE
*** WARNING ALL CURRENT TABLE DATA
WILL BE DESTROYED***
```

```
INITIALIZE Y OR N?
```

2. Initialization will delete the existing I/O Module Data Table information. Press "Y" if you want to initialize the Address Table. The following will be displayed:

```
DATA TABLE INITIALIZED
```

```
PRESS ESC TO RETURN TO THE MENU
```

Pressing the "ESC" key returns you to the I/O Module Address Detect Menu.

3. Press "N" if you do not want to initialize the data table. The I/O Module Address Detect Menu will automatically be displayed.

Entering I/O Table Data

This option allows address data for an I/O module to be entered into the I/O Module Address Table. If an error is made while typing in address data, the I/O module must be deleted from the table (Option 4) and the information for that module then re-entered in its desired form.

1. With the I/O Module Address Detect Menu displayed, enter a "2" and press Return. The following will be displayed:

ADD MENU

- 1 - ANY 4 POINT OUTPUT
- 2 - ANY 8 POINT OUTPUT
- 3 - ANY 8 POINT INPUT
- 4 - ANY 16 POINT INPUT
- 5 - TTL
- 6 - VIDEO INTERFACE
- 7 - VIDEO MEMORY
- 8 - D TO A CONVERTER
- 9 - DATA ACQUISITION
- 10 - RES-232
- 11 - ENCODER
- 12 - DIGITIZING REFERENCE
- 13 - MICRO DIGITIZING
- 14 - SRPC OR PROGRAMMABLE TIMER
- 15 - FIFO
- 16 - 4 TO 20 MA OUTPUT
- 17 - FPA PROCESSOR

PRESS DEL OR RUB TO CHANGE MODULE TYPE, ESC TO RETURN

PRESS MODULE TYPE (1-17) THEN PRESS RETURN

2. To add a module to the I/O Module Data Table, enter the number corresponding to the correct type of module and press Return. The following will be displayed:

ENTER DECIMAL START ADDRESS THEN
PRESS RETURN
PRESS DEL OR RUB TO CHANGE ADDRESS
PRESS ESC TO RETURN TO THE MAIN MENU

STARTING ADDRESS =

3. Type in the address for the module you are adding to the table and press Return. The following will be displayed:

ALL MODULES ENTERED Y OR N?

If you wish to enter address data for another module, press "N" to remain in the Add Menu. When all data information has been entered, press "Y" to return to the I/O Module Address Detect Menu.

Displaying the I/O Module Address Table

This option displays the I/O modules that have been entered into the I/O Module Address Table. Included in the displayed information is the type of module each one is and the address that was entered as the location of the module.

1. With the I/O Module Address Detect Menu displayed, enter a "3" and press Return. The following will be displayed:

PRESS THE SPACEBAR TO VIEW TABLE DATA

2. Pressing the spacebar on the keyboard displays the I/O module address entries. They are listed in order of their indicated addresses. When the last entry in the Data Table is shown, the following will be displayed:

END OF MODULE DATA

PRESS ESC TO RETURN TO THE MENU

Deleting Table Data

This option allows the user to delete address information for an I/O module from the I/O Module Address Table.

1. With the I/O Module Address Detect Menu displayed, enter a "4" and press Return. The following will be displayed:

DELETE MENU

- 1 - ANY 4 POINT OUTPUT
- 2 - ANY 8 POINT OUTPUT
- 3 - ANY 8 POINT INPUT
- 4 - ANY 16 POINT INPUT
- 5 - TTL
- 6 - VIDEO INTERFACE
- 7 - VIDEO MEMORY
- 8 - D TO A CONVERTER
- 9 - DATA ACQUISITION
- 10 - RES-232
- 11 - ENCODER
- 12 - DIGITIZING REFERENCE
- 13 - MICRO DIGITIZING
- 14 - SRPC OR PROGRAMMABLE TIMER
- 15 - FIFO
- 16 - 4 TO 20 MA OUTPUT
- 17 - FPA PROCESSOR

PRESS DEL OR RUB TO CHANGE MODULE TYPE, ESC TO RETURN

PRESS MODULE TYPE (1-17) THEN PRESS RETURN

2. To delete a module from the I/O Module Data Table, enter the number corresponding to the type of module being deleted and press Return. The following will be displayed:

ENTER DECIMAL START ADDRESS THEN
PRESS RETURN
PRESS DEL OR RUB TO CHANGE ADDRESS
PRESS ESC TO RETURN TO THE MAIN MENU

STARTING ADDRESS =

3. Type in the address for the module you are deleting from the table and press Return. The following will be displayed:

MODULE DELETED

DELETE ANOTHER Y OR N?

If you wish to delete address data for another module, press "Y" to remain in the Delete Menu. When all desired data information has been deleted, press "N" to return to the I/O Module Address Detect Menu.

Performing the I/O Module Address Test

This option carries out a test of the I/O module addresses. The PiC checks each address location to see if the I/O modules are located at the addresses indicated in the I/O Module Address Table.

IMPORTANT

Remove power from the I/O modules before testing them for address location. Testing I/O module addresses with module power supplies ON may not provide valid results.

Every PiC containing I/O modules that are being tested must contain a Resistor Termination Module. See Section 7.5.1.2 for more information on this module.

1. With the I/O Module Address Detect Menu displayed, enter a "5" and press Return. The following will be displayed:

TEST MODULE ADDRESSING

INSTALL A RESISTOR TERMINATION
MODULE IN EACH RACK
TURN OFF ALL I/O POWER SUPPLIES
* - INDICATES A PASS COMPLETE
PRESS ESC TO EXIT THE TEST

READY TO TEST Y OR N?

2. Make certain the power supplies for input modules are turned off. Otherwise, invalid results will be obtained. If you wish to abort

the I/O Module Address Test, press "N" to exit and return to the I/O Module Address Detect Menu.

If you wish to proceed with the I/O Module Address Test, press "Y".

3. If each I/O module is found at the address indicated for it in the I/O Module Data Table, the following will be displayed:

MODULE(S) PRESENT
REMOVE RESISTOR TERMINATION
MODULE(S) IF DONE

CONTINUE TESTING Y OR N?

Each asterisk indicates a successful I/O Module Address Test. The text in the display is not shown until the ESC key is pressed, halting the test.

4. Press "Y" to continue the test, or press "N" to exit the I/O Module Address Test and return to the I/O Module Address Detect Menu.
5. If an I/O module or modules cannot be found at the address indicated in the I/O Module Data Table, the name of the first such module and the address entered for it in the I/O Module Address Table will be displayed. In addition, the following prompt is displayed:

CONTINUE TESTING Y OR N?

6. Press "Y" to display the next addressing error in sequence. Each time "Y" is pressed, the next sequential addressing error located will be displayed until all the addressing errors are indicated. At that time an asterisk will be displayed to indicate that the remaining I/O modules are correctly addressed.
7. Press "N" to exit the I/O Module Address Test and return to the I/O Module Address Detect Menu.

Troubleshooting Suggestions

Check the following when a module is not found at the address entered for it.

IMPORTANT

TURN OFF THE POWER TO THE PiC BEFORE REMOVING OR INSERTING ANY MICROCOMPUTER MODULES. Failure to do so may result in permanent damage to the module.

1. Is the I/O module present in the control?

Make certain the missing module is in the appropriate rack. If an I/O module is not present in the PiC, it will be listed as missing from the address it is supposed to be found at.

2. If present, is the module correctly addressed?

After turning off the power to the PiC, remove the module in question. Check the address switch settings on the I/O module to see if the switches are set for the address listed in the I/O Module Address Table. I/O module address switch use is explained for each I/O module in Appendix A of the PiC409 User's Manual

3. If the module is correctly addressed, is there evidence of damage to the module?

After turning off the power to the PiC, remove the module in question. Visually check for damage to the module. If an I/O module is severely damaged, the address test may not be able to recognize it in the PiC.

4. If the module is an input module, was the input power supply turned off while the address check was underway?

When an address test is carried out, I/O module power supplies must be turned off. If this is not done, input modules will give

erroneous address data.

Overlapping Address Locations

For purposes of explanation, assume that I/O Module A requires 8 address locations. Module A is entered into the address information table at address 2200, when the module is actually incorrectly addressed at 2204.

I/O Module B requires 4 address locations. Module B is correctly entered into the address information table at address 2208. This situation results in the address location of Module A (2204-2212) overlapping into the address location of Module B (2208-2212).

When address locations overlap in such a way, the I/O module that is incorrectly addressed (Module A) will not be found at its indicated address. In addition, it is likely that the memory overlap will cause the correctly addressed module (Module B) to not be found at its address location. When the memory locations no longer overlap, the correctly addressed module will be located at its indicated address by the address test.

7.7 TESTING THE BATTERY

As a precaution to avoid loss of data due to a power loss, the PiC contains battery-backed RAM for user memory. A Panasonic Lithium BR-2/3 3V battery (or equivalent) is used. The battery should last approximately 10 years with the PiCTurbo base unit and four years with the memory expansion option, but it is advisable to test it occasionally.

IMPORTANT

A low battery cannot provide adequate power to protect the contents of user memory. If the battery test diagnostic shows the battery to be low, record the contents of user memory and replace the battery.

1. With the Diagnostic Menu displayed, enter a

"5" and press Return. In response, the PiC will test the battery.

Upon successful completion of the test, the PiC will display the following message:

BATTERY OK. PRESS CONTROL-Q TO
RETURN TO MAIN MENU.

If the battery is low, the PiC will display the following message:

BATTERY LOW. PRESS CONTROL-Q TO
RETURN TO MAIN MENU.

If this message is displayed, return to the Aux 1 Menu, record the contents of user memory, and replace the battery. Procedures for replacing the battery are presented in Section 4.7.

To return to the Aux 1 Menu, enter CONTROL-Q.

APPENDIX A

MODULE INFORMATION



PiC409 and PiC49 MODULE CURRENT REQUIREMENTS

The information on this sheet is to help you determine the power supply requirements for your PiC. Use the table on the reverse side to determine how much your PiC modules will use.

Example:

Description	Part Number	Current Required For Each Module (Amps)			Number of Modules	Total Current Required (Amps)		
		+5V	+15V	-15V		+5V	+15V	-15V
12. 24V 8 DC Output	502-02815-00	.19			4	.76		

Select the rack(s) listed below that will accommodate all of your modules and their power requirements. The total load must not exceed the maximum power supply output. Order more racks if additional slots or power is required.

Rack Description	Rack Part Number	*Power Supply	Number of Slots	Maximum Current Capability (Amps)			Maximum Power Supply **Output
				+5V	+15V	-15V	
PiC49 Rack	503-16262-02	Converter Concepts	25	10	.8	.8	75 Watts
PiC409 Master/Extension Rack	503-16265-02	LH Research	50	12	1.5	1.5	100 Watts

*Converter Concepts part number VST75-3799-01-0000
LH Research part number TTM-23-133

**Watts = Voltage x Current

Specifications subject to change without notice.

PiC409 and PiC49 MODULE CURRENT REQUIREMENTS

Description	Part Number	*Current Required For Each Module (Amps)			Number of Modules	Total Current Required (Amps)		
		+5V	+15V	-15V		+5V	+15V	-15V
1. PiCTurbo Processor	503-17XXX-XX	.762	.069	.069				
2. Scan Monitor	502-02906-00	.08						
3. Floating Point Arithmetic	502-02917-02	.22	.07					
4. 8K CMOS	502-02998-28	.15	.02					
5. 64K EPROM	503-15529-00	.46						
6. Static RAM	502-03206-08	.60						
7. 40K CMOS	502-03280-00	.25						
8. 24V 8 DC Input	502-02814-08	.09						
9. 15V 8 DC Input	502-02972-08	.08						
10. 24V 16 DC Input	502-02814-16	.14						
11. 15V 16 DC Input	502-02972-16	.12						
12. 24V 8 DC Output	502-02815-00	.19						
13. 24V 4 DC Output - 3 Amp	502-02999-00	.21						
14. 24V 8 DC Output Interface	502-02954-00	.18						
15. 32 I/O TTL	502-02869-20	.40						
16. 2 Amp 8 DC Output	502-03381-00	.20						
17. 120V 8 AC Input	502-02959-00	.11						
18. 120V/230V 8 AC Input	502-02959-50	.21						
19. 120V/230V 8 AC Output	502-02960-00	.19						
20. 24V 8 AC Input	502-03172-00	.11						
21. 24V 8 AC Output	502-03173-00	.20						
22. RS-232C Interface	502-02833-20	.18	.02	.02				
23. Remote I/O Driver (FIFO)	502-15274-27	.80	.02	.02				
24. PiC to PiC Communication	502-15613-00	.65	.02	.02				
25. Remote I/O Receiver (PMC)	503-15275-27	.75	.02	.02				
26. 20mA - RS-422 Converter	502-03253-00	.10	.02	.02				
27. Video Interface	502-02904-20	.44						
28. Video Memory	502-02905-00	.48						
29. Video Memory (with RTD)	503-70075-00	1.00						
30. uP Digitizing	502-02819-00	.32	.01	.01				
31. Digitizing Reference	502-02820-01	.25	.03	.03				
32. Resolver/Inductosyn Driver	502-02821-00		.51	.51				
33. Encoder Receiver	502-02947-01	.39						
34. Data Acquisition	502-02907-20	.52	.01	.04				
35. D/A Converter	502-02822-00	.20	.04	.05				
36. Unipolar Data Acquisition	502-03362-00	.52	.01	.04				
37. uP Programmable Timer	502-02908-00	.35						
38. Stepper Motor w/o Ramp	502-03016-00	.26						
39. Stepper Motor w/Ramp	502-03016-50	.32	.04					
40. High-Speed Encoder	502-03581-00	.35						
41. Digital Cam	502-03593-00	.45						
A. Nest Driver	502-02952-20	.39						
B. Nest Receiver	502-02953-00	.38						

*Normal requirements under static conditions.

**To compensate for dynamic and peak loads,
multiply total Amps required by 1.25.

TOTAL
****TOTAL AMPS REQUIRED**
 (Total x 1.25)

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PiCTURBO PROCESSOR

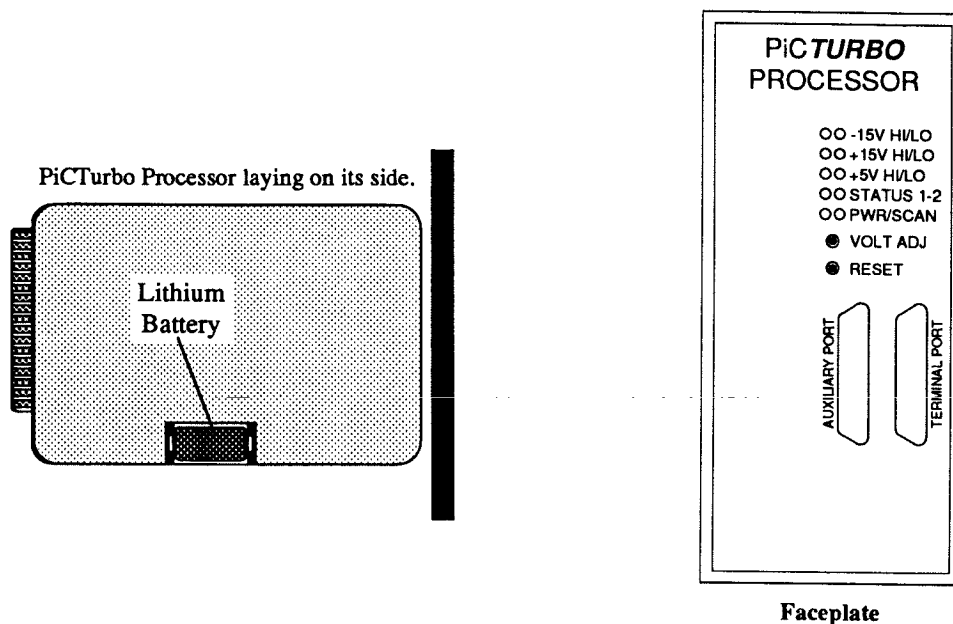


FIGURE 1. PiCTURBO PROCESSOR MODULE

1.0 INTRODUCTION

The PiCTurbo Processor contains the hardware and software components that are required for PiC operation. The PiCTurbo consists of two printed circuit boards (containing related hardware and firmware) and a faceplate. One of the printed circuit boards has a rear-edge connector that inserts into the backplane of the PiC. The module is constructed as a single unit. The PiCTurbo Processor contains no jumpers or address switches. The only part of the PiCTurbo Processor that is user-serviceable is the on-board battery.

NOTE

The faceplate on the PiCTurbo Processor is an integral part of the module. Do not attempt to remove the PiCTurbo faceplate under any circumstances.

The PiCTurbo Processor contains the following:

1. The LDN processor with associated bus

drivers, buffers, and system clock circuitry.

2. Voltage monitor/reset circuitry with voltage adjust switch and HI/LO LEDs.
3. System firmware.
4. System RAM.
5. Up to 132K of battery-backed user memory with software-configurable write protection.
6. Programmable timer.
7. Status LEDs.
8. Power-up diagnostics.
9. NMI (Non-Maskable Interrupt) generator.
10. Optional motion co-processor.
11. Wait-state generator.

1.2 PiCTURBO PROCESSOR COMPONENTS

The PiCTurbo Processor contains a number of components that provide information about the condition of the control system and also provide the user with the capability to initiate certain functions. Please refer to Figure 1 for the location of the components described in this section. In some cases, Section 4 contains more information on a given component.

PICTURBO PROCESSOR

Voltage Monitor LEDs

The three sets of amber LEDs (uppermost on the faceplate) are Voltage Monitor LEDs. When a Voltage Monitor LED illuminates, the indicated voltage (high or low) is more than 5% out of tolerance.

If one of the Voltage Monitor LEDs illuminates, adjust the appropriate voltage as explained in Section 1.4.

Status LEDs

Status LED 1 illuminates to indicate a hardware failure on the PiCTurbo Processor. Status LED 2 illuminates to indicate a checksum error (which means there is a problem with the user LDN).

Power LED

The green Power LED illuminates to indicate that the +5V DC and the ± 15 V DC from the power supply are present and within tolerance.

Scan LED

The green Scan LED illuminates to indicate that the LDN is being scanned. The Scan LED only illuminates when the PiC is in the Run Mode. If the LED is not illuminated, it means that the LDN is either not being scanned, or that the scan time exceeds 100 milliseconds.

Voltage Adjust Push Button

The Voltage Adjust push button narrows the tolerance for the three voltages from the power supply to $\pm 1.0\%$.

Reset Push Button

Pressing the Reset push button has the same effect as removing and then reapplying power to the PiC. Whatever mode is currently active is aborted and the PiC goes through its power-up sequence. A reset is automatically initiated by an out of tolerance power supply.

IMPORTANT

The Reset push button should never be pressed while the PiC is controlling a machine or process. Injury to personnel and/or damage to machinery may result if this is done. The correct method for exiting the Run mode when the PiC is carrying out its control function is explained in Section 6.3 of this manual.

Terminal Port

The Terminal Port allows the user to connect a personal computer to the PiC.

Auxiliary Port

The Auxiliary Port allows the user to connect an auxiliary interface device to the PiC, such as a Fluke Touch Control Screen or a Termiflex Hand-Held Programming Pendant.

Battery

Mounted in a holder on the PiCTurbo Processor is a Panasonic® Lithium BR-2/3 3V battery, or equivalent (G&L part no. 401-52446-00). This battery protects against the loss of data stored in user memory RAM should the PiC lose power. A capacitor on the PiCTurbo Processor continues providing memory back-up protection for up to thirty minutes while the battery is absent. Battery removal and installation is explained in Section 4.4 of this manual.

1.3 INSTALLATION

The PiCTurbo Processor requires three slots in the PiC rack (using slots 1-3 is recommended). If the next module to be inserted into the rack does not have a faceplate, that module may be inserted into the next slot (slot 4). If the next module does have a faceplate, that module would need to be inserted into slot 5.

To put the PiCTurbo in an operational state,

remove power from the PiC, insert the rear edge of the PiCTurbo Processor into the backplane, and return power to the PiC.

1.4 ADJUSTING POWER SUPPLY VOLTAGES

When any of the three power supply voltages exceeds a $\pm 5\%$ tolerance, the related Voltage Monitor LED will illuminate. This indicates that the out of tolerance power supply requires adjustment.

The following procedure is an abbreviated explanation of how to adjust the power supplies. For an expanded version, refer to Section 4.5 of this manual.

1. Remove the other modules from the nest so that only the PiCTurbo Processor remains in the nest.

CAUTION

Do not allow the screwdriver used in adjusting the power supply potentiometers to come in contact with anything but the potentiometers.

2. Using a small screwdriver with an insulated handle, slowly turn the adjustment pot(s) for the voltages(s) you wish to adjust.
3. When both Voltage Monitor LEDs for the voltage being adjusted extinguish, press the Voltage Adjust push button and hold it in. If any of the LEDs illuminate, adjust the appropriate pot(s) with the Voltage Adjust push button depressed until the LED(s) extinguish.
4. Insert the other modules into the nest and check to see if the voltages are still within tolerance. If not, repeat steps 2-3.



SCAN MONITOR MODULE

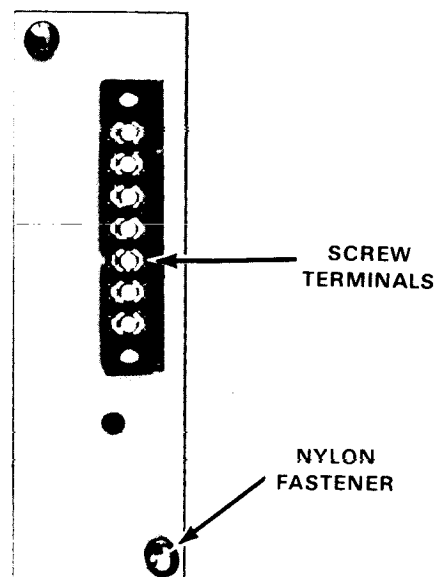
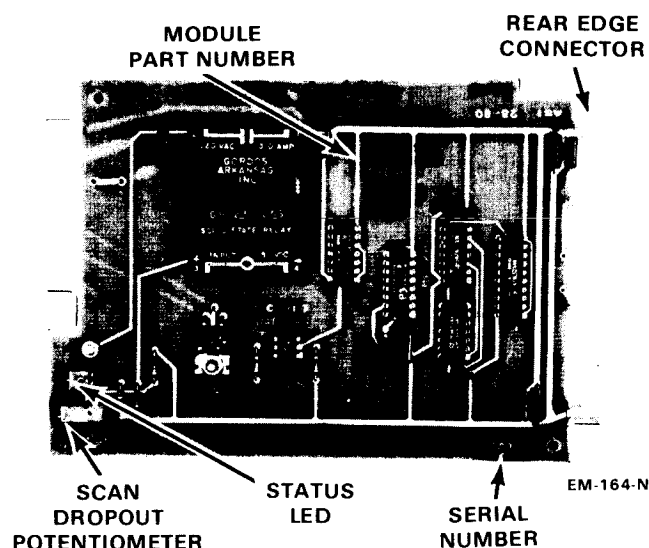


FIGURE 1. SCAN MONITOR MODULE AND OPTIONAL FACEPLATE

1.0 INTRODUCTION

The Scan Monitor Module, part number 502-02906-00, monitors the PiC for proper operation. The ladder diagram network (LDN) scan is monitored so that excessive scan times can be detected. The module's timing circuitry controls an AC output circuit and a DC output circuit. Both of these circuits will open if the scan times exceed a preset limit.

The output circuits may be wired to a power on relay, horn, light etc., to indicate that the scan time has exceeded the maximum time limit. An on-board LED is also provided to indicate the scan status. The LED will be illuminated when the scan is normal. A scan fault will turn the LED off.

The scan time limit is adjustable by means of an on-board potentiometer. The maximum allowable scan time is adjustable from 5 to 230 milliseconds. Turning the potentiometer in a clockwise direction will reduce the maximum allowable scan time. Turning it in a counter-clockwise direction will increase the maximum allowable scan time.

External devices are wired to the module through either a 24-pin card edge connector or a Scan Monitor Module Faceplate (part number 502-03205-00). The latter option permits wiring connections to be made to compression screw terminals.

2.0 HARDWARE INTERFACING

2.1 CARD EDGE CONNECTOR

A 24-pin card edge connector, part number 401-50656-00 may be used to connect the Scan Monitor Module to external devices. Phosphor bronze, crimp contacts, with gold-over-nickel plating, are available as part number 401-50495-00. "Dummy" contacts, part number 401-50459-00 may be inserted into the connector at unused places to provide a tighter grip between the connector and the module card edge.

The recommended external wiring is as follows: 120 Volts AC line (IN) and load (OUT) should be wired with #18 red conductors; 24 volts DC LINE (IN) and LOAD (OUT) should be wired with #18 blue conductors.

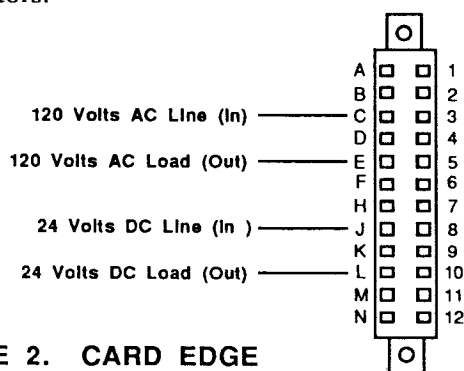


FIGURE 2. CARD EDGE CONNECTOR WIRING

SCAN MONITOR MODULE

2.2 FACEPLATE CONNECTOR

The faceplate connector allows wiring connections to be made to compression terminals. The System Status LED on the Scan Monitor Module may be viewed through the faceplate LED hole.

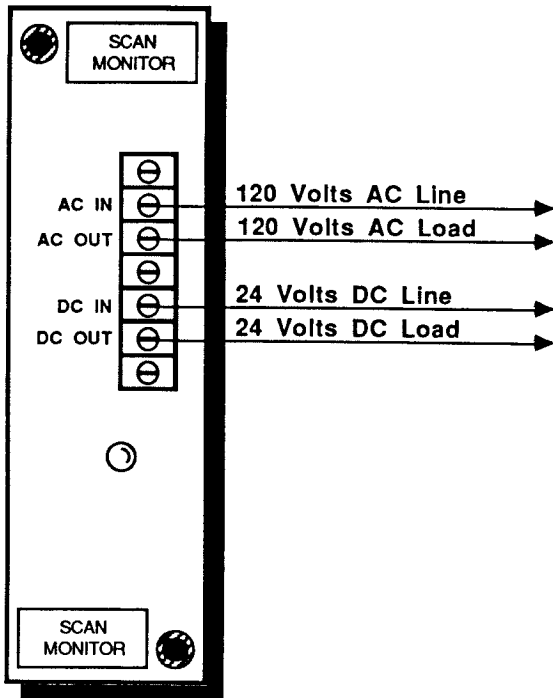


FIGURE 3. FACEPLATE WIRING

3.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD EDGE IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY OTHER MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

The Scan Monitor Module may be installed in either the Master or Extension Racks. The racks are physically keyed to prevent modules from being inserted incorrectly.

4.0 APPLICATION EXAMPLES

Figure 4 illustrates one wiring configuration for incorporating the Scan Monitor Module in the PiC system. The DC Output Module supplies 24 volts DC from LOAD 0 to the DC IN terminal of the Scan Monitor Module. The 24 volts DC is passed through the Scan Monitor Module to the DC OUT terminal. The 24 volt DC OUT terminal is wired directly to the machine on/off switch, emergency stop switch, machine start switch, power-on relay and the power-on relay contact.

In the event that the scan time exceeds the maximum allowable limit, the DC output circuit of the Scan Monitor Module will open. An open DC output circuit will disconnect the 24 volt DC source to the power-on relay. A de-energized power-on relay will disconnect power to all devices that use the power-on relay as the contact for electrical power.

Additional control of the power-on relay is available through the ladder diagram network. Control relays, switches and coils may be programmed to control LOAD 0 of the DC Output Module.

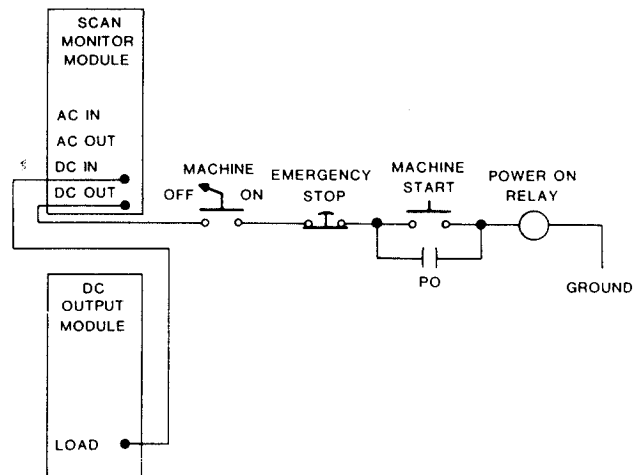


FIGURE 4. EXAMPLE CIRCUIT

The block diagram illustrates the control system architecture. On the left, a vertical double-headed arrow is labeled "CONTROL SIGNALS". Two lines originate from this signal source: one goes directly to the "BUFFER" block, and the other is labeled "CTSG" and goes to the "RETRIGGERABLE ONE SHOT" block. The signal flow is as follows: "CONTROL SIGNALS" → "BUFFER" → "FLIP-FLOP" → "RETRIGGERABLE ONE SHOT". From the "RETRIGGERABLE ONE SHOT", the signal branches to three output blocks: "SOLID STATE RELAY" (which is connected to an "AC" output), "DC OUTPUTS" (connected to a "DC" output), and "LED".

Page 1-7



FLOATING POINT ARITHMETIC MODULE

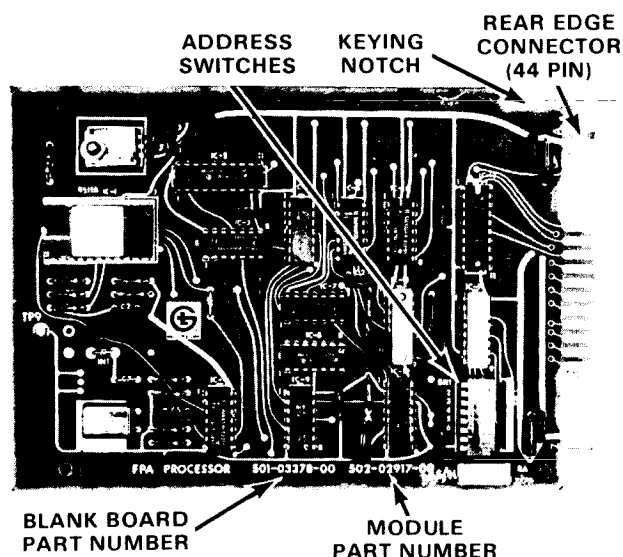


FIGURE 1. FPA MODULE

1.0 INTRODUCTION

The Floating Point Arithmetic (FPA) Processor Module provides the capability of performing 16-bit and 32-bit fixed point arithmetic, 32-bit floating point arithmetic and a variety of floating point trigonometric and mathematical operations. The microcomputer on the 6809 CPU module interfaces with the arithmetic processing unit (APU) on the FPA Processor Module via Call Routines to utilize the computational power of the APU. In addition to having enhanced computational power, the FPA Processor Module reduces the software overhead that would be required if the 6809 CPU Module had to perform the enhanced arithmetic operations.

2.0 ADDRESSING

The FPA Processor Module occupies four memory locations. The eight board-mounted Address switches must be set for the lowest of the four addresses desired. Table 1 contains the Address switch settings for the 60 possible beginning address points. Switches 7 and 8 are not used and may be ignored.

NOTE

For most applications the default address will be 2148 (1-off, 2-on, 3-off, 4-on, 5-on, 6-off). Also, with the FPA Processor Module at this address, LET statements will be executed faster in the LDN without the aid of Call Routines.

The only time that address 2148 is not used is when a specific Call Routine requires a different address. When using an FPA Processor Module in conjunction with Call Routines, refer to the Call Routine documentation for specific addressing instructions.

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	123456		123456		123456
2000	ON OFF	2088	ON OFF	2176	ON OFF
2004	ON OFF	2092	ON OFF	2180	ON OFF
2008	ON OFF	2096	ON OFF	2184	ON OFF
2012	ON OFF	2100	ON OFF	2188	ON OFF
2016	ON OFF	2104	ON OFF	2192	ON OFF
2020	ON OFF	2108	ON OFF	2196	ON OFF
2024	ON OFF	2112	ON OFF	2200	ON OFF
2028	ON OFF	2116	ON OFF	2204	ON OFF
2032	ON OFF	2120	ON OFF	2208	ON OFF
2036	ON OFF	2124	ON OFF	2212	ON OFF
2040	ON OFF	2128	ON OFF	2216	ON OFF
2044	ON OFF	2132	ON OFF	2220	ON OFF
2048	ON OFF	2136	ON OFF	2224	ON OFF
2052	ON OFF	2140	ON OFF	2228	ON OFF
2056	ON OFF	2144	ON OFF	2232	ON OFF
2060	ON OFF	2148	ON OFF	2236	ON OFF
2064	ON OFF	2152	ON OFF		
2068	ON OFF	2156	ON OFF		
2072	ON OFF	2160	ON OFF		
2076	ON OFF	2164	ON OFF		
2080	ON OFF	2168	ON OFF		
2084	ON OFF	2172	ON OFF		

TABLE 1. ADDRESS SWITCH SETTINGS

[illegible]

uP PROGRAMMABLE TIMER MODULE

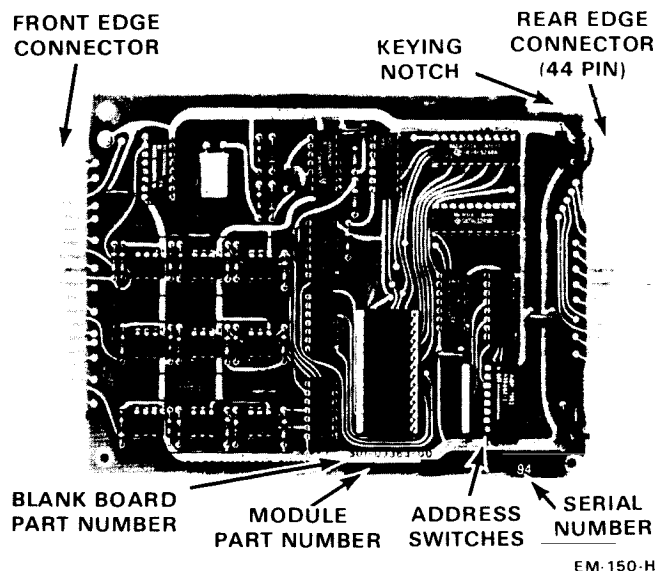


FIGURE 1. uP PROGRAMMABLE TIMER

1.0 INTRODUCTION

The uP Programmable Timer Module, part number 502-02908-00, provides a variety of timing signals and system interrupts. The module may be utilized for such tasks as frequency measurement, event counting, interval measuring, square wave generation, gated delay signals, single pulses and pulse width modulation.

The uP Programmable Timer Module contains three sets of user signals. These signals are brought out to the frontplane of the module for interfacing to the programmable controller. Each set of signals contains an output signal, external clock signal and external gate signal. The signals may be interfaced directly to TTL devices or through optical isolation circuitry for isolated devices.

An on-board 4 MHz clock is divided down to supply 4 MHz, 2 MHz, 1 MHz, 500 KHz and 250 KHz signals. These clock signals may be used to source the external clock and external gate signals.

2.0 ADDRESSING

The uP Programmable Timer Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired.

TABLE 1. ADDRESS SWITCH SETTINGS

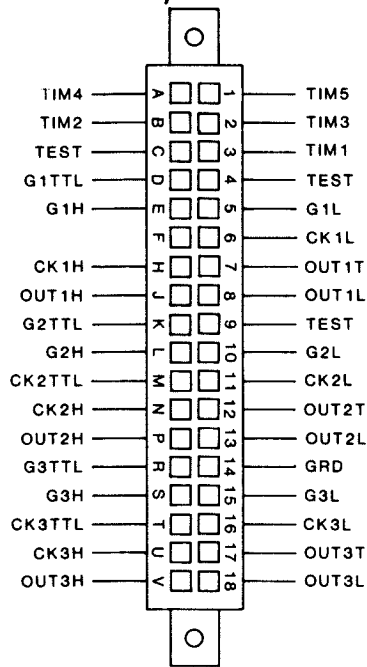
PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF	x128	ON OFF
x008	ON OFF	x136	ON OFF
x016	ON OFF	x144	ON OFF
x024	ON OFF	x152	ON OFF
x032	ON OFF	x160	ON OFF
x040	ON OFF	x168	ON OFF
x048	ON OFF	x176	ON OFF
x056	ON OFF	x184	ON OFF
x064	ON OFF	x192	ON OFF
x072	ON OFF	x200	ON OFF
x080	ON OFF	x208	ON OFF
x088	ON OFF	x216	ON OFF
x096	ON OFF	x224	ON OFF
x104	ON OFF	x232	ON OFF
x112	ON OFF		
x120	ON OFF		

TABLE 1 contains the Address Switch settings for the 30 possible beginning address points. Note that switches 6, 7 and 8 are supplied but not used and may be ignored.

3.0 CARD EDGE CONNECTOR

A 36-pin card edge connector (part number 401-50657-00) may be used to wire the uP Programmable Timer Module to external devices. Phosphor bronze crimp contacts (part number 401-50460-00) with gold-over-nickel plating are available. "Dummy" contacts (part number 401-50459-

μP PROGRAMMABLE TIMER MODULE



A000268

FIGURE 2. CARD EDGE CONNECTOR WIRING

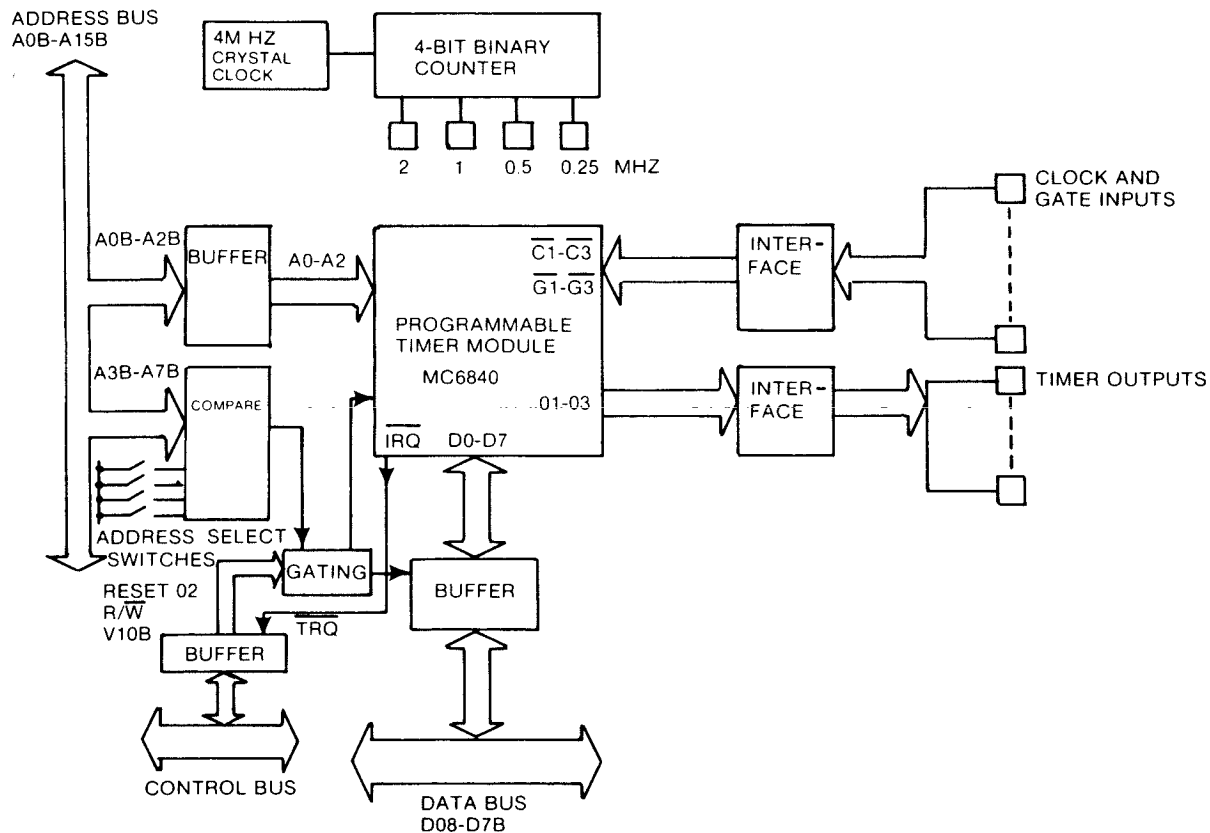
00) may be inserted into the connector at unused places for better holding power.

4.0 INSTALLATION

The uP Programmable Timer Module must be installed in the Master Rack. The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 2.0.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.



A000269

FIGURE 3. BLOCK DIAGRAM



μ P PROGRAMMABLE TIMER MODULE

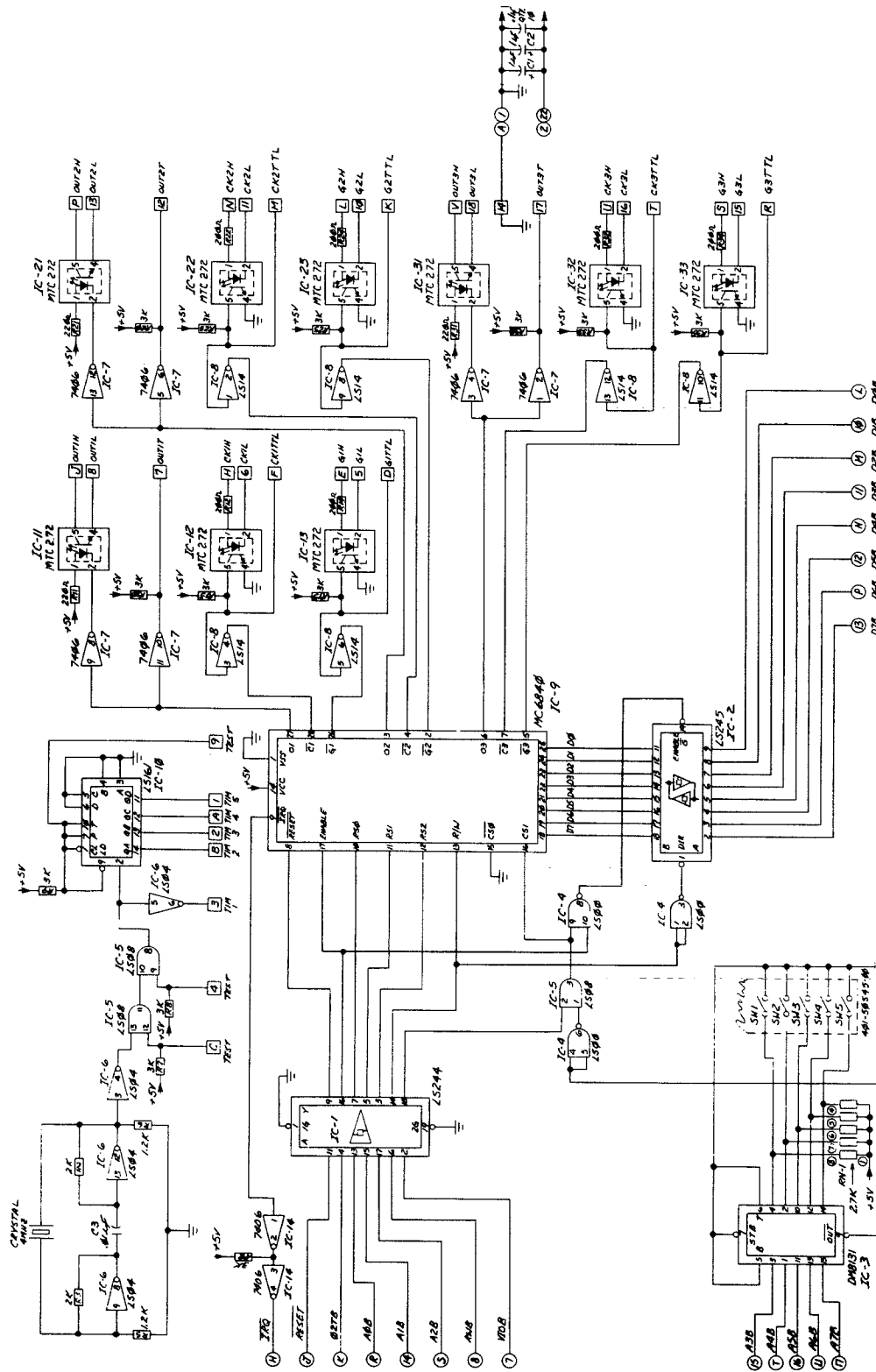
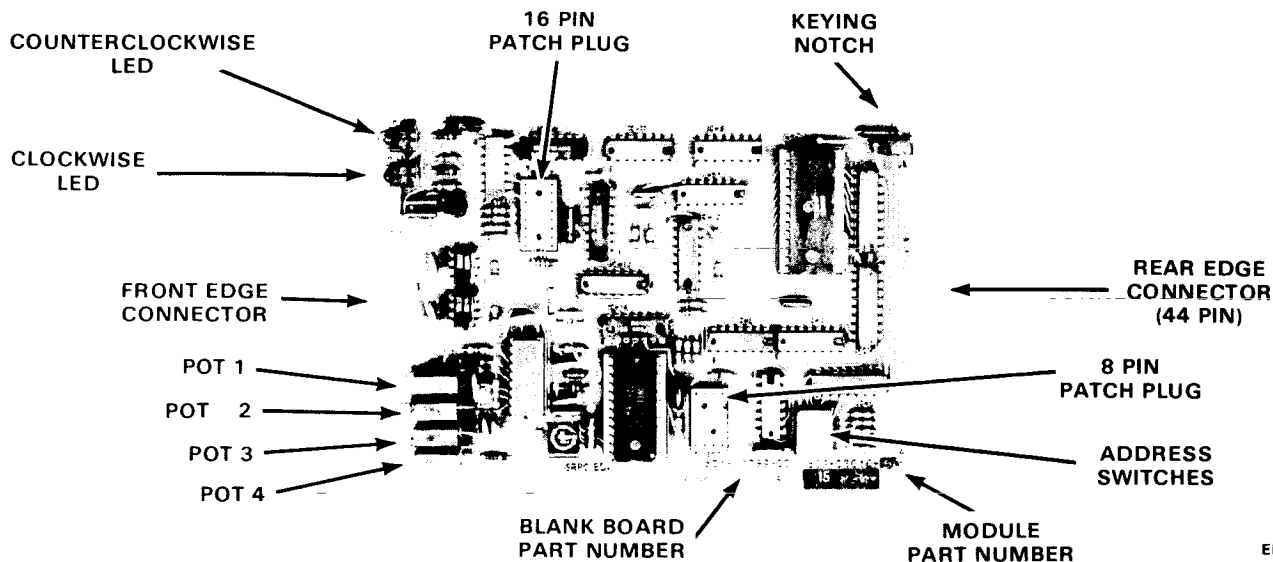


FIGURE 4. SCHEMATIC

502-02908-00



STEP RATE POSITION COUNTER MODULE



EM-148-D

FIGURE 1. STEP RATE POSITION COUNTER MODULE

1.0 INTRODUCTION

The Step Rate Position Counter (SRPC) Module allows the user to control the speed and direction of a step motor. The speed is controlled by a stream of pulses that can be spaced and timed to match load and motor characteristics. Four versions of the SRPC Module are available.

The part numbers of the SRPC Modules with different options are:

502-03016-00: SRPC Module without ramping and with 5 volt optical isolators.

502-03016-10: SRPC Module without ramping and with open collector optical isolators.

502-03016-50: SRPC Module with ramping and with 5 volt optical isolators.

502-03016-60: SRPC Module with ramping and with open collector optical isolators.

1.1 RAMPING OPTION

The SRPC Module is available with or

without ramping circuitry. The ramping circuitry provides the ability to gradually accelerate and decelerate a step motor. If the step motor will be operated at a step rate greater than the maximum starting/stopping step rate of the translator/step motor, and the translator does not have ramping, an SRPC Module with ramping should be used. The ramping circuitry on the SRPC Module will not allow acceleration of a step motor after initial acceleration. To change speeds, the motor must first be decelerated to zero and then accelerated to the new speed.

NOTE

A translator is the electrical drive portion of the step motor that converts the pulse rate from the SRPC Module into the switching sequence needed to drive the motor in steps. A translator with ramping circuitry may be referred to as a buffered translator.

1.2 OPTICAL ISOLATOR OPTION

Each SRPC Module has two optical isolators. One optical isolator sends

STEP RATE POSITION COUNTER MODULE

pulses when clockwise motion is commanded and the other sends pulses when counterclockwise motion is commanded. An external supply voltage must be connected to the SRPC Module to provide a source voltage for the optical isolators. The source voltage should be supplied by the translator. The source voltage may be either regulated to 5 volts dc or used directly as the input to the transistor portion of the optical isolator. The transistors act as solid state switches so that the source voltage will be pulsed at the commanded step rate. The PC bus is optically isolated from the transistor switches for reliable operation. A 5 volt optical isolator and an open collector optical isolator are available.

1.2.1 5 VOLT OPTICAL ISOLATOR

The 5 volt optical isolator requires a 5 volt dc source voltage. Voltages between 8 and 15 volts dc may be regulated to 5 volts dc by using the on-board regulator. The 5 volt optical isolator has very fast switching characteristics. Stepping motors that require very fast rise and fall times may require this type of optical isolator.

1.2.2 OPEN COLLECTOR OPTICAL ISOLATOR

This type of optical isolator requires a source voltage that is between 5 and 30 volts dc.

2.0 STEP RATES

The step rate is the number of off-to-on transitions (pulses) of the step line voltage that occur in a given period of time. The step rate is normally expressed in steps per second (steps/sec). The higher the step rate, the faster the motor will rotate. For example; if a step motor that requires 200 steps per revolution is commanded to rotate at 2000 steps/sec, the step motor will rotate at a velocity of 10 revolutions per second.

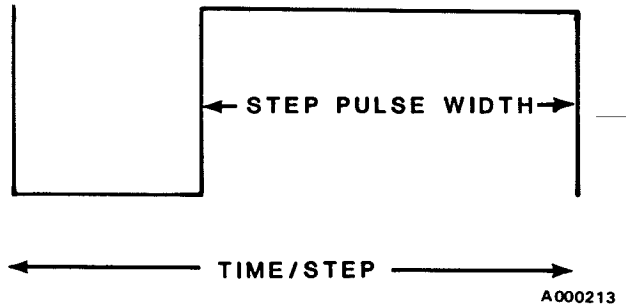


FIGURE 2. STEP PULSE COMPONENTS

FIGURE 2 shows the components of each step. The time/step is defined by the Call Routine that controls the SRPC Module. The step pulse width is defined by the position of a jumper on the 16 pin patch plug (SECTION 4.0).

The maximum and minimum step rates that can be commanded by the SRPC Module are a function of the 2 MHZ internal clock and the Call Routine used to control the SRPC Module. The highest step rate obtainable is 100,000 steps/sec. The lowest step rate obtainable, without an external clock, is 2 steps/sec.

CAUTION

For SRPC Modules with ramping, step rates greater than 30,000 steps/sec should not be commanded. Unpredictable speeds and inaccurate positioning could result.

An external clock may be used to reduce the step rate below 2 steps/sec. The frequency of the external clock (as compared to the 1 MHZ) determines the new minimum step rate. The formula for determining the minimum step rate is:

$$\frac{\text{EXTERNAL CLOCK FREQUENCY}}{1,000,000 \text{ Hz}} = \text{STEPS/SEC. (MIN.)}$$

The minimum step rate (as determined by the preceding formula) is required to calculate the new maximum step rate. The formula for determining the maximum step rate is:

$$\text{STEPS/SEC. (MIN.)} * 65,000 = \text{STEPS/SEC. (MAX.)}$$

STEP RATE POSITION COUNTER MODULE

EXAMPLE: If a 1 MHZ external clock is connected to the SRPC Module, the minimum step rate that can be commanded is 1 step/sec. The maximum step rate that can be commanded is 65,000 steps/sec.

NOTE

Connection of an external clock is described in Section 5.0.

3.0 ADDRESSING

Each SRPC Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired. TABLE 1 contains the Address Switch settings for the 30 possible beginning address points.

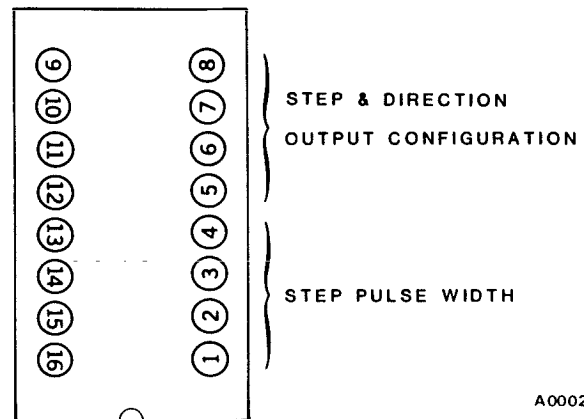
TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS SWITCHES		PC ADDRESS SWITCHES	
	1 2 3 4 5		1 2 3 4 5
2000	ON OFF	2128	ON OFF
2008	ON OFF	2136	ON OFF
2016	ON OFF	2144	ON OFF
2024	ON OFF	2152	ON OFF
2032	ON OFF	2160	ON OFF
2040	ON OFF	2168	ON OFF
2048	ON OFF	2176	ON OFF
2056	ON OFF	2184	ON OFF
2064	ON OFF	2192	ON OFF
2072	ON OFF	2200	ON OFF
2080	ON OFF	2208	ON OFF
2088	ON OFF	2216	ON OFF
2096	ON OFF	2224	ON OFF
2104	ON OFF	2232	ON OFF
2112	ON OFF		
2120	ON OFF		

Note that the last two switch settings in TABLE 1, corresponding to addresses 2240 through 2255, should not be used since these locations may be occupied by fixed-address modules.

4.0 16 PIN PATCH PLUG

A 16 pin patch plug (with 3 jumpers) is provided so that the user can configure the SRPC Module to match the requirements of the translator being employed. The 3 jumpers must be installed on this patch plug. Refer to FIGURE 3 and Sections 4.1 through 4.3 for information regarding the positioning of the three jumpers.



A000212

FIGURE 3. 16 PIN PATCH PLUG

4.1 INDEPENDENT STEP & DIRECTION SIGNALS

The following jumper configuration is to be used when the translator which is being employed requires an independent step signal and an independent direction signal. To achieve this condition, jumper pin 8 to pin 9 and pin 5 to pin

NOTE

When pin H is low, counterclockwise (CCW) rotation will be commanded and the CCW LED will be illuminated. Conversely, when pin H is high, clockwise (CW) rotation will be commanded and the CW LED will be illuminated.

STEP RATE POSITION COUNTER MODULE

12. The step signal will now be provided to pin D of the front edge connector and the direction signal will be provided to pin H of the front edge connector.

4.2 COMBINED STEP & DIRECTION SIGNALS

The following jumper configuration is to be used when the translator which is being employed requires a combined step and direction signal. To achieve this condition, jumper pin 7 to pin 10 and pin 6 to pin 11. When CW rotation is commanded, the required signal will be present on pin D of the front edge connector and the CW LED will be illuminated. When CCW rotation is commanded, the required signal will be present on pin H of the front edge connector and the CCW LED will be illuminated.

4.3 STEP PULSE WIDTH

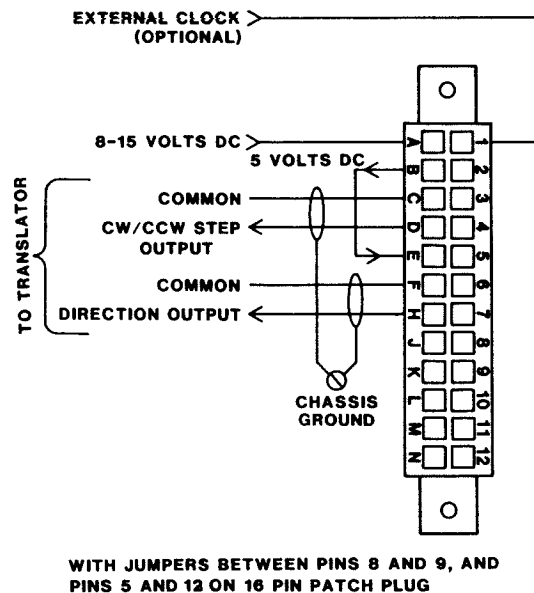
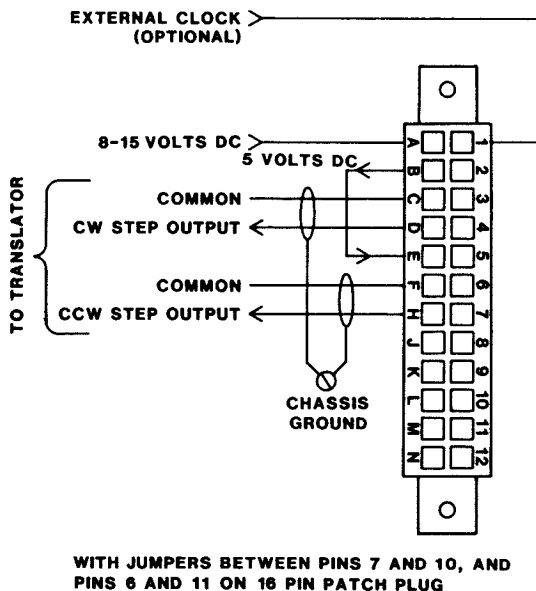
The following jumper configurations are used to select the desired width of the step pulse. One of the following configurations must be selected:

1. 80 Microsecond width - Jumper pin 4 to pin 13.

2. 40 Microsecond width - Jumper pin 3 to pin 14.
3. 15 Microsecond width - Jumper pin 2 to pin 15.
4. 5 Microsecond width - Jumper pin 1 to pin 16.

5.0 HARDWARE INTERFACING

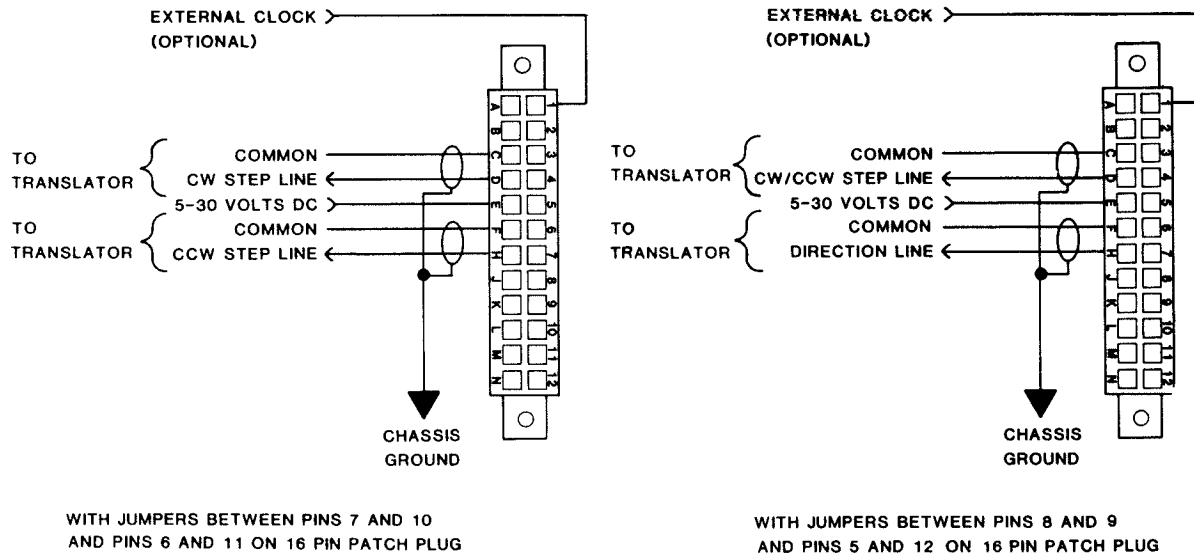
The SRPC Module interfaces to the translator of the step motor via a 24 pin edge connector. FIGURE 4 illustrates the pin connections and pin functions for an SRPC Module with 5 volt dc optical isolators (502-03016-00 and 502-03016-50). The 5 volt dc optical isolators require a 5 volt dc input at pin E. A 5 volt dc regulator is provided on the module to regulate 8-15 volt dc inputs. Pin A is the input to the regulator. Pin B is the output of the regulator. FIGURE 5 illustrates the pin connections and pin functions for an SRPC Module with open collector optical isolators (502-03016-10 and 502-03016-60). Both figures show the two variations in the functions of pin D and H. The configuration of the jumpers on the 16 pin patch plug, as explained in SECTION 4.0, determines the functions of pins D and H.



A000209

FIGURE 4. CARD EDGE CONNECTOR WIRING FOR 5 VOLT DC OPTICAL ISOLATORS

STEP RATE POSITION COUNTER MODULE



A000210

FIGURE 5. CARD EDGE CONNECTOR WIRING FOR OPEN COLLECTOR OPTICAL ISOLATORS

IMPORTANT

If the translator does not have optically isolated inputs, the shielded cables between the SRPC Module and translator should be limited to a length of 10 feet.

6.0 RAMPING

SECTION 6.1 and SECTION 6.2 only apply to SRPC Modules with ramping (502-03016-50 and 502-03016-60).

6.1 8 PIN PATCH PLUG

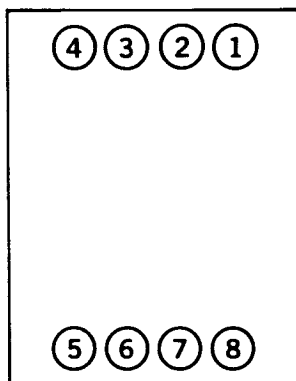


FIGURE 6. 8 PIN PATCH PLUG

A000211

An 8 pin patch plug is provided to enable the user to configure the ramping characteristics of the SRPC Module. Three components, two capacitors and one resistor, will be inserted on this patch plug. The values of these components is dependent on the commanded step rate. Ramping will only be implemented for step rates that are less than 30,000 steps/sec.

FIGURE 6 depicts the 8 pin patch plug and sections 6.1.1 through 6.1.3 explain how the three components should be installed on this patch plug.

6.1.1 OSCILLATOR CAPACITOR

The oscillator capacitor determines the maximum step rate of the ramping output. TABLE 2 shows the optimum values of this capacitor at various step rates. Insert one lead of the oscillator capacitor into pin 1 and the other lead into pin 8.

6.1.2 DAMPING RESISTOR

The damping resistor is used to reduce the oscillation or overshoot of the step motor rotor. As indicated in TABLE 2, the value of this resistor will be the

STEP RATE POSITION COUNTER MODULE

same for all step rates up to 30,000 steps/min. Insert one lead of the damping resistor into pin 2 and the other lead into pin 7.

6.1.3 RAMP CAPACITOR

The ramp capacitor determines the slope of the ramp (ramp time) during acceleration and deceleration. TABLE 2 shows the optimum values of this capacitor at various step rates. Insert one lead of the ramp capacitor into pin 4 and the other lead into pin 5.

TABLE 2. 8 PIN PATCH PLUG COMPONENTS

STEPS/SEC.	OSCILLATOR CAPACITOR (PIN 1 TO PIN 8)	DAMPING RESISTOR (PIN 2 TO PIN 7)	RAMP CAPACITOR (PIN 4 TO PIN 5)
0-3000	.01 uf	5.6 K OHM	68 UF
0-6000	.0047 uf	5.6 K OHM	68 uf
0-12000	.0022 uf	5.6 K OHM	1 uf
0-30000	.001 uf	5.6 K OHM	1 uf

6.2 RAMPING ADJUSTMENTS

Four potentiometers (pots) are provided near the front edge of the SRPC Module to fine tune the ramping characteristics. The functions of the four pots are:

POT 1: Balances the ramp up and ramp down time. For example: Adjust Pot 1 when the ramp down time is so long that the step motor will not "creep" into position at the end of a move.

POT 2: Fine tunes the slope of the ramp (ramp time) established by the ramp capacitor.

POT 3: Adjusts the minimum step rate output during ramping. This step rate must be within the starting/stopping step rate that is specified for the translator/step motor.

POT 4: Adjusts the maximum step rate established by the oscillator capacitor.

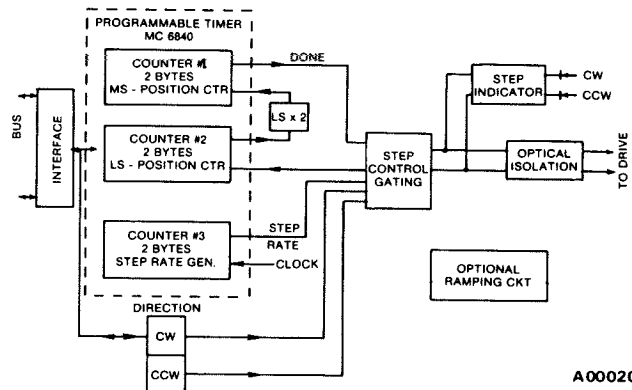
7.0 INSTALLATION

The SRPC Module must be installed in the Master Rack. The rack is physically keyed to prevent modules from being

inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Fasten the front edge connector before applying power.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUER MODULE. Failure to do so may result in permanent damage to the module.



A000205

FIGURE 7. BLOCK DIAGRAM

502-03016-50



8 DC INPUT MODULE

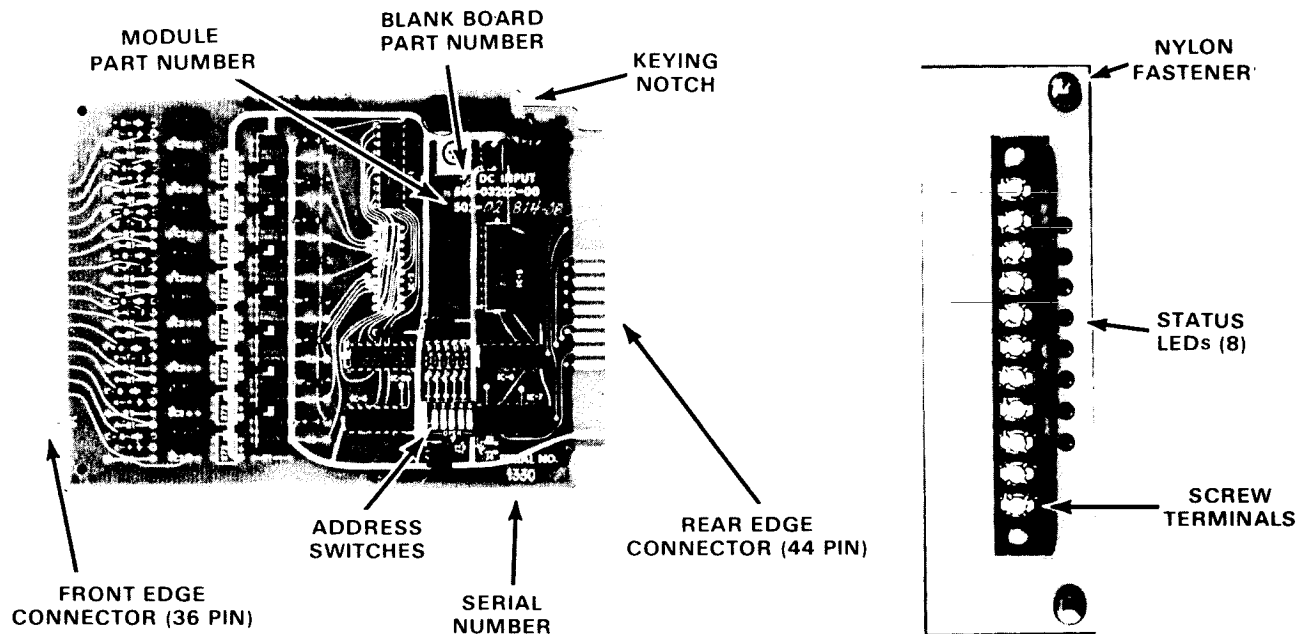


FIGURE 1 DC INPUT MODULE & OPTIONAL FACEPLATE

EM-160-U

1.0 INTRODUCTION

Each 8 DC Input Module (part no. 502-02814-08) allows the user to sense the presence or absence of up to eight 24 volt dc signals. DC Input Module 502-02972-08 is used to sense eight 15 volt dc signals. DC Input Module 502-03358-08 is used to sense eight 12 volt dc signals. These input signals are converted to data in a form that can be used by the CPU.

Input circuits are filtered and optically isolated from the microcomputer bus to facilitate reliable operation in electrically noisy environments.

External devices are wired to the module through either a 36-pin card edge connector or a DC Input Faceplate. The latter option permits simplified wiring connections to be made to compression screw terminals and also features eight input status LEDs.

The DC Input Module input circuit is shown in Figure 2. This circuit is typical of the eight inputs.

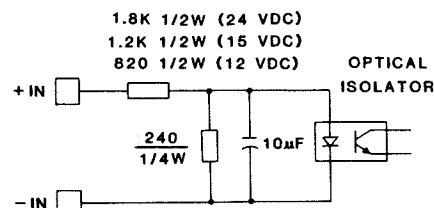


FIGURE 2. INPUT CIRCUIT (1 of 8)

2.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

DC Input Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly.

8 DC INPUT MODULE

Set the Address Select Switches per the instructions in Section 3.0. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

3.0 ADDRESSING

Each 8 DC Input Module occupies eight memory locations. The five board-mounted address switches must be set for the lowest of the eight addresses desired. When the state of address lines A3 through A7 matches the switch settings, the module is selected. A CLOSED switch (handle in the ON position) requires the corresponding address line to be LOW for module selection. An OPEN switch (OFF position) requires the address line to be HIGH.

Table 1 contains the switch settings for the 32 possible beginning address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF OFF OFF OFF	x128	ON OFF OFF OFF OFF
x008	ON OFF OFF OFF OFF	x136	ON OFF OFF OFF OFF
x016	ON OFF OFF OFF OFF	x144	ON OFF OFF OFF OFF
x024	ON OFF OFF OFF OFF	x152	ON OFF OFF OFF OFF
x032	ON OFF OFF OFF OFF	x160	ON OFF OFF OFF OFF
x040	ON OFF OFF OFF OFF	x168	ON OFF OFF OFF OFF
x048	ON OFF OFF OFF OFF	x176	ON OFF OFF OFF OFF
x056	ON OFF OFF OFF OFF	x184	ON OFF OFF OFF OFF
x064	ON OFF OFF OFF OFF	x192	ON OFF OFF OFF OFF
x072	ON OFF OFF OFF OFF	x200	ON OFF OFF OFF OFF
x080	ON OFF OFF OFF OFF	x208	ON OFF OFF OFF OFF
x088	ON OFF OFF OFF OFF	x216	ON OFF OFF OFF OFF
x096	ON OFF OFF OFF OFF	x224	ON OFF OFF OFF OFF
x104	ON OFF OFF OFF OFF	x232	ON OFF OFF OFF OFF
x112	ON OFF OFF OFF OFF	x240	ON OFF OFF OFF OFF
x120	ON OFF OFF OFF OFF	x248	ON OFF OFF OFF OFF

Numbers in the PC ADDRESS column may be used for contact number suffixes. The leading "x" becomes a decimal number that is based on the rack in which the

TABLE 2. RACK I/O ADDRESSES

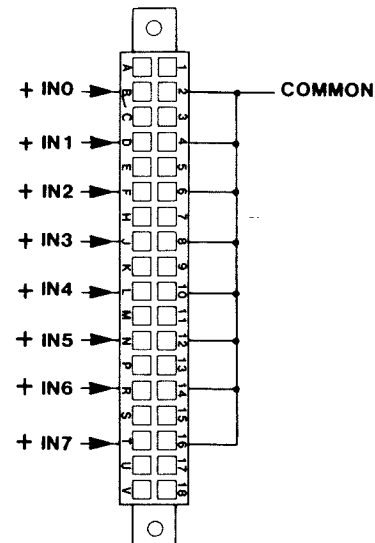
RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

board is installed. As seen in Table 2, "x" can be 2 through 9.

Rack address assignments are made in 256 address increments. A jumper on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignments into upper and lower 128-address increments.

4.0 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 8 DC Input Module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available. Dummy contacts may be inserted into the connector at unused places for improved holding power. A complete eight foot DC Input Harness is available.



A00016

FIGURE 3. CARD EDGE CONNECTOR WIRING

8 DC INPUT MODULE

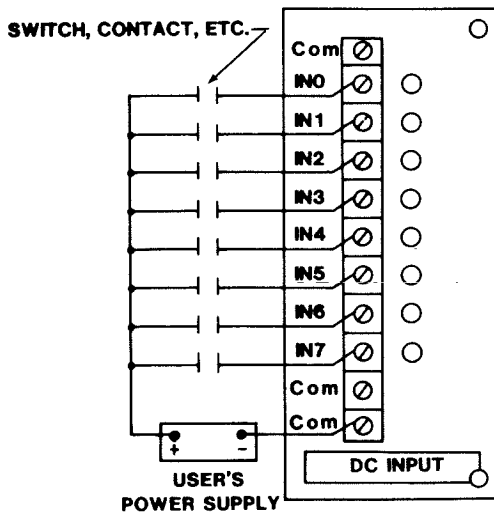
The recommended external wiring convention is as follows: +Inputs should use No. 20 blue wire; common and jumpers should use No. 20 white/green wire.

NOTE

The eight jumper pins labeled COMMON are the return paths from the +IN inputs. These pins are not connected to the system logic ground.

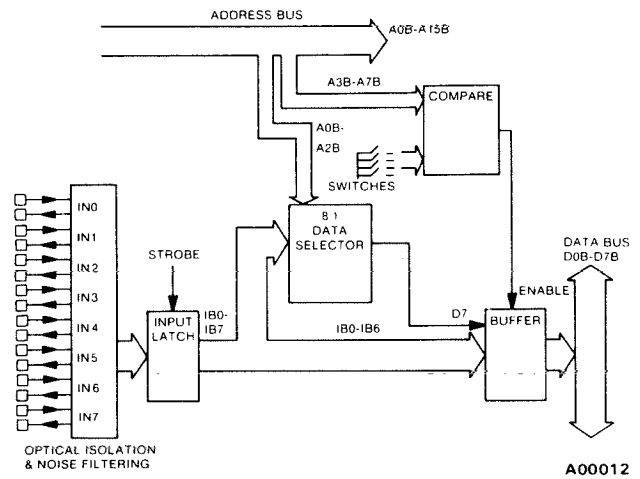
5.0 FACEPLATE CONNECTOR

The faceplate connector allows wiring connections to be made to compression screw terminals. LED indicators are supplied to assist in troubleshooting by glowing when an input signal is present.



A00017

FIGURE 4. FACEPLATE WIRING



A00012

FIGURE 5. BLOCK DIAGRAM

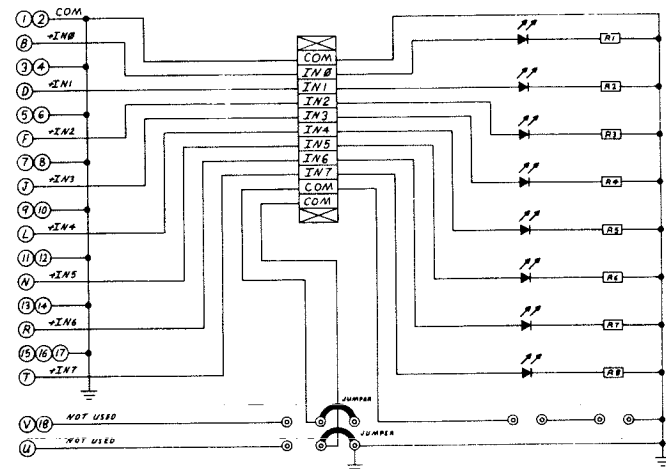
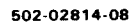


FIGURE 6. FACEPLATE SCHEMATIC

[illegible]

Page 3-4



16 DC INPUT MODULE

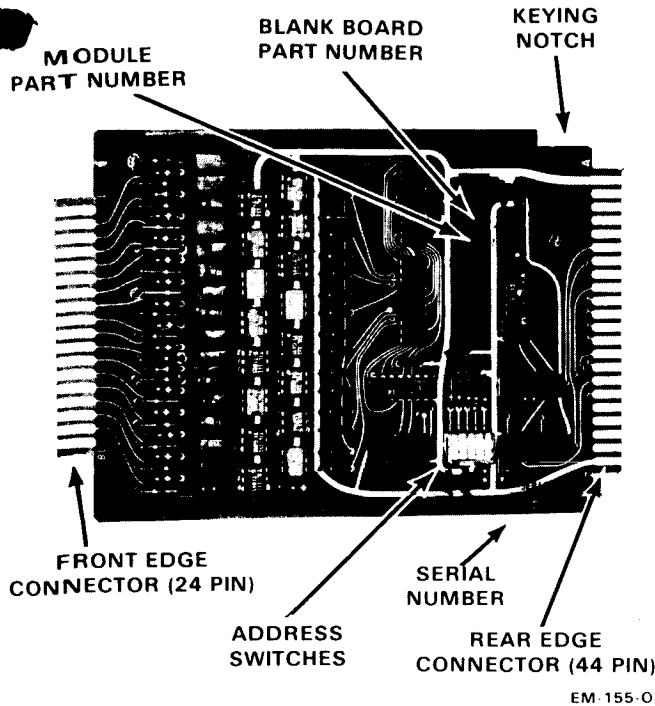


FIGURE 1. 16 DC INPUT MODULE

1.0 INTRODUCTION

Each 16-input DC Input Module, part 502-02814-16, allows the user to sense the presence or absence of up to sixteen 24 volt dc signals. DC Input Module 502-02972-16 is used to sense sixteen 15 volt dc signals. DC Input Module 502-03358-16 is used to sense sixteen 12 volt dc signals. These input signals are converted to data in a form that can be used by the CPU.

Input circuits are filtered and optically isolated from the microcomputer bus for reliable operation in electrically noisy environments.

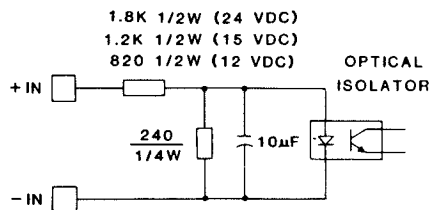


FIGURE 2. INPUT CIRCUIT (1 of 16)

External devices are connected to the module through a 36-pin card edge connector.

The DC Input Module input circuit is shown in Figure 2. This circuit is typical of the sixteen inputs.

2.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

DC Input Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wire connections to and fasten the card edge connector before applying power.

3.0 ADDRESSING

Each 16 DC Input Module occupies sixteen memory locations. The board-mounted Address Switches must be set for the lowest of the sixteen addresses desired. Switch 1 may be disregarded. When the state of address lines A4 through A7 matches the Address Switch settings, the

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	1 2 3 4 5		1 2 3 4 5
X000	ON OFF	X128	ON OFF
X016	ON OFF	X144	ON OFF
X032	ON OFF	X160	ON OFF
X048	ON OFF	X176	ON OFF
X064	ON OFF	X192	ON OFF
X080	ON OFF	X208	ON OFF
X096	ON OFF	X224	ON OFF
X112	ON OFF	X240	ON OFF

16 DC INPUT MODULE

module is selected. A CLOSED Address Switch (handle in the ON position) requires the corresponding address line to be LOW for module selection. An OPEN Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1 contains the Address Switch settings for the 16 possible beginning address points.

The PC ADDRESS column may be used for contact number suffixes. The leading "x" becomes a decimal number that is based on the rack in which the board is installed. As seen in TABLE 2, "x" can be 2 through 9.

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

Rack address assignments are made in 256-address increments. A jumper on the Nest Receiver Board permits either one rack to respond to all 256 addresses, or two racks to split the assignments into upper and lower 128-address increments.

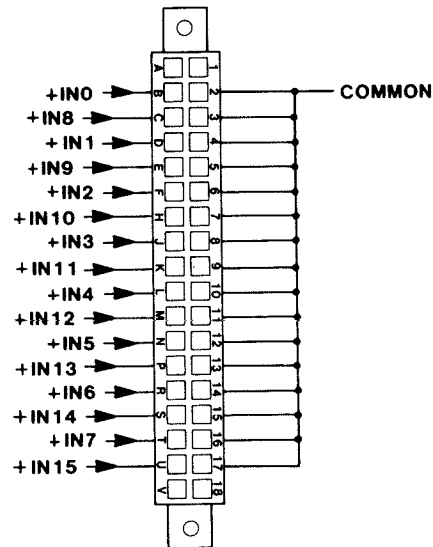
4.0 HARDWARE INTERFACING

A 36-pin card edge connector may be used to connect the 16 DC Input Module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available. Dummy contacts may be inserted into the connector at unused places for improved holding power. A complete eight foot 16 DC Input Harness is available.

The recommended external wiring convention is as follows: +Inputs should be No. 20 blue wire; common jumpers should be No. 20 white/green wire.

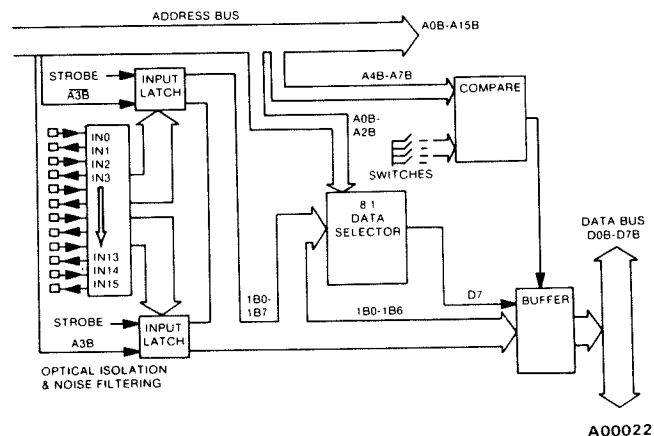
NOTE

The sixteen pins labeled COMMON are the return paths from the +IN inputs. These pins are not connected to the system logic ground.



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FIGURE 3. CARD EDGE CONNECTOR WIRING



A000022

FIGURE 4. BLOCK DIAGRAM

16 DC INPUT MODULE

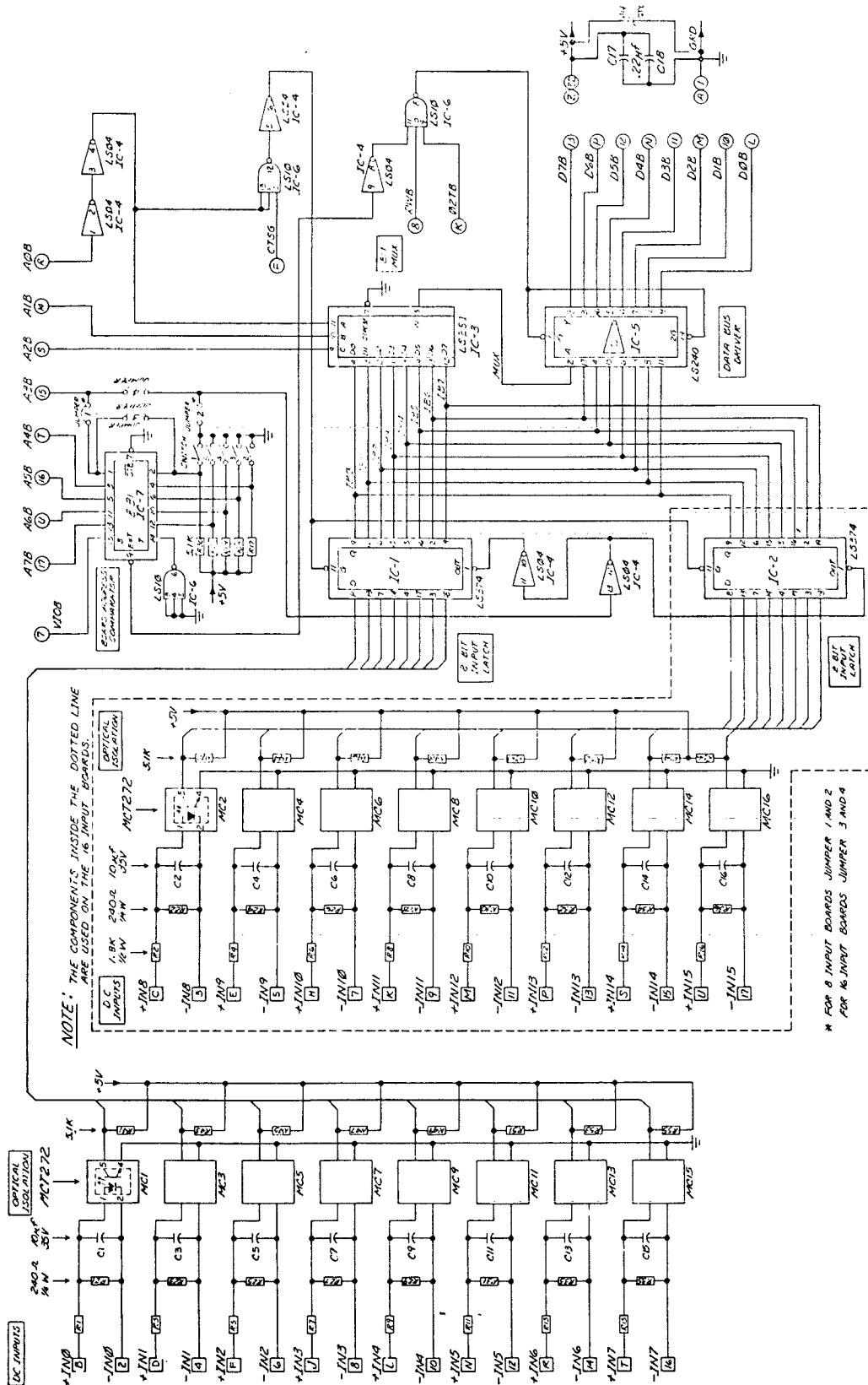
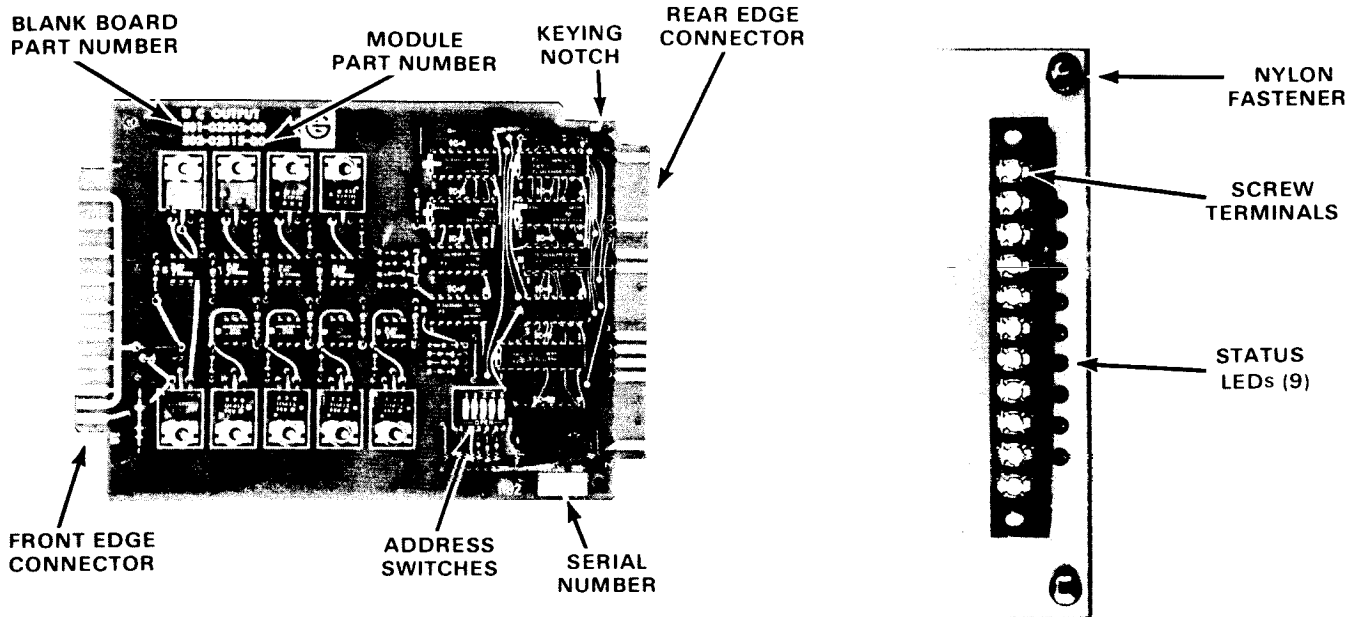


FIGURE 5. 16 DC INPUT MODULE SCHEMATIC

502-02814-16



DC OUTPUT MODULE



EM-155-M

FIGURE 1 DC OUTPUT MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each DC Output Module (part no. 502-02815-00) allows the user to control up to eight 8 to 30 volt dc circuits. Total current output from a DC Output Module is limited to 1 ampere. A user-furnished dc power supply must be connected to the module to provide a source voltage. This voltage is distributed to the loads by transistors which act as solid-state switches. Electronic current limiting prevents damage to the module due to excessive loads. The microcomputer bus is optically isolated from the transistor switches. External devices are connected to the module with either a 36 pin card edge connector or a DC Output Faceplate Connector. The latter option permits simplified wiring to compression screw terminals and features nine status LEDs.

2.0 INSTALLATION

DC Output modules may be installed in the Master Rack or Expansion Racks. The

racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Select Switches per the instructions in Section 2.1. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to comply may result in permanent damage to the module.

2.1 ADDRESSING

Each DC Output Module occupies eight memory locations. The five board-mounted address switches must be set for the lowest of the eight addresses desired. When the states of address lines A3 through A7 match the switch settings, the module is selected. A CLOSED switch (handle in the ON

DC OUTPUT MODULE

position) requires the corresponding address line to be LOW for selection. An OPEN switch (OFF position) requires the address line to be HIGH.

Table 1 contains the switch settings for the 32 possible beginning address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF OFF OFF OFF	x128	ON OFF OFF OFF OFF
x008	ON OFF OFF OFF OFF	x136	ON OFF OFF OFF OFF
x016	ON OFF OFF OFF OFF	x144	ON OFF OFF OFF OFF
x024	ON OFF OFF OFF OFF	x152	ON OFF OFF OFF OFF
x032	ON OFF OFF OFF OFF	x160	ON OFF OFF OFF OFF
x040	ON OFF OFF OFF OFF	x168	ON OFF OFF OFF OFF
x048	ON OFF OFF OFF OFF	x176	ON OFF OFF OFF OFF
x056	ON OFF OFF OFF OFF	x184	ON OFF OFF OFF OFF
x064	ON OFF OFF OFF OFF	x192	ON OFF OFF OFF OFF
x072	ON OFF OFF OFF OFF	x200	ON OFF OFF OFF OFF
x080	ON OFF OFF OFF OFF	x208	ON OFF OFF OFF OFF
x088	ON OFF OFF OFF OFF	x216	ON OFF OFF OFF OFF
x096	ON OFF OFF OFF OFF	x224	ON OFF OFF OFF OFF
x104	ON OFF OFF OFF OFF	x232	ON OFF OFF OFF OFF
x112	ON OFF OFF OFF OFF	x240	ON OFF OFF OFF OFF
x120	ON OFF OFF OFF OFF	x248	ON OFF OFF OFF OFF

Numbers in the PC ADDRESS column may be used for coil number suffixes. The leading "x" represents a decimal number based on the rack in which the module is plugged. As indicated in Table 2, "x" can be 2 through 9.

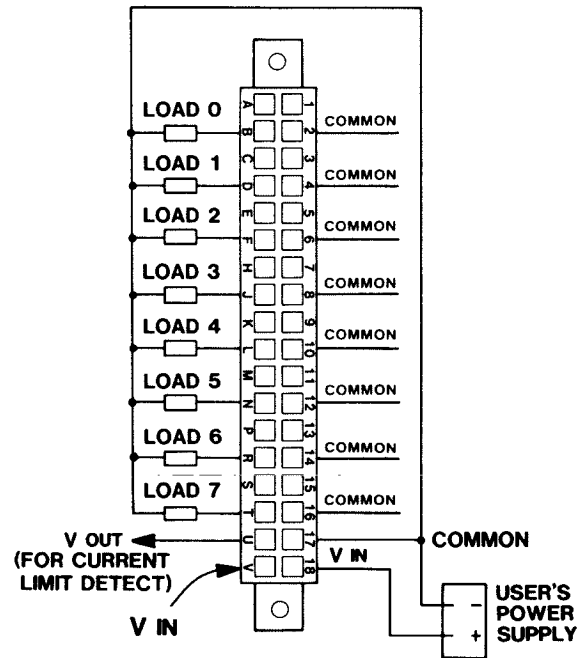
TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

Rack address assignments are made in 256 address increments. A jumper on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignment into upper and lower 128-address increments.

2.2 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the DC Output Module to external devices. Phosphor bronze-crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding capability. A complete eight foot DC Output Harness is available.



A00004

FIGURE 2. CARD EDGE CONNECTOR WIRING

The recommended external wiring convention is as follows: V-IN, V-OUT, and LOADS should be No. 20 blue wire; common, No. 20 white/green wire.

NOTE

The nine pins that are marked COMMON form a return path from the loads to the user's power supply. These pins are not connected to the system logic ground.

DC OUTPUT MODULE

2.3 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals. LED indicators are provided to assist in troubleshooting. The upper eight LEDs indicate output status by glowing when the respective outputs are energized. The lower LED glows when power is present from the user's power supply.

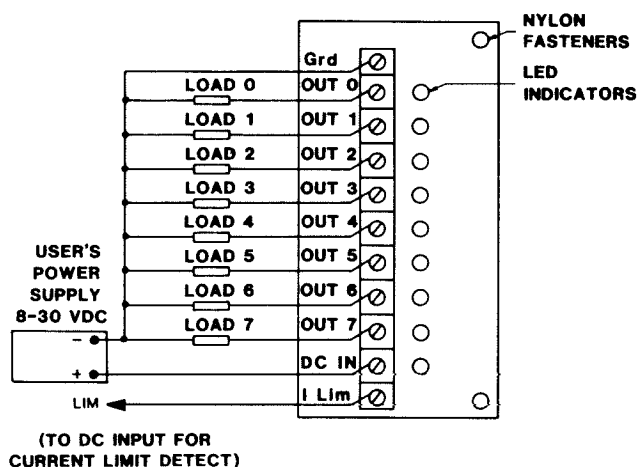


FIGURE 3. FACEPLATE WIRING

Module can monitor eight DC Output Modules. The current limit circuit will return the board to normal operation when the overload is removed.

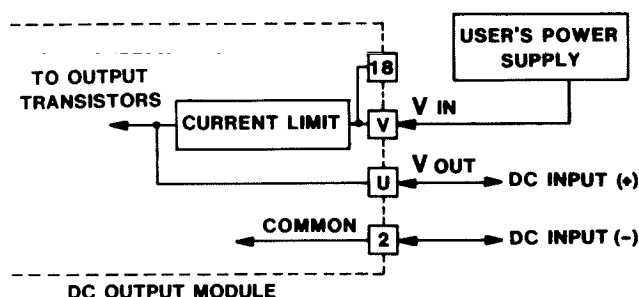


FIGURE 4. CURRENT LIMIT CIRCUIT

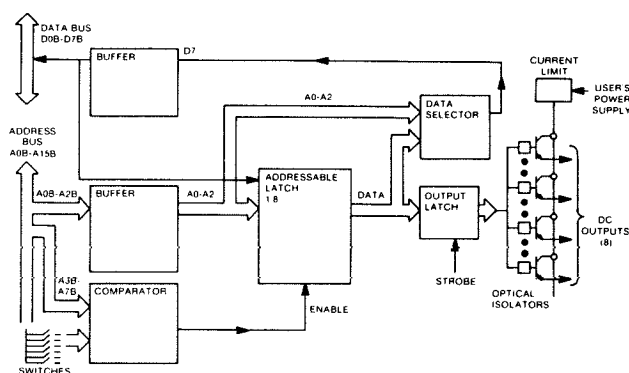


FIGURE 5. BLOCK DIAGRAM

3.0 CURRENT LIMIT

The current limit circuit prevents damage to the module from occurring in the event of a high-current condition (e.g. shorted output). Total current output for a DC Output Module is limited to 1.0 ampere for any combination of outputs. If desired, an optional circuit may be connected to each DC Output Module to signal an over-current condition. By connecting these circuits to dc inputs, the system can detect and display any boards in current limit.

The signal presented to the DC Input Module will be at a high level when the DC Output Module is functioning correctly. When this signal falls to a low level, the DC Output Module is in current limit. Each DC Output Module has one V-OUT pin so that an 8 DC Input

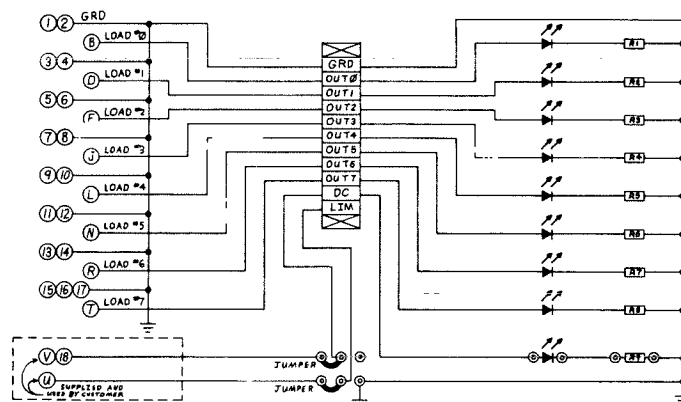
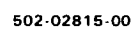


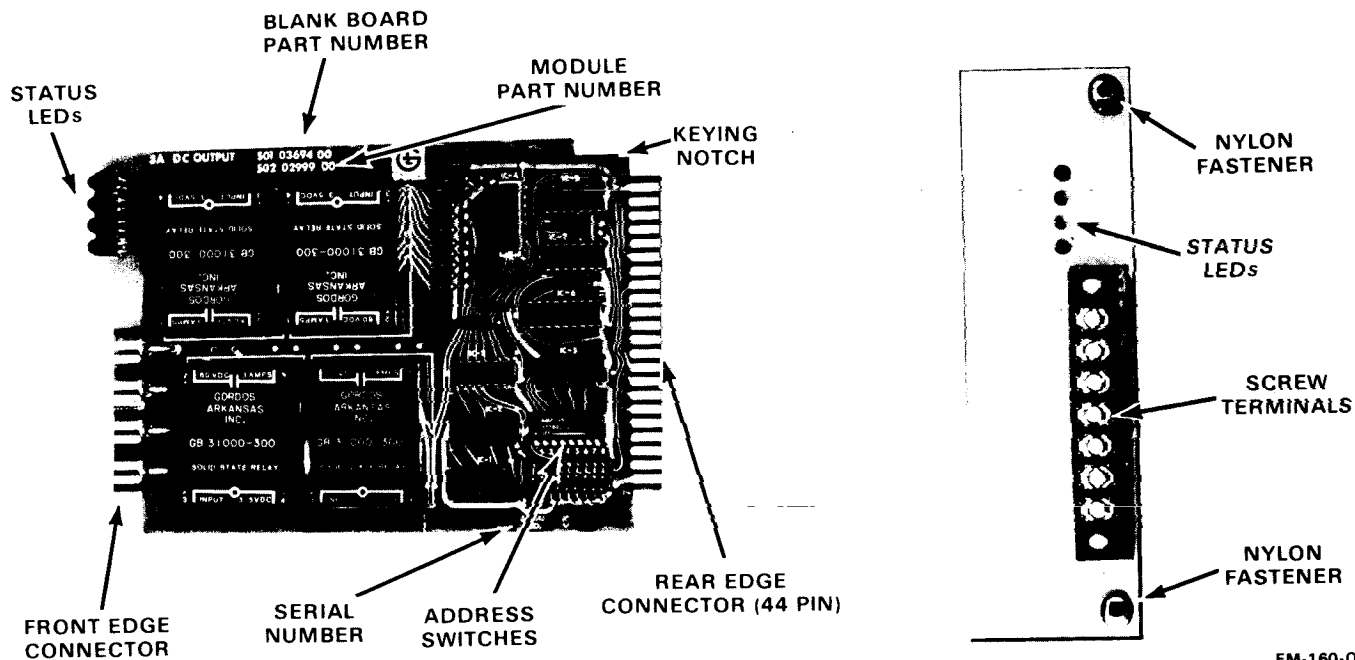
FIGURE 6. FACEPLATE SCHEMATIC

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APPENDIX A

3 AMP DC OUTPUT MODULE



EM-160-Q

FIGURE 1. 3 AMP DC OUTPUT MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each 3 Amp DC Output Module (part 502-02999-00) allows the user to control up to four dc circuits. Loads of up to 3 amperes and 50 volts are permitted. A user-furnished dc power supply must be connected to the module to provide a source voltage. This voltage is distributed to the loads by solid state relays. Four on-board fuses protect the relays from overload. The microcomputer bus is optically isolated from the relays. External devices are connected to the module with either a 24-pin card edge connector or a 3 Amp DC Output Faceplate (shown in Figure 1). The latter option permits simplified wiring to compression screw terminals. Four board-mounted status LEDs are visible through windows in the faceplate.

2.0 INSTALLATION

DC Output modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the

instructions in Section 3.0. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

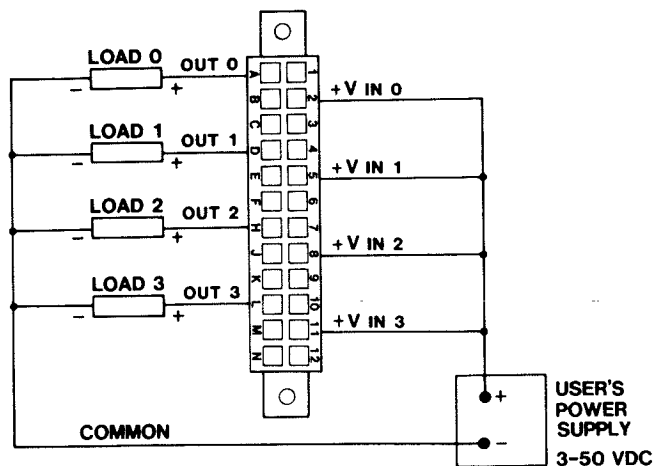
2.1 CARD EDGE CONNECTOR

A 24-pin card edge connector may be used to connect the 3 Amp DC Output Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power.

Recommended external wiring is as follows: V IN and positive sides of the load should be wired with No. 16 blue

3 AMP DC OUTPUT MODULE

wire. Common should be No. 16 white/green wire.

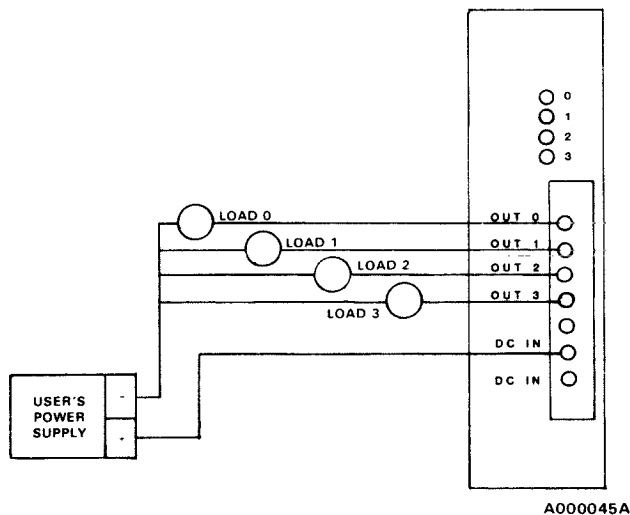


A000026

FIGURE 2. CARD EDGE CONNECTOR WIRING

2.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals. Four LED indicators assist in troubleshooting by glowing when the respective outputs are energized.



A000045A

FIGURE 3. FACEPLATE WIRING

3.0 ADDRESSING

Each 3 Amp DC Output Module occupies four memory locations. The six board-mounted Address Switches must be

set for the lowest of the four addresses desired. When the states of address lines A2 through A7 match the Address Switch settings, the module is selected. A CLOSED Address Switch (handle in the ON position) requires the corresponding address line to be LOW for selection. An OPEN Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1 contains Address Switch settings for the 64 possible beginning address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
x000	ON 123456	x088	ON 123456	x176	ON 123456
x004	ON 123456	x092	ON 123456	x180	ON 123456
x008	ON 123456	x096	ON 123456	x184	ON 123456
x012	ON 123456	x100	ON 123456	x188	ON 123456
x016	ON 123456	x104	ON 123456	x192	ON 123456
x020	ON 123456	x108	ON 123456	x196	ON 123456
x024	ON 123456	x112	ON 123456	x200	ON 123456
x028	ON 123456	x116	ON 123456	x204	ON 123456
x032	ON 123456	x120	ON 123456	x208	ON 123456
x036	ON 123456	x124	ON 123456	x212	ON 123456
x040	ON 123456	x128	ON 123456	x216	ON 123456
x044	ON 123456	x132	ON 123456	x220	ON 123456
x048	ON 123456	x136	ON 123456	x224	ON 123456
x052	ON 123456	x140	ON 123456	x228	ON 123456
x056	ON 123456	x144	ON 123456	x232	ON 123456
x060	ON 123456	x148	ON 123456	x236	ON 123456
x064	ON 123456	x152	ON 123456	x240	ON 123456
x068	ON 123456	x156	ON 123456	x244	ON 123456
x072	ON 123456	x160	ON 123456	x248	ON 123456
x076	ON 123456	x164	ON 123456	x252	ON 123456
x080	ON 123456	x168	ON 123456		
x084	ON 123456	x172	ON 123456		

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

3 AMP DC OUTPUT MODULE

The PC ADDRESS column may be utilized for coil number suffixes. The leading "x" becomes a decimal number based on the rack in which the board is plugged. As seen in TABLE 2, "x" can be 2 through 9.

Rack address assignments are made in 256-address increments. A jumper on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignment into upper and lower 128 address increments.

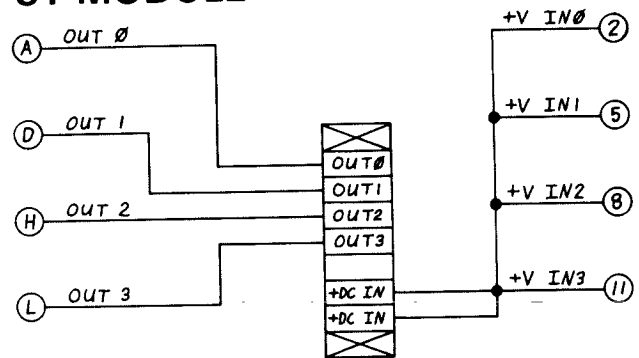
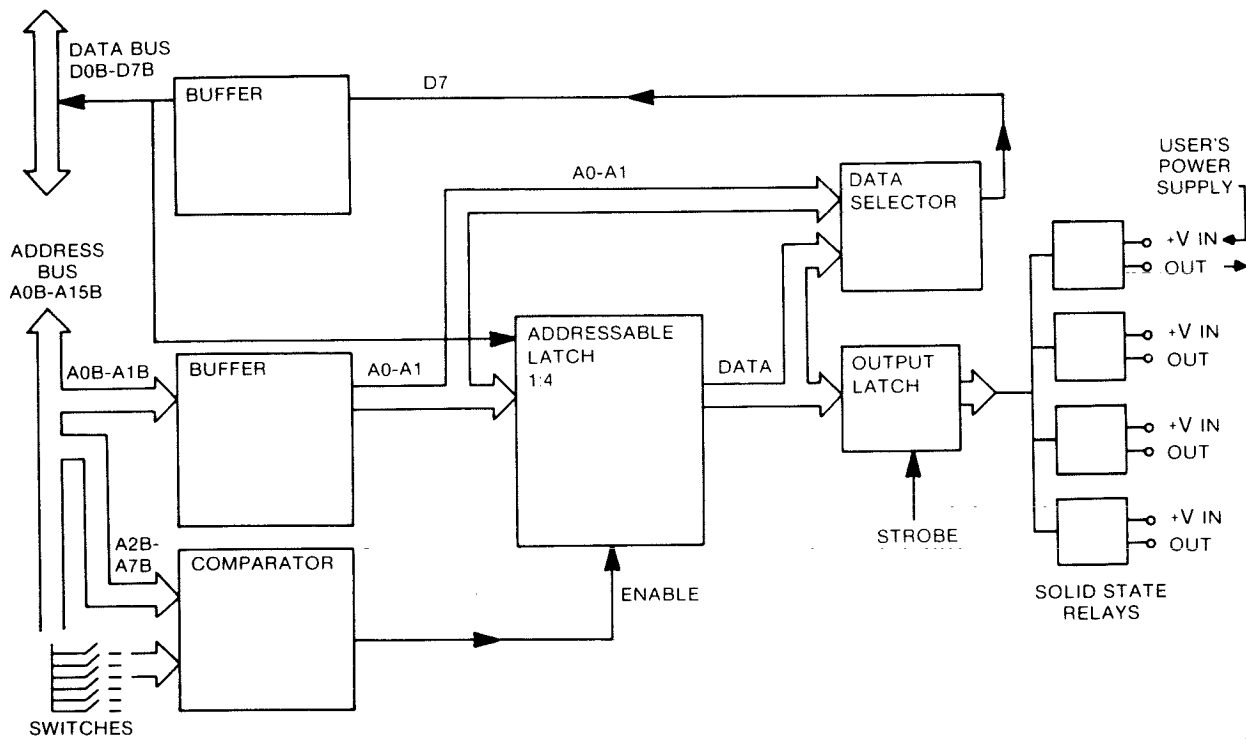


FIGURE 5. FACEPLATE SCHEMATIC



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FIGURE 4. BLOCK DIAGRAM

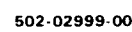
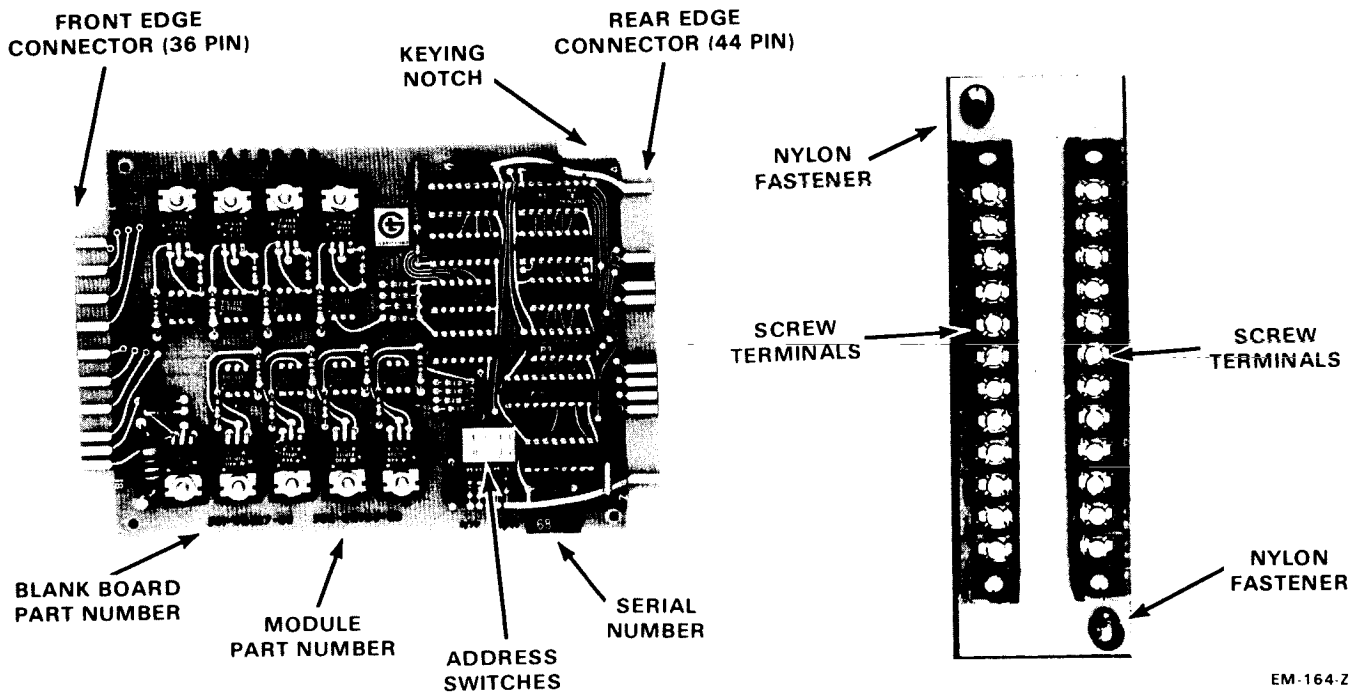
[illegible]

FIGURE 6. 3 AMP DC OUTPUT MODULE SCHEMATIC

DC OUTPUT INTERFACE MODULE



EM-164-Z

FIGURE 1. DC OUTPUT INTERFACE MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each DC Output Interface Module (part 502-02954-00) allows the user to control up to eight independent 8 to 30 volt dc circuits. Total current output for a DC Output Interface module is limited to 1 ampere. A user-furnished dc power supply must be connected to the module to provide a source voltage. This voltage is distributed to the loads by transistors acting as solid-state switches. Alternatively, wiring connections to the module may be configured to sink current from the loads. Both positive and negative circuits may be controlled. An electronic current limit circuit is provided to prevent damage to the module from excessive loads. The microcomputer bus is optically isolated from the transistor switches for reliable operation in electrically noisy environments.

External devices are connected to the module through either a 36-pin card edge connector or a DC Output Interface

Faceplate (shown in FIGURE 1). The latter option permits simplified wiring connections to be made to compression screw terminals.

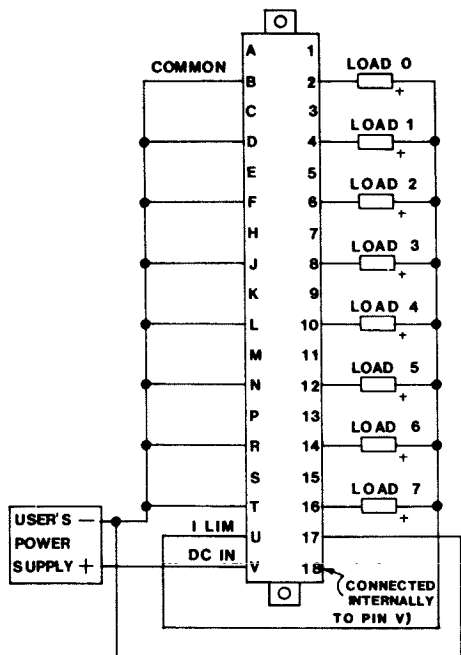
2.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

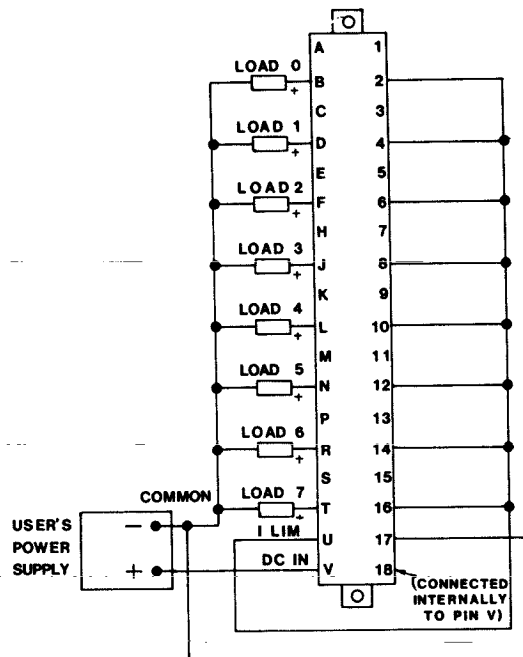
DC Output Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

DC OUTPUT INTERFACE MODULE



A000046

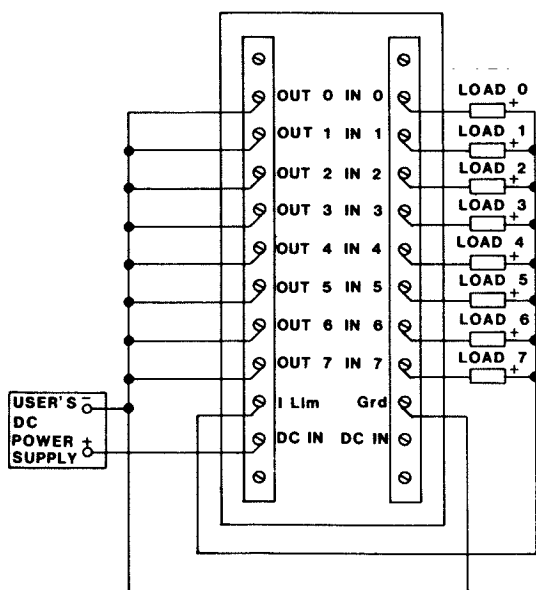
SINK MODE



A000047

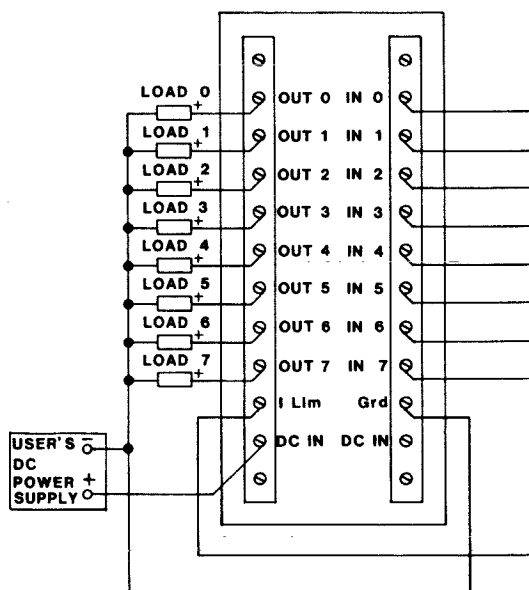
SOURCE MODE

FIGURE 2. CARD EDGE CONNECTOR WIRING



A000051

SINK MODE



A000050

SOURCE MODE

FIGURE 3. FACEPLATE WIRING

DC OUTPUT INTERFACE MODULE

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the DC Output Interface Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power. A complete eight foot DC Output Interface Harness is available.

The recommended external wiring convention is as follows: V-IN, V-OUT, and LOAD circuits should be No. 20 blue wire; COMMON should be No. 20 white/green wire.

FIGURE 2 illustrates a DC Output Interface Module connected for the current sinking mode. Current for the load is provided by the user power supply through the current limit circuit. The loads are controlled via the return (or negative) sides.

FIGURE 2 also illustrates a DC Output Interface Module connected for the current sourcing mode. Current is provided by the user power supply through the current limit circuit, and distributed to the loads via the positive sides.

2.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be made to compression screw terminals. See FIGURE 3.

3.0 ADDRESSING

Each DC Output Interface Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired. The module will be selected when the states of address lines A3 through A7 match the Address Switch settings. A closed Address Switch (handle in the ON position) requires the corresponding address line to be LOW for selection. An open Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1 contains the Address Switch settings for the 32 possible address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF	x128	ON OFF
x008	ON OFF	x136	ON OFF
x016	ON OFF	x144	ON OFF
x024	ON OFF	x152	ON OFF
x032	ON OFF	x160	ON OFF
x040	ON OFF	x168	ON OFF
x048	ON OFF	x176	ON OFF
x056	ON OFF	x184	ON OFF
x064	ON OFF	x192	ON OFF
x072	ON OFF	x200	ON OFF
x080	ON OFF	x208	ON OFF
x088	ON OFF	x216	ON OFF
x096	ON OFF	x224	ON OFF
x104	ON OFF	x232	ON OFF
x112	ON OFF	x240	ON OFF
x120	ON OFF	x248	ON OFF

The PC ADDRESS column may be utilized for coil number suffixes. The leading "x" becomes a decimal number based on the rack in which the board is installed. As seen in TABLE 2, "x" can be 2 through 9.

Rack address assignments are made in 256-address increments. A jumper on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignment into upper and lower 128-address increments.

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

DC OUTPUT INTERFACE MODULE

4.0 CURRENT LIMIT

A current limit circuit located on the module can be connected by the user to prevent damage to the module in the event of a shorted output. To provide the system with monitoring capabilities, the V-OUT pin of each module current limiter may be connected to a dc input. With proper software, the system will detect and display any boards in a current limit condition. Figure 4 illustrates the proper connections for current limit monitoring.

The signal presented to the DC Input Module will be a high level when the DC Output Interface Module is functioning correctly. When this signal falls to a low level, the dc output circuit is in current limit. Since each DC Output Interface Module has a V-OUT pin, an 8-input DC Input Module can monitor eight DC Output Interface Modules. The current limit circuit will return the module to normal operation when the overload is removed.

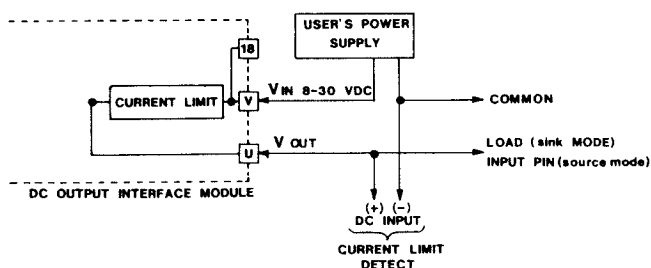


FIGURE 4. CURRENT LIMIT CIRCUIT

5.0 OUTPUT DERATING WITH TEMPERATURE

A given output can pass 1A at 25°C. Under typical conditions at 60°C, an output can safely pass .7A. Under worst case conditions at 70°C, this is reduced to .4A. However, under these same worst case conditions, 1A can be allowed to flow at a 40% duty cycle. The maximum period of the duty cycle is 250 mSec.

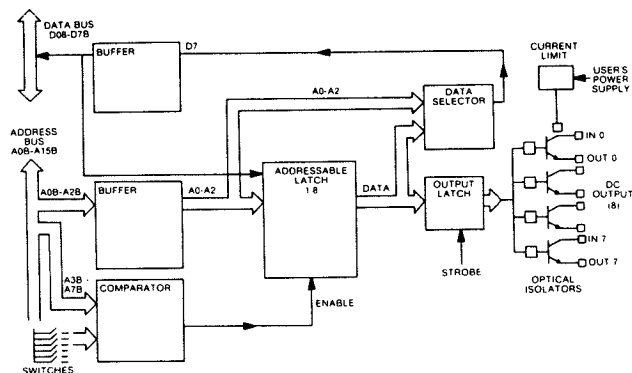


FIGURE 5. BLOCK DIAGRAM

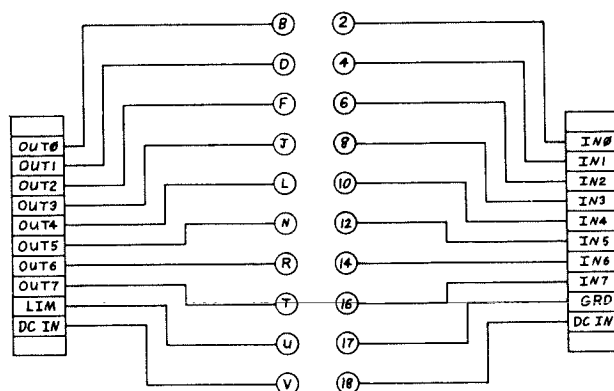
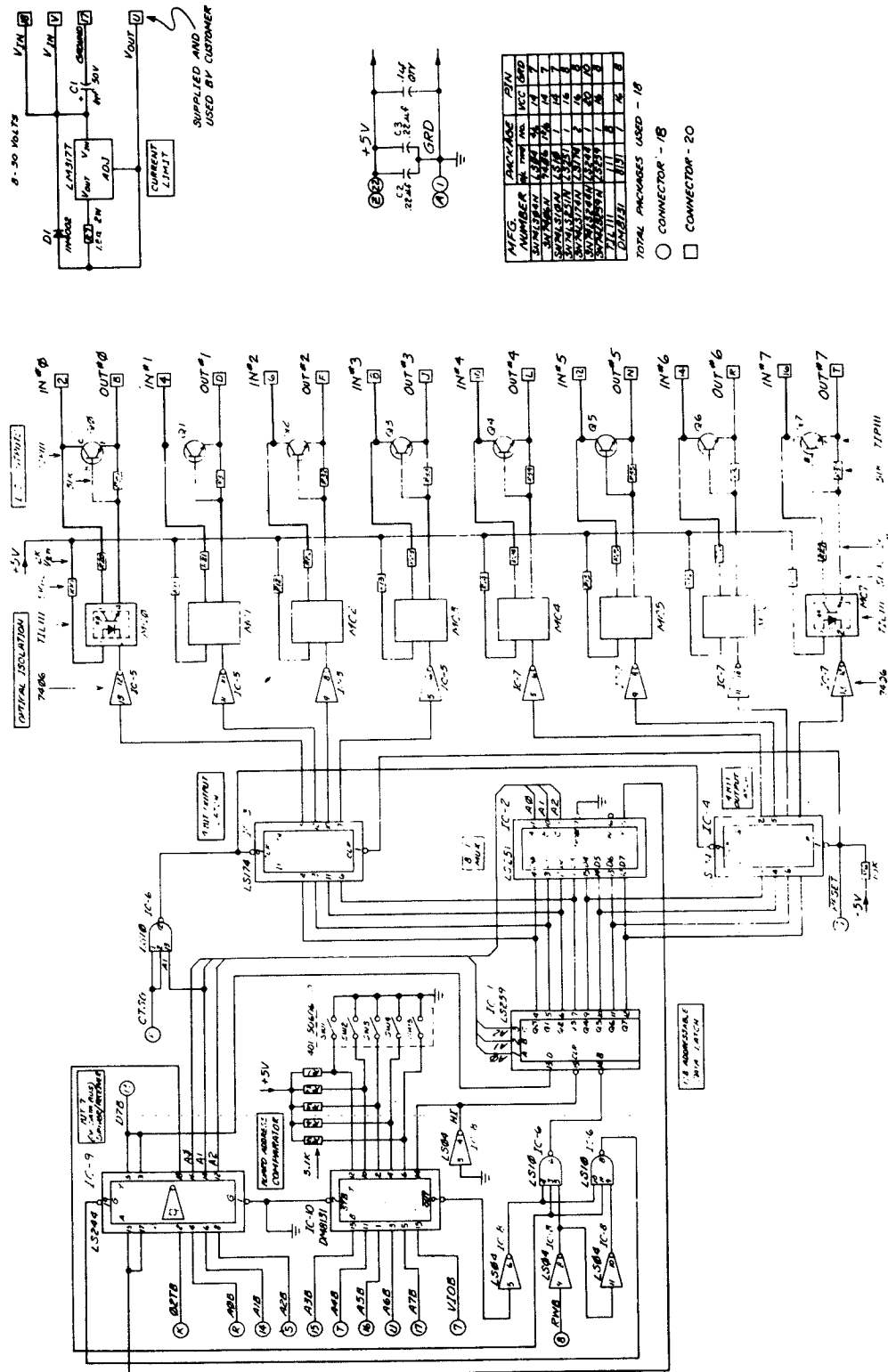


FIGURE 6. FACEPLATE SCHEMATIC

DC OUTPUT INTERFACE MODULE





PARALLEL TTL I/O MODULE

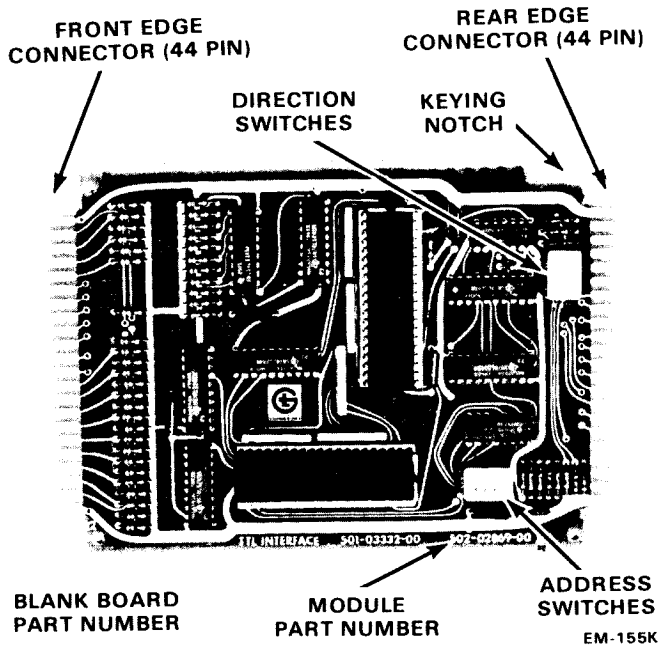


FIGURE 1. PARALLEL TTL I/O MODULE

1.0 INTRODUCTION

The Parallel TTL I/O Module provides interfacing between the Programmable Controller and devices using standard 5-volt TTL logic levels. Four, 8-bit, bi-directional ports and appropriate control lines are buffered and have pull up resistors attached. External devices are wired to the module through a 44-pin card edge connector.

2.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

The TTL I/O Module may only be installed in the Master Rack. Expansion racks are used for AC and DC Input/Output Modules.

The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address and Direction Switches per the instructions in Sections 3.0 and 2.1 respectively. Make wiring connections to and fasten the card edge connector before applying power.

2.1 DIRECTION SWITCHES

Each TTL I/O Module has four, 8-bit ports with appropriate control lines that are used for communication with a peripheral device. All ports and control lines are buffered to ensure that proper logic levels are received and sent by the modules and the associated peripherals.

TABLE 1. DIRECTION SWITCH SETTINGS

PORT NO.	INPUT OR OUTPUT	DIRECTION SWITCHES				
		1	2	3	4	5
1	INPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
1	OUTPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
2	INPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
2	OUTPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
3	INPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
3	OUTPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
4	INPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐
4	OUTPUT	ON	☐	☐	☐	☐
		OFF	☐	☐	☐	☐

The ports are bi-directional; that is, the ports may be configured in software to act as either input or output ports. The buffers connected to these ports must also be configured either as input buffers or as output buffers. A Direction Switch, described in TABLE 1, selects the desired buffer configuration.

PARALLEL TTL I/O MODULE

(Peripheral Interface Adapter). Two 5V and GRD connections are provided. All port lines, and CA1/CB1, are pulled up with resistors to provide logical "high" levels. The buffer TTL I/O Module is capable of sourcing 8mA and sinking 17mA.

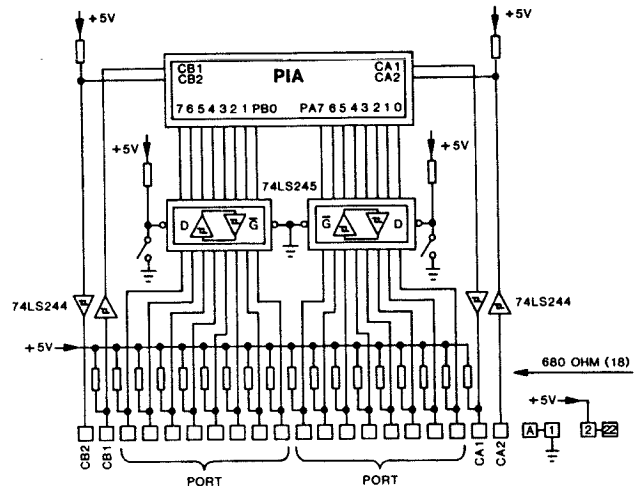


FIGURE 3. I/O CONFIGURATION

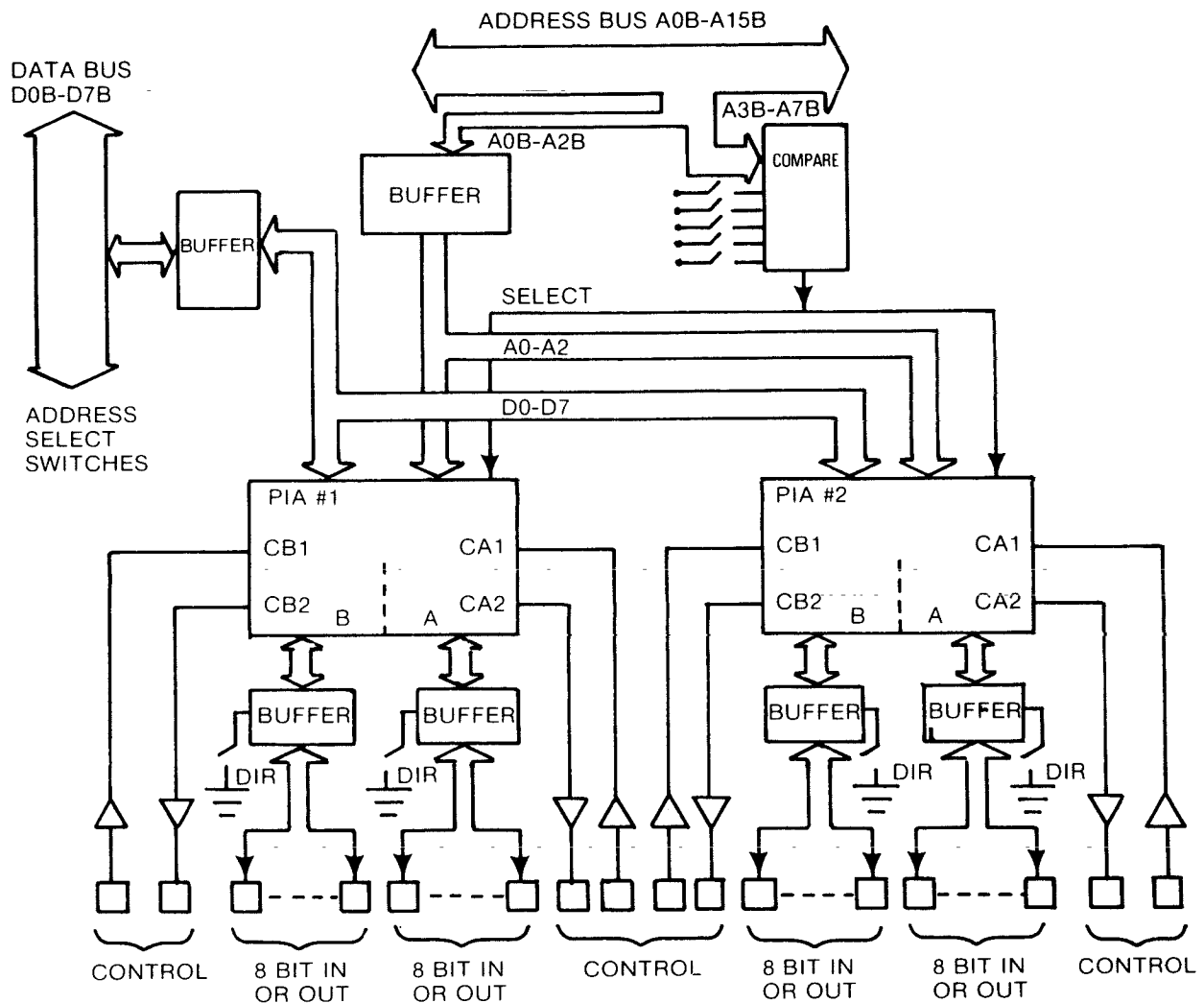


FIGURE 4. BLOCK DIAGRAM

PARALLEL TTL I/O MODULE

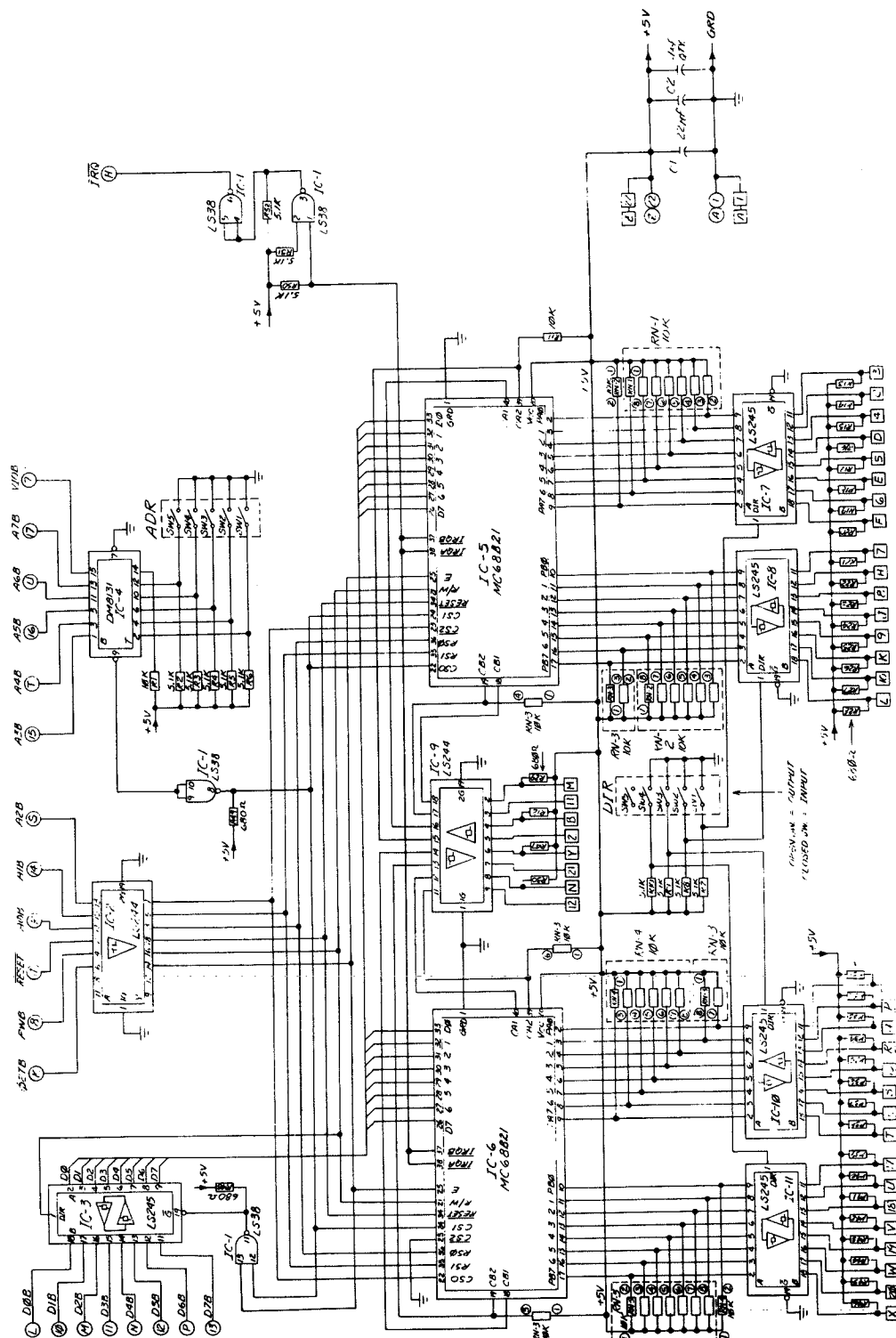


FIGURE 5. SCHEMATIC

502-02869-20

2 AMP DC OUTPUT MODULE

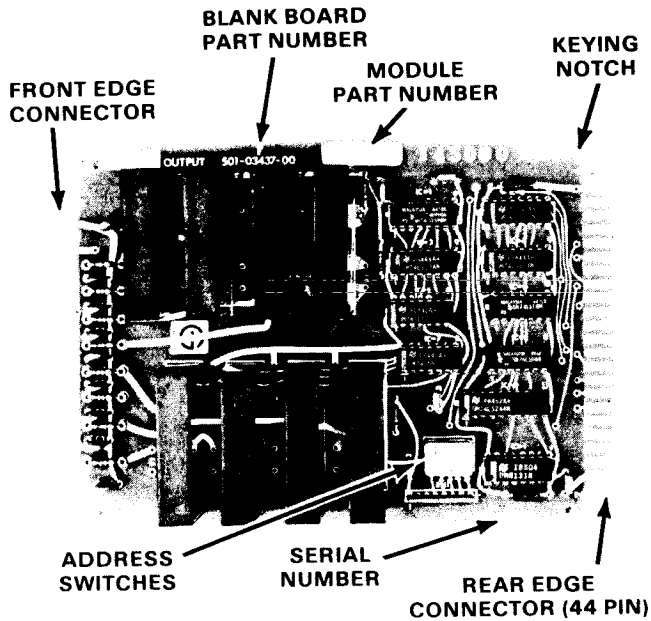


FIGURE 1. 2 AMP DC OUTPUT MODULE

1.0 INTRODUCTION

Each 2 Amp DC Output Module, part no. 502-03381-00, allows the user to control up to eight dc circuits with an operating voltage range of 4-50V dc.

A user-furnished dc power supply must be connected to the module. The dc voltage is distributed to the loads by solid state relays. The solid state relays have internal optical isolation for reliable computer operation in electrically noisy environments. The solid state relays are protected from current overload by on-board fuses. External devices may be connected to the module with a 36-pin card edge connector (see section 2.1).

1.1 CURRENT-CARRYING CAPACITY

The 2 Amp DC Output Module is capable of conducting up to 2 amps of current to each individual load. The maximum total current the module is designed to pass to all eight loads combined is 10 amps. Thus, five loads maximum can draw the peak 2 amp current at one time.

2.0 INSTALLATION

2 Amp DC Output Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wiring connections to the card edge connector and fasten the connector to the module before applying power.

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 2 Amp DC Output Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power. A complete 8-foot 2 Amp DC Output harness is available (part no. 502-03385-08).

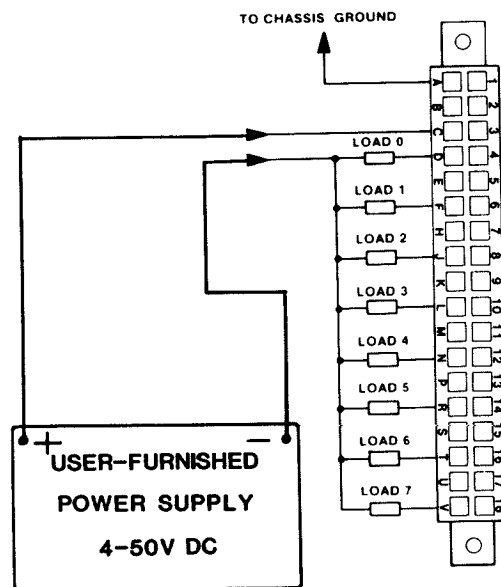


FIGURE 2. CARD EDGE CONNECTOR WIRING

The recommended external wiring convention is as follows: LOAD 0 through LOAD 7 and 4-50 volt dc should be No. 16 blue wire; CHASSIS GROUND should be No. 16 white/green wire.

2 AMP DC OUTPUT MODULE

NOTE

The CHASSIS GROUND pin should be connected to the frame of the card rack as close as possible to this module.

3.0 ADDRESSING

Each 2 Amp DC Output Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired.

TABLE 1 contains the Address Switch settings for the 32 possible beginning address points.

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF OFF OFF OFF	x128	ON OFF OFF OFF OFF
x008	ON OFF OFF OFF OFF	x136	ON ON OFF OFF OFF
x016	ON OFF OFF OFF OFF	x144	ON ON ON OFF OFF
x024	ON OFF OFF OFF OFF	x152	ON ON ON ON OFF
x032	ON OFF OFF OFF OFF	x160	ON ON ON ON ON
x040	ON OFF OFF OFF OFF	x168	ON ON ON ON ON
x048	ON OFF OFF OFF OFF	x176	ON ON ON ON ON
x056	ON OFF OFF OFF OFF	x184	ON ON ON ON ON
x064	ON OFF OFF OFF OFF	x192	ON ON ON ON ON
x072	ON OFF OFF OFF OFF	x200	ON ON ON ON ON
x080	ON OFF OFF OFF OFF	x208	ON ON ON ON ON
x088	ON OFF OFF OFF OFF	x216	ON ON ON ON ON
x096	ON OFF OFF OFF OFF	x224	ON ON ON ON ON
x104	ON OFF OFF OFF OFF	x232	ON ON ON ON ON
x112	ON OFF OFF OFF OFF	x240	ON ON ON ON ON
x120	ON OFF OFF OFF OFF	x248	ON ON ON ON ON

ON OFF ON OFF
OFF ON

TABLE 1. ADDRESS SWITCH SETTINGS

The PC ADDRESS column in Table 1 may be utilized for coil number suffixes. The leading "x" represents a decimal number based on the rack in which the module is plugged. As seen in TABLE 2, "x" can be 2 through 9.

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

TABLE 2. RACK I/O ADDRESSES

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

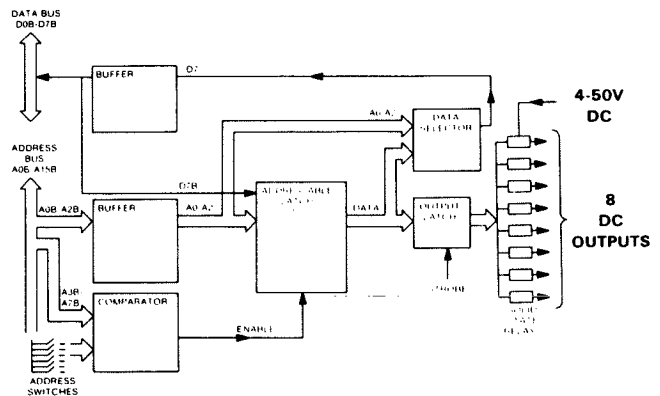
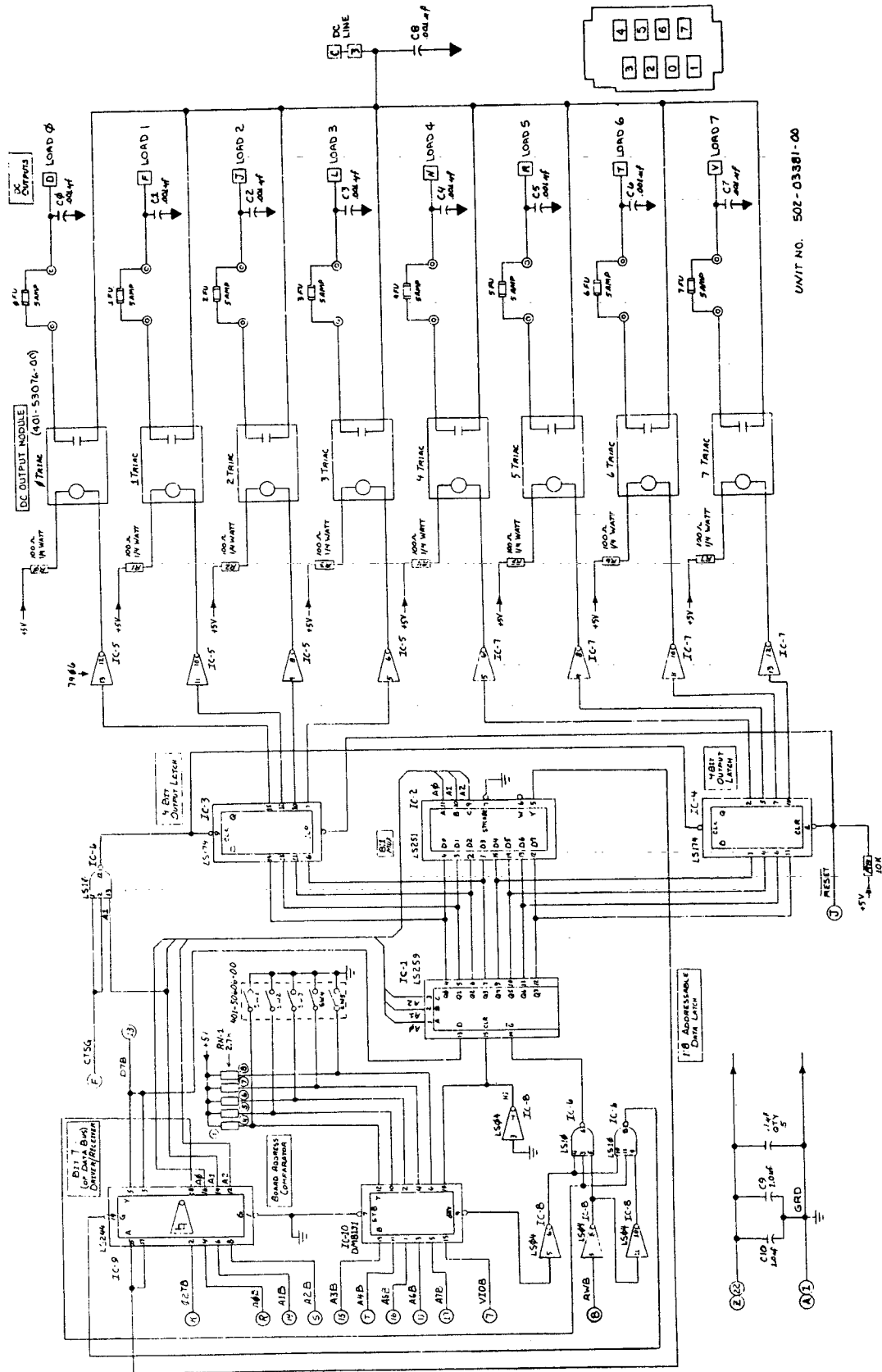


FIGURE 3. BLOCK DIAGRAM

2 AMP DC OUTPUT MODULE



UNIT NO. 502-03381-00

FIGURE 4. MODULE SCHEMATIC



DIGITAL CAM MODULE

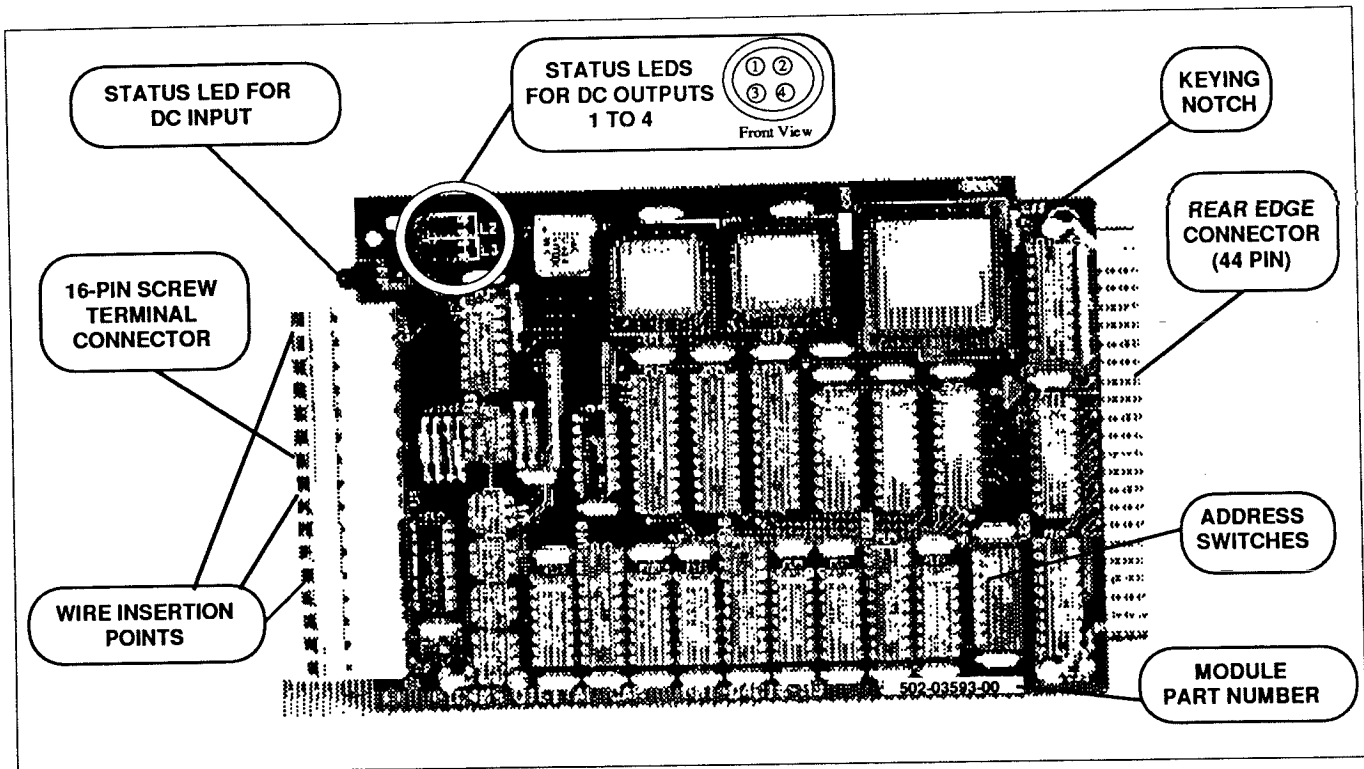


FIGURE 1. DIGITAL CAM MODULE

1.0 INTRODUCTION

The Digital Cam Module, part number 502-03593-00, contains circuitry for controlling the on/off states of four DC outputs. It operates in conjunction with an encoder module (Figure 2).

The control of the four outputs is based on the comparison of a 24-bit position counter to 24-bit high and low limit values. These limits are programmable in software.

The position counter receives count up and count down pulses from an encoder module. These pulses represent incremental position changes of the encoder. The counter can be preset and given a "rollover" value. An index pulse from the encoder module or a switched DC input can be used to reset the counter.

The comparison and subsequent update of the four outputs occurs each time a count up or count down pulse is received up to a rate of 400KHz. For higher rates (up to 1MHz), the update occurs approximately every 2 microseconds. There can be a trade off between count rate and number of limits. (See section 5.0.)

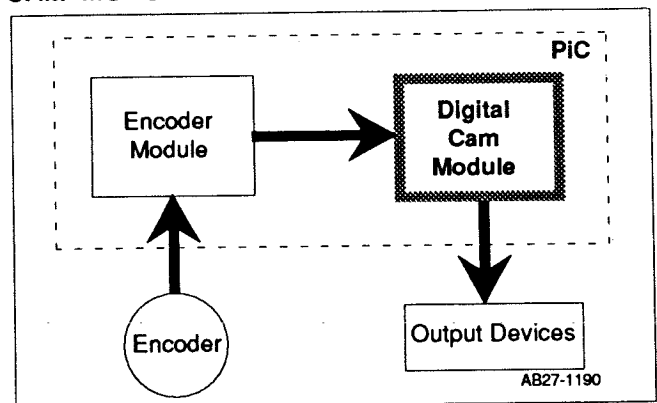


FIGURE 2. USING THE DIGITAL CAM MODULE

Total output current is rated at 1 A for any combination of the four outputs. The outputs are sink only.

The maximum VCE of the outputs = 32VDC and the user power supply voltage = 5 VDC minimum.

There are internal clamping diodes (available on pin 14) used to protect the outputs when driving inductive loads.

There are Digital Cam Call Routines designed to work with this module.

DIGITAL CAM MODULE

2.0 OVERVIEW OF USER INTERFACE

2.1 LEDS

There is an LED on the front of the Digital Cam Module corresponding to the logic state of a DC input (Figure 1). When it is on, it indicates the presence of a voltage. The DC input is used for an external reset of the position counter.

There is also a set of four status LEDs corresponding to the logic states of the four DC outputs available.

2.2 PIN CONNECTIONS

External input and output wires are connected to the Digital Cam Module through a 16-pin screw terminal plug-in connector (part number 401-53820-00) supplied with the module (Figure 1). Connecting wires are inserted on the right hand side.

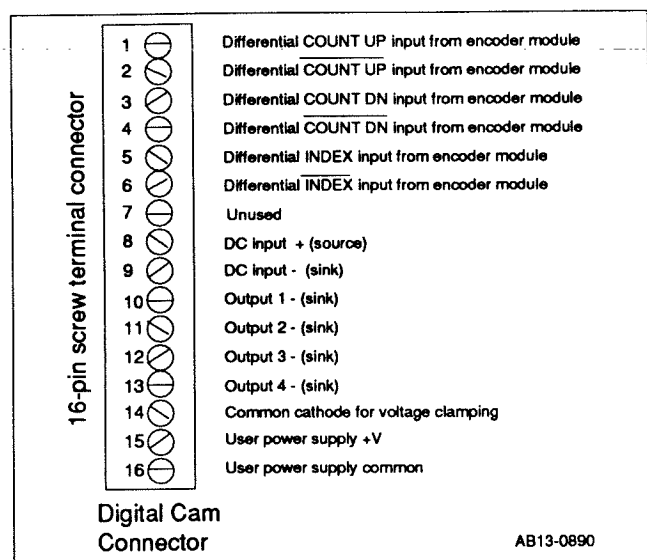


FIGURE 3. 16-PIN CONNECTIONS

NOTE: In the diagrams in this write-up, connections between two modules using 16-pin plug-in connectors are sometimes shown with wires on the left. This is for clarity in the diagram only. Wires are actually inserted on the right when using 16-pin plug-in connectors.

Figure 3 lists the pin assignments for the 16 screw connections.

The first six pins are used for inputs. They receive signals from an encoder module. Pin 7 is unused.

Pins 8 and 9 are used for a switched DC input which can reset the position counter. (The index pulse from the

encoder can also be used to reset.) The pins must be wired according to the polarity shown (+ on pin 8, - on pin 9). NOTE: Reset must be enabled in software.

Pins 10, 11, 12, and 13 are used for the four DC outputs.

Pin 14 provides voltage clamping capability to be used with inductive loads.

Pin 15 and 16 are used to connect the user-supplied power supply that provides the source voltage for the outputs.

3.0 HARDWARE INTERFACING DETAILS

Through the 16-pin screw terminal plug-in connector, the Digital Cam Module interfaces with various field devices as described in this section.

3.1 ENCODER MODULES (PINS 1-6)

The Digital Cam Module can be used with the High-Speed Encoder Module, Part Number 502-03581-00, or the Encoder Receiver Module, Part Number 502-02947-00.

HIGH-SPEED ENCODER MODULE

The wiring between a High-Speed Encoder Module and a Digital Cam Module is shown in Figure 4 below. Twisted pair wires are used for these interconnections and 100 ohm resistors are used to terminate each end of the twisted pair.

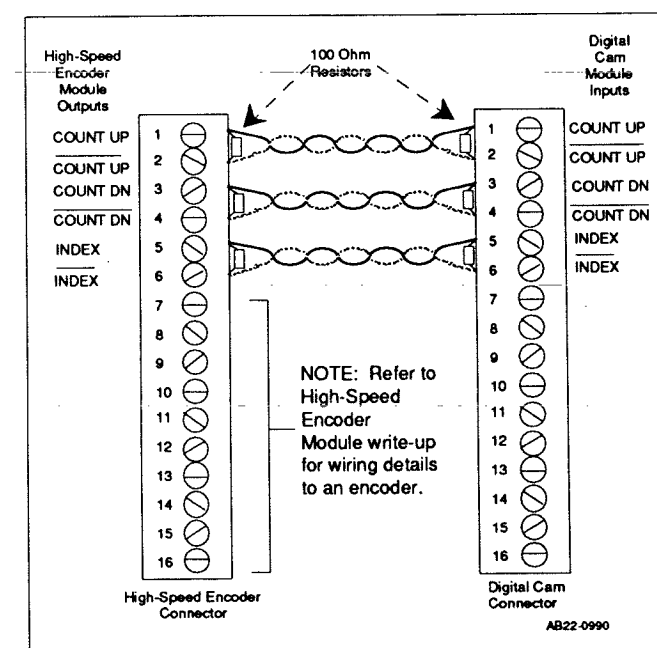


FIGURE 4. HIGH-SPEED ENCODER MODULE CONNECTION

DIGITAL CAM MODULE

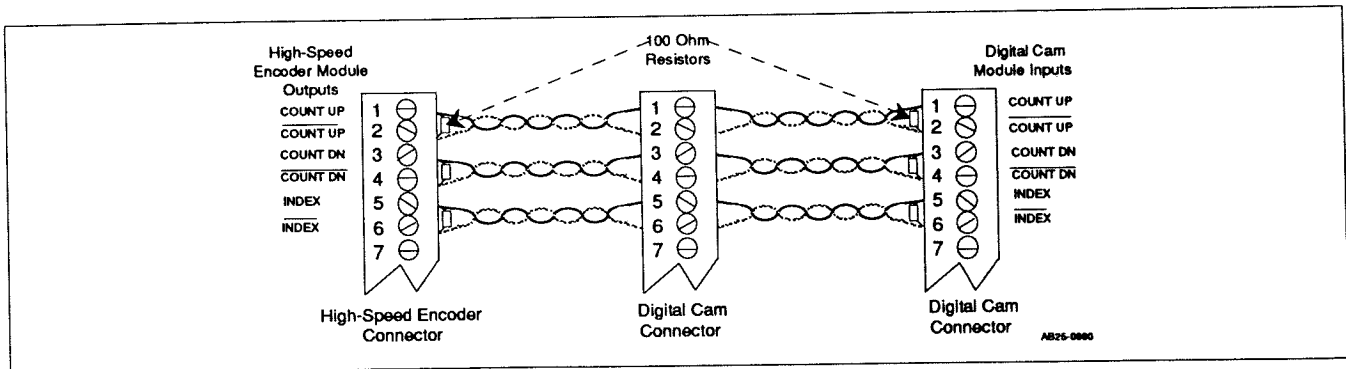


FIGURE 5. WIRING WITH MULTIPLE CAM MODULES

If several cam modules are daisy chained together, place one resistor on the encoder module end of the twisted pair and the other on the *last* cam module in the chain as shown in Figure 5.

ENCODER RECEIVER MODULE

The wiring between an Encoder Receiver Module and the Digital Cam Module is shown in Figure 6. (Single wires are used to interconnect the modules in this case because the signal drivers from the Encoder Receiver Module are single-ended. Twisted pairs are used with the High-Speed Encoder Module because its signal drivers are differential. *Do not confuse these interface signal drivers with the signal drivers inside an encoder!*)

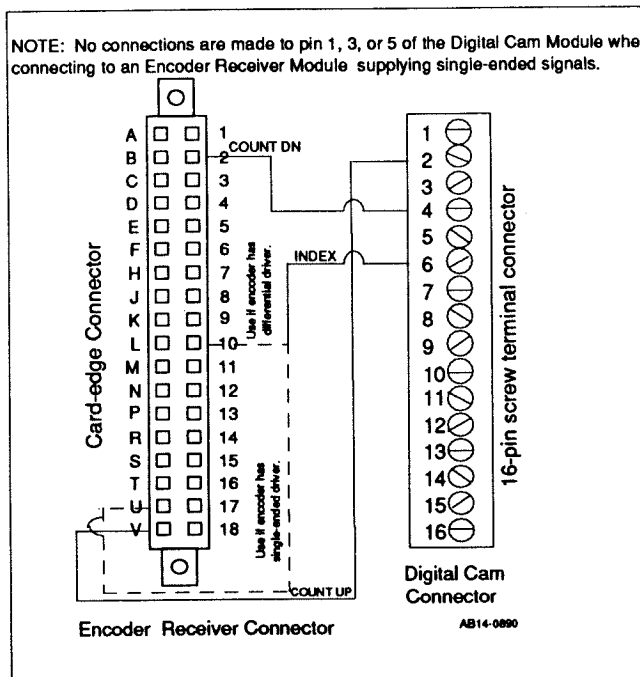


FIGURE 6. ENCODER RECEIVER MODULE CONNECTION

Note the dashed wire connection for the INDEX signal in Figure 6. When the encoder connected to the Encoder Receiver Module uses single-ended drivers, connect INDEX to Pin U. When the encoder connected to the Encoder Receiver Module uses differential drivers, connect INDEX to pin 10. Refer to the Encoder Receiver Module write-up for wiring details for the encoder.

3.2 DC INPUT (EXTERNAL COUNTER RESET) PINS 8-9

The position counter on the Digital Cam Module can be reset with a switched input to the DCIN+ and DCIN- connection (pins 8 and 9).

NOTE: Reset must be enabled in software.
The DCIN characteristics are listed below.

Maximum voltage for guaranteed on	15VDC
Minimum voltage for guaranteed off	5VDC
Maximum voltage allowed	30VDC
Typical input impedance	2.7K

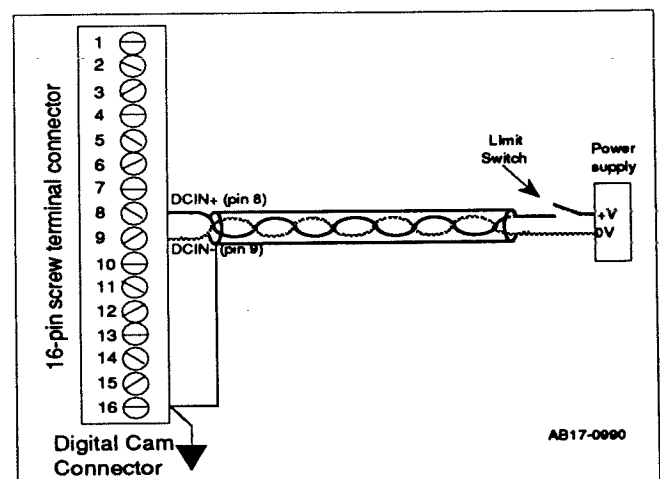


FIGURE 7. DCIN CONNECTION USING TWISTED PAIR WIRING

DIGITAL CAM MODULE

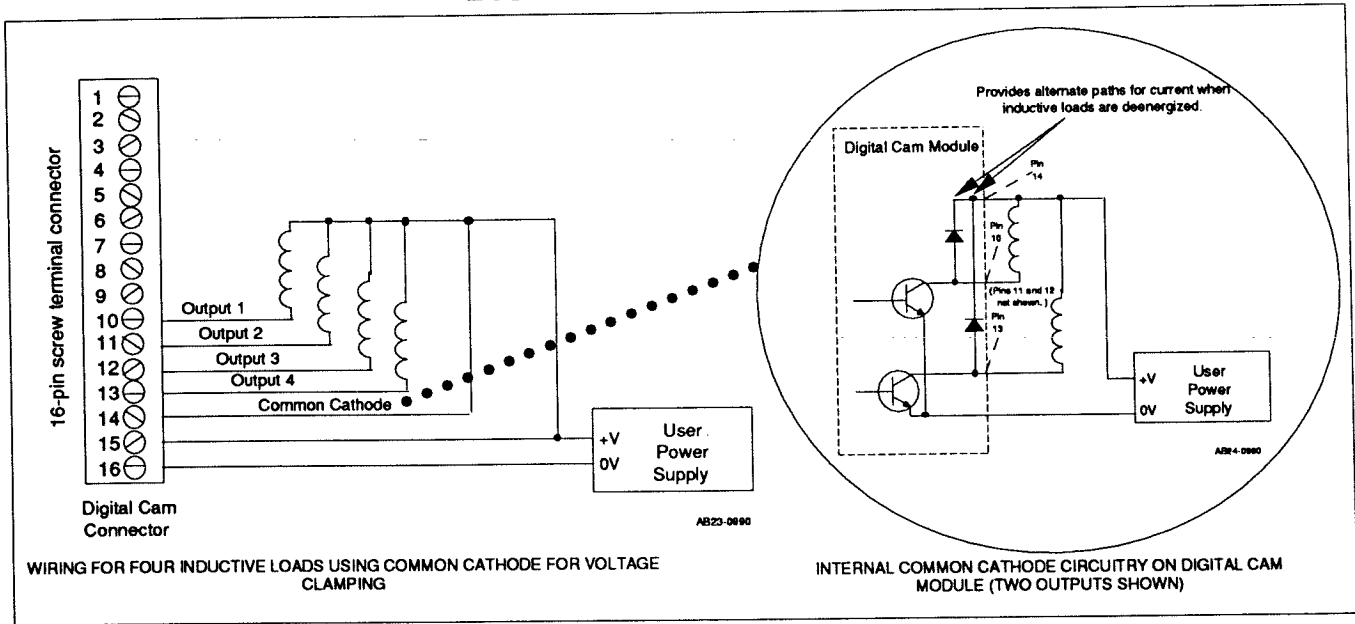


FIGURE 8. INDUCTIVE LOAD WIRING

The optically isolated DC input circuit has a maximum on/off time of 50 microseconds. Because of this fast response time, it is referred to as a high speed input. Special care should be taken in routing external wires to it to provide noise immunity. As shown in Figure 7, it is recommended that shielded twisted pair wiring be used.

3.3 FOUR OUTPUTS (LOADS) PINS 10-16

User devices (loads) should be wired to the four optically isolated outputs as shown in Figure 8. The diagram illustrates inductive loads. If resistive loads are being used, pin 14 (common cathode for voltage clamping) is not required.

4.0 MODULE OPERATION

The operation of the Digital Cam Module is explained in terms of the block diagram shown in Figure 9. An example of a mechanically equivalent device is illustrated in Figure 10.

4.1 COUNT UP/COUNT DOWN

The count up/count down pulses can come from any source that interfaces to the module's 26LS32 differential receivers. The pulse should represent an incremental change in position. Counting occurs on the positive transition of each incoming pulse.

Typically, the source of these count pulses is a High-Speed Encoder Module or an Encoder Receiver Module.

4.2 THE POSITION COUNTER

A 24-bit up/down counter is used to represent position. Count up pulses increase the value and count down pulses decrease the value of the counter.

The counter can count within a range between zero and any value up to $2^{24}-1$. This range is established with the programming of a 24-bit rollover value. Counting down past zero brings the counter back to the top of the range.

The counter can be preset to a value anywhere from zero to $2^{24}-1$. It also can be cleared by a positive transition on either of two external inputs to the module: the DC input or the index input.

4.3 OUTPUTS

An output is typically turned on when the value of the position counter is between the values programmed into a pair of limits. However, the logic state of each of the four outputs can be complemented through programming. In this way, the output can be programmed to be "normally on" or "normally off" when the value of the position counter is between the limits. The "on" state corresponds to the output driver sinking current.

The outputs are optically isolated. The field side of the output driver requires connection to the user's power supply.

DIGITAL CAM MODULE

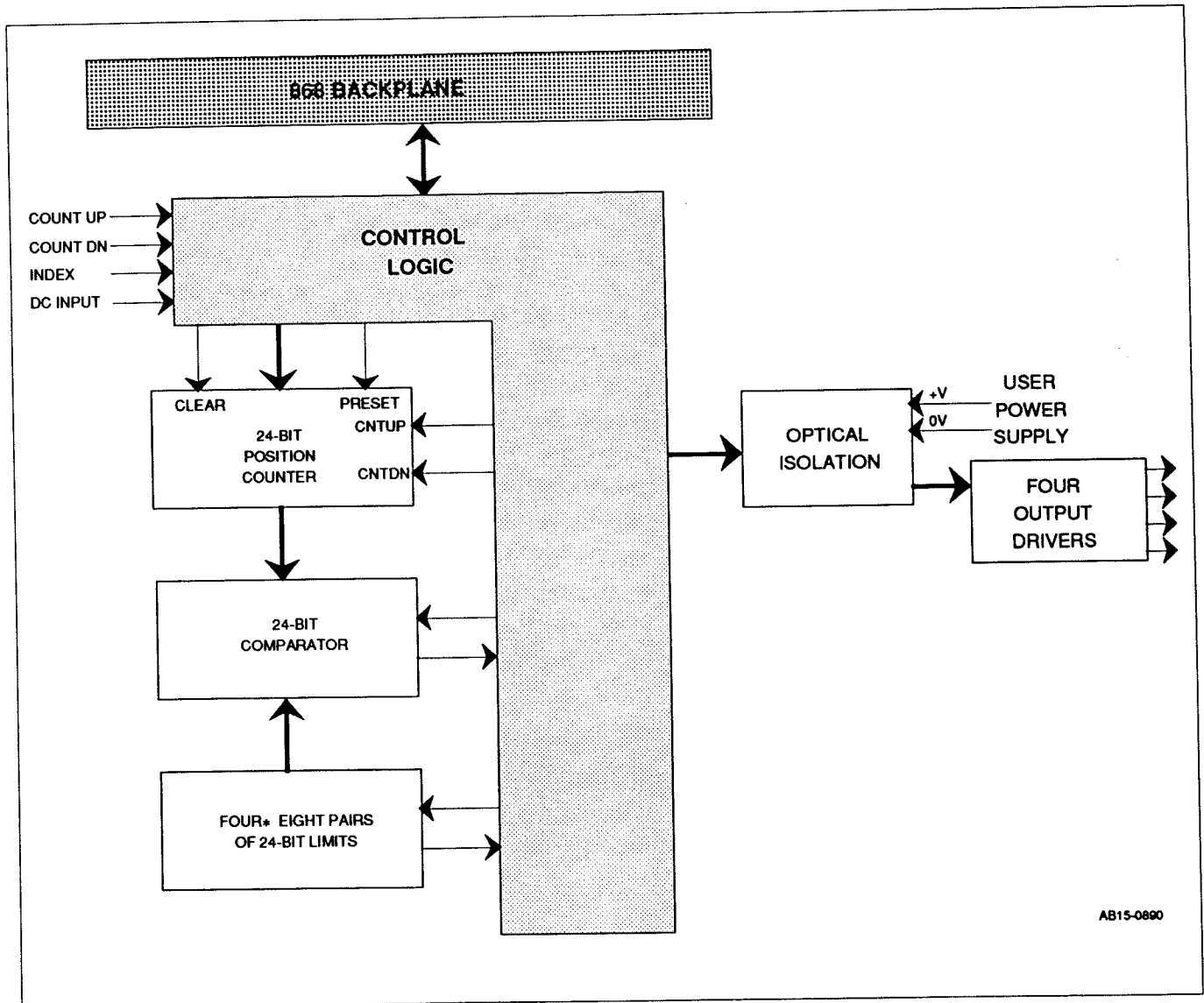


FIGURE 9. DIGITAL CAM MODULE BLOCK DIAGRAM

4.4 PROGRAMMABLE LIMITS

From one to eight pairs of limits can be programmed for each output. A pair of limits consists of a 24-bit upper limit and a 24-bit lower limit. Normally, if the 24-bit counter value is between the values in any pair of limits, the output is turned on. When the 24-bit counter value is not between the values in any pair of limits, the output is turned off.

4.5 CAM SHAFT EXAMPLE

The functions of the Digital Cam Module can be compared to the functions of a cam shaft and associated limit

switches. Each pair of limits can be compared to a lobe on a cam shaft (Figure 10). With the Digital Cam Module, the length and position of each lobe is programmable. The value in the position counter can be compared to the angular position of the shaft. However, the resolution, or coarseness, of angular rotation is programmable. The programmed range of the counter corresponds to one shaft rotation. Also, any position can be used as a reference point.

Each output can be compared to the on/off state of a limit switch positioned above the lobe path. There is one output for each of four different lobe paths. There can be from one to eight lobes for each lobe path.

DIGITAL CAM MODULE

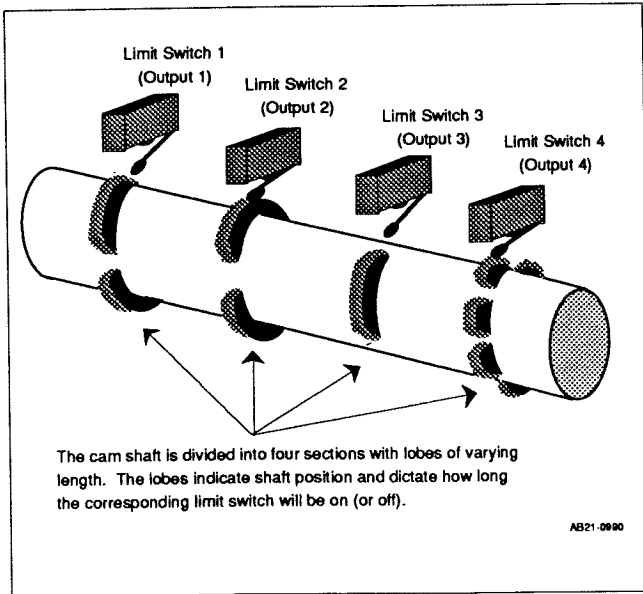


FIGURE 10. CAM SHAFT

5.0 COUNTER SPEED/NUMBER OF LIMITS

There is a fixed amount of time associated with each comparison of the position counter to a pair of limits. This time is multiplied by the number of limit pairs programmed for the outputs.

Two rates were given earlier for maximum count input. One (up to 400 KHz) applied to compares and output updates occurring after each count. The other (up to 1MHz) applied to compares and output updates occurring within three counts from the previous count. At this maximum count rate, integrity of the count value is more important than the time of the compare.

Table 1 compares the maximum allowed count rates to the highest number of limit pairs used for any output. This rate applies even if the other outputs use fewer limit pairs.

Highest Number of limit pairs (Lobes/Any Output)	Maximum count, then compare rate	Absolute maximum count rate
1	400 KHz	1 MHz
2	200 KHz	500 KHz
3	133 KHz	333 KHz
4	100 KHz	250 KHz
5	80 KHz	200 KHz
6	67 KHz	167 KHz
7	57 KHz	143 KHz
8	50 KHz	125 KHz

TABLE 1. LIMIT PAIRS AND COUNT RATES

NOTE: All outputs are updated at the same time. This occurs after comparison of the position counter to all pairs of limits is completed.

6.0 ADDRESSING

The Digital Cam Module occupies four memory locations. The eight board-mounted address switches must be set for the lowest of the four addresses desired.

Table 2 contains the address switch settings for the 60 possible beginning address points. Switches seven and eight are not used and may be ignored.

IMPORTANT

Always check the module switches to be sure you know which position is off and which position is on before setting the address. Do not use addresses which have already been used for other modules in your system.

DIGITAL CAM MODULE

7.0 INSTALLATION IN RACK

The Digital Cam Module must be installed in the Master Rack of the PiC adjacent to the encoder module. The rack is physically keyed to prevent modules from being inserted incorrectly. Set the address switches. (See section 6.0.) Make the necessary connections to the 16-pin connector before applying power.

IMPORTANT

Ensure that power to the rack is off before inserting or removing this or any micro-computer module. Failure to do so may result in permanent damage to the module.

The Digital Cam Module interface schematic is shown in Figure 11.

ON OFF

ON OFF

OFF ON

PIC ADDRESS	SWITCHES	PIC ADDRESS	SWITCHES	PIC ADDRESS	SWITCHES
	1 2 3 4 5 6		1 2 3 4 5 6		1 2 3 4 5 6
2000	ON OFF	2080	ON OFF	2160	ON OFF
2004	ON OFF	2084	ON OFF	2164	ON OFF
2008	ON OFF	2088	ON OFF	2168	ON OFF
2012	ON OFF	2092	ON OFF	2172	ON OFF
2016	ON OFF	2096	ON OFF	2176	ON OFF
2020	ON OFF	2100	ON OFF	2180	ON OFF
2024	ON OFF	2104	ON OFF	2184	ON OFF
2028	ON OFF	2108	ON OFF	2188	ON OFF
2032	ON OFF	2112	ON OFF	2192	ON OFF
2036	ON OFF	2116	ON OFF	2196	ON OFF
2040	ON OFF	2120	ON OFF	2200	ON OFF
2044	ON OFF	2124	ON OFF	2204	ON OFF
2048	ON OFF	2128	ON OFF	2208	ON OFF
2052	ON OFF	2132	ON OFF	2212	ON OFF
2056	ON OFF	2136	ON OFF	2216	ON OFF
2060	ON OFF	2140	ON OFF	2220	ON OFF
2064	ON OFF	2144	ON OFF	2224	ON OFF
2068	ON OFF	2148	ON OFF	2228	ON OFF
2072	ON OFF	2152	ON OFF	2232	ON OFF
2076	ON OFF	2156	ON OFF	2236	ON OFF

AB26-0990

AB26-0990

TABLE 2. ADDRESS SWITCH SETTINGS

DIGITAL CAM MODULE

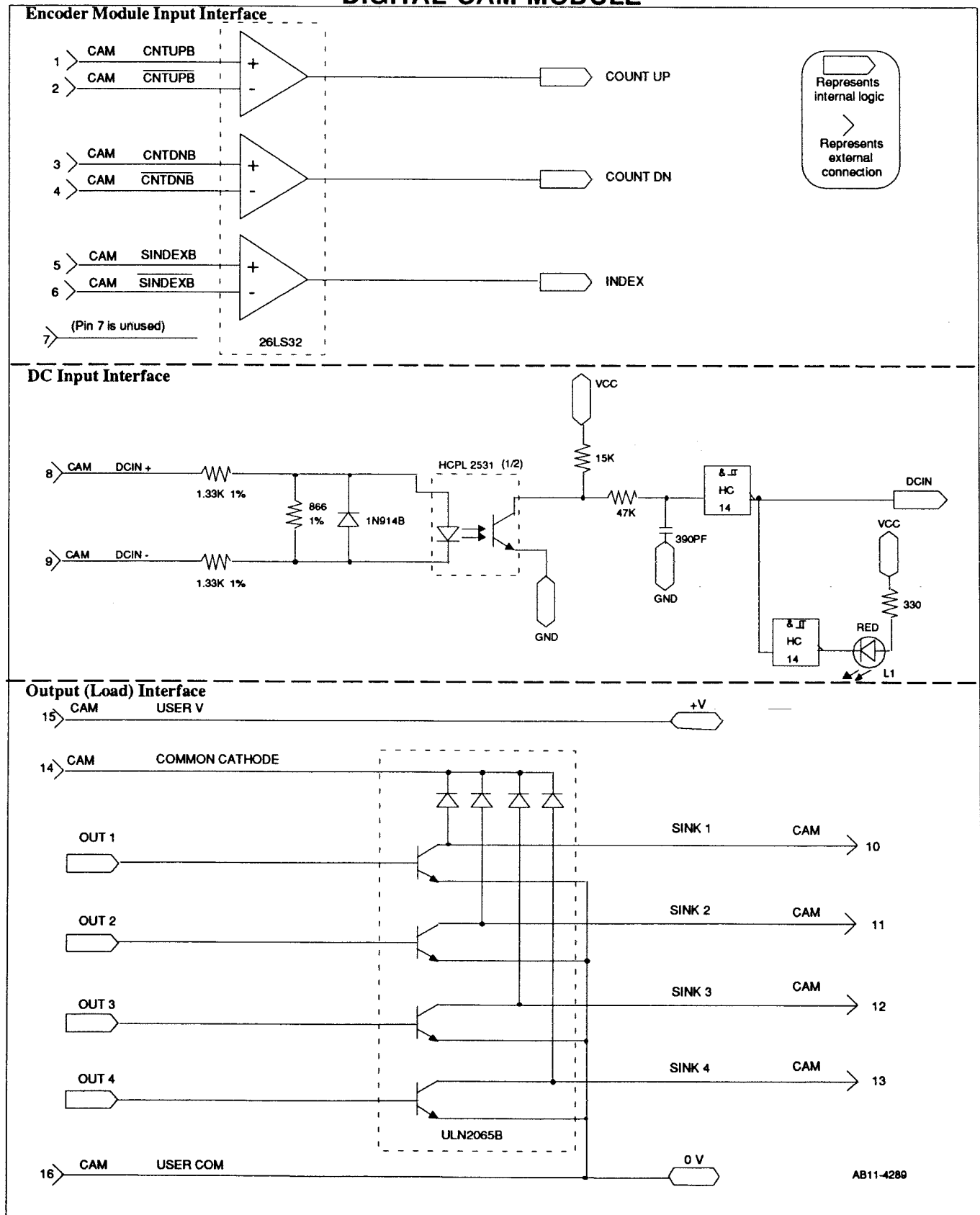


FIGURE 9. DIGITAL CAM MODULE SCHEMATIC

8 AC INPUT MODULE

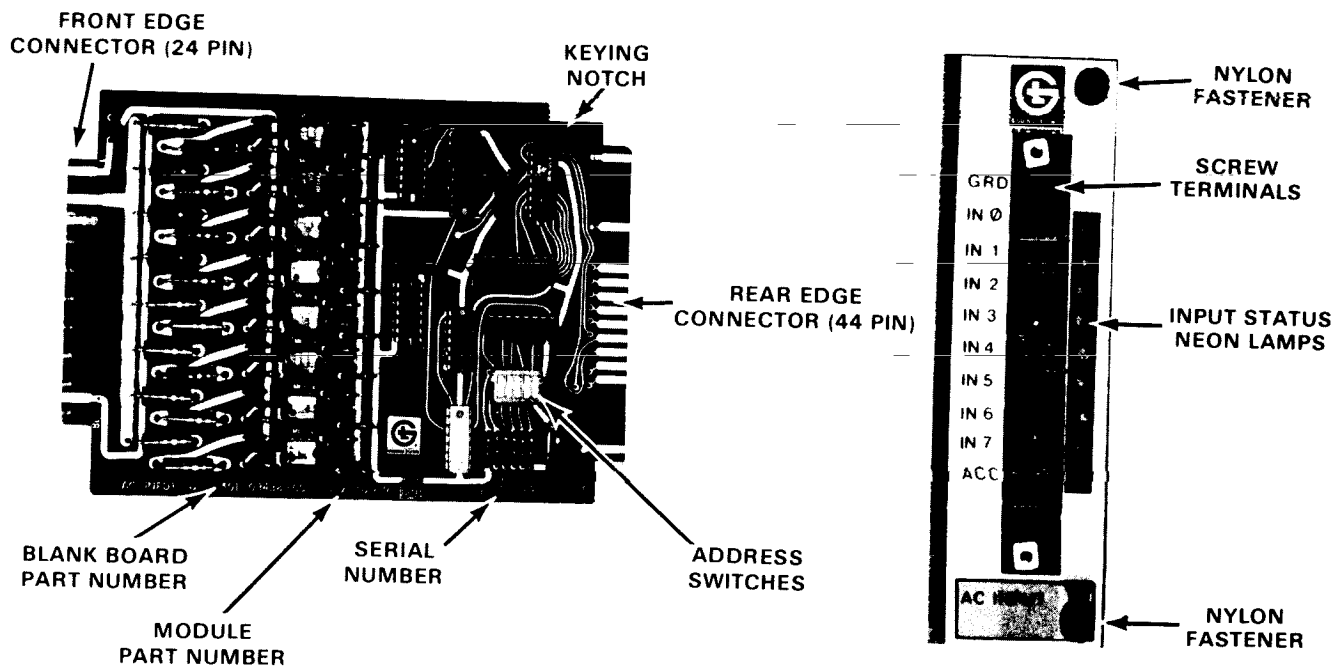


FIGURE 1. 8 AC INPUT MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each 8 AC Input Module (part 502-02959-00) allows the user to sense the presence or absence of up to eight 115 volt ac signals. AC Input Module 502-02959-50 is used to sense 230 volt ac signals. The module converts these signals to data in a form that can be used by the CPU.

Input circuits are filtered and optically isolated from the microcomputer bus for reliable operation in electrically noisy environments.

External devices are wired to the module through either a 36-pin card edge connector or an AC Input Faceplate (shown in Figure 1). The latter option permits simplified wiring connections to be made to compression screw terminals and also features eight input status neon lamps.

The AC Input Module input circuit is shown in Figure 2. This circuit is typical of the eight inputs.

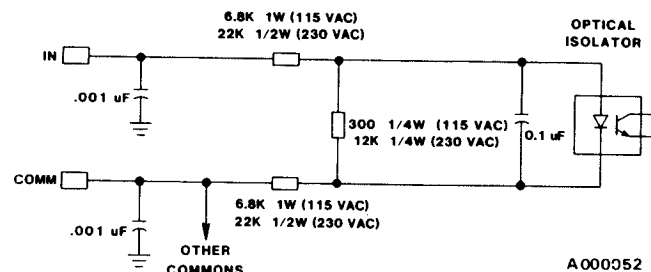


FIGURE 2. INPUT CIRCUIT (1 of 8)

2.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

AC Input Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0.

8 AC INPUT MODULE

Make wire connections to and fasten the card edge connector or faceplate before applying power.

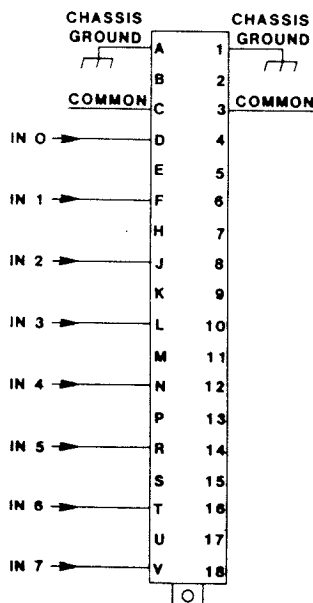
2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 8 AC Input Module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available. Dummy contacts may be inserted into the connector at unused places for improved holding power. A complete eight foot AC Input Harness is available.

The recommended external wiring convention is as follows: Inputs should be No. 18 red wire; common should be No. 18 white wire; and a green No. 18 wire should be connected from pin 1 or A to chassis ground.

NOTE

The two pins labeled COMMON are internally connected to the input return path. These pins are not connected to the system logic ground.

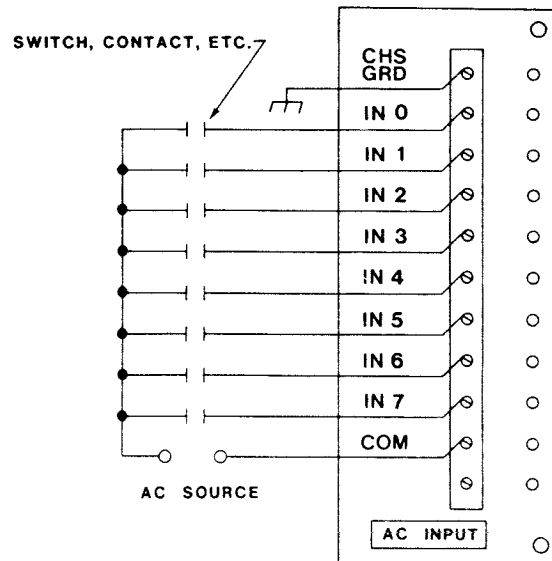


A000053

FIGURE 3. CARD EDGE CONNECTOR WIRING

2.2 FACEPLATE CONNECTOR

The faceplate connector allows wiring connections to be made to compression screw terminals. Neon indicators assist in troubleshooting by glowing when an input signal is present.



A000054

FIGURE 4. FACEPLATE WIRING

3.0 ADDRESSING

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF	x128	ON OFF
x008	ON OFF	x136	ON OFF
x016	ON OFF	x144	ON OFF
x024	ON OFF	x152	ON OFF
x032	ON OFF	x160	ON OFF
x040	ON OFF	x168	ON OFF
x048	ON OFF	x176	ON OFF
x056	ON OFF	x184	ON OFF
x064	ON OFF	x192	ON OFF
x072	ON OFF	x200	ON OFF
x080	ON OFF	x208	ON OFF
x088	ON OFF	x216	ON OFF
x096	ON OFF	x224	ON OFF
x104	ON OFF	x232	ON OFF
x112	ON OFF	x240	ON OFF
x120	ON OFF	x248	ON OFF

lines A3 through A7 match the Address Switch settings, the module is selected. A closed Address Switch (handle in the ON position) requires the corresponding address line to be LOW for module selection. An open Address Switch (OFF position) requires the address line to be HIGH.

Table 1 contains the Address Switch settings for the 32 possible beginning address points.

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

The PC ADDRESS column may be utilized for contact number suffixes. The leading "x"—becomes a decimal number that is based on the rack in which the module is installed. As seen in Table 2, "x" can be 2 through 9.

Rack address assignments are made in 256-address increments. A jumper on the Nest Receiver Board permits either one rack to respond to all 256 addresses, or two racks to split the assignments into upper and lower 128-address increments.

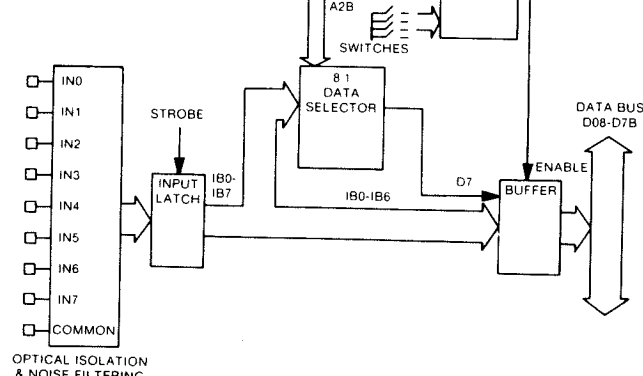


FIGURE 5. BLOCK DIAGRAM

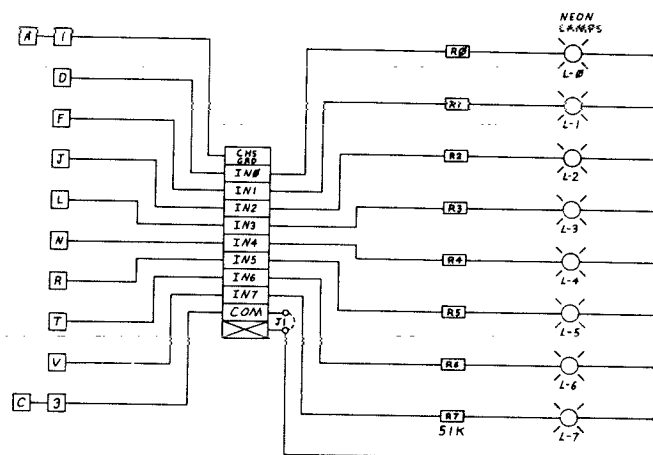


FIGURE 6. FACEPLATE SCHEMATIC

[illegible][illegible][illegible]

8 AC OUTPUT MODULE

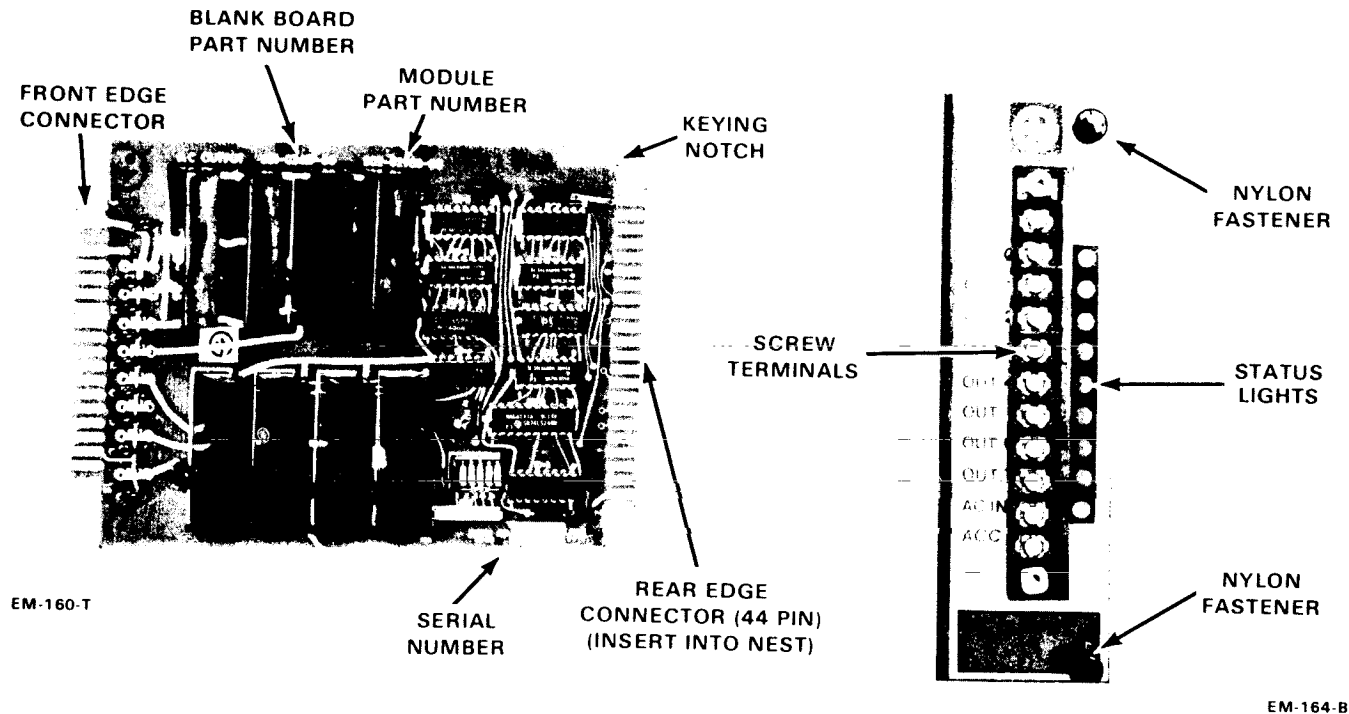


FIGURE 1. 8 AC OUTPUT MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each AC Output Module, part 502-02960-00, allows the user to control up to eight 115 volt or 230 volt ac circuits. A user-furnished ac source must be connected to the module. This voltage is distributed to the loads by solid state relays. The solid state relays have internal optical isolation for reliable computer operation in electrically noisy environments. The solid state relays are protected from current overload by on-board fuses and from voltage transients by varistors. External 115 or 230 volt devices may be connected to the module with a 36-pin card edge connector (see section 2.1). 115 volt wiring connections may be done with an 8 AC Output Faceplate (502-03211-00), shown in Figure 1. The latter option permits simplified wiring connections to be made to compression screw terminals and also features eight neon indicators.

2.0 INSTALLATION

AC Output modules may be installed in the Master Rack or Expansion Racks. The

racks are physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

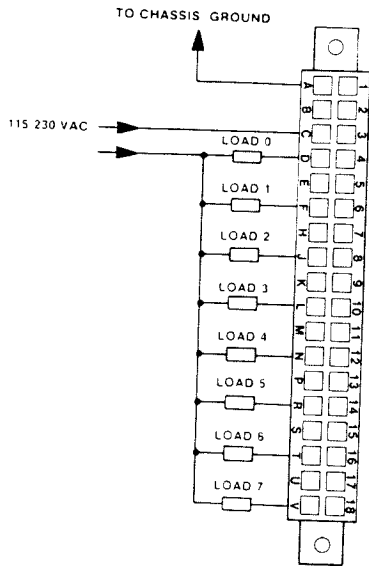
IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 8 AC Output Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power. A complete eight foot AC Output Harness is available.

8 AC OUTPUT MODULE



A000020

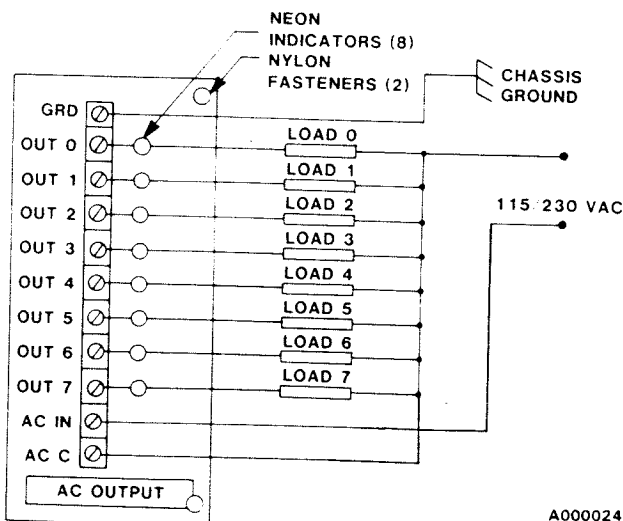
FIGURE 2. CARD EDGE CONNECTOR WIRING

The recommended external wiring convention is as follows: LOAD 0 through LOAD 7 and 115/230 volt ac should be No. 16 red wire; CHASSIS GROUND should be No. 16 green wire.

NOTE

The CHASSIS GROUND pin should be connected to the frame of the card rack as close as possible to this module.

2.2 FACEPLATE CONNECTOR



A000024

FIGURE 3. FACEPLATE WIRING

The Faceplate Connector allows 115 volt ac wiring connections to be conveniently made to compression screw terminals. Neon indicators assist in troubleshooting by glowing when the respective outputs are energized. Neon indicators on unused outputs will also glow.

3.0 ADDRESSING

Each 8 AC output module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired. When the state of address lines A3 through A7 match the Address Switch settings, the module is selected. A CLOSED Address Switch (handle in the ON position) requires the corresponding address line to be LOW for selection. An OPEN Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1 contains the Address Switch settings for the 32 possible beginning address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON	x128	ON
	OFF		OFF
x008	ON	x136	ON
	OFF		OFF
x016	ON	x144	ON
	OFF		OFF
x024	ON	x152	ON
	OFF		OFF
x032	ON	x160	ON
	OFF		OFF
x040	ON	x168	ON
	OFF		OFF
x048	ON	x176	ON
	OFF		OFF
x056	ON	x184	ON
	OFF		OFF
x064	ON	x192	ON
	OFF		OFF
x072	ON	x200	ON
	OFF		OFF
x080	ON	x208	ON
	OFF		OFF
x088	ON	x216	ON
	OFF		OFF
x096	ON	x224	ON
	OFF		OFF
x104	ON	x232	ON
	OFF		OFF
x112	ON	x240	ON
	OFF		OFF
x120	ON	x248	ON
	OFF		OFF

The PC ADDRESS column may be utilized for coil number suffixes. The leading "x" represents a decimal number based on the rack in which the module is plugged. As seen in TABLE 2, "x" can be 2 through 9.

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

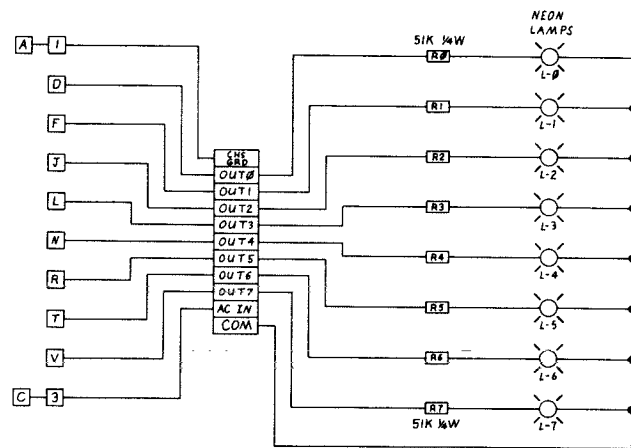
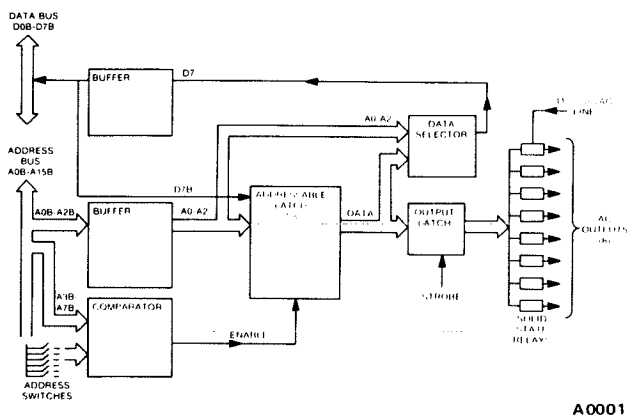


FIGURE 5. FACEPLATE SCHEMATIC

Rack address assignments are made in 256 address increments. A number on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignment into upper and lower 128 address increments.



A00015

FIGURE 4. BLOCK DIAGRAM

8 AC OUTPUT MODULE

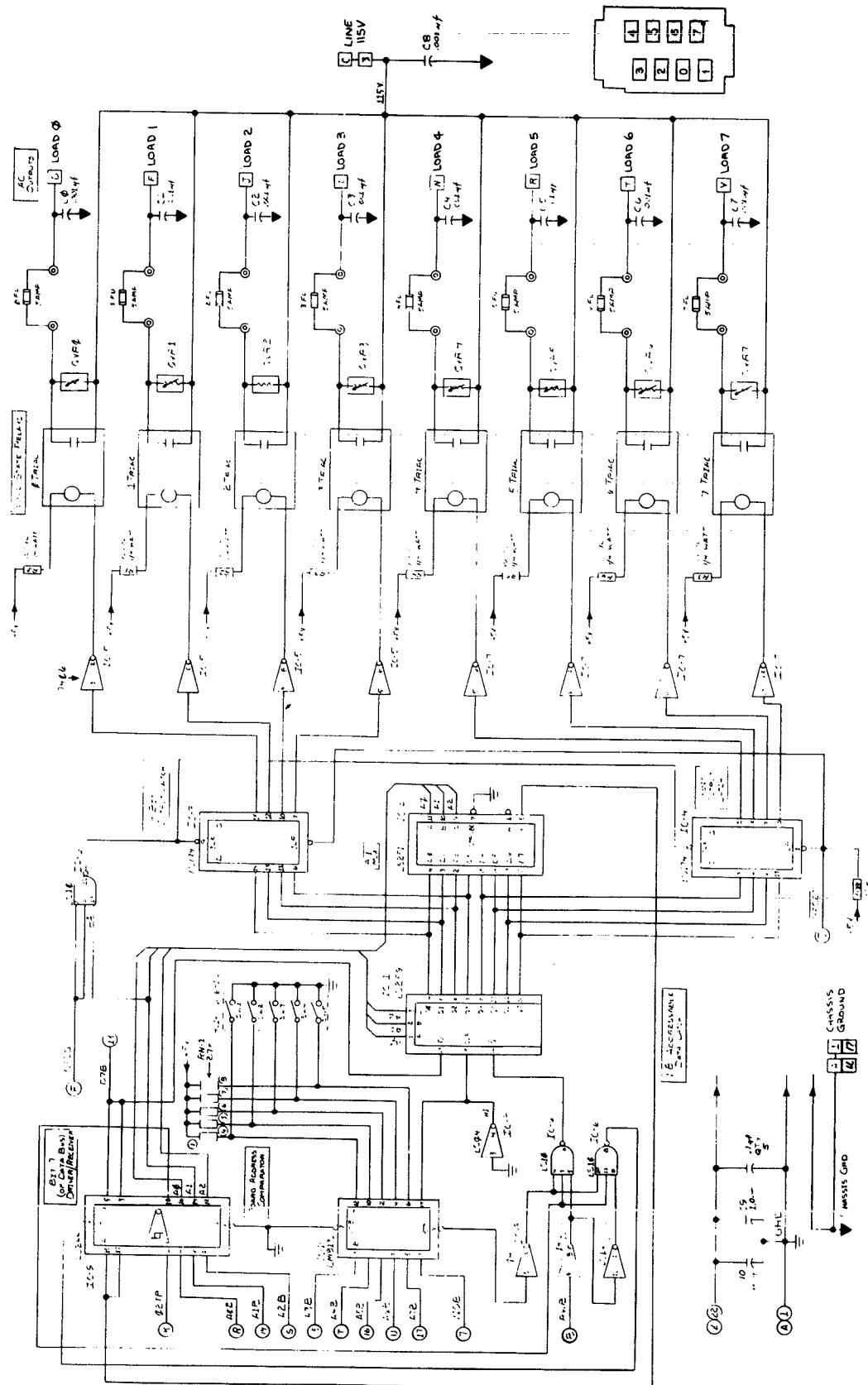


FIGURE 6. 8 AC OUTPUT MODULE SCHEMATIC

502-02960-00

24 VOLT-8 AC INPUT MODULE

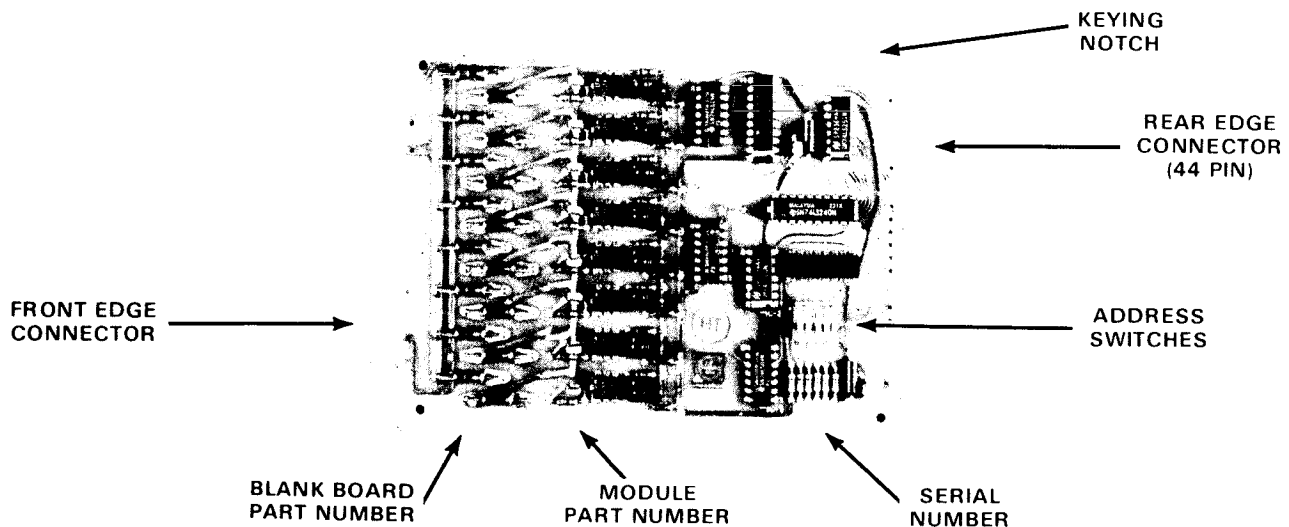


FIGURE 1. 24 VOLT-8 AC INPUT MODULE

1.0 INTRODUCTION

Each 24 volt 8 AC Input Module (part 502-03172-00) allows the user to sense the presence or absence of up to eight 24 volt ac signals. The module converts these signals to data in a form that can be used by the CPU.

Input circuits are filtered and optically isolated from the micro-computer bus for reliable operation in electrically noisy environments.

External 24 volt ac devices are connected to the module through either a 36-pin card edge connector (see Section 2.1) or an AC Input Faceplate (502-02838-10), which is shown in Figure 1. The latter option permits simplified wiring connections to be made to compression screw terminals and also features eight input status LEDs.

2.0 INSTALLATION

AC Input Modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent

modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wire connections to and fasten the card edge connector or faceplate before applying power.

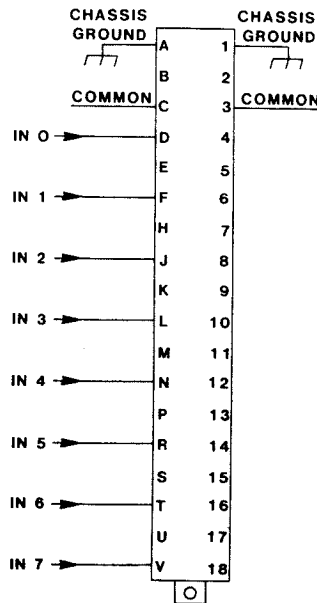
IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 8 AC Input Module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available. Dummy contacts may be inserted into the connector at unused places for improved holding power. A complete eight foot AC Input Harness is available.

24 VOLT-8 AC INPUT MODULE



A000053

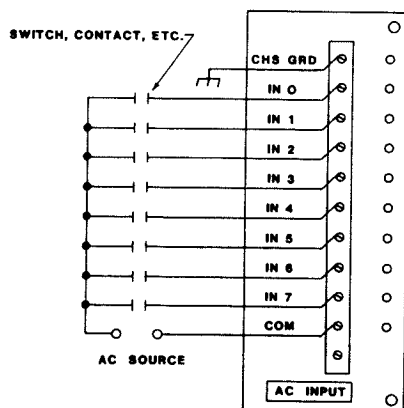
FIGURE 2. CARD EDGE CONNECTOR WIRING

The recommended external wiring convention is as follows: Inputs should be No. 18 red wire; common should be No. 18 white wire; and a green No. 18 wire should be connected from pin 1 or A to chassis ground.

NOTE

The two pins labeled COMMON are internally connected to the input return path. These pins are not connected to the system logic ground.

2.2 FACEPLATE CONNECTOR



A000054A

FIGURE 3. FACEPLATE WIRING

The faceplate connector allows wiring connections to be made to compression screw terminals. Neon indicators assist in troubleshooting by glowing when an input signal is present.

3.0 ADDRESSING

Each 8 AC Input Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired. When the states of address lines A3 through A7 match the Address Switch settings, the module is selected. A closed Address Switch (handle in the ON position) requires the corresponding address line to be LOW for module selection. An open Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
x000	ON 12345	x128	ON 12345
	OFF		OFF
x008	ON	x136	ON
	OFF		OFF
x016	ON	x144	ON
	OFF		OFF
x024	ON	x152	ON
	OFF		OFF
x032	ON	x160	ON
	OFF		OFF
x040	ON	x168	ON
	OFF		OFF
x048	ON	x176	ON
	OFF		OFF
x056	ON	x184	ON
	OFF		OFF
x064	ON	x192	ON
	OFF		OFF
x072	ON	x200	ON
	OFF		OFF
x080	ON	x208	ON
	OFF		OFF
x088	ON	x216	ON
	OFF		OFF
x096	ON	x224	ON
	OFF		OFF
x104	ON	x232	ON
	OFF		OFF
x112	ON	x240	ON
	OFF		OFF
x120	ON	x248	ON
	OFF		OFF

TABLE 1 contains the Address Switch settings for the 32 possible beginning address points.

24 VOLT-8 AC INPUT MODULE

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

The PC ADDRESS column may be utilized for contact number suffixes. The leading "x" becomes a decimal number that is based on the rack in which the module is installed. As seen in TABLE 2, "x" can be 2 through 9.

Rack address assignments are made in 256-address increments. A jumper on the Nest Receiver Board permits either one

rack to respond to all 256 addresses, or two racks to split the assignments into upper and lower 128-address increments.

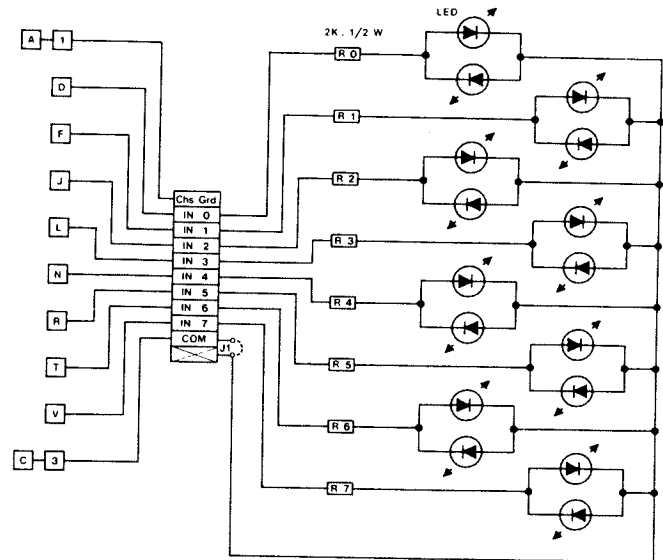


FIGURE 5. FACEPLATE SCHEMATIC

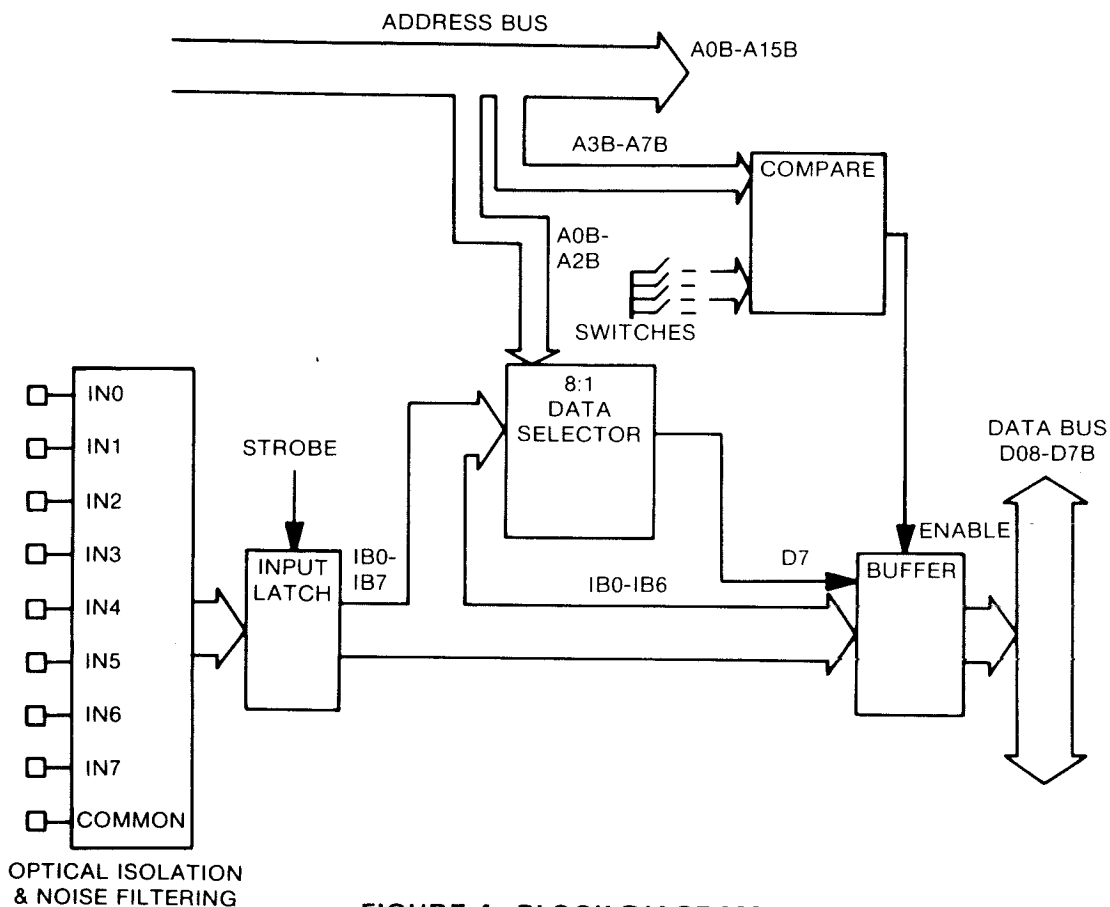
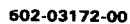


FIGURE 4. BLOCK DIAGRAM

A000028



24 VOLT-8 AC OUTPUT MODULE

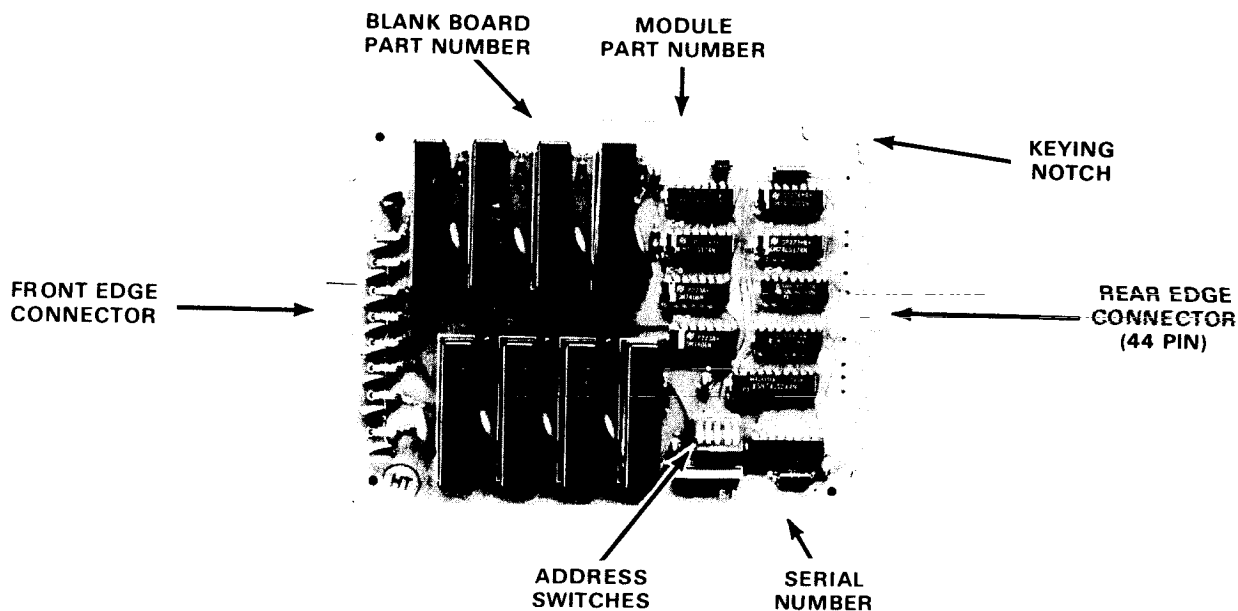


FIGURE 1. 24 VOLT-8 AC OUTPUT MODULE

1.0 INTRODUCTION

Each 24 Volt AC Output Module, part 502-03173-00, allows the user to control up to eight 24 volt ac circuits. A user-furnished ac source must be connected to the module. This voltage is distributed to the loads by solid state relays. The solid state relays have internal optical isolation for reliable computer operation in electrically noisy environments. The solid state relays are protected from current overload by on-board fuses and from voltage transients by varistors. External 24 volt ac devices are connected to the module with a 36-pin card edge connector (see section 2.1), or an 8 AC Output Faceplate (502-02837-10). The latter option permits simplified wiring connections to be made to compression screw terminals and also features eight LED indicators.

2.0 INSTALLATION

AC Output modules may be installed in the Master Rack or Expansion Racks. The racks are physically keyed to prevent

modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

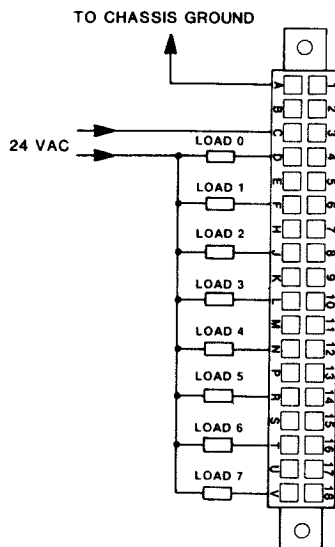
IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the 8 AC Output Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power. A complete eight foot AC Output Harness is available.

24 VOLT-8 AC OUTPUT MODULE



A000219

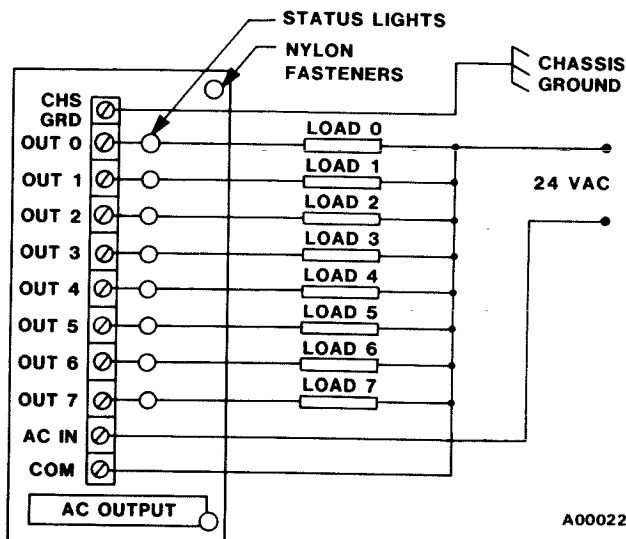
FIGURE 2. CARD EDGE CONNECTOR WIRING

The recommended external wiring convention is as follows: LOAD 0 through LOAD 7 and 24 volt ac should be No. 16 red wire; CHASSIS GROUND should be No. 16 green wire.

NOTE

The CHASSIS GROUND pin should be connected to the frame of the card rack as close as possible to this module.

2.2 FACEPLATE CONNECTOR



A000220

FIGURE 3. FACEPLATE WIRING

The Faceplate Connector allows 24 volt ac wiring connections to be conveniently made to compression screw terminals. LED indicators assist in troubleshooting by illuminating when the respective outputs are energized.

3.0 ADDRESSING

Each 8 AC Output Module occupies eight memory locations. The five board-mounted Address Switches must be set for the lowest of the eight addresses desired. When the state of address lines A3 through A7 match the Address Switch settings, the module is selected. A CLOSED Address Switch (handle in the ON position) requires the corresponding address line to be LOW for selection. An OPEN Address Switch (OFF position) requires the address line to be HIGH.

TABLE 1 contains the Address Switch settings for the 32 possible beginning address points.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES	PC ADDRESS	SWITCHES
	12345		12345
x000	ON OFF	x128	ON OFF
x008	ON OFF	x136	ON OFF
x016	ON OFF	x144	ON OFF
x024	ON OFF	x152	ON OFF
x032	ON OFF	x160	ON OFF
x040	ON OFF	x168	ON OFF
x048	ON OFF	x176	ON OFF
x056	ON OFF	x184	ON OFF
x064	ON OFF	x192	ON OFF
x072	ON OFF	x200	ON OFF
x080	ON OFF	x208	ON OFF
x088	ON OFF	x216	ON OFF
x096	ON OFF	x224	ON OFF
x104	ON OFF	x232	ON OFF
x112	ON OFF	x240	ON OFF
x120	ON OFF	x248	ON OFF

24 VOLT-8 AC OUTPUT MODULE

The PC ADDRESS column may be utilized for coil number suffixes. The leading "x" represents a decimal number based on the rack in which the module is plugged. As seen in TABLE 2, "x" can be 2 through 9.

TABLE 2. RACK I/O ADDRESSES

RACK NAME	PC ADDRESSES	MAX. I/O PER RACK
MASTER RACK	2000 - 2239	240
1st EXTENSION	3000 - 3255	256
2nd EXTENSION	4000 - 4255	256
3rd EXTENSION	5000 - 5255	256
4th EXTENSION	6000 - 6255	256
5th EXTENSION	7000 - 7255	256
6th EXTENSION	8000 - 8255	256
7th EXTENSION	9000 - 9255	256

Rack address assignments are made in 256 address increments. A number on the Nest Receiver Board permits one rack to respond to all 256 addresses, or two racks to split the assignment into upper and lower 128 address increments.

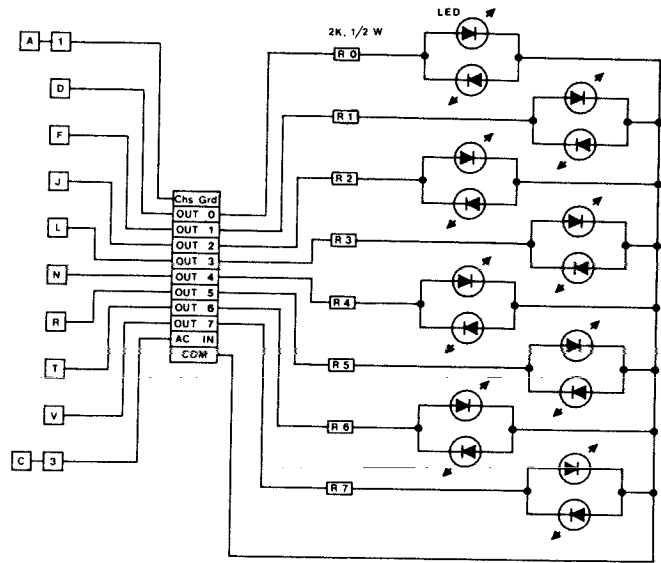


FIGURE 5. FACEPLATE SCHEMATIC

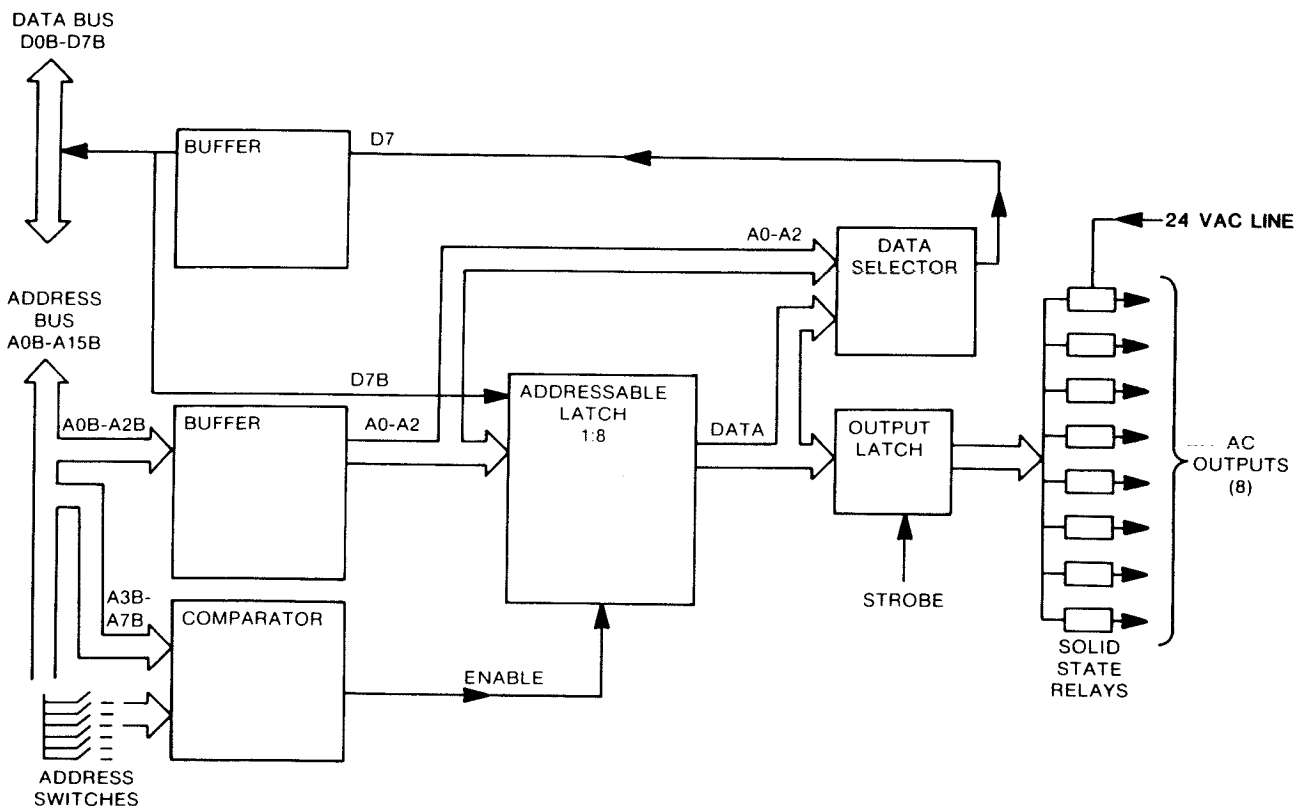


FIGURE 4. BLOCK DIAGRAM

A000218

[illegible][illegible][illegible]

RS-232-C INTERFACE MODULE

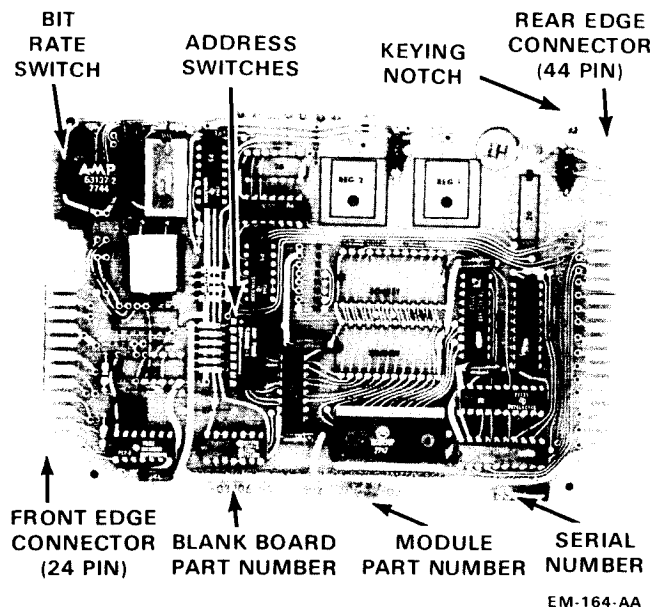


FIGURE 1. RS-232-C INTERFACE MODULE

1.0 INTRODUCTION

Each RS-232-C Interface Module, part 502-02833-20, allows the user to communicate with the system via a serial "terminal". The data rate is selectable from 50 to 19,200 bits per second in fourteen steps.

External devices are wired to the module through a 24-pin card edge connector.

The RS-232-C Interface Module must be located in the Master Rack.

2.0 ADDRESSING

Each RS-232-C Interface Module occupies four memory locations. The board-mounted Address Switches must be set for the lowest of the four addresses desired.

TABLE 1 contains the Address Switch settings for the 60 possible beginning address points.

NOTE

When using a printer or a GTEK EPROM programmer, the RS-232-C Interface Module address switch setting must be 2236.

3.0 BIT RATE SELECTION

3.1 ON-BOARD BIT RATE SWITCH

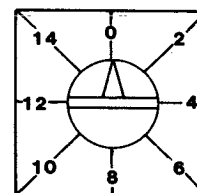
A sixteen-position, screwdriver-actuated switch is located near the front edge of the module for bit rate selection. See TABLE 2 for the various Bit Rate Switch positions and corresponding bit rates.

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF	2088	ON OFF	2176	ON OFF
2004	ON OFF	2092	ON OFF	2180	ON OFF
2008	ON OFF	2096	ON OFF	2184	ON OFF
2012	ON OFF	2100	ON OFF	2188	ON OFF
2016	ON OFF	2104	ON OFF	2192	ON OFF
2020	ON OFF	2108	ON OFF	2196	ON OFF
2024	ON OFF	2112	ON OFF	2200	ON OFF
2028	ON OFF	2116	ON OFF	2204	ON OFF
2032	ON OFF	2120	ON OFF	2208	ON OFF
2036	ON OFF	2124	ON OFF	2212	ON OFF
2040	ON OFF	2128	ON OFF	2216	ON OFF
2044	ON OFF	2132	ON OFF	2220	ON OFF
2048	ON OFF	2136	ON OFF	2224	ON OFF
2052	ON OFF	2140	ON OFF	2228	ON OFF
2056	ON OFF	2144	ON OFF	2232	ON OFF
2060	ON OFF	2148	ON OFF	2236	ON OFF
2064	ON OFF	2152	ON OFF		
2068	ON OFF	2156	ON OFF		
2072	ON OFF	2160	ON OFF		
2076	ON OFF	2164	ON OFF		
2080	ON OFF	2168	ON OFF		
2084	ON OFF	2172	ON OFF		

TABLE 2. BIT RATE vs SWITCH POSITION

BIT RATE	SWITCH POSITION
50	13
75	12
110	0
134.5	11
150	1
200	10
300	2
600	9
1200	4
1800	5
2400	3 OR 8
4800	6
9600	7
19200	14 OR 15



FRONT VIEW

RS-232-C INTERFACE MODULE

3.2 EXTERNAL BIT RATE SWITCHES

An external switch may be connected to the module to remotely control the bit rate. If an external Bit Rate Switch is used, the board-mounted Bit Rate Switch must be set to position 0. A 24-pin card edge connector, part 401-50656-00, may be wired as shown in FIGURE 2.

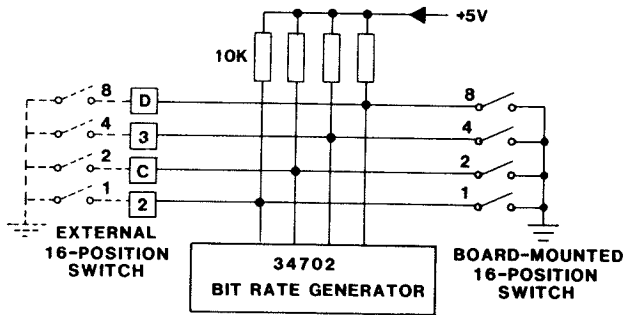


FIGURE 2. BIT RATE SWITCHES

3.3 RECEIVE BIT RATE CONNECTION

The RECEIVE bit rate is normally the same as the TRANSMIT bit rate. Therefore, a jumper is present between pins N and 12 on the card edge connector to supply the RECEIVE circuit with clocking pulses from the bit rate generator (see FIGURE 3). Some applications use a self-clocking cassette system, or other device, which supplies a separate receive bit rate clock. In this case, the jumper is deleted and the external clock source is connected to pin 12. The frequency of the external clock must be sixteen times the desired bit rate.

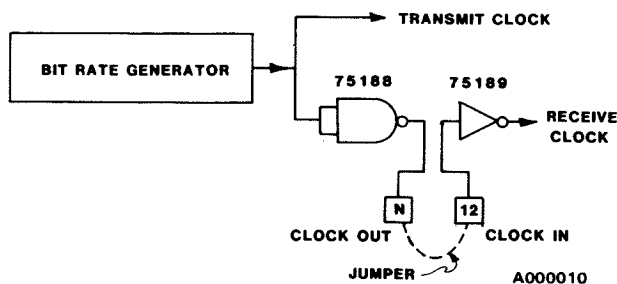


FIGURE 3. RECEIVE BIT RATE CONNECTION

4.0 TERMINAL CONNECTIONS

FIGURE 4 illustrates the circuitry and pin designations used for modem and terminal communications. Wiring is done via a 24-pin card edge connector, part 401-50656-00. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available as part 401-50460-00. "Dummy" contacts, part 401-50459-00, may be inserted into the connector at unused places for improved holding power.

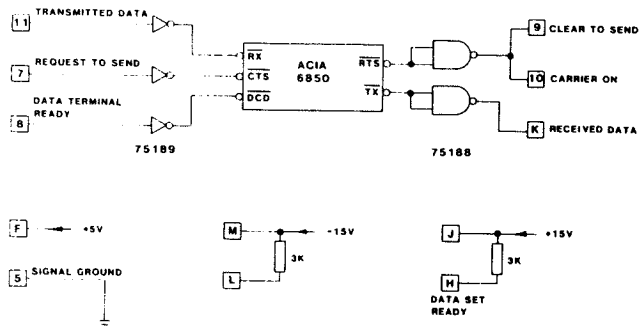


FIGURE 4. MODEM & TERMINAL CONNECTIONS

4.1 MODULE NOMENCLATURE

The nomenclature in FIGURE 4 shows the module as a modem or "data set". The communications device is designated as a "data terminal".

4.2 INTERCONNECTION CABLE

An interconnection cable typically has a 24-pin card edge connector at one end for the RS-232-C Interface Module, and a 25-pin "D" plug or socket for the terminal. See FIGURE 5 for card edge wiring. A "D" plug is available as part 401-50453-00. Pins are part 401-50451-00. A "D" socket is available as part 401-50454-00. Pins are part 401-50450-00.

The "D" connector is usually wired as follows: Pin 2, TRANSMIT DATA; Pin 3, RECEIVE DATA; Pin 7, GROUND; and Pin 20, DATA TERMINAL READY. Pins 2 and 3 may be reversed in some devices.

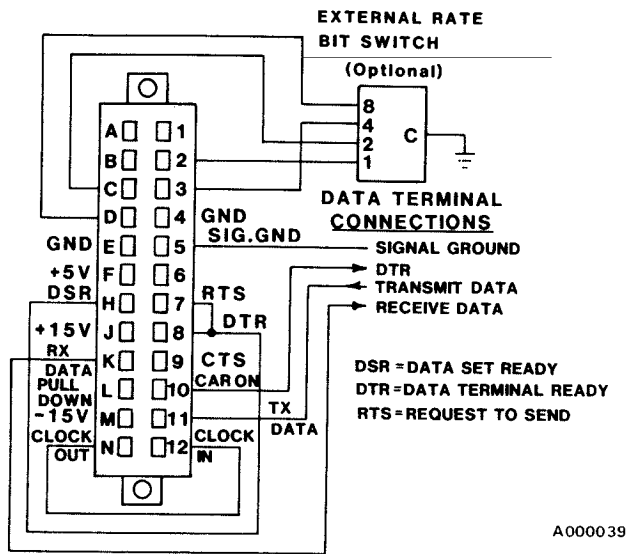
RS-232-C INTERFACE MODULE

5.0 INSTALLATION

IMPORTANT

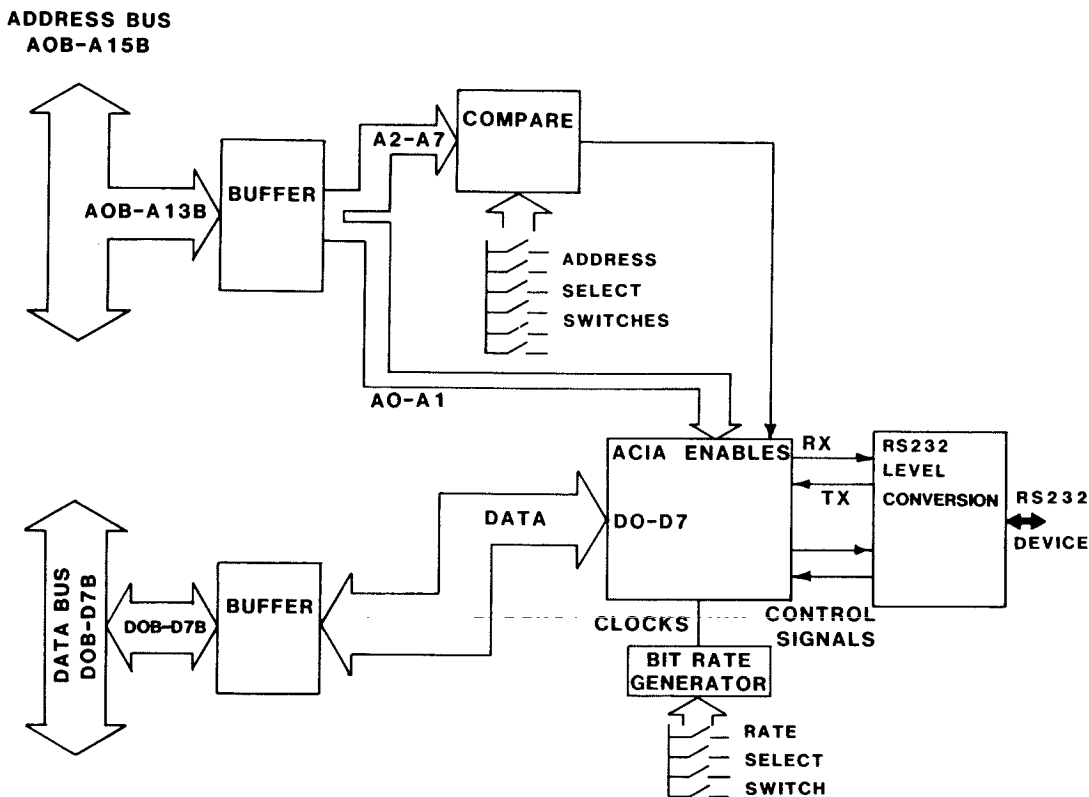
ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

RS-232-C Interface Modules must be installed in the Master Rack. The racks are physically keyed to prevent the module from being inserted incorrectly. Set the Address Switches per the instructions in Section 2.0. Make wire connections and fasten the card edge connector before applying power.



A000039

FIGURE 5. CARD EDGE CONNECTOR WIRING



A000040A

FIGURE 6. BLOCK DIAGRAM

A000040

RS-232-C INTERFACE MODULE

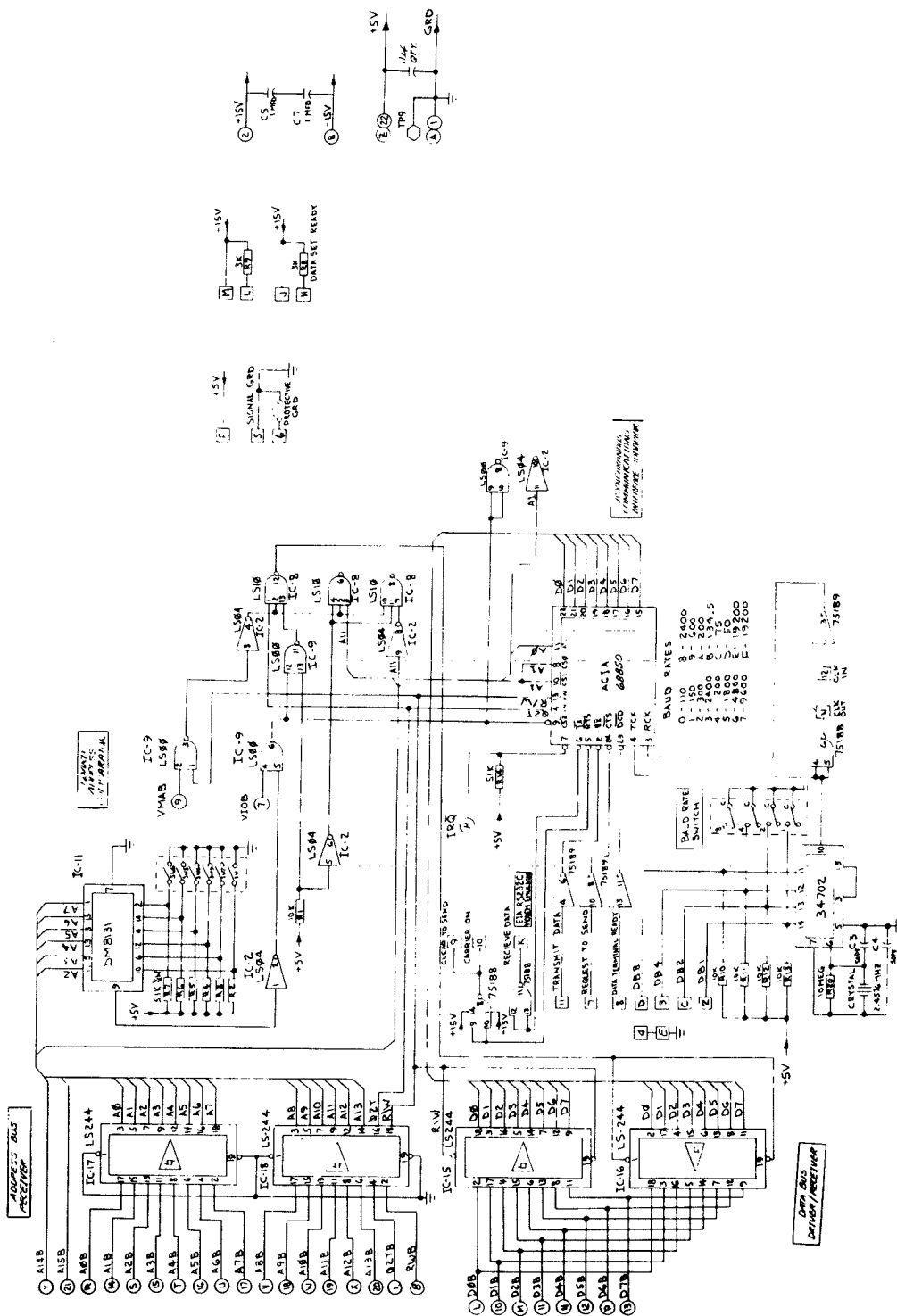


FIGURE 7. SCHEMATIC

502-02833-20

FIFO COMMUNICATIONS MODULE

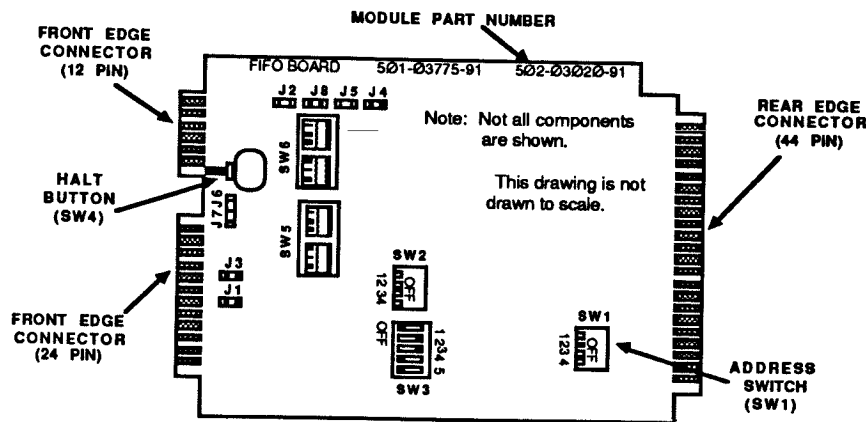


FIGURE 1. FIFO COMMUNICATIONS MODULE

1.0 INTRODUCTION

The First-In-First-Out (FIFO) Communications Module functions as an intelligent peripheral. The FIFO Module contains a 1K memory buffer. Data is exchanged between the CPU and the 1K buffer on an interrupt basis. Between interrupts, the module handles serial data transfers between the 1K buffer and the peripheral device.

The FIFO Module is used with remote I/O and communications.

2.0 HALT BUTTON

Momentarily depressing the HALT Button causes a non-maskable interrupt (NMI) to be generated. The NMI signal is used in conjunction with appropriate software as a troubleshooting aid.

3.0 MODULE-MOUNTED SWITCHES

3.1 SWITCHES SW2 & SW3

The application that the FIFO Communications Module is used in determines how Switches 2 and 3 should be set. Refer to the documentation for your application for instructions on setting Switches 2 and 3.

3.2 SWITCHES SW5 & SW6

Switches 5 and 6 enable or disable the module-mounted transformer (see Section 4.0). The switches are used as shown in Figure 2.

3.3 ADDRESS SWITCH (SW1)

Each FIFO Module occupies sixteen memory locations in the PiC. The Address Switch (SW1) must be set for the lowest of the sixteen addresses desired. Table 1 contains the Address Switch settings for the fifteen possible beginning address locations.

TABLE 1. ADDRESS SWITCH SETTINGS

PiC Address	Switches	PiC Address	Switches
	1234		1234
2000	ON OFF	2128	ON OFF
2016	ON OFF	2144	ON OFF
2032	ON OFF	2160	ON OFF
2048	ON OFF	2176	ON OFF
2064	ON OFF	2192	ON OFF
2080	ON OFF	2208	ON OFF
2096	ON OFF	2224	ON OFF
2112	ON OFF		ON OFF
			ON OFF

FIFO COMMUNICATIONS MODULE

4.0 MODULE-MOUNTED TRANSFORMER

The FIFO Communications Module contains a transformer that can be enabled or disabled by the user (see Figure 2). The transformer should be enabled if noise is a problem when communications are carried out, providing that the use of the transformer is possible with the application.

The following information must be observed when considering whether or not to use the module-mounted transformer:

1. The transformer cannot be used if communications are in the RS-232 format.
2. If a transformer is used at one end of the communications, a transformer must be used at the other end as well.

This can be done by using two modules that contain a transformer, or by using a pulse module kit (which is a transformer) at the module that does not have a transformer mounted on it.

3. G&L supports using 76.8K baud, biphasic communications.
4. Pin 5 on the 44-pin FIFO Module connector must be connected to chassis ground if the transformer is used. Run a wire from pin 5 to a screw that is in one of the threaded holes in the PiC rack.

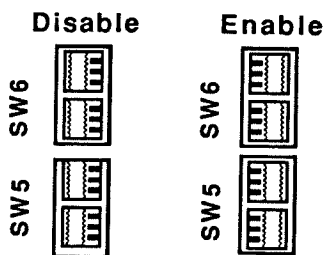


FIGURE 2. TRANSFORMER SWITCH SETTINGS

5.0 MODULE-MOUNTED JUMPERS

The FIFO Module contains eight jumpers that are set according to the application the Module is being used in. These jumpers should be correctly set when the module arrives from the G&L factory. Refer to the documentation for your application for instructions on setting the module-mounted jumpers.

Jumper 8 (J8) should be installed on the FIFO Module if RS 232 communications are being performed.

6.0 MODULE INSTALLATION

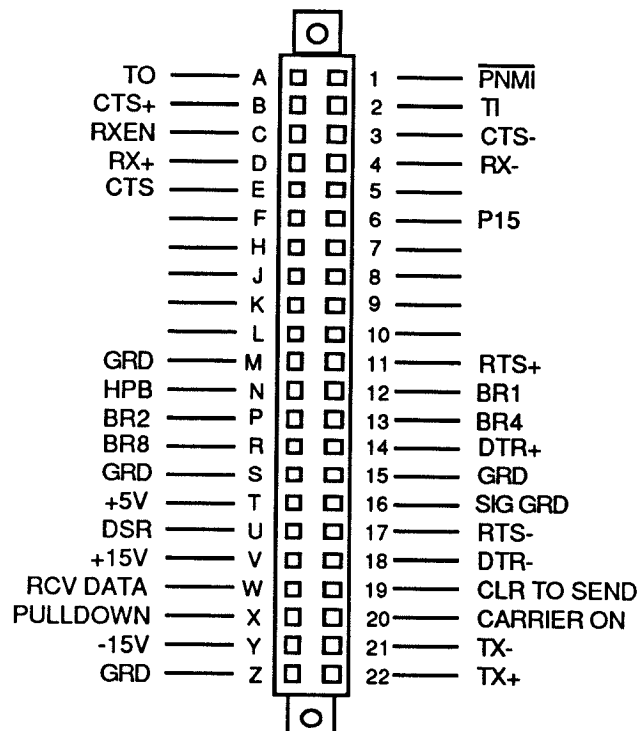
IMPORTANT

ENSURE THAT POWER TO THE PIC IS REMOVED BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

7.0 CARD EDGE CONNECTOR

The rack is physically keyed to prevent modules from being inserted incorrectly. Make wiring connections to and fasten the card edge connector before applying power to the PiC.

A 44-pin (0.156-inch centers) card edge connector is used to make wiring connections to the FIFO Module from external devices. Figure 3 depicts proper interfacing to the card edge connector.



NOTE: Pin 5 must be connected to chassis ground if the module-mounted transformer is used.

FIGURE 3. CARD EDGE CONNECTOR WIRING

FIFO COMMUNICATIONS MODULE

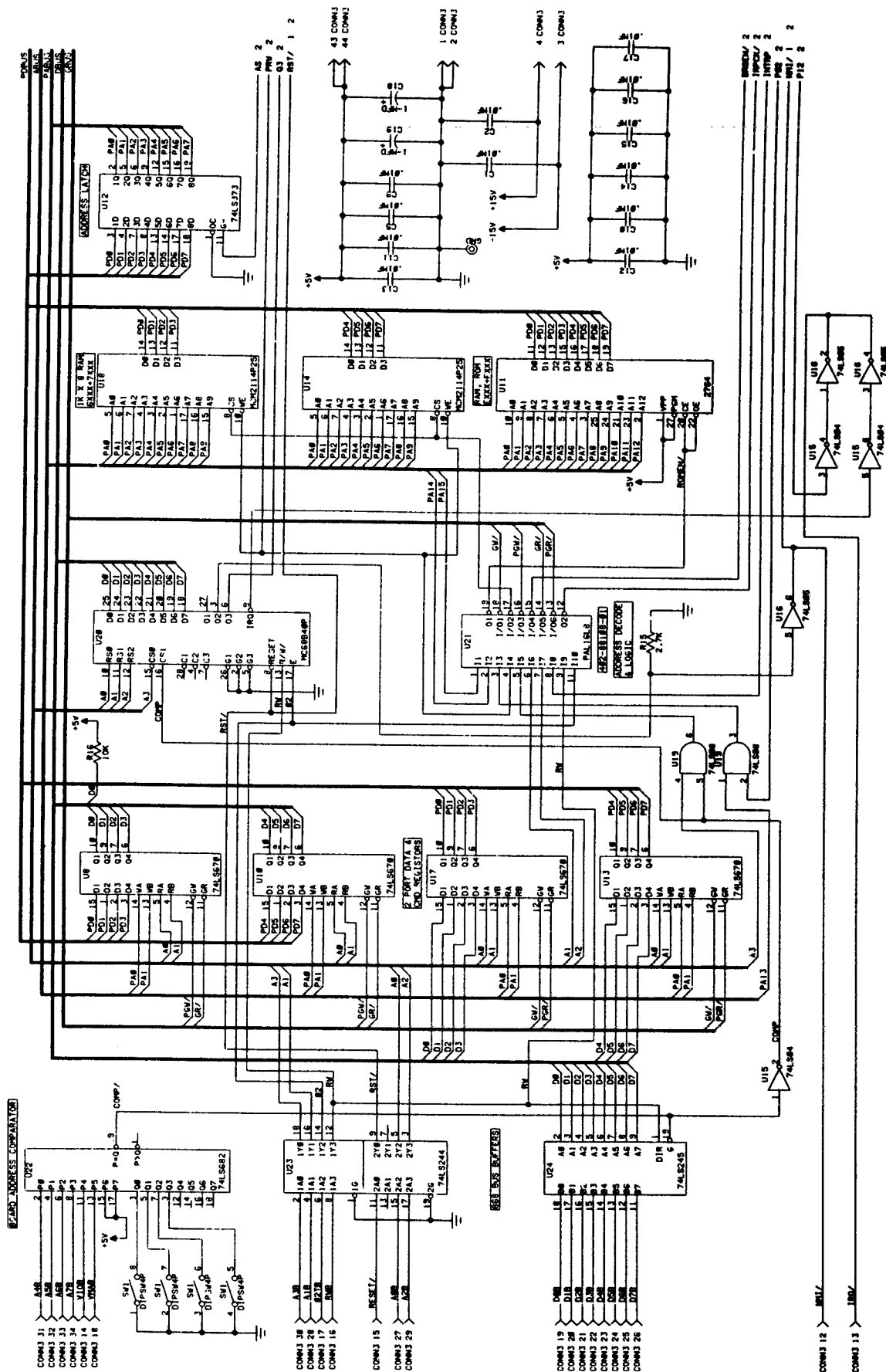


FIGURE 3.A. FIFO MODULE SCHEMATIC (PAGE 1 OF 2)

FIFO COMMUNICATIONS MODULE

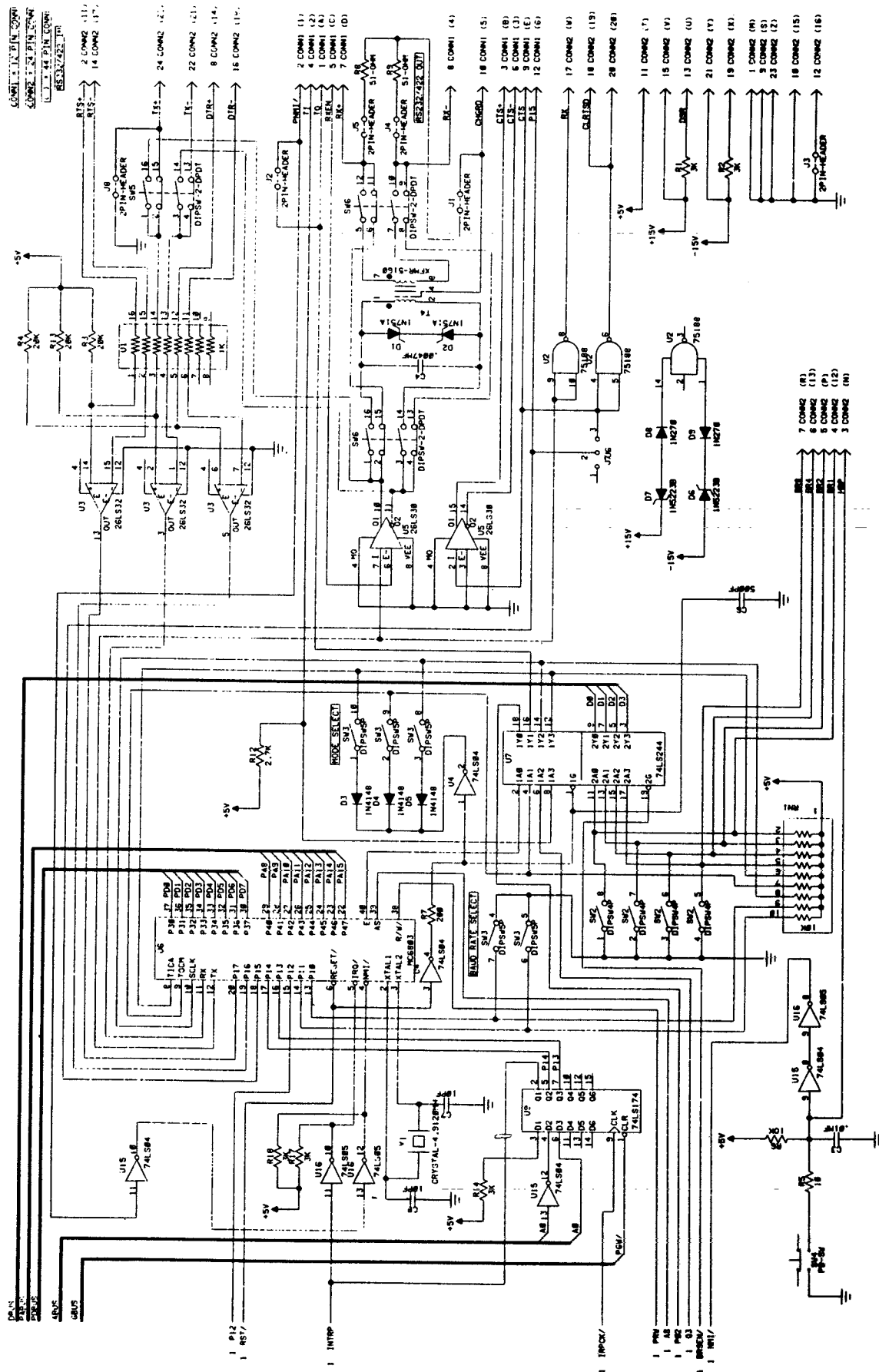


FIGURE 3.B. FIFO MODULE SCHEMATIC (PAGE 2 OF 2)

PERIPHERAL MICROCONTROLLER MODULE

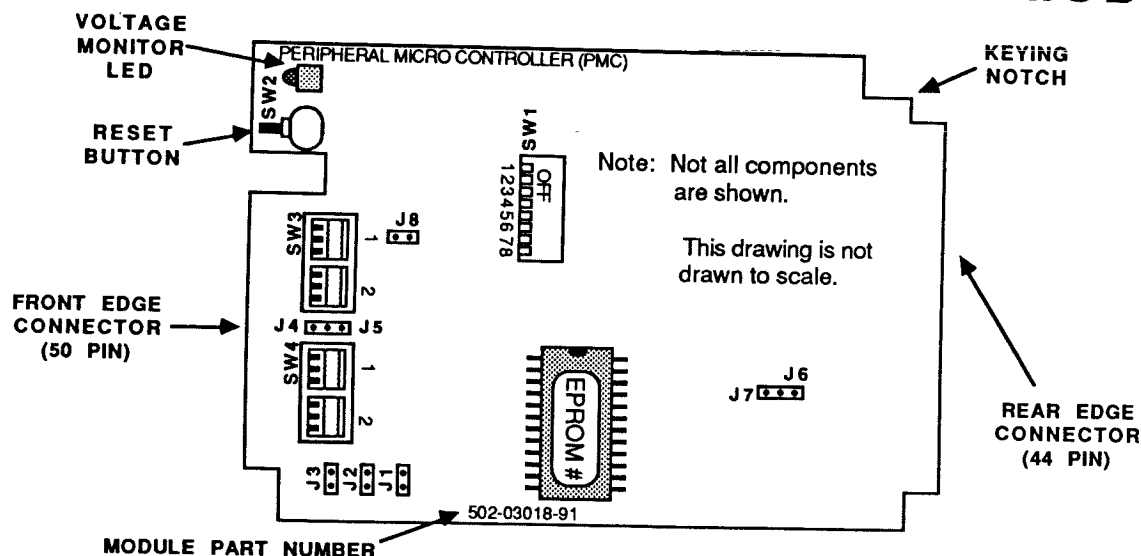


FIGURE 1. PERIPHERAL MICROCONTROLLER MODULE

1.0 INTRODUCTION

The Peripheral Microcontroller (PMC) Module functions as an independent computer. The PMC Module incorporates a CPU, up to 8K bytes of EPROM, 1.1K bytes of RAM, a Serial Communications Interface, parallel I/O, and a 16-bit timer. The PMC Module uses a 6801 microcomputer unit that is object code compatible with the 6800 and has several additional instructions.

2.0 VOLTAGE MONITOR

A voltage monitor is provided on the PMC Module to generate a RESET signal when the +5 volt supply falls below tolerance. The on-board LED illuminates when this happens and remains illuminated as long as the RESET signal persists.

3.0 MODULE-MOUNTED SWITCHES

3.1 SWITCH 1 (SW1)

Switch 1 (SW1) is a switch package consisting of eight individual switches (see Figure 1). Switches 1-3 are used to select remote stations and are connected to a port on the microcomputer. Switches 4 and 5 are used to select the baud rate. Switches 6, 7, and 8 are used to select the operating mode (memory and I/O usage) of the microcomputer IC on the PMC Module. Refer to the documentation for the Call Routine that the PMC Module is being used with for information

regarding Switch 1 switch settings.

3.2 RESET BUTTON (SW2)

Momentarily depressing the RESET Button causes the CPU to initiate a restart sequence. Since the CPU is typically operated in Mode 2, the starting address of the program to be executed is fetched from the on-board EPROM.

3.3 SWITCHES 3 AND 4 (SW3 & SW4)

Switches 3 and 4 enable or disable the module-mounted transformer (see Section 4.0). The switches are used as shown in Figure 2.

4.0 MODULE-MOUNTED TRANSFORMER

The PMC Module contains a transformer that can be enabled or disabled by the user (see Figure 2). The transformer should be enabled if noise is a problem when communications are carried out, providing that the use of the transformer is possible with the application.

The following information must be observed when considering whether or not to use the module-mounted transformer:

1. The transformer cannot be used if communications are in the RS-232 format.
2. If a transformer is used at one end of the communications, a transformer must be used at the

PERIPHERAL MICROCONTROLLER MODULE

other end as well.

This can be done by using two modules that contain a transformer, or by using a pulse module kit (which is a transformer) at the module that does not have a transformer mounted on it.

3. G&L supports using 76.8K baud, biphasic communications.
4. Pin 15 on the 50-pin PMC Module card edge connector must be connected to chassis ground if the transformer is used. Run a wire from pin 15 to a screw that is in one of the threaded holes in the PiC rack.

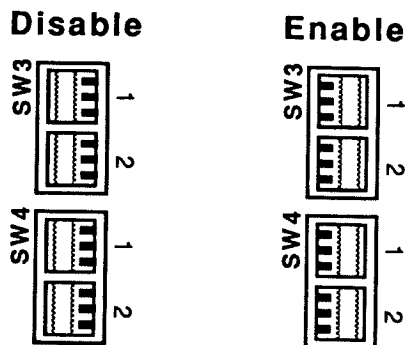


FIGURE 2. PMC TRANSFORMER SWITCH SETTINGS

5.0 MODULE-MOUNTED JUMPERS

5.1 JUMPERS 1-7

The PMC Module contains eight jumpers that are set according to the user's application. Jumpers 1-7 should be set as indicated in the documentation for the Call Routine used with the PMC Module.

The Bus Enable Jumper (J6) enables or disables the ICs that are used to drive an external bus (see Figure 3). When J6 is enabled, the PMC Module becomes a CPU, and it controls the other modules in the rack via address, data and control buses. When J6 is disabled, the PMC Module becomes a peripheral device and communicates only through the serial or parallel interfaces. The PMC Module will respond to externally generated RESET and interrupt signals.

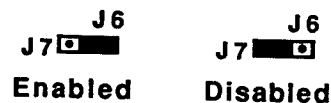


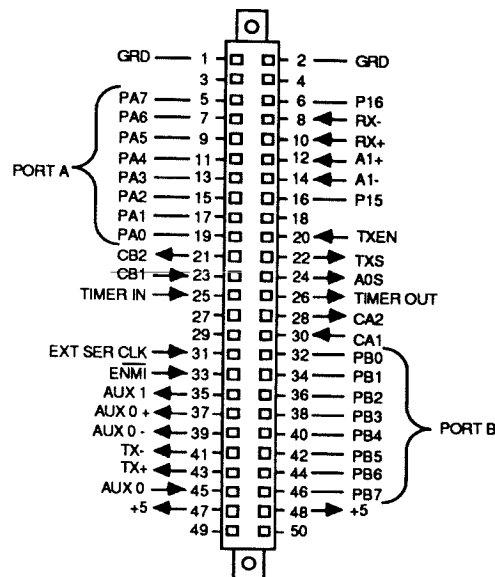
FIGURE 3. BUS ENABLE JUMPER SETTINGS

5.2 JUMPER 8

Jumper 8 (J8) should be installed on the PMC Module if RS-232 communications are being performed.

6.0 CARD EDGE CONNECTOR

A 50-pin card edge connector is used to make wiring connections to the PMC Module from external devices. Figure 4 shows wiring connections to the PMC card edge connector.



NOTE: Be sure the numbers on the card edge connector match the numbers on the PMC Module card edge.

FIGURE 4. CARD EDGE CONNECTOR WIRING

PERIPHERAL MICROCONTROLLER MODULE

7.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE PIC IS REMOVED BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

The rack is physically keyed to prevent modules from being inserted incorrectly.

Make wiring connections to the card edge connector and fasten the card edge connector to the module before applying power to the PIC.

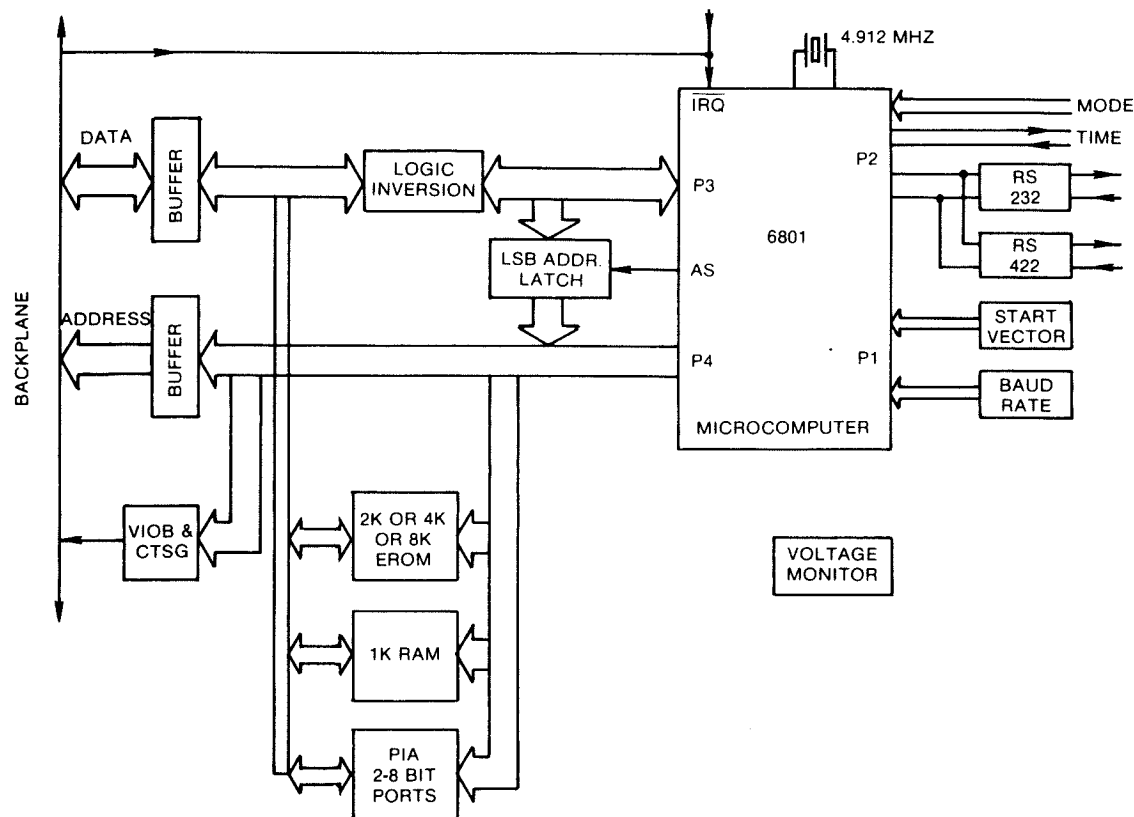


FIGURE 5. BLOCK DIAGRAM

PERIPHERAL MICROCONTROLLER MODULE

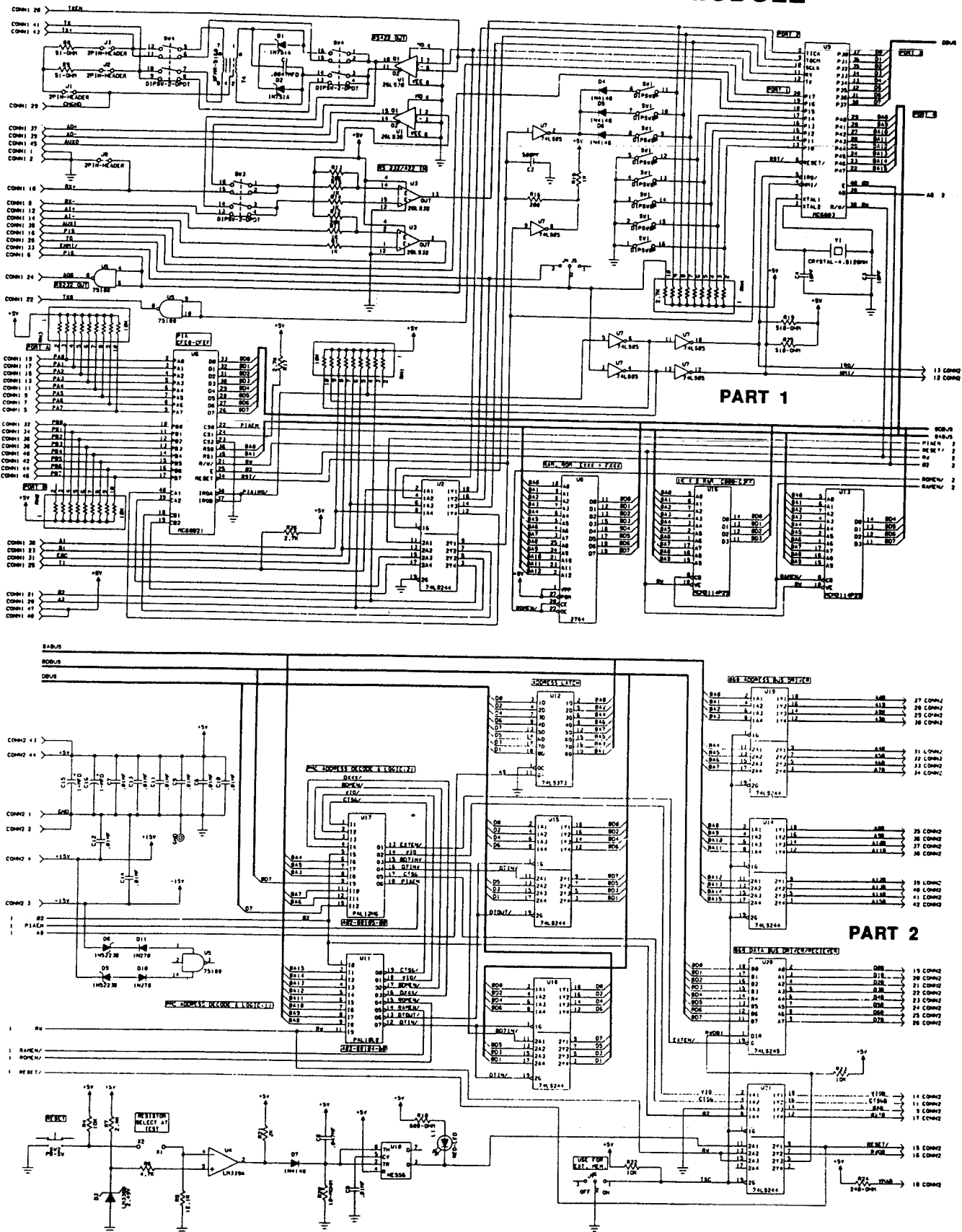


FIGURE 6. SCHEMATIC

20 mA/RS-422 CONVERTER MODULE

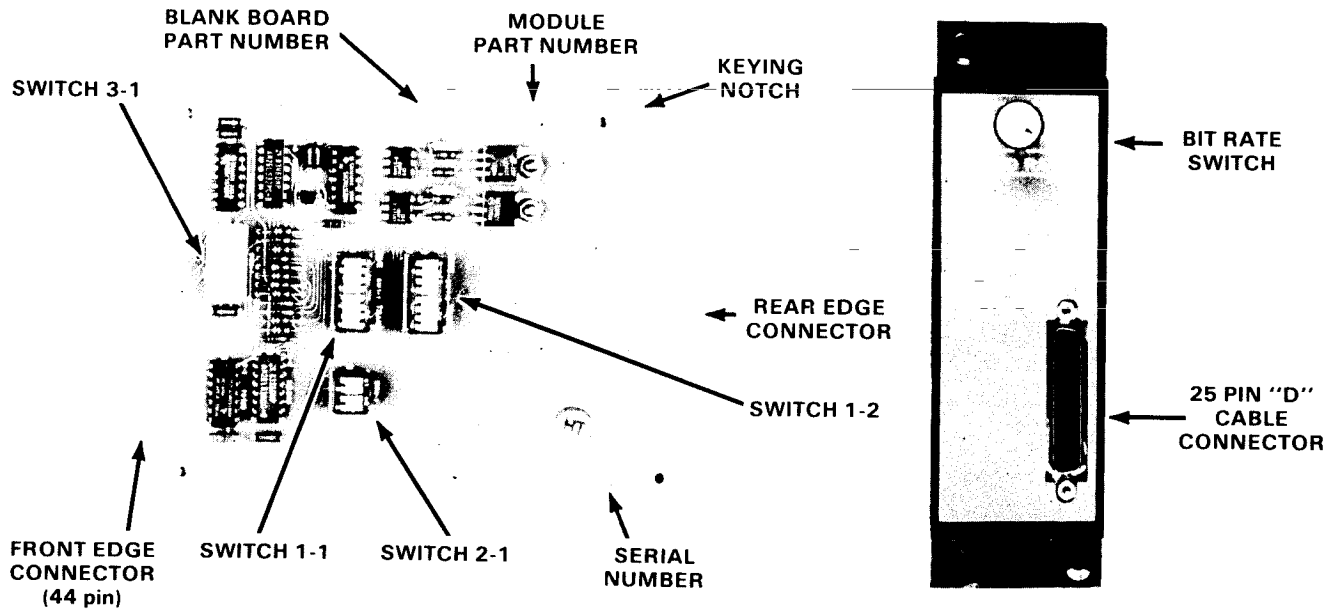


FIGURE 1. 20 mA/RS-422 CONVERTER MODULE & OPTIONAL SERIAL COMMUNICATIONS FACEPLATE

1.0 INTRODUCTION

The 20mA/422 Converter Module, part no. 502-03253-00, allows the user to convert RS-232-C type serial communications data to either 20mA current loop or RS-422 type serial communications data and vice versa. This allows the user to locate a data terminal or other device at greater distances from the PC409 than RS-232-C allows and still transmit and receive accurate serial data.

- 1) 502-02871-20 Programmer's Console Interface Module
- 2) 502-02833-20 RS-232-C Interface Module
- 3) 503-15613-00 FIFO Communications Module (for PC to PC communications)

An optional faceplate, the Serial Communications Interface Faceplate part no. 502-03266-00, connects the Converter Module to any one of the three modules listed above. It allows the user to simply connect a correctly configured cable, with a 25-pin "D" connector, from a data terminal or other device to the PC409.

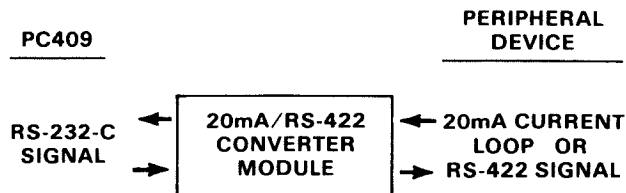


FIGURE 2. BLOCK DIAGRAM

This module will be configured in conjunction with one of the following three PC409 modules:

2.0 SWITCH CONFIGURATIONS

There are four user configured switches on the 20mA/422 Converter Module.

2.1 SWITCH 1-1 (SW1-1)

SW1-1 is a 16-pin dip switch with two movable switches. These two switches are used to configure the transmit and receive circuits of the 20mA/422 Con-

20mA/RS-422 CONVERTER MODULE

verter Module for either the 20mA current loop or RS-422 mode.

Switch configurations for SW1-1 are shown in Figure 3.

RECEIVE AND TRANSMIT MODE SELECTION

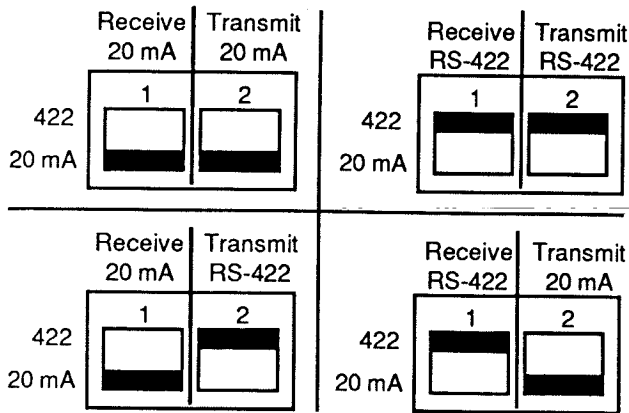


FIGURE 3. SWITCH 1-1

2.2 SWITCH 1-2 (SW1-2)

SW1-2 is a 16-pin dip switch with two movable switches. These two switches are used to configure the transmit and receive circuits of the module for either an "active" or "passive" current loop mode of operation.

In the active current loop mode, current is supplied by the 20mA/422 Converter Module. In the passive current loop mode, current is supplied by the user's data terminal or device.

Switch configurations for SW1-2 are shown in Figure 4.

20 mA CURRENT LOOP MODE SELECTION

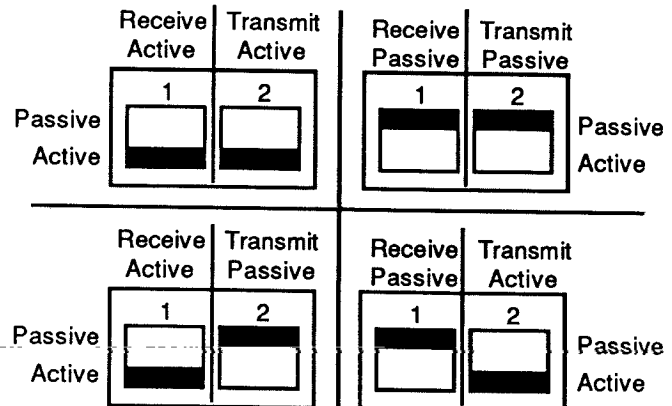


FIGURE 4. SWITCH 1-2

- 2) RS-422 Party Line Mode - This mode is used when wiring multiple RS-422 devices or terminals in parallel to the 20mA/422 Converter Module.
- 3) 20mA Normal Mode - This mode is used when connecting a single 20mA device to the 20mA/422 Converter Module.
- 4) 20mA Daisy Mode - This mode is used when wiring multiple 20mA current loop devices or terminals to the 20mA/422 Converter Module in series.

Switch configurations for SW2-1 are shown in Figure 5.

2.3 SWITCH 2-1 (SW2-1)

SW2-1 is an 8-pin dip switch with two movable switches. These two switches are used to configure the module for one of the following four modes:

- 1) RS-422 Normal Mode - This mode is used when connecting a single RS-422 device to the 20mA/422 Converter Module.

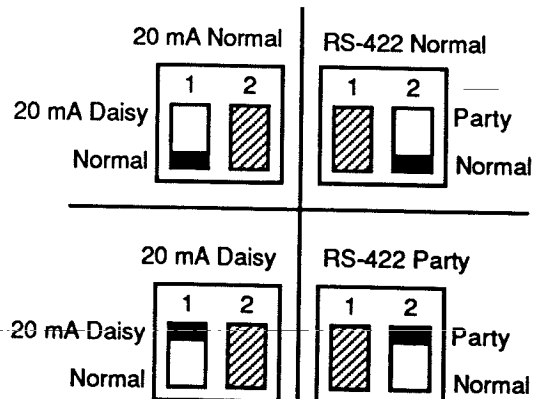


FIGURE 5. SWITCH 2-1

20mA/RS-422 CONVERTER MODULE

2.4 SWITCH 3-1 (SW3-1)

SW3-1 is a multi-purpose 16-pin dip switch. Definitions for each of the six (of the eight) switches used follows:

Switches 1,2,3 and 4 are used for RS-422 party line terminations. These switches should be closed (in circuit) on those modules used at each end of the party line. If the module is not used at the end of the party line, the switches should be open (out of circuit). The functions of the individual switches are defined below.

Switch 1 - 120 ohms between RTS+ and RTS-

Switch 2 - 120 ohms between DTR+ and DTR-

Switch 3, Switch 4 - (see NOTE)

NOTE

When operating the 20mA/RS-422 Converter Module in the 20mA mode, close switches 4 and 5 on SW3-1.

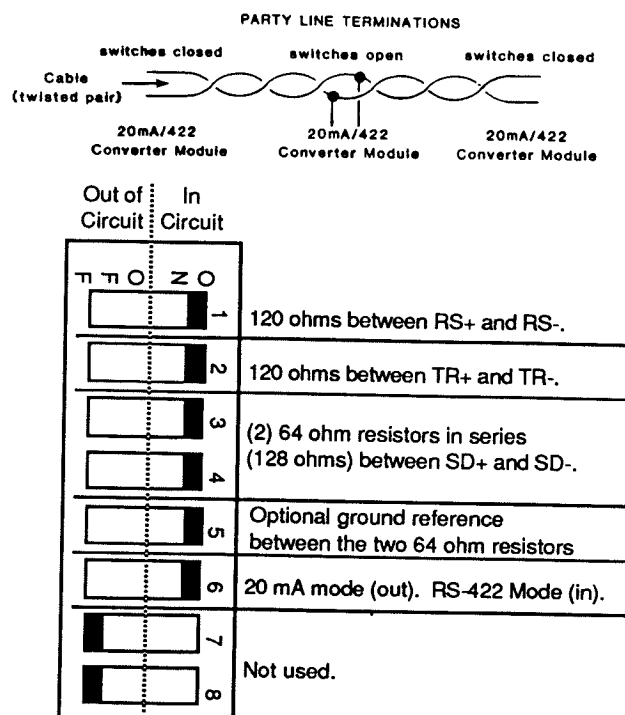


FIGURE 6. SWITCH 3-1

Switch 5 may be used in addition to switches 3 & 4 as a ground reference between the two 64 ohm resistors. With switch 5 closed, noise immunity may improve.

Switch 6 is used to configure the 20mA/422 Converter Module for either the 20mA Current Loop or the RS-422 modes. It is configured as follows:

OUT OF CIRCUIT - 20mA Current Loop mode

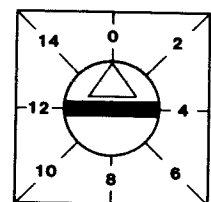
IN CIRCUIT - RS-422 mode

Switch configurations for SW3-1 are shown in Figure 6.

3.0 BIT RATE SELECTION

3.1 ON-BOARD BIT RATE SWITCH

BIT RATE	SWITCH POSITION
50	13
75	12
110	0
134.5	11
150	1
200	10
300	3
600	9
1200	4
1800	5
2400	3 or 8
4800	6
9600	7
19200	14 or 15



FRONT VIEW

FIGURE 7. BIT RATE vs SWITCH POSITION

Bit rate selection for the Programmer's Console Interface module and the RS-232-C Interface module is accomplished using the 16 position, screw-driver actuated switches located near the front edges of these modules. See Figure 7 for the various bit rate switch positions and corresponding bit rates.

3.2 EXTERNAL BIT RATE SWITCH

An external bit rate switch may be connected to the Programmer's Console Interface module and the RS-232-C

20mA/RS-422 CONVERTER MODULE

Interface module to remotely control the bit rate. If an external bit rate switch is used, as when using the Serial Communications Interface faceplate, the on-board bit rate switch must be set to position 0. A 24-pin card edge connector, part no. 401-50656-00, may be used to wire the external bit rate switch as shown in Figure 8.

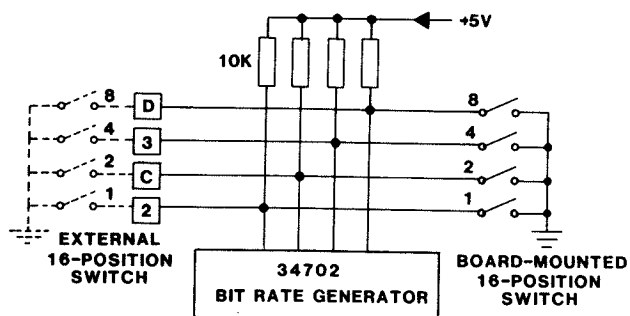


FIGURE 8. BIT RATE SWITCHES

3.3 FIFO BIT RATE SWITCH SELECTION

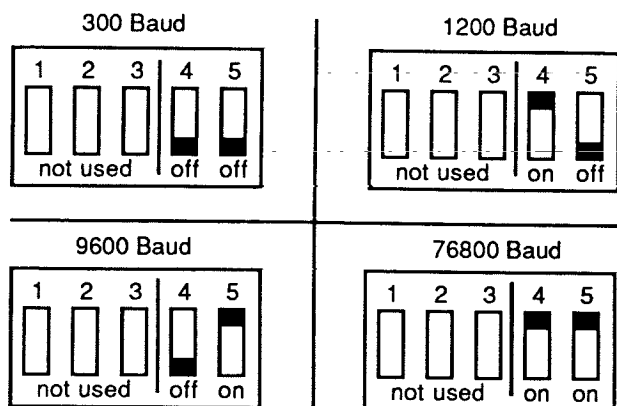


FIGURE 9. FIFO BIT RATE SELECTION

When using a FIFO Communications module in conjunction with the 20mA/422 Converter Module for PC to PC communications, the bit rate is selected by setting SW3-4 and SW3-5 on the FIFO Communications module. See Figure 9 for switch configuration and corresponding bit rates.

4.0 RS-232-C TO 20 mA CURRENT LOOP CONFIGURATIONS

The following modules may be used in conjunction with the 20mA/422 Converter Module to provide the user with a 20mA current loop configuration.

- 1) Programmer's Console Interface
- 2) RS-232-C Interface
- 3) FIFO Communications

IMPORTANT

When wiring external connections for a 20mA current loop configuration, do not reverse the + and - leads on the transmit and receive lines. This will result in damage to the 20mA/422 Converter Module.

4.1 CARD EDGE CONNECTOR

PROGRAMMER'S
CONSOLE MODULE
OR RS-232-C MODULE
OR FIFO MODULE

20 mA/RS-422
CONVERTER MODULE

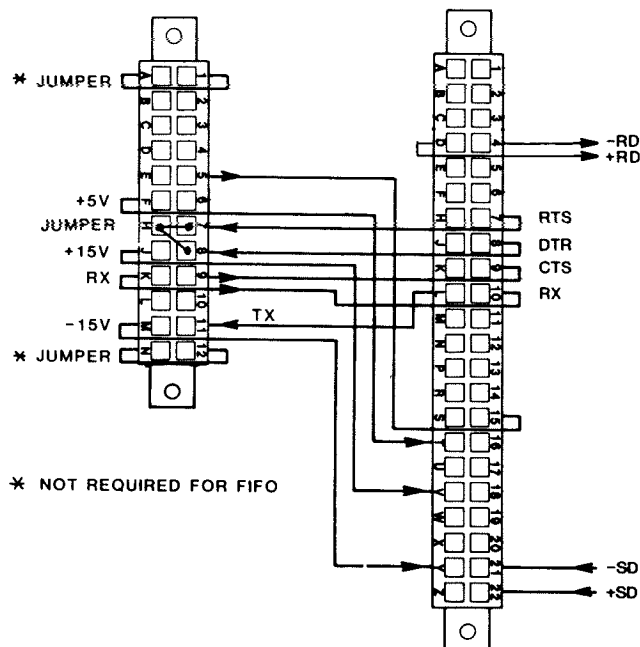


FIGURE 10. RS-232-C TO 20 mA CURRENT LOOP USING CARD EDGE CONNECTORS

20mA/RS-422 CONVERTER MODULE

A 24-pin card edge connector, part no. 401-50656-00, and a 44-pin card edge connector, part no. 401-50993-00, can be used to connect the 20mA/422 Converter Module to one of the PC409 modules discussed in the previous section. Phosphor bronze crimp contacts, with gold over nickel plating, are available as part no. 401-50460-00. "Dummy" contacts, part no. 401-50459-00, may be inserted in unused places for improved holding power.

Figure 10 illustrates the necessary connections when using card edge connectors for configuring the 20mA current loop option.

4.2 OPTIONAL FACEPLATE CONNECTOR

If the optional Serial Communications Interface faceplate is used, the 20mA current loop option is configured as shown in Figure 11. When using the faceplate, the Converter Module must be in the Master Rack slot directly to the left of the module it will be connected to. The faceplate will then fit over the front edge connectors of both modules.

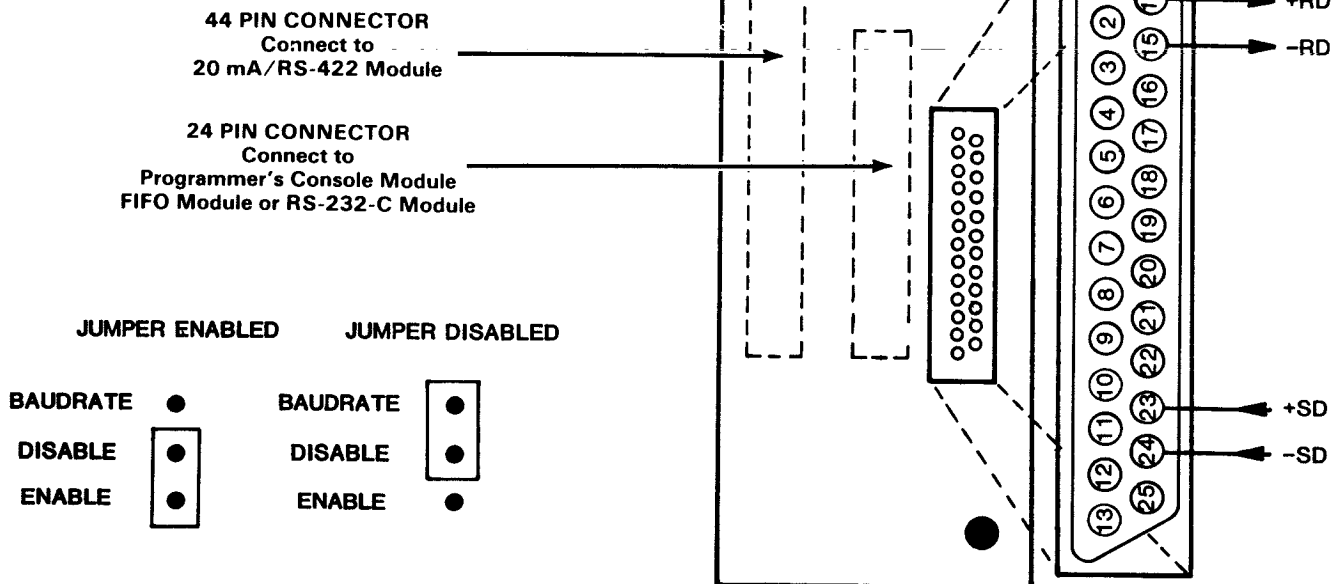


FIGURE 11. RS-232-C TO 20 mA CURRENT LOOP USING OPTIONAL FACEPLATE

NOTE

If intending to use the external bit rate switch on the Serial Communications Interface faceplate, the following steps must be completed or the external switch will not be usable.

- 1) Set the rotary switch on the Programmer's Console Interface or the RS-232-C Interface to Position 0.
- 2) Place the BAUDRATE Jumper on the Serial Communications Interface faceplate to the "ENABLE" position.

20mA/RS-422 CONVERTER MODULE

5.0 RS-232-C TO RS-422 CONFIGURATIONS

The following modules may be used in conjunction with the 20mA/422 Converter Module to provide the user with an RS-422 configuration.

- 1) Programmer's Console Interface
- 2) RS-232-C Interface

NOTE

The FIFO Communications module is capable of RS-422 communications without the use of the 20mA/422 Converter Module.

5.1 CARD EDGE CONNECTOR

A 24-pin card edge connector, part no. 401-50656-00, and a 44-pin card edge connector, part no. 401-50993-00, can

be used to connect the 20mA/422 Converter Module to one of the PC409 modules discussed in the previous section. Phosphor bronze crimp contacts, with gold over nickel plating, are available as part no. 401-50460-00. "Dummy" contacts, part no. 401-50459-00, may be inserted in unused places for improved holding power.

Figure 12 illustrates the necessary connections when using card edge connectors for configuring the RS-422 option.

5.2 OPTIONAL FACEPLATE CONNECTOR

If the optional Serial Communications Interface faceplate is used, the RS-422 option is configured as shown in Figure 13. When using the faceplate, the Converter Module must be in the Master Rack slot directly to the left of the module it will be connected to. The faceplate will then fit over the front edge connectors of both modules.

NOTE

If intending to use the external bit rate switch on the Serial Communications Interface faceplate, the following steps must be completed or the external switch will not be usable.

- 1) Set the rotary switch on the Programmer's Console Interface or the RS-232-C Interface to Position 0.
- 2) Place the BAUDRATE jumper on the Serial Communications Interface faceplate to the "ENABLE" position.

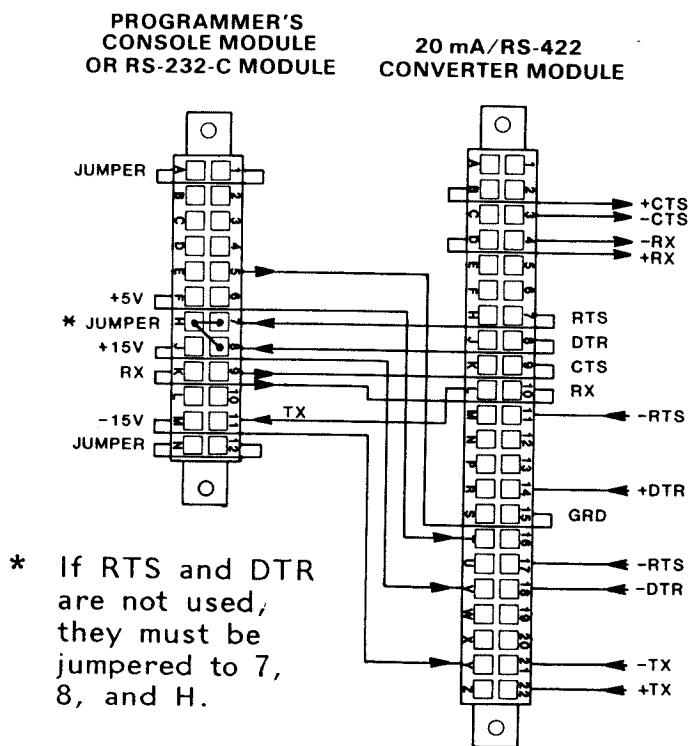


FIGURE 12. RS-232-C TO RS-422 USING CARD EDGE CONNECTORS

20mA/RS-422 CONVERTER MODULE

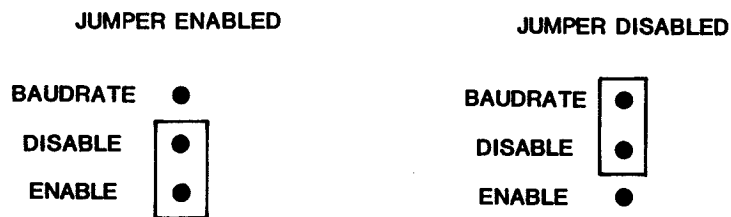
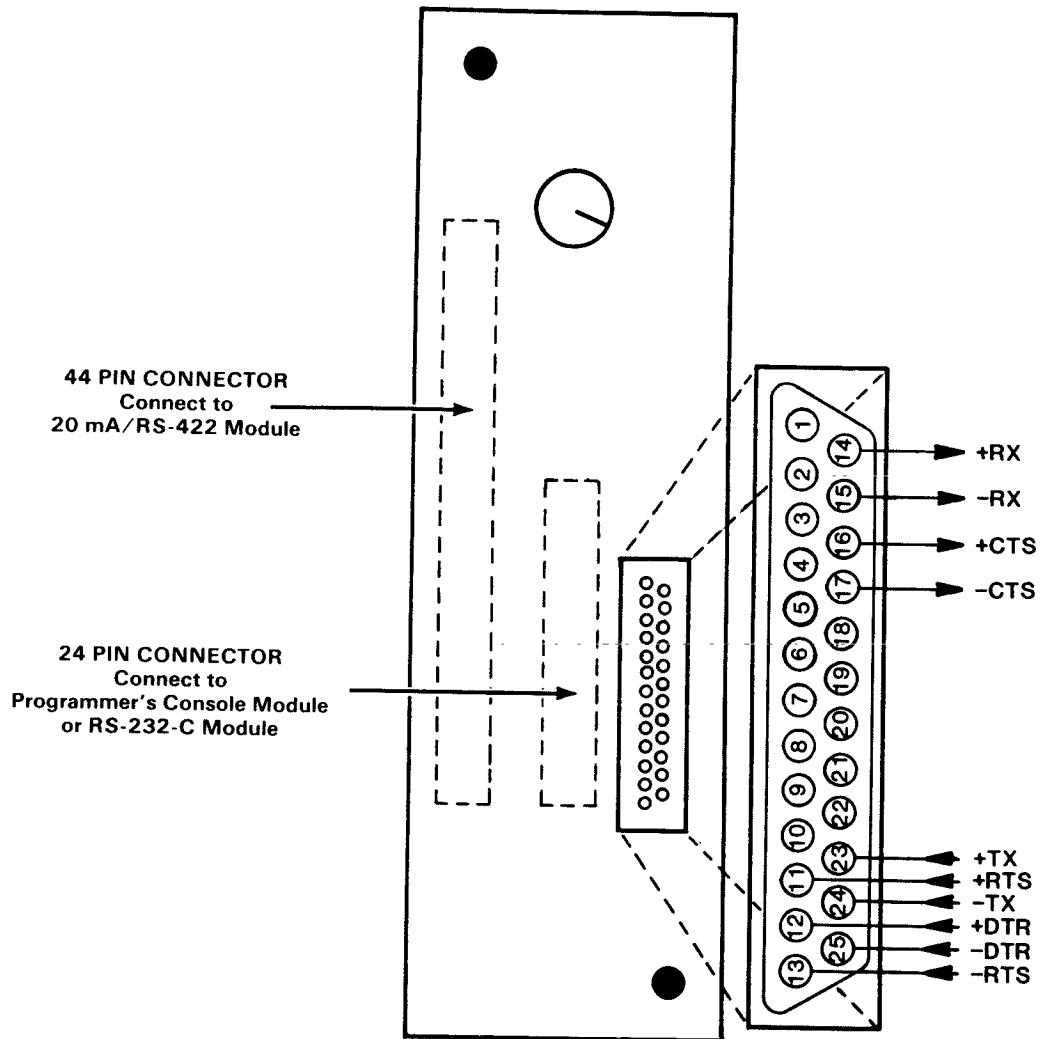


FIGURE 13. RS-232-C TO RS-422 USING OPTIONAL FACEPLATE

20mA/RS-422 CONVERTER MODULE

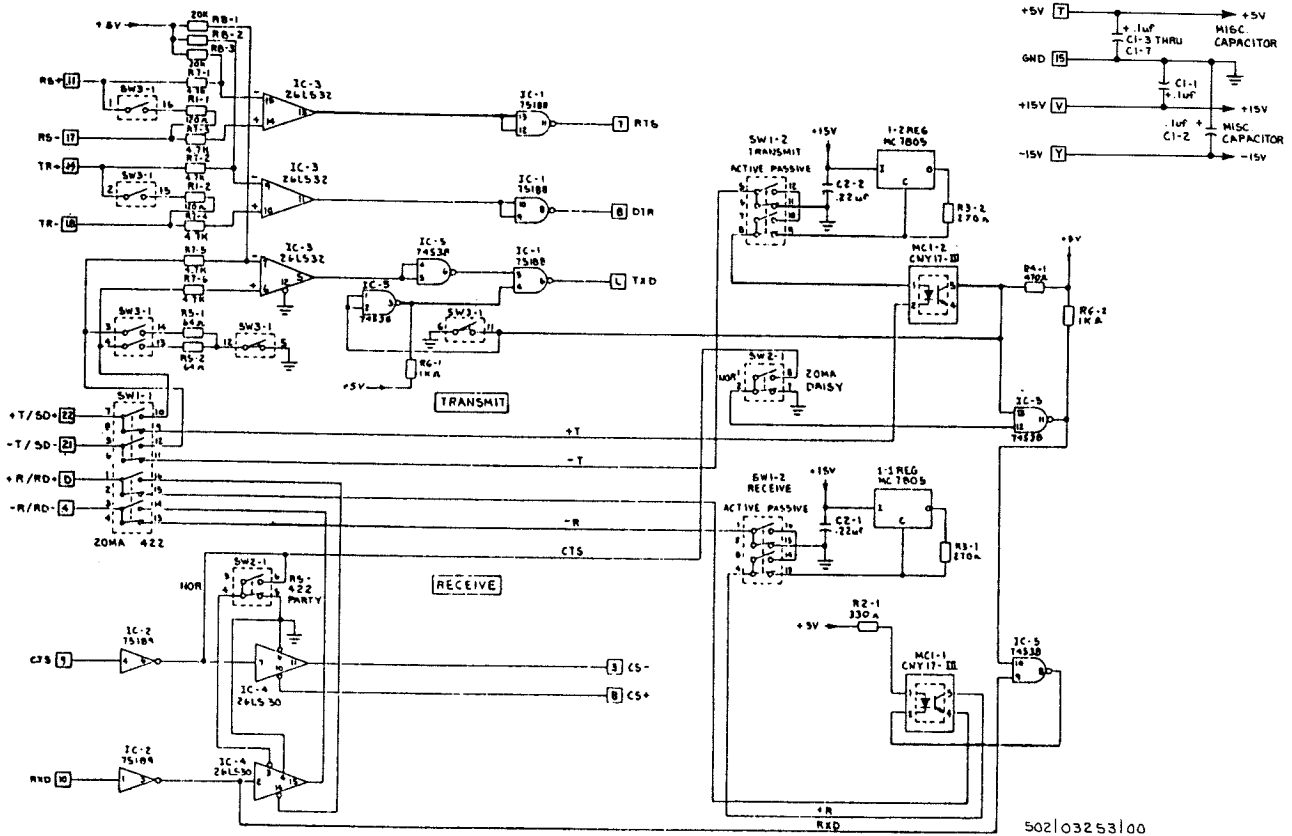


FIGURE 14. 20 mA/ RS-422 CONVERTER MODULE SCHEMATIC

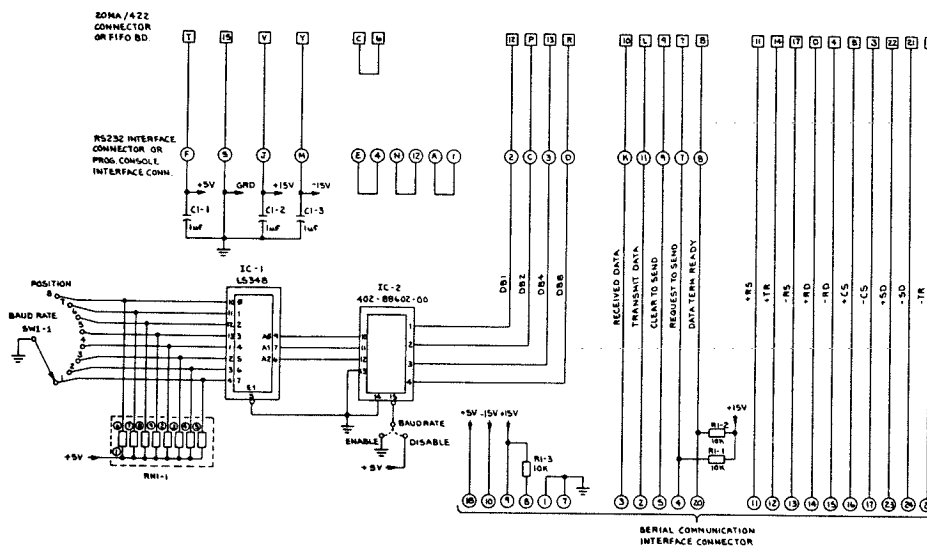


FIGURE 15. SERIAL COMMUNICATIONS INTERFACE FACEPLATE SCHEMATIC

SERIAL COMMUNICATIONS FACEPLATE

Part Number 502-03266-00

1.0 INTRODUCTION

The Serial Communications Faceplate, part no. 502-03266-00, provides a convenient interface between the G&L PiC communications modules and communications cables coming from peripheral devices. It has an on-board baud rate selector switch and a 25 pin female "D" cable connector.

This faceplate fits directly onto the front edge connectors of the following four modules:

RS-232C Interface Module
Part No. 502-02833-20.

Programmer's Console Module
Part No. 502-02871-00.

FIFO Communications Module
(for PiC to PiC communications)
Part No. 502-15613-00.

20 mA/RS-422 Converter Module
Part No. 502-03253-00

NOTE

Refer to the 20 mA/RS-422 Converter Module documentation when using the faceplate with that module.

2.0 BAUD RATE SELECTOR SWITCH

The baud rate on the RS-232C Interface Module and the Programmer's Console Module can be set by the selector switch on the front of the Serial Communications Faceplate. The baud rate on the FIFO module must be set by the internal switches on the module.

If the BAUD RATE switch is to be used, follow the next four steps.

1. Set the rotary switch on the Programmer's Console or the RS-232C module to position 0.
2. Place the BAUD RATE jumper on the back of the Serial Communications Faceplate to the ENABLE position.
3. Connect the 24 pin connector on the faceplate to the front edge connector of the module.
4. Set the BAUD RATE switch on the faceplate to the desired position.

If the BAUD RATE switch on the faceplate is not used, set the BAUD RATE jumper to the DISABLE position before connecting the faceplate to the front edge of the module.

IMPORTANT

ENSURE THAT POWER TO THE MASTER RACK IS OFF BEFORE INSERTING OR REMOVING OR ANY OTHER MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

3.0 25 PIN "D" CONNECTOR

The connector on the front of the faceplate is a standard 25 pin female "D" connector typically used in serial communications. The purpose of each pin depends upon the function selected for the module connected to the faceplate.

Use pin configuration "B" if you are using a module for RS-232C communications. Use pin configuration "A" if you are using the FIFO module for RS-422 communications. Refer to the 20 mA/RS-422 Converter Module documentation when using that particular module for 20 mA or RS-422 communications.

SERIAL COMMUNICATIONS FACEPLATE

JUMPER DISABLED

BAUDRATE

DISABLE

ENABLE



JUMPER ENABLED

BAUDRATE

DISABLE

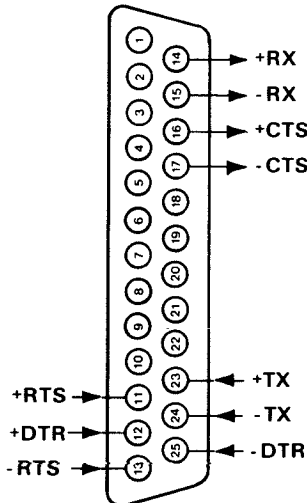
ENABLE



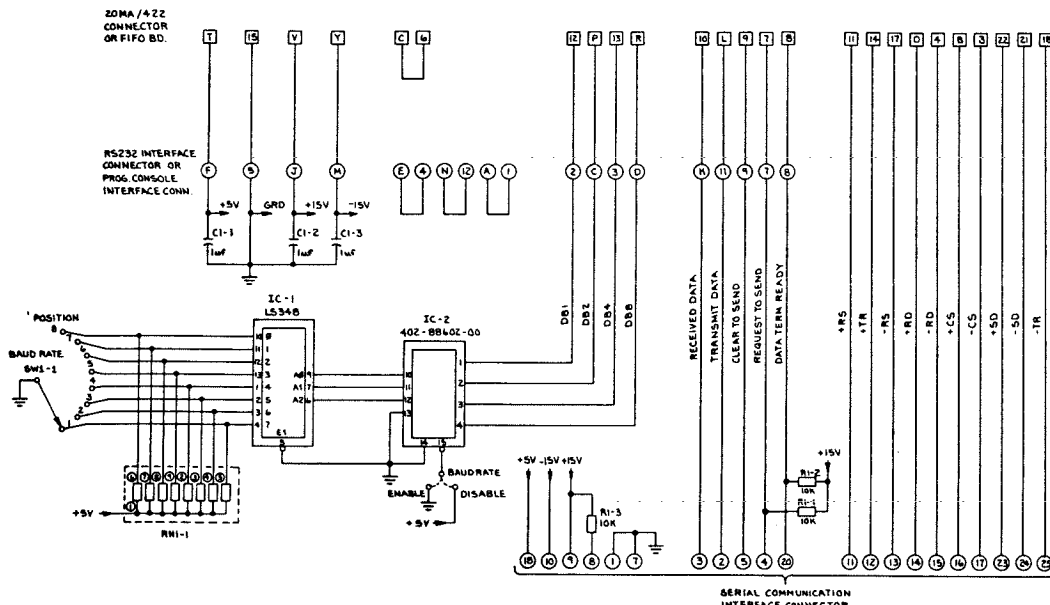
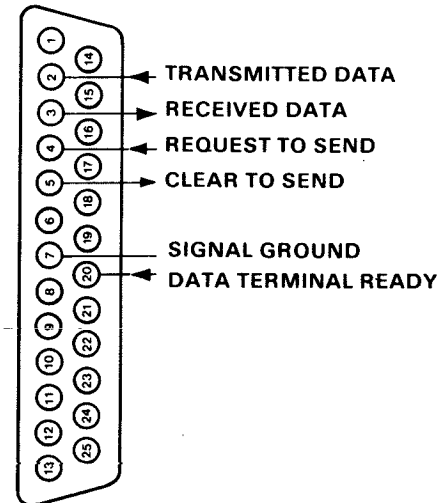
44 PIN CONNECTOR
Connect to FIFO
Module for RS-422
Communications

24 PIN CONNECTOR
Connect to RS-232C,
Programmer's Console
or FIFO Module
for RS-232C
Communications.

A
RS-422 PIN
CONFIGURATION



B
RS-232C PIN
CONFIGURATION



SERIAL COMMUNICATIONS FACEPLATE SCHEMATIC

VIDEO INTERFACE MODULE

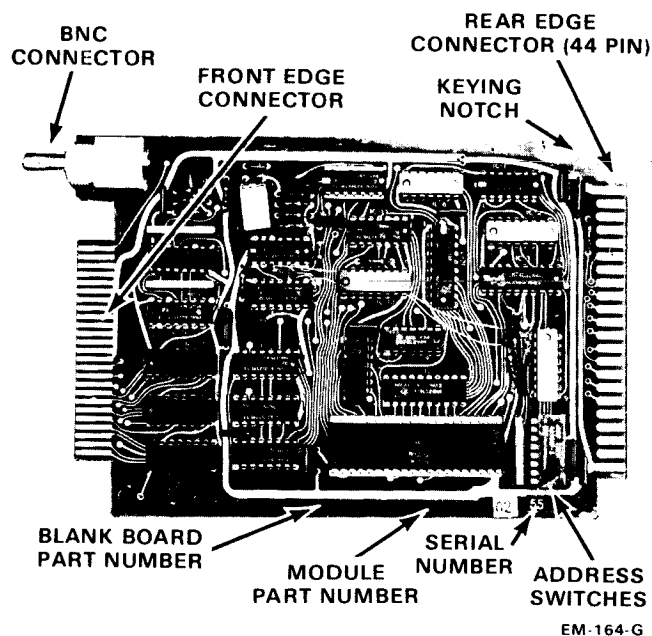


FIGURE 1. VIDEO INTERFACE MODULE

1.0 INTRODUCTION

A video display system may be constructed of a Video Interface Module, from one to four Video Memory Modules, and a standard video monitor (CRT). This combination provides the capability of displaying alphanumeric and/or graphic characters in many sizes and formats. In general, data can be arranged in 12- to 80-character lines, with 6 to 25 lines on a screen.

2.0 ADDRESSING

The Video Interface Module occupies four memory locations. The six board-mounted Address Switches must be set for the lowest of the four addresses desired. TABLE 1 contains the Address Switch settings for the 60 possible beginning address points.

Note that no two modules may occupy the same address area in the Programmable Controller. In addition, the Video Interface Module may not occupy the highest 16 addresses (2240-2255); these locations are reserved for use by fixed-address modules. The Video Interface Module may only be installed

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF OFF OFF OFF OFF	2088	ON OFF OFF OFF OFF OFF	2176	ON OFF OFF OFF OFF OFF
2004	ON OFF OFF OFF OFF OFF	2092	ON OFF OFF OFF OFF OFF	2180	ON OFF OFF OFF OFF OFF
2008	ON OFF OFF OFF OFF OFF	2096	ON OFF OFF OFF OFF OFF	2184	ON OFF OFF OFF OFF OFF
2012	ON OFF OFF OFF OFF OFF	2100	ON OFF OFF OFF OFF OFF	2188	ON OFF OFF OFF OFF OFF
2016	ON OFF OFF OFF OFF OFF	2104	ON OFF OFF OFF OFF OFF	2192	ON OFF OFF OFF OFF OFF
2020	ON OFF OFF OFF OFF OFF	2108	ON OFF OFF OFF OFF OFF	2196	ON OFF OFF OFF OFF OFF
2024	ON OFF OFF OFF OFF OFF	2112	ON OFF OFF OFF OFF OFF	2200	ON OFF OFF OFF OFF OFF
2028	ON OFF OFF OFF OFF OFF	2116	ON OFF OFF OFF OFF OFF	2204	ON OFF OFF OFF OFF OFF
2032	ON OFF OFF OFF OFF OFF	2120	ON OFF OFF OFF OFF OFF	2208	ON OFF OFF OFF OFF OFF
2036	ON OFF OFF OFF OFF OFF	2124	ON OFF OFF OFF OFF OFF	2212	ON OFF OFF OFF OFF OFF
2040	ON OFF OFF OFF OFF OFF	2128	ON OFF OFF OFF OFF OFF	2216	ON OFF OFF OFF OFF OFF
2044	ON OFF OFF OFF OFF OFF	2132	ON OFF OFF OFF OFF OFF	2220	ON OFF OFF OFF OFF OFF
2048	ON OFF OFF OFF OFF OFF	2136	ON OFF OFF OFF OFF OFF	2224	ON OFF OFF OFF OFF OFF
2052	ON OFF OFF OFF OFF OFF	2140	ON OFF OFF OFF OFF OFF	2228	ON OFF OFF OFF OFF OFF
2056	ON OFF OFF OFF OFF OFF	2144	ON OFF OFF OFF OFF OFF	2232	ON OFF OFF OFF OFF OFF
2060	ON OFF OFF OFF OFF OFF	2148	ON OFF OFF OFF OFF OFF	2236	ON OFF OFF OFF OFF OFF
2064	ON OFF OFF OFF OFF OFF	2152	ON OFF OFF OFF OFF OFF		
2068	ON OFF OFF OFF OFF OFF	2156	ON OFF OFF OFF OFF OFF		
2072	ON OFF OFF OFF OFF OFF	2160	ON OFF OFF OFF OFF OFF		
2076	ON OFF OFF OFF OFF OFF	2164	ON OFF OFF OFF OFF OFF		
2080	ON OFF OFF OFF OFF OFF	2168	ON OFF OFF OFF OFF OFF		
2084	ON OFF OFF OFF OFF OFF	2172	ON OFF OFF OFF OFF OFF		

in the Master Rack. Extension Racks are used for AC and DC Input/Output Modules.

3.0 HARDWARE INTERFACING

3.1 MODULE INTERCONNECTION

The Video Interface and Video Memory Modules are interconnected by a short 50-conductor ribbon cable. This cable mates with the front edge connectors and permits the transfer of memory addresses and data among the modules. No faceplates are available for these modules. A typical ribbon cable installation is shown in FIGURE 2.

3.2 VIDEO MONITOR INTERCONNECTION

A BNC socket is provided for making connections to a standard 75-ohm coaxial cable assembly. The video monitor should appear as a 75-ohm termination

FIGURE 2. RIBBON CABLE INSTALLATION

The diagram illustrates the internal architecture of the video memory module. It features several interconnected components:

- Address Bus (A00-A15B):** Provides the primary address input to the system.
- ADDRESS DECODE:** Receives address signals and outputs to the **MODE REG DATA POINTER**.
- MODE REGISTER:** Receives **BOARD SELECT** and **ON OFF SPC FUNCTIONS** signals. It outputs to the **MC6845 CRT CONTROLLER**.
- MC6845 CRT CONTROLLER:** The central control unit that manages the video memory. It outputs **ROW ADDRESS** (12 BITS) and **DO-D1 MEMORY ADDRESS** (12 BITS) to the **MULTIPLEXER**.
- DATA BUS (D0B-D7B):** Connected to the **MULTIPLEXER** via a **Buffer**.
- CONTROL BUS:** Connected to the **MULTIPLEXER** via a **Buffer**.
- COUNTERS (DATA POINTER):** Receives control signals and outputs to the **MULTIPLEXER**.
- MULTIPLEXER:** Combines data from the **DATA BUS**, **CONTROL BUS**, and **COUNTERS** to output a **VIDEO ADDRESS BUS (M0-M11)** (12 BITS) to the **RAM ON VIDEO MEMORY MODULE**.
- DOUBLE HEIGHT SELECTOR (ON OFF):** Receives a **5 BITS** signal from the **MC6845 CRT CONTROLLER** and outputs to the **12-BIT SHIFT REG**.
- 12-BIT SHIFT REG:** Receives a **12 BITS** signal from the **MC6845 CRT CONTROLLER** and outputs to the **COMPOSITE VIDEO GENERATION** block.
- COMPOSITE VIDEO GENERATION:** Receives **VIDEO** signals from the **12-BIT SHIFT REG** and the **DOUBLE HEIGHT SELECTOR**. It outputs to the **E/A VIDEO OUT**.
- VIDEO ROW BUS (R0-R3):** Receives a **4 BITS** signal from the **MC6845 CRT CONTROLLER** and outputs to the **DOUBLE WIDTH 2** block.
- DOUBLE WIDTH 2:** Receives a **CLOCK** signal and outputs to the **DOT COUNTER 12**.
- DOT COUNTER 12:** Outputs to the **COMPOSITE VIDEO GENERATION** block.

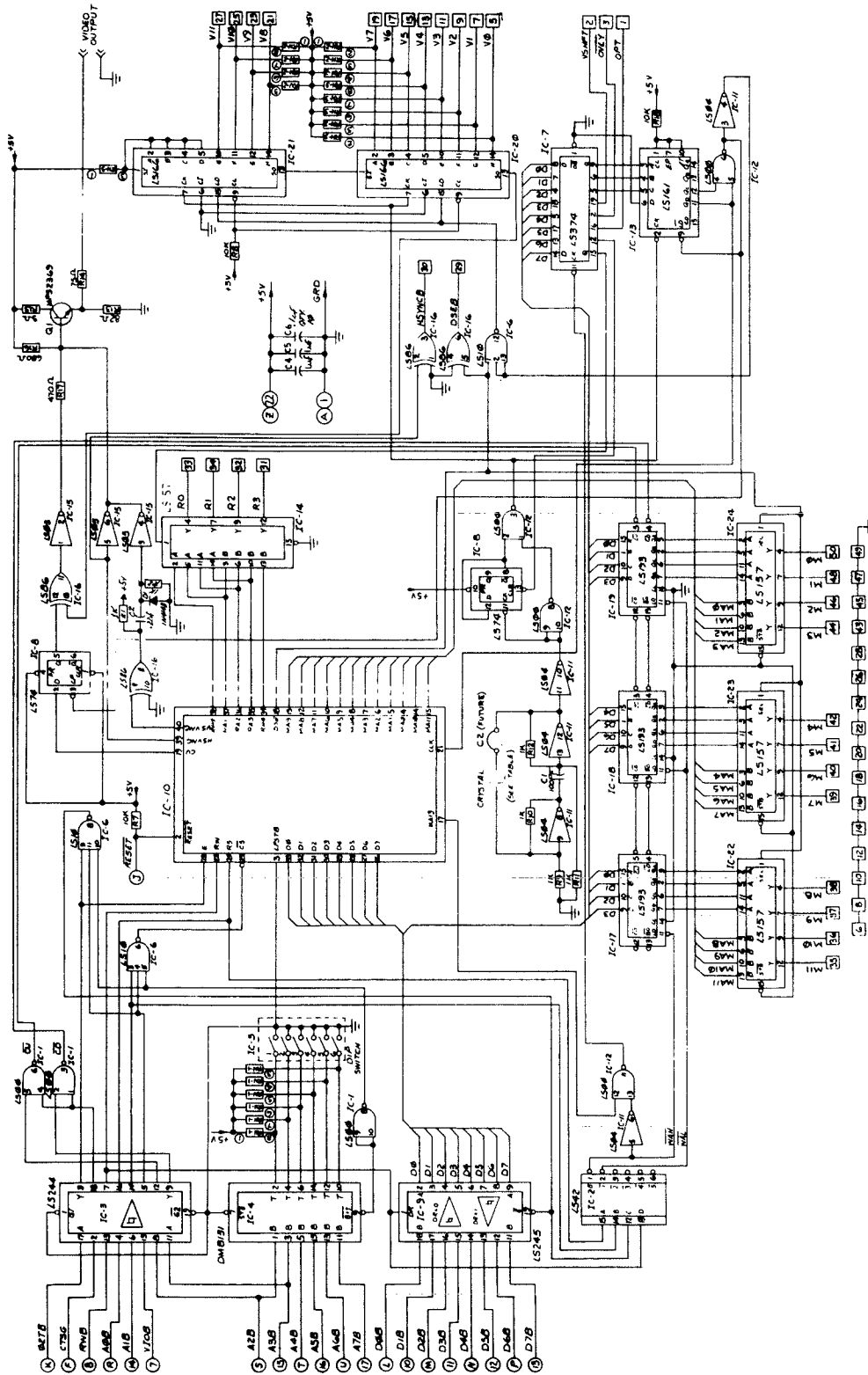
FIGURE 3. BLOCK DIAGRAM

4.0 AVAILABLE VERSIONS

5.0 INSTALLATION

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

VIDEO INTERFACE MODULE



502-02904-03

FIGURE 4. SCHEMATIC



VIDEO MEMORY MODULE

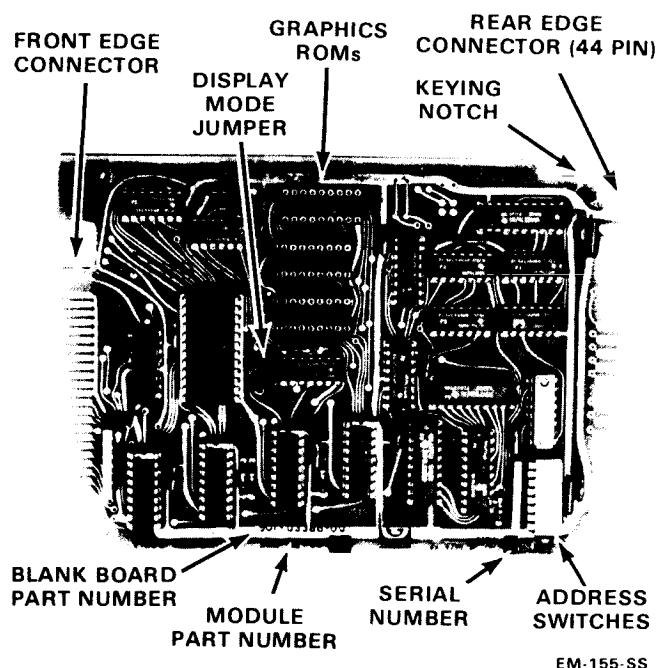


FIGURE 1. VIDEO MEMORY MODULE

1.0 INTRODUCTION

A video display system may be constructed of a Video Interface Module, one to four Video Memory Modules, and a standard video monitor (CRT). This combination provides the user the capability of displaying alphanumeric and/or graphic characters in many sizes and formats. In general, data can be arranged in 12- to 80- character lines, with 6 to 25 lines on a screen.

2.0 ADDRESSING

Each Video Memory Module occupies four memory locations. The six board-mounted Address Switches must be set for the lowest of the four addresses desired. TABLE 1 contains the Address Switch settings for the 60 possible beginning address points.

Note that no two modules may occupy the same address area in the Programmable Controller. In addition, the Video Memory Module may not occupy the highest 16 addresses (2240-2255); these locations are reserved for use by

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
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2008	ON OFF OFF OFF OFF OFF	2096	ON OFF OFF OFF OFF OFF	2184	ON OFF OFF OFF OFF OFF
2012	ON OFF OFF OFF OFF OFF	2100	ON OFF OFF OFF OFF OFF	2188	ON OFF OFF OFF OFF OFF
2016	ON OFF OFF OFF OFF OFF	2104	ON OFF OFF OFF OFF OFF	2192	ON OFF OFF OFF OFF OFF
2020	ON OFF OFF OFF OFF OFF	2108	ON OFF OFF OFF OFF OFF	2196	ON OFF OFF OFF OFF OFF
2024	ON OFF OFF OFF OFF OFF	2112	ON OFF OFF OFF OFF OFF	2200	ON OFF OFF OFF OFF OFF
2028	ON OFF OFF OFF OFF OFF	2116	ON OFF OFF OFF OFF OFF	2204	ON OFF OFF OFF OFF OFF
2032	ON OFF OFF OFF OFF OFF	2120	ON OFF OFF OFF OFF OFF	2208	ON OFF OFF OFF OFF OFF
2036	ON OFF OFF OFF OFF OFF	2124	ON OFF OFF OFF OFF OFF	2212	ON OFF OFF OFF OFF OFF
2040	ON OFF OFF OFF OFF OFF	2128	ON OFF OFF OFF OFF OFF	2216	ON OFF OFF OFF OFF OFF
2044	ON OFF OFF OFF OFF OFF	2132	ON OFF OFF OFF OFF OFF	2220	ON OFF OFF OFF OFF OFF
2048	ON OFF OFF OFF OFF OFF	2136	ON OFF OFF OFF OFF OFF	2224	ON OFF OFF OFF OFF OFF
2052	ON OFF OFF OFF OFF OFF	2140	ON OFF OFF OFF OFF OFF	2228	ON OFF OFF OFF OFF OFF
2056	ON OFF OFF OFF OFF OFF	2144	ON OFF OFF OFF OFF OFF	2232	ON OFF OFF OFF OFF OFF
2060	ON OFF OFF OFF OFF OFF	2148	ON OFF OFF OFF OFF OFF	2236	ON OFF OFF OFF OFF OFF
2064	ON OFF OFF OFF OFF OFF	2152	ON OFF OFF OFF OFF OFF		
2068	ON OFF OFF OFF OFF OFF	2156	ON OFF OFF OFF OFF OFF		
2072	ON OFF OFF OFF OFF OFF	2160	ON OFF OFF OFF OFF OFF		
2076	ON OFF OFF OFF OFF OFF	2164	ON OFF OFF OFF OFF OFF		
2080	ON OFF OFF OFF OFF OFF	2168	ON OFF OFF OFF OFF OFF		
2084	ON OFF OFF OFF OFF OFF	2172	ON OFF OFF OFF OFF OFF		

fixed-address modules. The Video Memory Module may only be installed in the Master Rack. Extension Racks are used for AC and DC Input/Output Modules.

3.0 HARDWARE INTERFACING

The Video Interface and Video Memory Modules are interconnected by a short 50-conductor ribbon cable. This cable mates with the front edge connectors and permits the transfer of memory addresses and data among the modules. No faceplates are available for these modules. A typical ribbon cable installation is shown in FIGURE 2.

4.0 OPTIONAL CAPABILITIES

4.1 GRAPHICS CHARACTERS

In addition to the 128 standard alphanumeric characters, up to 64 graphics (per Video Memory Module) may

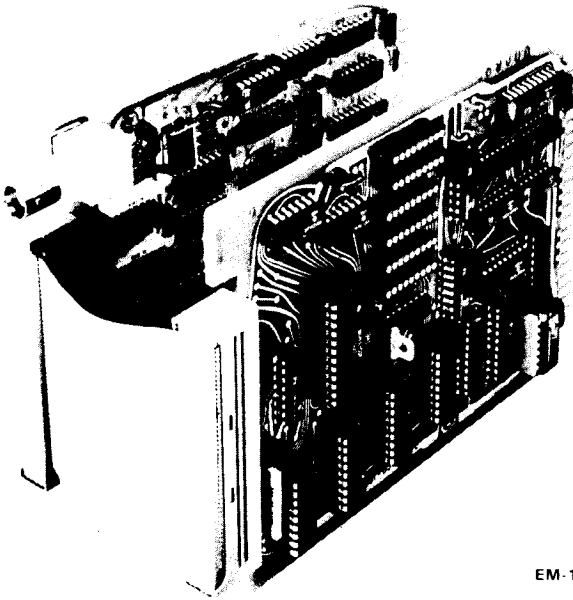
VIDEO MEMORY MODULE

additional modules in this manner, several "pages" of video data could be stored for quick retrieval.

5.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.



EM-127-L

FIGURE 2. RIBBON CABLE INSTALLATION

be added. These characters are stored in three programmed ROM's which are inserted into sockets on the Video Memory Module. Contact the factory for programming worksheets and details.

4.2 DISPLAY MODES

4.2.1 ONE VIDEO MEMORY MODULE

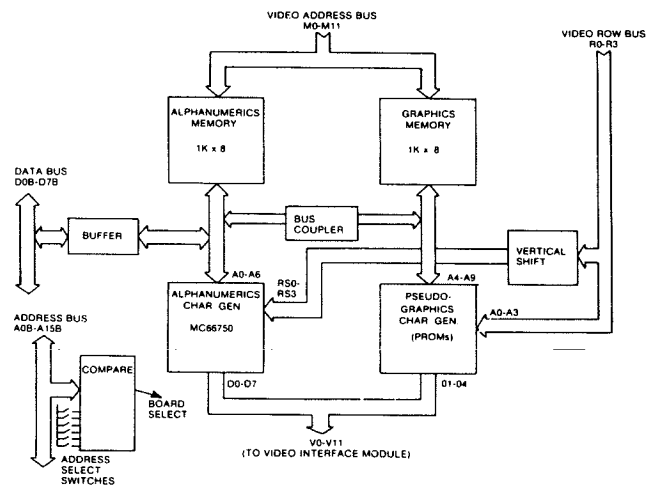
If one module is used, the 3-position jumper is placed in the OFF position. Under software control, there may be either one image (using any of the 192 possible characters), or two overlaying images, consisting of one all-alphanumeric and one all-graphic image.

4.2.2 TWO/FOUR VIDEO MEMORY MODULES

Additional display mode possibilities exist when the number of Video Memory Modules increases:

1. The additional modules may be used to permit overlaying several graphic character sets.
2. The additional modules may be used to increase the amount of character storage available. By using

Video Memory Modules must be installed in the Master Rack. The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 2.0. Fasten the ribbon cable before applying power.



A000203

FIGURE 3. BLOCK DIAGRAM

VIDEO MEMORY MODULE

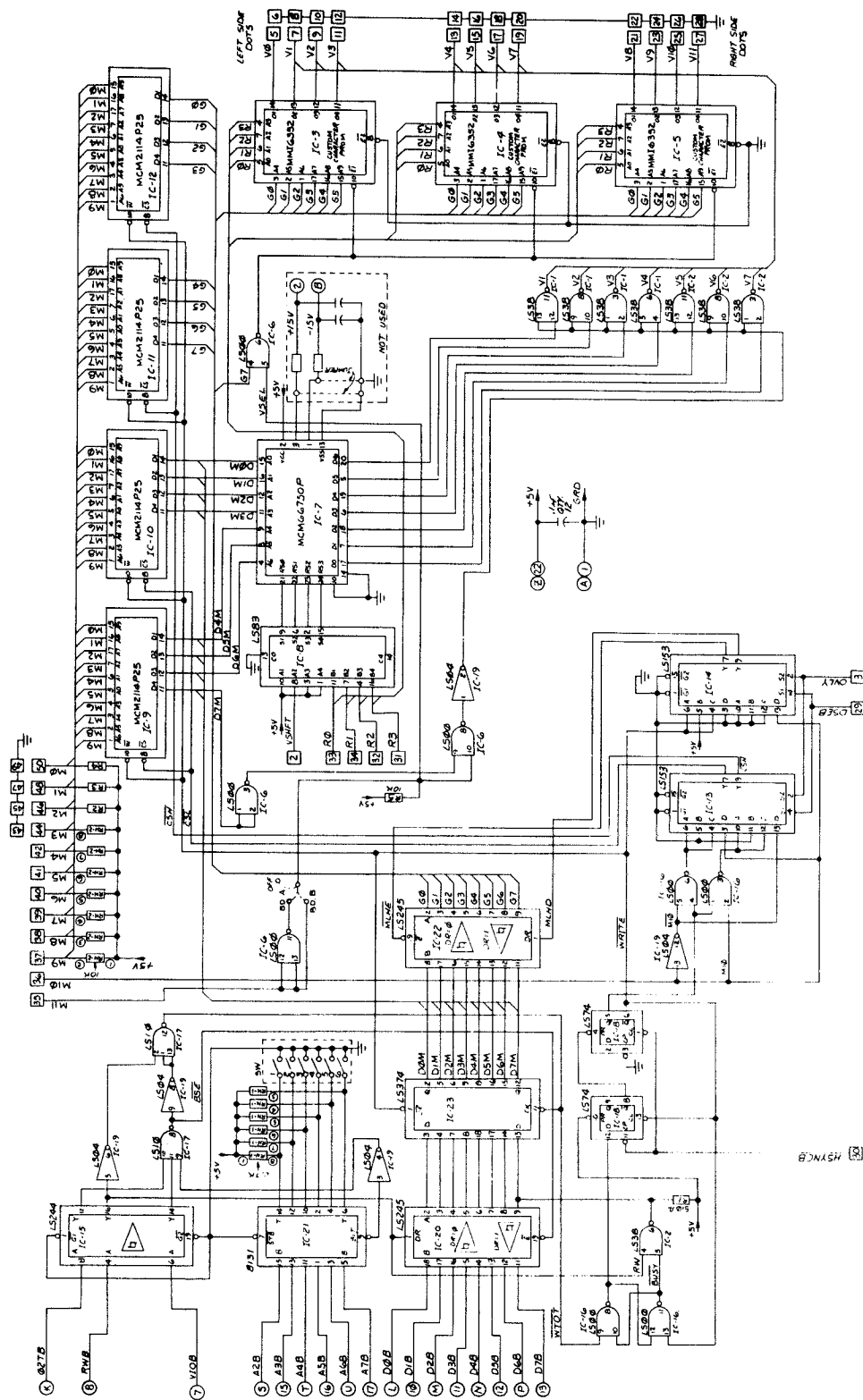


FIGURE 4. SCHEMATIC



MICROPROCESSOR DIGITIZING MODULE

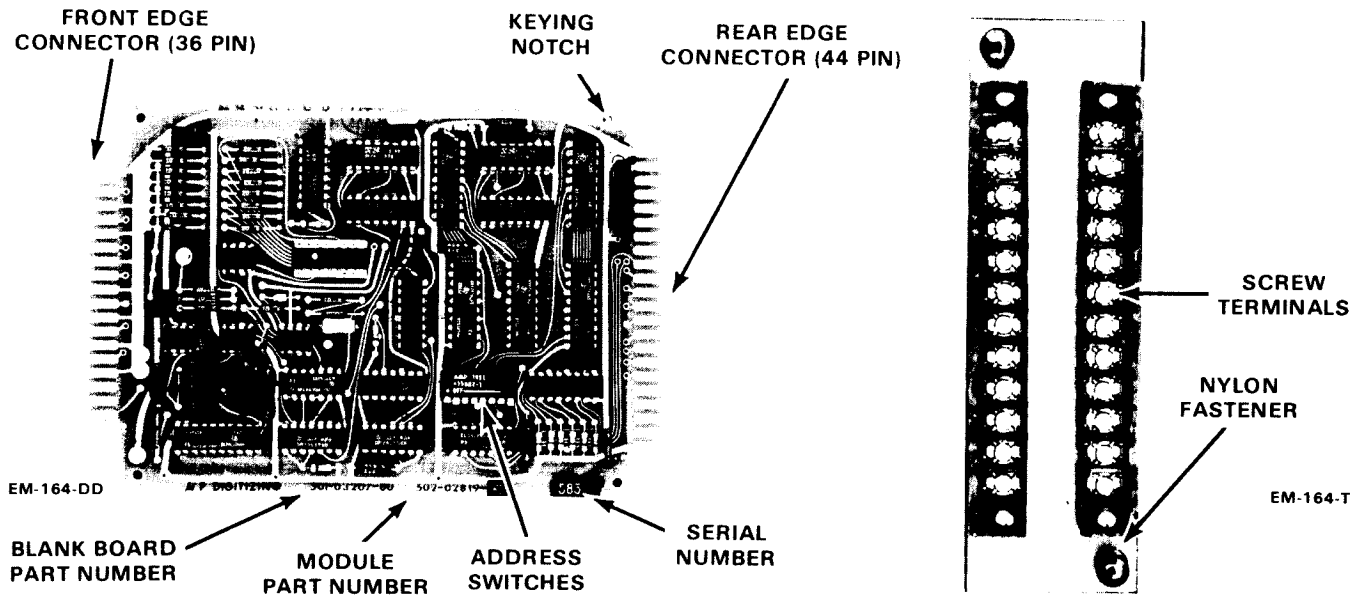


FIGURE 1. MICROPROCESSOR DIGITIZING MODULE & OPTIONAL FACEPLATE

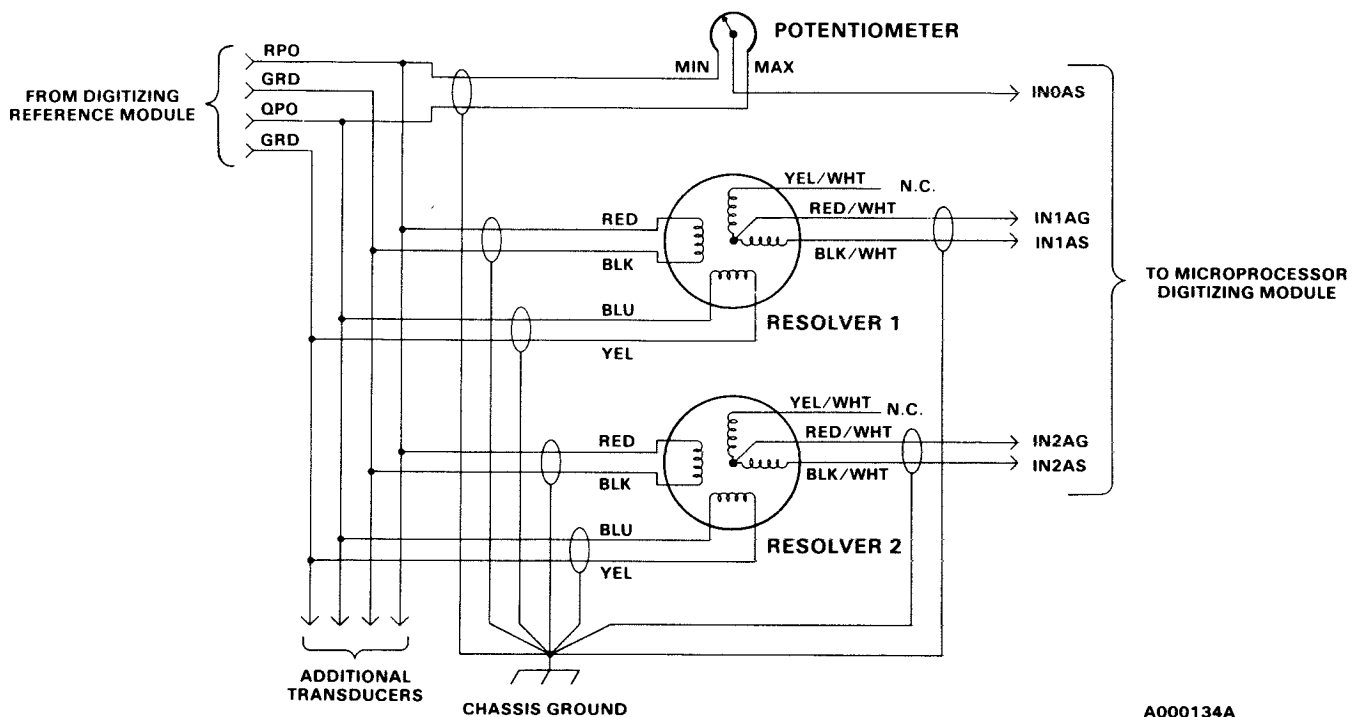


FIGURE 2. TYPICAL TRANSDUCER WIRING

MICROPROCESSOR DIGITIZING MODULE

1.0 INTRODUCTION

The uP (microprocessor) Digitizing Module, part number 502-02819-00 contains circuitry to convert feedback signals from phase-type position measurement transducers into binary values. This module has the ability to "digitize" up to eight transducers. The companion Digitizing Reference Module generates synchronization signals used in the digitizing process and must be wired to the uP Digitizing Module.

External devices are connected to the module through either a 36-pin card edge connector or a uP Digitizing Faceplate, part number 502-03202-00. The latter option permits convenient wiring to compression screw terminals.

2.0 INSTALLATION

The uP Digitizing Module may only be installed in the Master Rack. Extension Racks are used for AC and DC Input/Output Modules.

The rack is physically keyed to prevent the modules from being inserted incorrectly. Set the Address and Filter switches per the instructions in Section 3.0 and 5.0 respectively.

IMPORTANT

ENSURE THAT POWER TO THE RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY OTHER MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

Figure 2 illustrates typical resolver and potentiometer connections. Shielded cable, such as Belden 8762S, should be used for transducer wiring. The cable shields should be connected to chassis ground at the PiC end and left unconnected at the transducer end. Refer to the shielding instructions in Section 3.

The Digitizing Reference and uP Digitizing Modules should be interconnected with short lengths (4") of #20 blue wire. Make wiring connections to and

fasten the card edge connectors or faceplates before applying power.

3.0 ADDRESSING

The uP Digitizing Module occupies four memory locations. The six board-mounted Address switches must be set for the lowest of the four addresses desired. Table 1 contains the Address switch settings for the 60 possible beginning address points.

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF OFF OFF OFF OFF	2088	ON OFF OFF OFF OFF OFF	2176	ON OFF OFF OFF OFF OFF
2004	ON OFF OFF OFF OFF OFF	2092	ON OFF OFF OFF OFF OFF	2180	ON OFF OFF OFF OFF OFF
2008	ON OFF OFF OFF OFF OFF	2096	ON OFF OFF OFF OFF OFF	2184	ON OFF OFF OFF OFF OFF
2012	ON OFF OFF OFF OFF OFF	2100	ON OFF OFF OFF OFF OFF	2188	ON OFF OFF OFF OFF OFF
2016	ON OFF OFF OFF OFF OFF	2104	ON OFF OFF OFF OFF OFF	2192	ON OFF OFF OFF OFF OFF
2020	ON OFF OFF OFF OFF OFF	2108	ON OFF OFF OFF OFF OFF	2196	ON OFF OFF OFF OFF OFF
2024	ON OFF OFF OFF OFF OFF	2112	ON OFF OFF OFF OFF OFF	2200	ON OFF OFF OFF OFF OFF
2028	ON OFF OFF OFF OFF OFF	2116	ON OFF OFF OFF OFF OFF	2204	ON OFF OFF OFF OFF OFF
2032	ON OFF OFF OFF OFF OFF	2120	ON OFF OFF OFF OFF OFF	2208	ON OFF OFF OFF OFF OFF
2036	ON OFF OFF OFF OFF OFF	2124	ON OFF OFF OFF OFF OFF	2212	ON OFF OFF OFF OFF OFF
2040	ON OFF OFF OFF OFF OFF	2128	ON OFF OFF OFF OFF OFF	2216	ON OFF OFF OFF OFF OFF
2044	ON OFF OFF OFF OFF OFF	2132	ON OFF OFF OFF OFF OFF	2220	ON OFF OFF OFF OFF OFF
2048	ON OFF OFF OFF OFF OFF	2136	ON OFF OFF OFF OFF OFF	2224	ON OFF OFF OFF OFF OFF
2052	ON OFF OFF OFF OFF OFF	2140	ON OFF OFF OFF OFF OFF	2228	ON OFF OFF OFF OFF OFF
2056	ON OFF OFF OFF OFF OFF	2144	ON OFF OFF OFF OFF OFF	2232	ON OFF OFF OFF OFF OFF
2060	ON OFF OFF OFF OFF OFF	2148	ON OFF OFF OFF OFF OFF	2236	ON OFF OFF OFF OFF OFF
2064	ON OFF OFF OFF OFF OFF	2152	ON OFF OFF OFF OFF OFF		
2068	ON OFF OFF OFF OFF OFF	2156	ON OFF OFF OFF OFF OFF		
2072	ON OFF OFF OFF OFF OFF	2160	ON OFF OFF OFF OFF OFF		
2076	ON OFF OFF OFF OFF OFF	2164	ON OFF OFF OFF OFF OFF		
2080	ON OFF OFF OFF OFF OFF	2168	ON OFF OFF OFF OFF OFF		
2084	ON OFF OFF OFF OFF OFF	2172	ON OFF OFF OFF OFF OFF		

TABLE 1. ADDRESS SWITCH SETTINGS

NOTE

Switches 7 and 8 are not part of the addressing scheme and must be set per the instructions in Section 5.0

MICROPROCESSOR DIGITIZING MODULE

4.0 HARDWARE INTERFACING

The uP Digitizing Module interfaces with measurement transducers and the companion Digitizing Reference Module through either a card edge connector or an optional faceplate connector. The module will accept analog feedback signals from up to eight transducers.

NOTE

This module may be used with up to eight transducers for open loop systems. However, for closed loop systems, only two transducers per module are permitted. For systems using coordinated motion, only one transducer per module is permitted.

4.1 CARD EDGE CONNECTOR

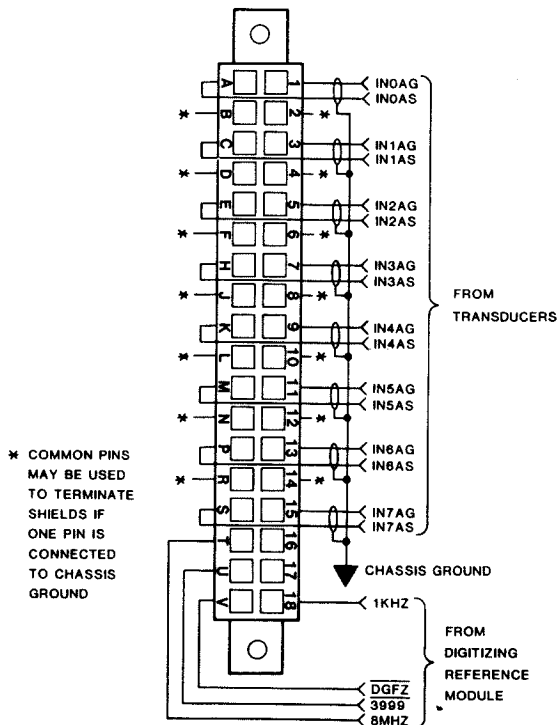


FIGURE 3. CARD EDGE CONNECTOR WIRING

A 36-pin card edge connector, part number 401-50657-00, may be used to make wiring connections from the module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available as part number 401-50460-00. "Dummy" contacts, part number 401-50459-00, may be inserted into the connector at unused places to provide a tighter grip between the connector and the module card edge.

4.2 FACEPLATE

The up Digitizing Faceplate, part number 502-03202-00, allows wiring connections to be conveniently made to compression screw terminals.

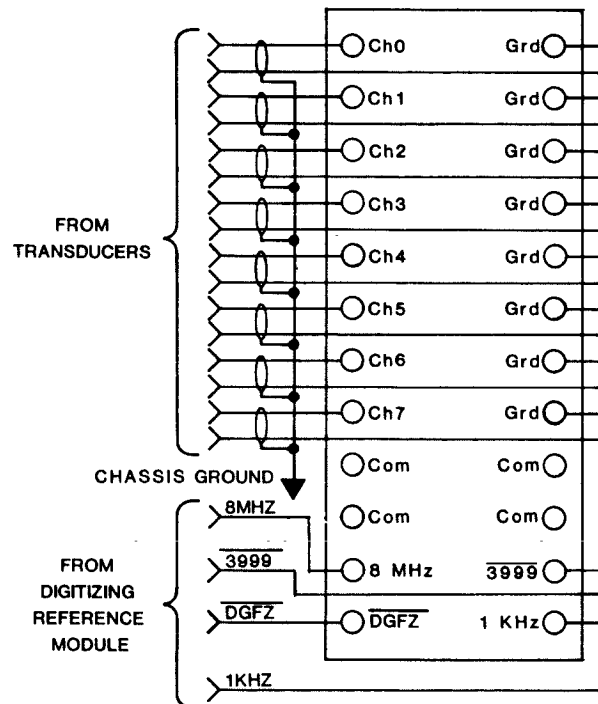


FIGURE 4. FACEPLATE CONNECTOR WIRING

MICROPROCESSOR DIGITIZING MODULE

5.0 NOISE FILTER

An active filter is available to reduce noise that may be picked up in an Inductosyn® 1 system. This filter is placed in or out of the circuit via two of the switches in the Address switch group. See Figure 5.

1 Inductosyn® is a registered trademark of Farrand Industries, Inc.

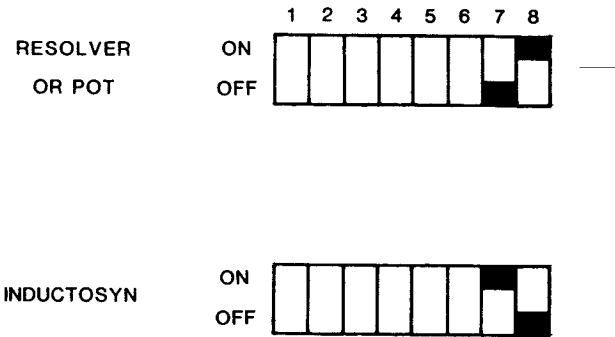


FIGURE 5. FILTER SWITCH SETTINGS

DIGITIZING REFERENCE MODULE

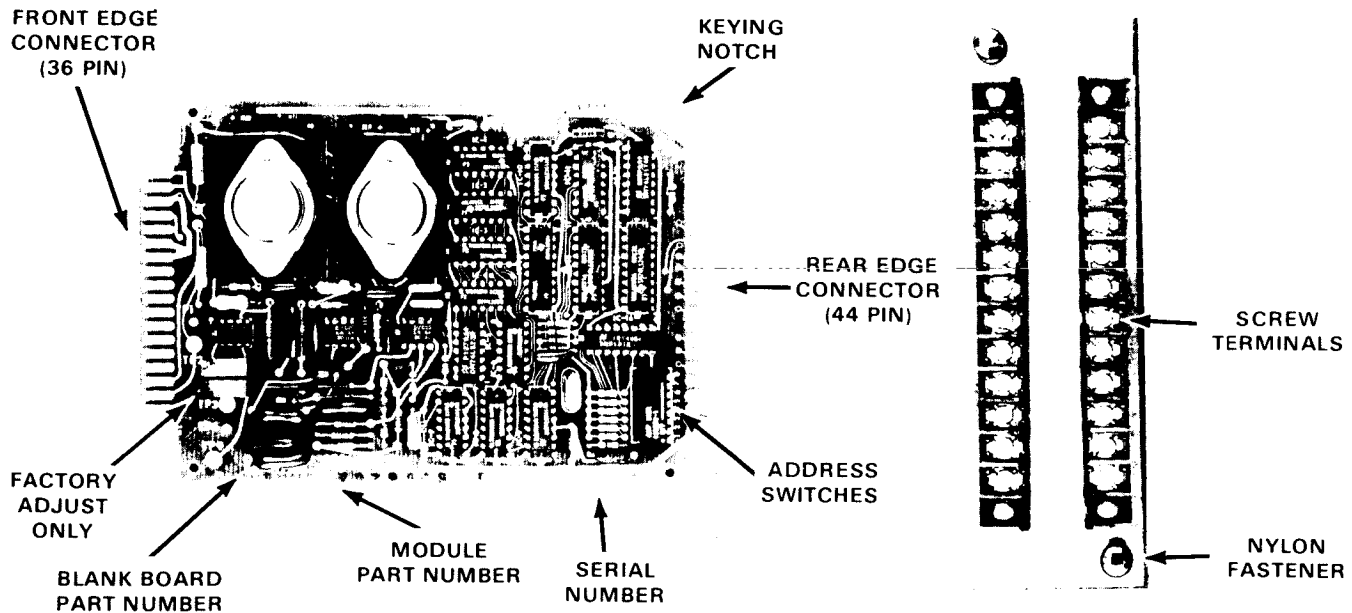


FIGURE 1. DIGITIZING REFERENCE MODULE & OPTIONAL FACEPLATE

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1.0 INTRODUCTION

The Digitizing Reference Module, part number 502-02820-01, contains circuitry to generate the accurate Reference and Quadrature signals used to drive position measurement transducers. Synchronization signals are also generated for the companion Microprocessor Digitizing Module.

External devices are wired to the module through either a 36-pin card edge connector or a Digitizing Reference Faceplate (part number 502-03203-00), shown in FIGURE 1. The latter option permits convenient wiring to compression screw terminals.

TABLE 1. ADDRESS SWITCH SETTINGS

PIC ADDRESS	SWITCHES 1 2 3 4 5 6 7 8	PIC ADDRESS	SWITCHES 1 2 3 4 5 6 7 8	PIC ADDRESS	SWITCHES 1 2 3 4 5 6 7 8
2000	ON OFF	2088	ON OFF	2176	ON OFF
2004	ON OFF	2092	ON OFF	2180	ON OFF
2008	ON OFF	2096	ON OFF	2184	ON OFF
2012	ON OFF	2100	ON OFF	2188	ON OFF
2016	ON OFF	2104	ON OFF	2192	ON OFF
2020	ON OFF	2108	ON OFF	2196	ON OFF
2024	ON OFF	2112	ON OFF	2200	ON OFF
2028	ON OFF	2116	ON OFF	2204	ON OFF
2032	ON OFF	2120	ON OFF	2208	ON OFF
2036	ON OFF	2124	ON OFF	2212	ON OFF
2040	ON OFF	2128	ON OFF	2216	ON OFF
2044	ON OFF	2132	ON OFF	2220	ON OFF
2048	ON OFF	2136	ON OFF	2224	ON OFF
2052	ON OFF	2140	ON OFF	2228	ON OFF
2056	ON OFF	2144	ON OFF	2232	ON OFF
2060	ON OFF	2148	ON OFF	2236	ON OFF
2064	ON OFF	2152	ON OFF		
2068	ON OFF	2156	ON OFF		
2072	ON OFF	2160	ON OFF		
2076	ON OFF	2164	ON OFF		
2080	ON OFF	2168	ON OFF		
2084	ON OFF	2172	ON OFF		

NOTE

Switch 8 of the Address switches opens or closes the on-board clock circuit and is used for factory testing of the module. Switch 8 must be left in the ON position or the module will be inoperative.

DIGITIZING REFERENCE MODULE

The digitizing Reference Module occupies four memory locations. The six board-mounted address switches must be set for the lowest of the four addresses desired. TABLE 1, contains the switch settings for the 60 possible beginning address points.

3.0 HARDWARE INTERFACING

The Digitizing Reference Module interfaces with the measurement transducers and the companion Microprocessor Digitizing Module through either a card-edge connector or an optional faceplate connector. The module will drive 16 potentiometers or brushless resolvers.

3.1 CARD EDGE CONNECTOR

A 36-pin card-edge connector, part 401-50657-00, may be used to wire the module to external devices. Phosphor bronze crimp contacts, with gold-over-nickel plating, are available as part 401-50460-00. "Dummy" contacts, part 401-50459-00, may be inserted into the connector at unused places for improved holding power.

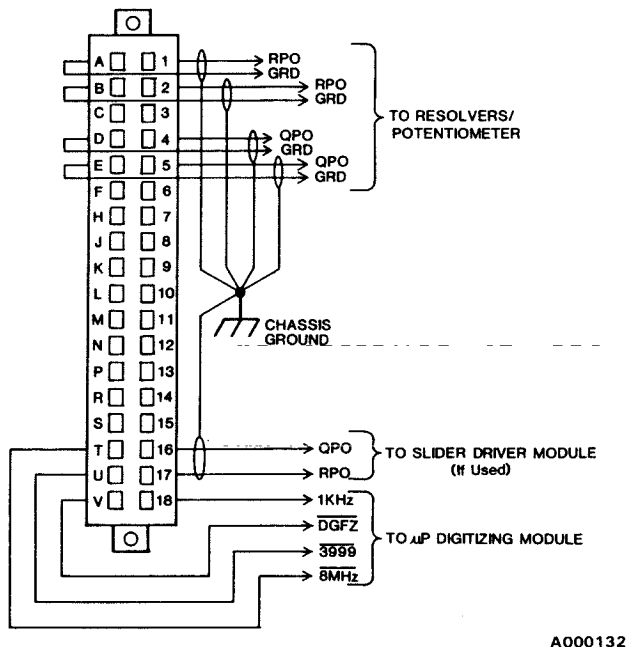


FIGURE 2. CARD EDGE CONNECTOR WIRING

3.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring to be conveniently made to compression screw terminals.

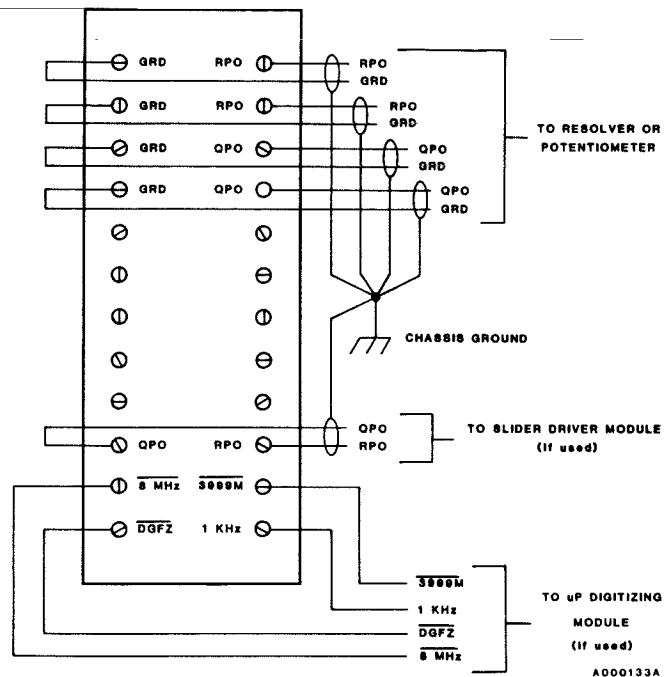


FIGURE 3. FACEPLATE CONNECTOR WIRING

4.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

The Digitizing Reference Module may only be installed in the Master Rack. Expansion Racks are used for AC and DC Input/Output Modules.

The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address Select switches per the instructions in Section 2.0. FIGURE 6 illustrates typical resolver and potentiometer connections. Shielded cable, such as Belden 8762S, should be used for transducer wiring.

DIGITIZING REFERENCE MODULE

The cable shield should be connected to chassis ground at the PC end, and left unconnected at the transducer end. The Digitizing Reference and Microprocessor Digitizing Modules should be

interconnected with short lengths (4") of #20 blue wire. Wire and fasten the card edge connector or faceplate before applying power.

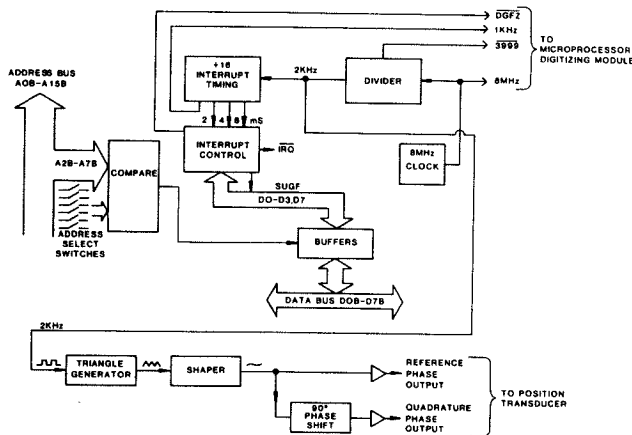


FIGURE 5. BLOCK DIAGRAM

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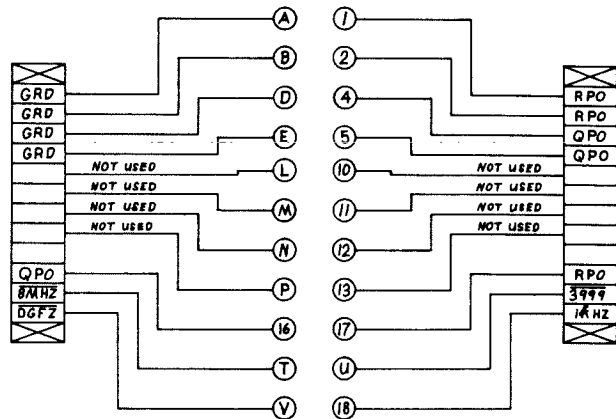


FIGURE 6 FACEPLATE SCHEMATIC

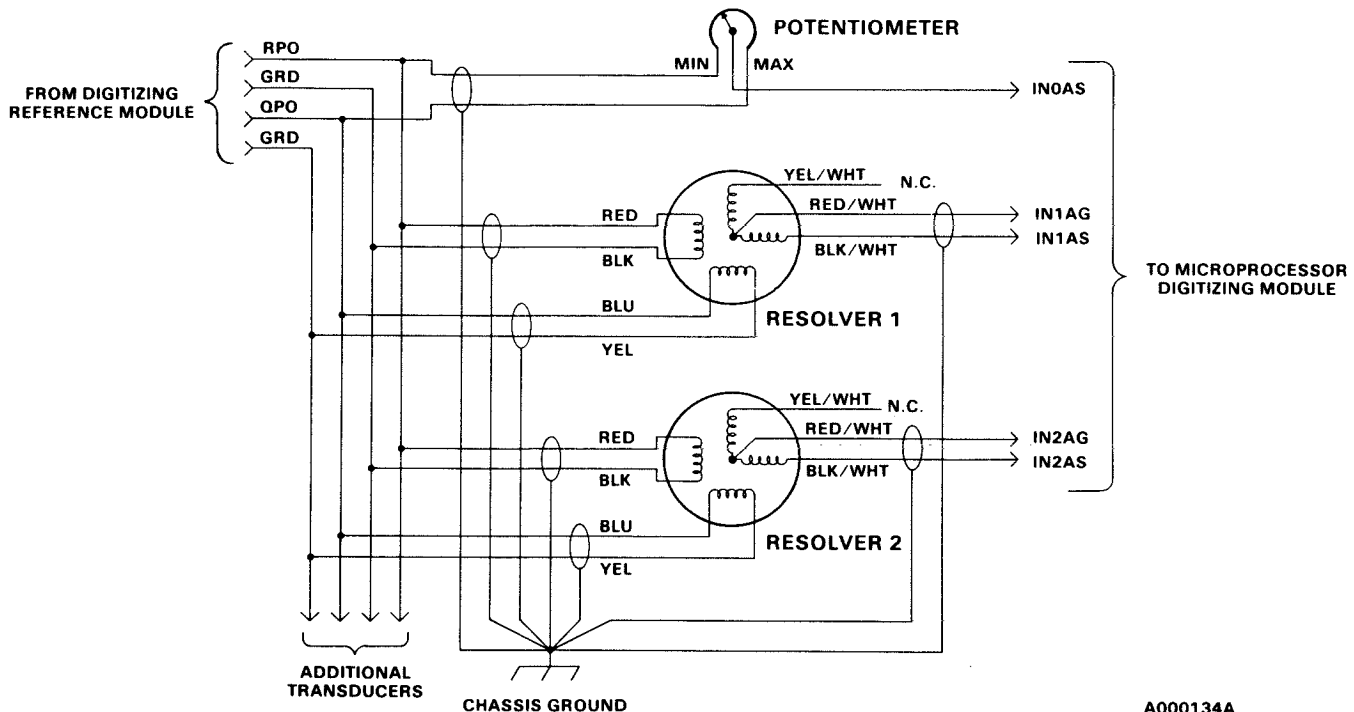


FIGURE 4. TYPICAL TRANSDUCER WIRING

DIGITIZING REFERENCE MODULE

5.0 RECOMMENDED RESOLVERS

The brushless resolvers listed here are typical of those that can be used with the PiC's 2KHz Phase Digitizing Modules.

- Harowe - 11BRW300-F-1/10
NOTE: This resolver is sold by G&L under the Part Number 501-98409-00.
- Clifton - 11BHW-OIE/A004
- Kearfott - CR41095059

Virtually any resolver, brush or brushless, can be used with 2KHz phase digitizing provided it conforms to the specifications listed below. However, G&L recommends brushless resolvers for greater reliability and longer life.

5.1 GAIN (Transformation Ratio)

G&L recommends a gain (also referred to as the transformation ratio) of at least 50%. A gain less than 50% may result in a loss of feedback error. However, the gain may be as high as but not greater than 140%.

The Digitizing Reference Module produces a voltage of approximately 15 volts peak-to-peak. Resolvers with a 50% gain will have an output of approximately 7.5 volts peak-to-peak. The maximum allowable output from any resolver used with the PiC is approximately 21 volts peak-to-peak.

5.2 RESOLUTION

The resolver should have an accuracy of approximately 10 minutes (one sixth of one degree) or greater.

RESOLVER/INDUCTOSYN DRIVER MODULE

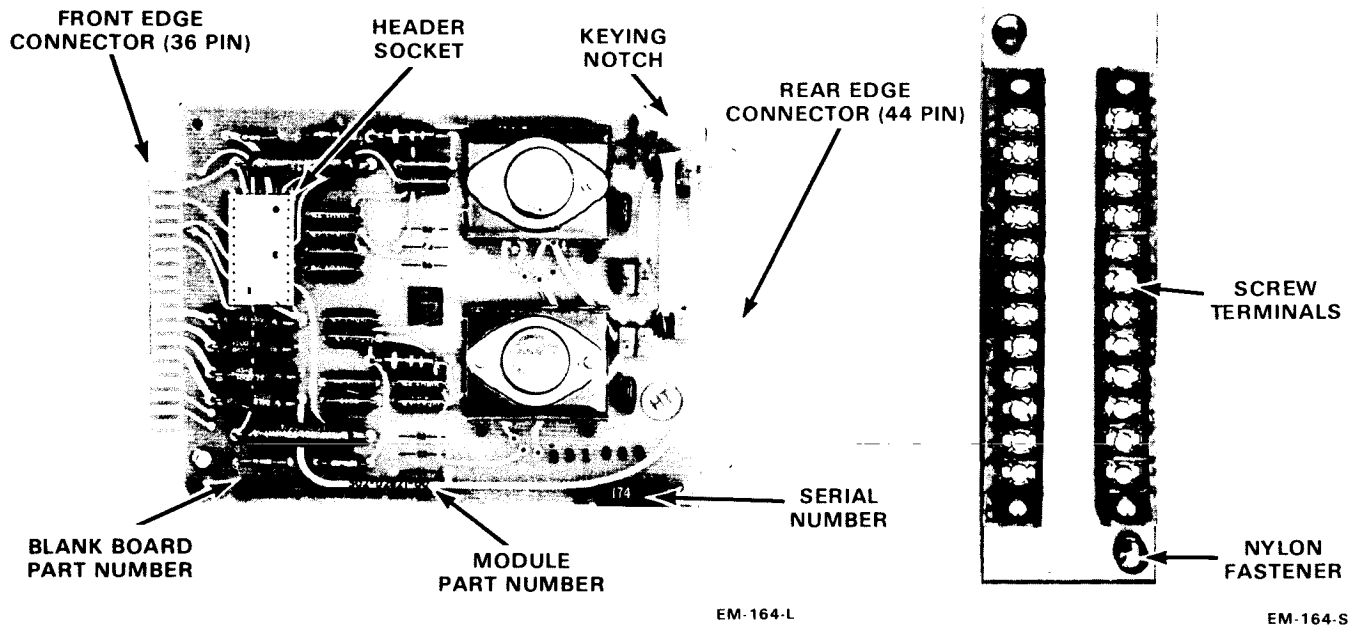


FIGURE 1. DRIVER MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

The Resolver/Inductosyn Driver Module contains circuitry to provide extra drive capability for additional resolvers or for Inductosyn sliders. The Resolver/Inductosyn Driver Module may also be used to provide extra drive from the D/A Converter Module.

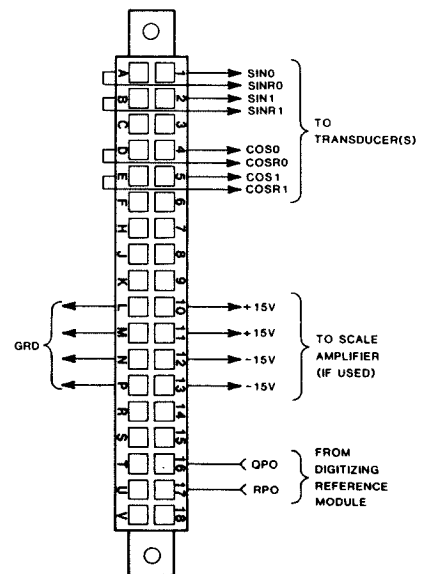
External devices are connected to the module through either a 36-pin card edge connector or a Resolver/Inductosyn Driver Faceplate. The latter option permits wiring connections to be made to compression screw terminals.

2.0 HARDWARE INTERFACING

The Resolver/Inductosyn Driver Module interfaces with the measurement transducers and the companion Digitizing Reference Module. The Resolver/Inductosyn Driver Module will drive up to sixteen resolvers in the voltage drive mode (in addition to the sixteen resolvers driven by the Digitizing Reference Module), and up to two Inductosyn sliders in the current drive mode.

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the module to external devices. Phosphor bronze crimp contacts, with gold-over-nickel plating, are available. "Dummy" contacts may be inserted into the connector at unused places for improved holding power.



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FIGURE 2. CARD EDGE CONNECTOR WIRING

RESOLVER/INDUCTOSYN DRIVER MODULE

2.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals.

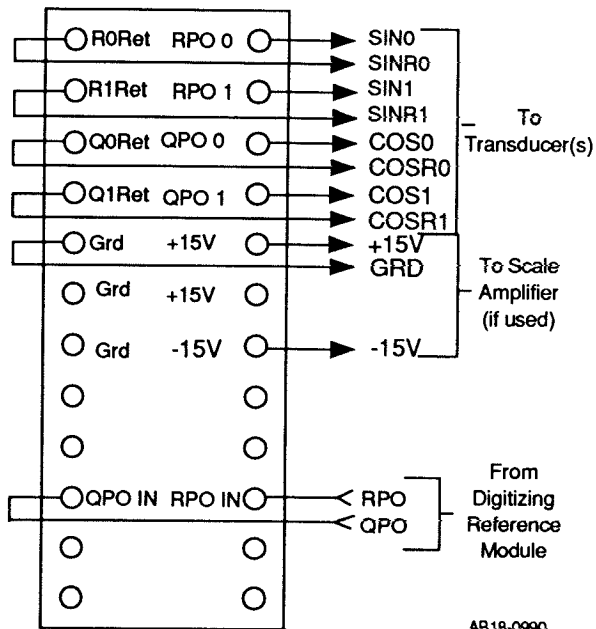


FIGURE 3. FACEPLATE CONNECTOR WIRING

3.0 INSTALLATION

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

The Resolver/Inductosyn Driver Module may only be installed in the Master Rack. Expansion Racks are used for AC and DC Input/Output Modules. The rack is physically keyed to prevent modules from being inserted incorrectly.

If only resolvers are to be driven, install Patch Plug 502-02749-52 on the module. The resolvers may be driven from either channel 0 (SIN 0 & COS 0) or channel 1 (SIN 1 & COS 1), or both.

If one Inductosyn slider and up to sixteen resolvers are to be driven, install Patch Plug 502-02749-62 on the module. The slider must be connected to channel 0, and the resolvers must be connected to channel 1.

If two Inductosyn sliders are to be driven, install Patch Plug 502-02749-50 on the module. Connect one slider to channel 0, and the other to channel 1.

Make wiring connections to and fasten the card edge connector or faceplate before applying power.

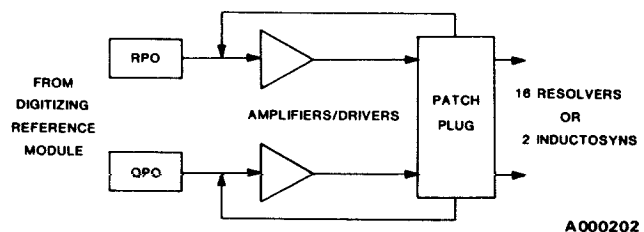


FIGURE 4. BLOCK DIAGRAM

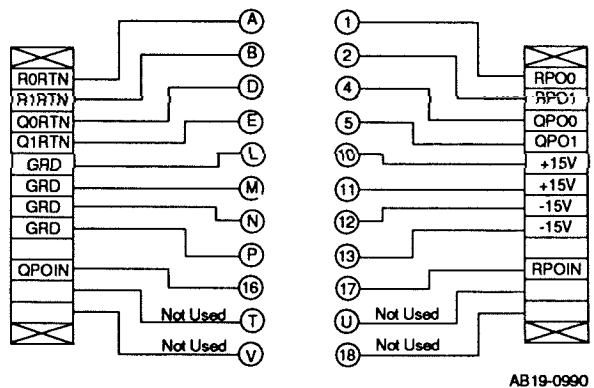


FIGURE 5. FACEPLATE SCHEMATIC

RESOLVER/INDUCTOSYN DRIVER MODULE

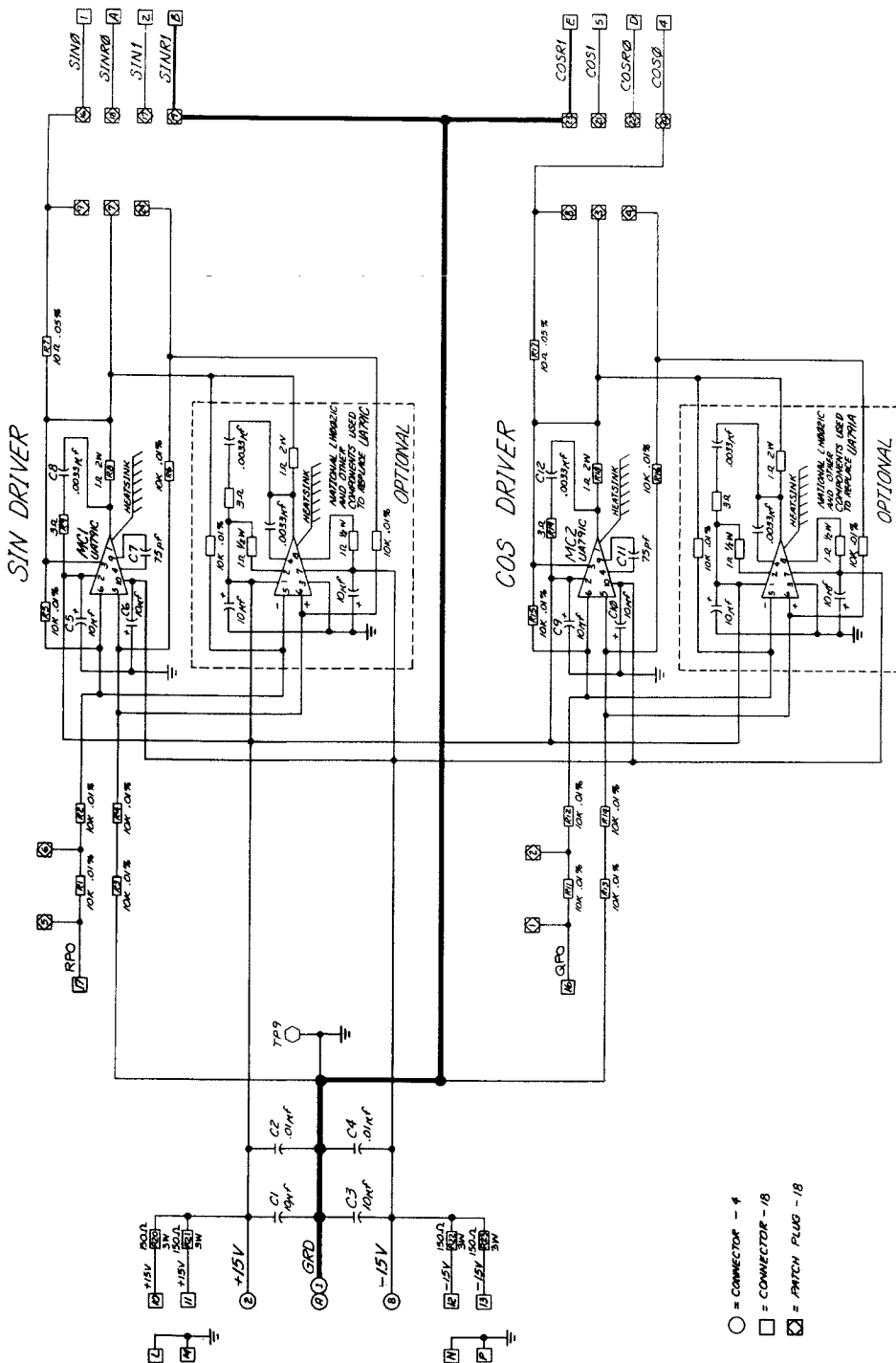


FIGURE 6. RESOLVER/INDUCTOSYN DRIVER MODULE SCHEMATIC



ENCODER MODULE

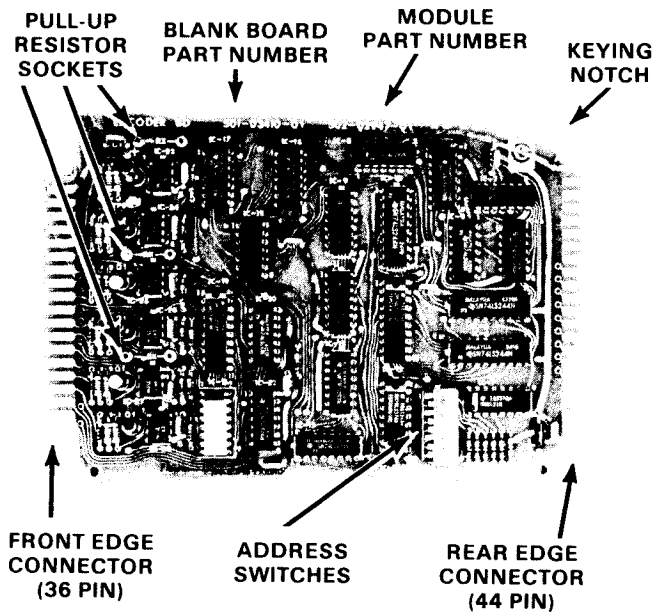


FIGURE 1. ENCODER MODULE

1.0 INTRODUCTION

The Encoder Module (part number 502-02947-01) contains circuitry to convert feedback signals from an incremental encoder into binary values. Incremental encoders are position measurement transducers that provide displacement information in a square wave format.

NOTE

Encoder signals that are in a sine wave format must be shaped into a square wave format before being fed into the Encoder Module.

Encoders are connected to the Encoder Module through a 36-pin edge connector.

2.0 COUNTER

Square waves from the encoder are recorded by a 16-bit up/down counter. If the encoder is properly phased, a square wave that corresponds to clockwise rotation of the encoder will cause

the counter to increment. Also, a square wave that corresponds to counterclockwise rotation of the encoder will cause the counter to decrement.

Encoder Call Routines are available that monitor and manipulate the counter.

3.0 ENCODER SELECTION

Feedback signals from either pulse or quadrature type encoders may be monitored by the Encoder Module. Jumpers must be inserted into specified pins on the front edge connector to select the type of encoder being employed. Jumper wiring is explained in Section 3.1.1 and Section 3.2.4.

Incremental encoders have three channels, channel A, channel B and index. For encoders with differential drivers, each channel has two signals, inverted and non-inverted. The Encoder Module will compare the non-inverted signals to the inverted signals to ensure the validity of the signals. A signal is recognized as valid only when the non-inverted and inverted signals are recognized by the Encoder Module as being opposite. For encoders with single-ended drivers, each channel has only the non-inverted signal. Single-ended drivers do not have the noise immunity advantages obtained with differential drivers. Therefore, incremental encoders with single-ended drivers are not recommended for transmission beyond 10 feet. Section 5.0 describes encoder connections for encoders that have single-ended drivers and differential drivers.

NOTE

The use of encoders with differential drivers is strongly recommended in all applications.

ENCODER MODULE

3.1 PULSE INCREMENTAL ENCODER

Figure 2 depicts the channel A, channel B and index outputs of a pulse type encoder. When the encoder shaft rotates in a clockwise direction, a continuous pulse train is present on channel A and no signal (a logic 0) is present on channel B. When the encoder shaft rotates in a counterclockwise direction, a continuous pulse train is present on channel B and no signal (a logic 0) is present on channel A. A logic 0 is present on both channels

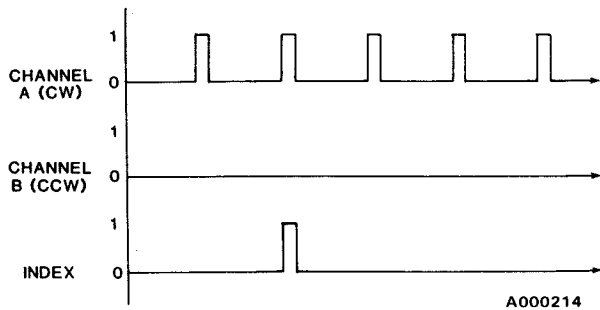


FIGURE 2. PULSE ENCODER OUTPUT

when the encoder shaft is stationary. A pulse is present on the index output once per revolution of the encoder. Figure 2 depicts a pulse type encoder that is rotating in a clockwise direction.

The frequency of channel A and channel B varies according to the resolution (counts/revolution) of the encoder and the revolutions/second. For example; if an encoder has a resolution of 2,000 counts/revolution and the shaft is being rotated at 10 revolutions/second, the frequency of the input to the Encoder Module will be 20,000 counts/second. The maximum input frequency that can be accommodated by the Encoder Module from a pulse type encoder is 100,000 counts/second. The width of the square wave must be greater than two microseconds.

3.1.1 JUMPER WIRING FOR A PULSE TYPE ENCODER

When a pulse type encoder is connected to the Encoder Module, the front edge connector must have pin 13 jumpered to

pin A and pin 1 jumpered to pin P.

3.2 QUADRATURE INCREMENTAL ENCODER

Figure 3 depicts the channel A, channel B and index outputs of a quadrature type encoder. A continuous square wave signal is present on channel A and channel B whenever the encoder shaft rotates at a constant speed. Channel A leads channel B by 90 degrees when the encoder shaft rotates in the clockwise direction. Channel A lags channel B by 90 degrees when the encoder shaft rotates in the counterclockwise direction. An on-off signal is present on the index output once per revolution of the encoder. Figure 3 depicts a quadrature type encoder that is rotating in a clockwise direction.

The frequency of channel A and channel B varies according to the resolution (counts/revolution) of the encoder and the revolutions/second. For example; if an encoder has a resolution of 2,000 counts/revolution and the shaft is being rotated at 10 revolutions/second, the frequency of the input to the Encoder Module is 20,000 revolutions/second. The maximum frequency that can be accommodated by the Encoder Module from a quadrature type encoder is 50,000 counts/second.

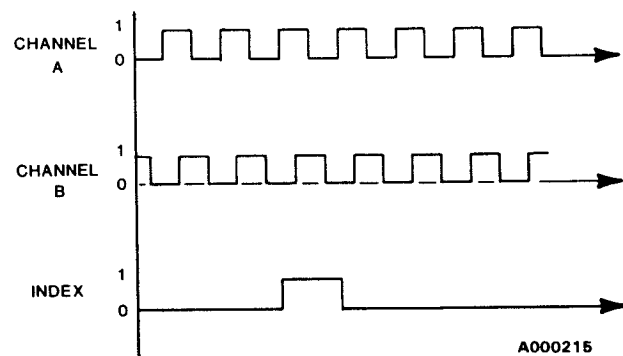


FIGURE 3. QUADRATURE ENCODER OUTPUT

The resolution of the encoder can be varied by selecting either the X2 mode or X4 mode of operation (see Section 3.2.2 and Section 3.2.4). Jumper

ENCODER MODULE

wiring for mode selection is explained in Section 3.2.4.

The Encoder Module must be placed in either the X1, X2, or X4 Mode when used to monitor a quadrature type incremental encoder. The desired mode is selected by inserting jumpers between the specified pins on the front edge connector.

3.2.1 X1 MODE

In the X1 Mode, the resolution of the encoder is equal to the specified frequency of the encoder. The counter on the Encoder Module will count the number of off-to-on transitions of channel A. Figure 4 depicts the operation of the X1 Mode.

3.2.2 X2 MODE

In the X2 Mode, the resolution of the encoder is equal to the specified frequency of the encoder times two. The counter on the encoder module will count the number of off-to-on and on-to-off transitions of channel A. Figure 4 depicts the operation of the X2 Mode.

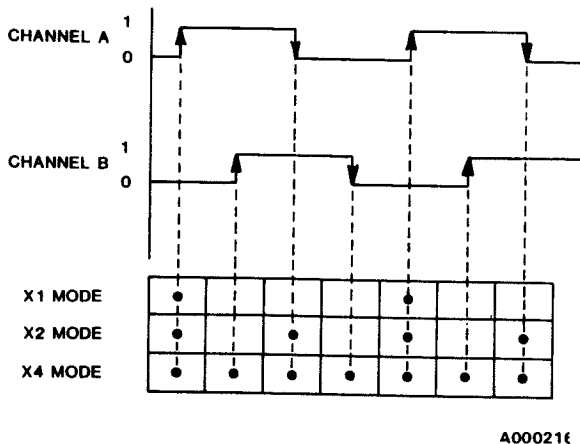


FIGURE 4. QUADRATURE MODES

3.2.3 X4 MODE

In the X4 Mode, the resolution of the encoder is equal to the specified frequency of the encoder times four. The counter on the Encoder Module will count the number of off-to-on transitions of channel A and channel B. Also, the number of on-to-off transitions of channel A and channel B will be counted. Figure 4 depicts the operation of the X4 Mode.

3.2.4 JUMPER WIRING FOR A QUADRATURE TYPE ENCODER

X1 MODE: Jumper Pin 1 to Pin P.

X2 MODE: Jumper Pin 13 to Pin A.

X4 MODE: No jumpers required.

4.0 ADDRESSING

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF	2088	ON OFF	2176	ON OFF
2004	ON OFF	2092	ON OFF	2180	ON OFF
2008	ON OFF	2096	ON OFF	2184	ON OFF
2012	ON OFF	2100	ON OFF	2188	ON OFF
2016	ON OFF	2104	ON OFF	2192	ON OFF
2020	ON OFF	2108	ON OFF	2196	ON OFF
2024	ON OFF	2112	ON OFF	2200	ON OFF
2028	ON OFF	2116	ON OFF	2204	ON OFF
2032	ON OFF	2120	ON OFF	2208	ON OFF
2036	ON OFF	2124	ON OFF	2212	ON OFF
2040	ON OFF	2128	ON OFF	2216	ON OFF
2044	ON OFF	2132	ON OFF	2220	ON OFF
2048	ON OFF	2136	ON OFF	2224	ON OFF
2052	ON OFF	2140	ON OFF	2228	ON OFF
2056	ON OFF	2144	ON OFF	2232	ON OFF
2060	ON OFF	2148	ON OFF	2236	ON OFF
2064	ON OFF	2152	ON OFF		
2068	ON OFF	2156	ON OFF		
2072	ON OFF	2160	ON OFF		
2076	ON OFF	2164	ON OFF		
2080	ON OFF	2168	ON OFF		
2084	ON OFF	2172	ON OFF		

ON OFF ON OFF

OFF ON

TABLE 1. ADDRESS SWITCH SETTINGS

ENCODER MODULE

The Encoder Module occupies four memory locations. The eight board-mounted Address Switches must be set for the lowest of the four addresses desired. Table 1 contains the Address Switch settings for the 60 possible beginning address points. Switches 7 and 8 are not used and may be ignored.

5.0 HARDWARE INTERFACING

The Encoder Module interfaces with an encoder through a 36-pin card edge connector. The type of driver on the encoder determines how the encoder will be connected. Figure 5 shows the card edge connections corresponding to an

encoder with a single-ended driver, an encoder with a differential current driver, and an encoder with a differential voltage driver. Section 5.4 lists typical drivers used in specific applications.

NOTE

In addition to the card edge wiring shown in Figure 5, jumpers corresponding to the type of encoder, pulse or quadrature, must be inserted. Section 3.1.1 specifies jumper placement for pulse type encoder. Section 3.2.4 specifies jumper placement for quadrature type encoders.

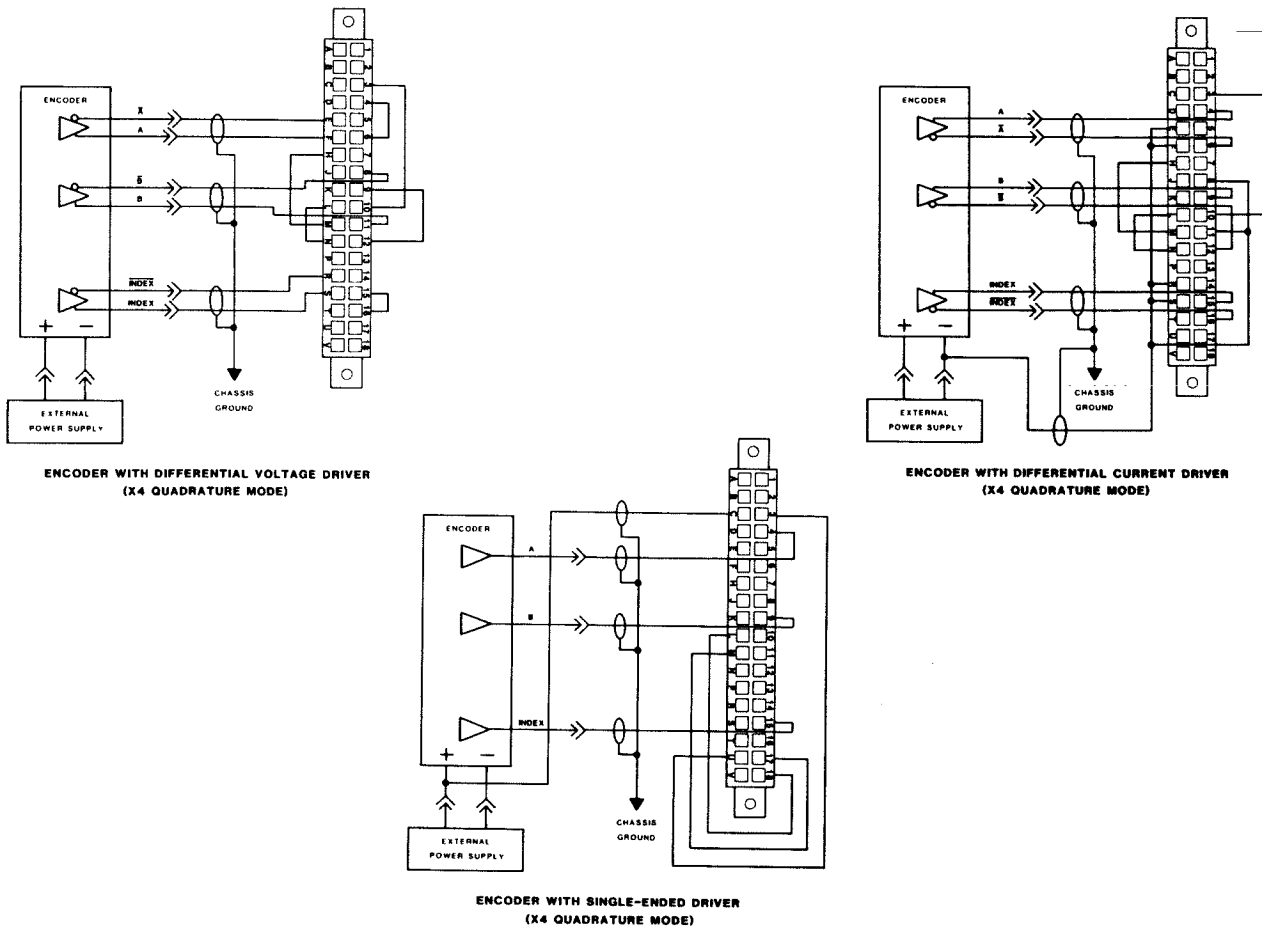


FIGURE 5. CARD EDGE CONNECTOR WIRING

ENCODER MODULE

5.1 REVERSING CHANNEL POLARITY

In reference to an encoder with a differential driver, a clockwise rotation of the encoder normally causes the 16-bit counter to count up. A clockwise rotation can make the counter count down if the polarity of channel A or channel B (not both) is reversed. The polarity of a channel can be reversed by exchanging the connections of the non-inverted signal wire and the inverted signal wire of the same channel (i.e. A exchanged with $\bar{A}$ or B exchanged with $\bar{B}$).

5.2 REVERSING INDEX POLARITY

When the polarity of index is reversed, index position as indicated by a logic 0, rather than a logic 1. The polarity of index can be reversed for an encoder with differential voltage or current driver by jumpering pin K to pin 3 rather than pin 10 to pin 3. The polarity of index can be reversed for an encoder with a single-ended driver by jumpering pin 7 to pin 3 instead of pin U to pin 3.

5.3 CURRENT LIMITS

IMPORTANT

Information received by the Encoder Module is optically isolated. The optical isolator can tolerate a maximum current of 60 mA. If the encoder can supply more than 60 mA to the Encoder Module, a resistor must be placed in series to limit current to 60 mA or less.

5.3.1 SINGLE-ENDED DRIVER ENCODER

When an encoder with a single-ended driver is used, pull-up resistors must be connected to the appropriate sockets on the Encoder Module to keep the

signal current within the module limits. The current must be kept between 10 mA (the minimum required for the module to operate correctly) and 60 mA (the maximum value the optical isolators on the module can accommodate). The following formula is used to figure the proper pull-up resistor value:

$$60 \text{ mA} > (E_s - 2.5) / R_x \geq 10 \text{ mA}$$

E_s is the voltage of the external power supply. 2.5 is a constant reflecting the voltage drop inherent in the module design. R_x is the value of the pull-up resistor.

5.3.2 DIFFERENTIAL DRIVER ENCODER

When an encoder with a differential driver is used, the signal current from the encoder must be between 10 mA and 60 mA. The signal current for typical differential drivers is well within this limit. However, when signal current can exceed 60 mA, the current must be limited. This is accomplished by connecting a resistor in series with one of the two connecting wires from channel A (A or $\bar{A}$), channel B (B or $\bar{B}$), and Index (Index or $\bar{\text{Index}}$). Channel A, channel B, and Index should all have a limiting resistor of equal value in one of the wires connecting them to the Encoder Module. The resistance required is dependent on the output level of the encoder being used.

5.4 TYPICAL DRIVERS

The following is a partial listing of typical drivers used in the various encoder applications:

Typical Differential Current Driver: 75110.

Typical Differential Voltage Drivers: 75183, 8830, 75114, 9614, 7513.

Typical Single-Ended Driver: 7406.

ENCODER MODULE

6.0 INSTALLATION

The Encoder Module must be installed in the Master Rack. The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 4.0. Fasten the front edge connector before applying power.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

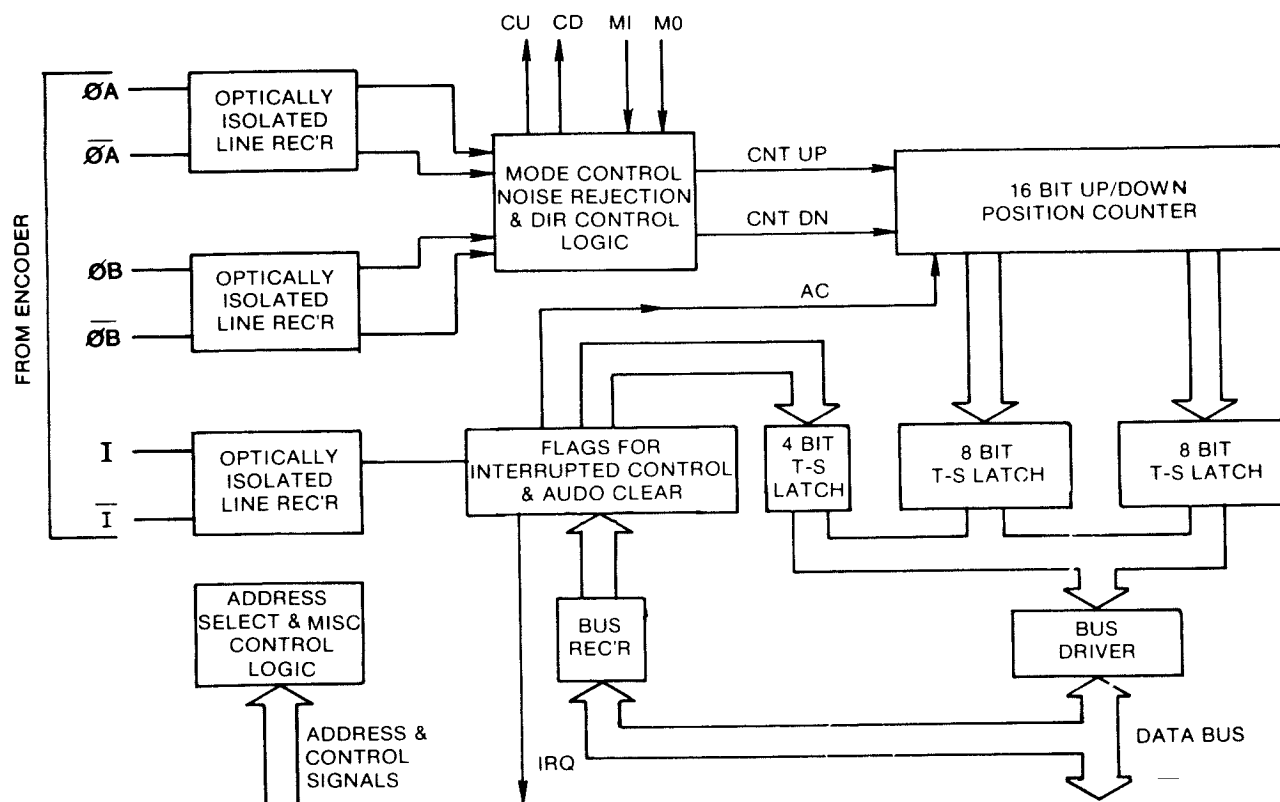
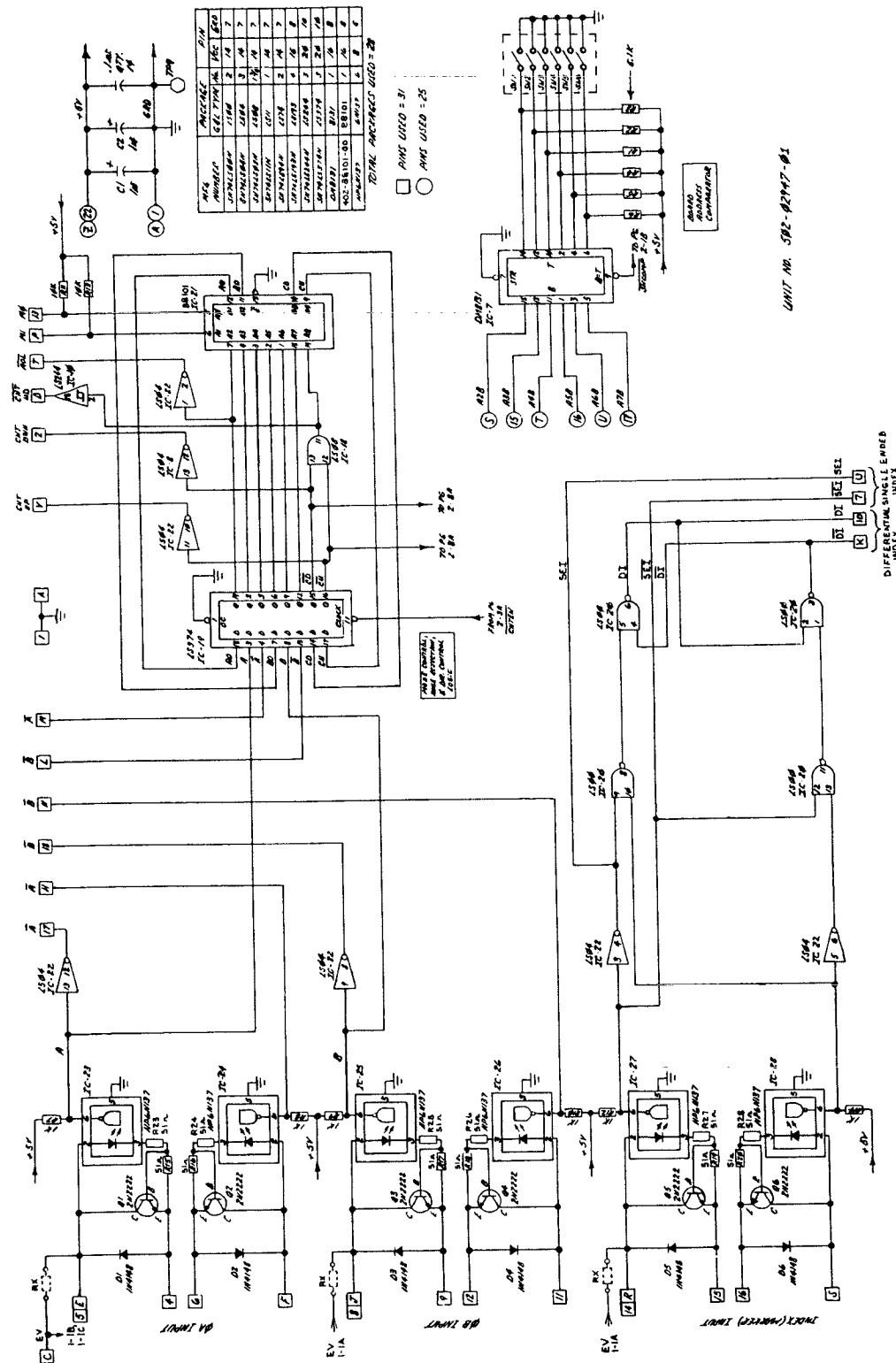


FIGURE 6. BLOCK DIAGRAM

FIGURE 7. MODULE SCHEMATIC



UNIT NO. 502-02947-01

DIFFERENTIAL SINGLE ENDED INDEX

ENCODER MODULE

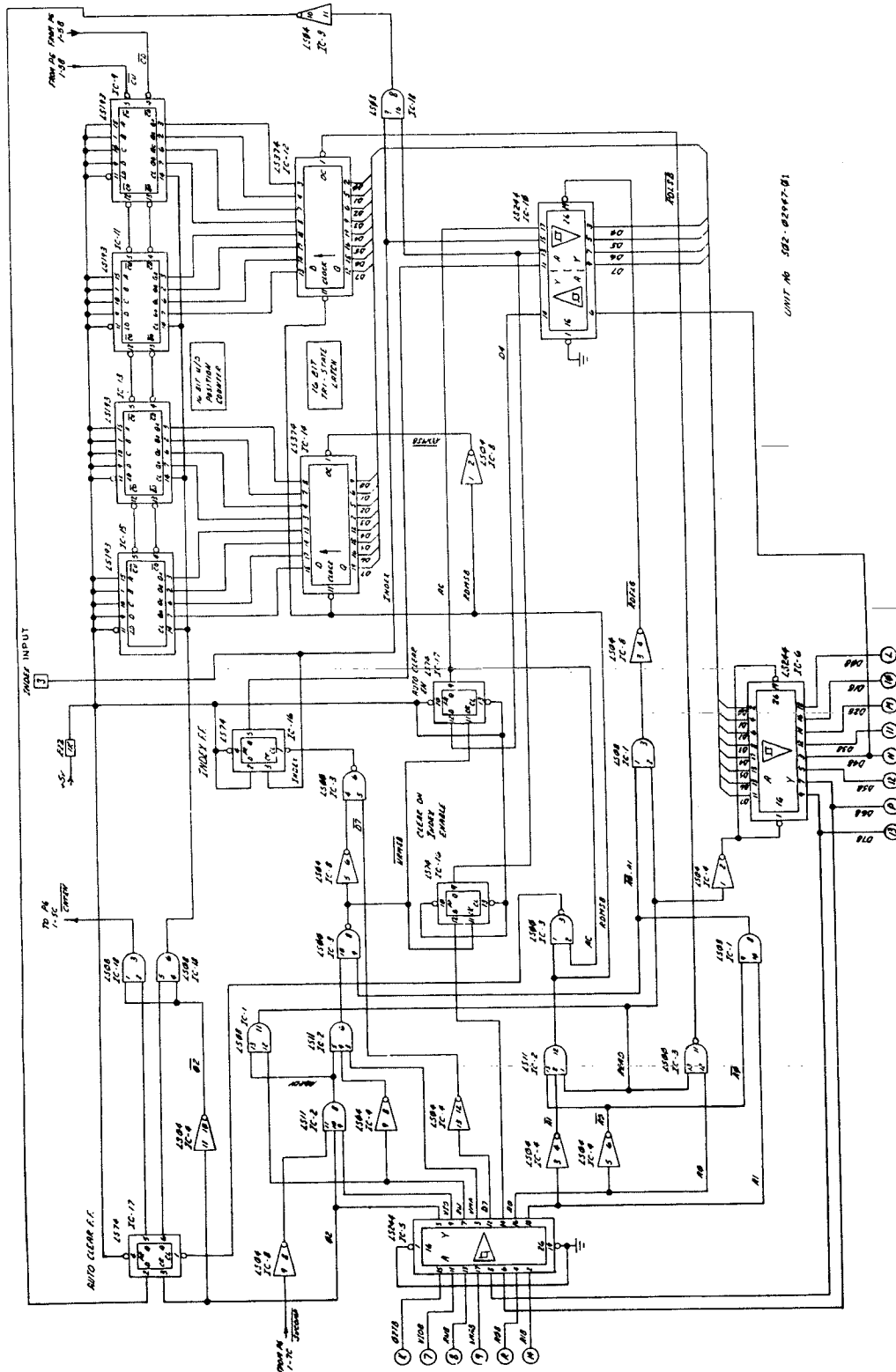


FIGURE 7. MODULE SCHEMATIC

HIGH-SPEED ENCODER MODULE

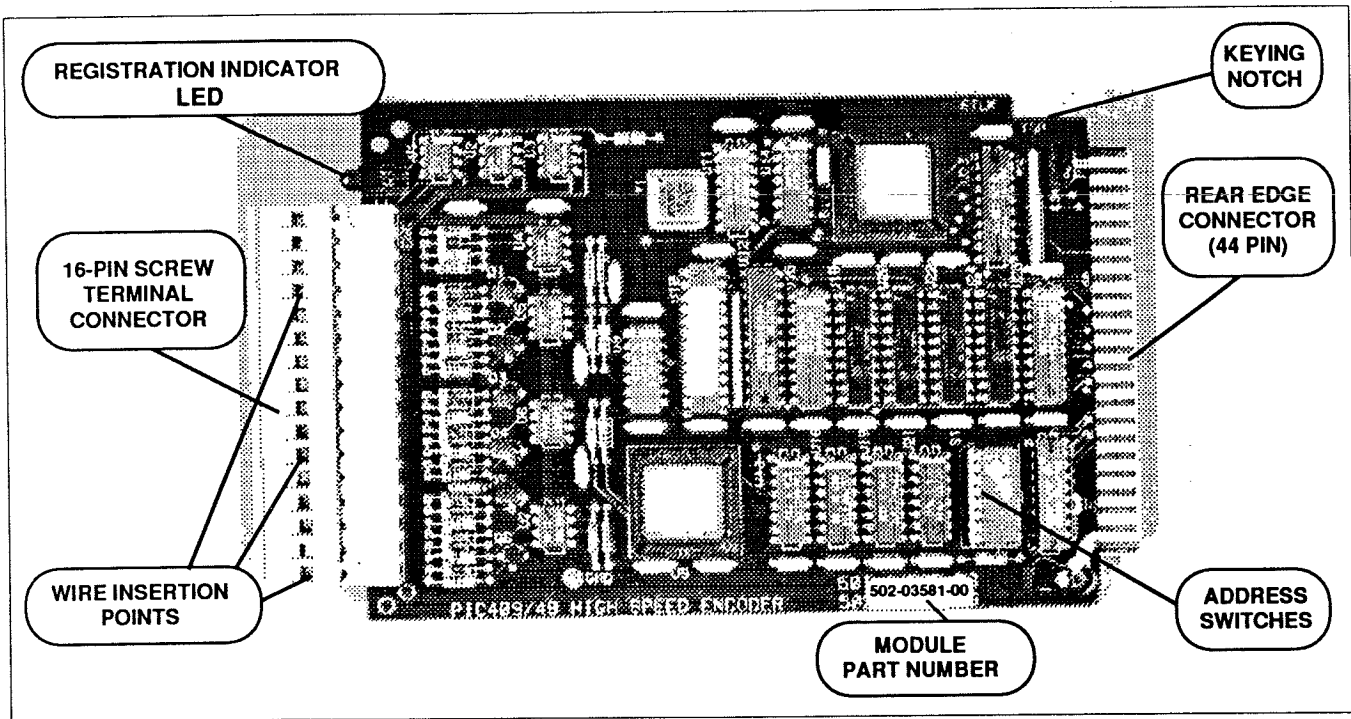


FIGURE 1. HIGH SPEED ENCODER MODULE

1.0 INTRODUCTION

The High-Speed Encoder Module, part number 502-03581-00, contains circuitry to convert feedback signals from an incremental encoder into binary values. Incremental encoders are position measurement transducers that typically provide position information in a square wave format.

Encoder signals that are in a sine wave format must be shaped into a square wave format before being fed into the High-Speed Encoder Module.

The maximum input frequency is 250 KHz. There is a maximum counter frequency of 1 MHz when operating the module in the X4 mode.

With the High-Speed Encoder Module, a position can be latched based on a registration input.

2.0 PIN CONNECTIONS

Encoders are connected to the High-Speed Encoder Module through a 16-pin screw terminal plug-in connector, part number 401-53820-00, which is attached to the module. (See Figure 1 above.) Connecting wires

are inserted on the right hand side. Figure 2 lists the pin connections for each of the 16 screw connections.

16-pin screw terminal connector	1	Differential COUNT UP output
	2	Differential COUNT UP output
	3	Differential COUNT DN output
	4	Differential COUNT DN output
	5	Differential INDEX output
	6	Differential INDEX output
	7	DC Input + (source)
	8	DC Input - (sink)
	9	Differential A/Single-ended channel A source input
	10	Differential A/Single-ended channel A sink input
	11	Differential B/Single-ended channel B source input
	12	Differential B/Single-ended channel B sink input
	13	Differential I/Single-ended index source input
	14	Differential I/Single-ended index sink input
	15	Screw termination for shields
	16	Screw termination for single point ground

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FIGURE 2. 16-PIN CONNECTIONS

The first six pins are outputs to be used with the Digital Cam Output Module only. Twisted pair wires should be used for these interconnections and 100 ohm resistors should be used to terminate each end of the twisted pair. For further information, refer to the Digital Cam Output Module write-up.

HIGH-SPEED ENCODER MODULE

Pins 7 and 8 are used for a switched DC input when using registration. (See section 6.3.) The pins must be wired according to the polarity shown (+ on pin 7, - on pin 8).

The remaining pins are used for receiving signals from an encoder. For the best noise immunity, the encoder should have differential outputs for its channel A, channel B, and index signals.

If an encoder with single-ended outputs is used, the connections depend upon the driver. With a TTL or open-collector driver, the encoder outputs A, B, and I should be connected to pins 10, 12, and 14 respectively. The 5V side of the encoder's power supply should be connected to pins 9, 11, and 13. (Shown in Figure 6.) With a low impedance source driver, encoder outputs A, B, and I, should be wired to pins 9, 11, and 13 respectively. Pins 10, 12, and 14 should be connected to the 0 V line of the encoder's power supply.

Pins 9 & 10, 11 & 12, and 13 & 14 are input pairs. They each have the following characteristics:

Maximum voltage allowed = 16.5VDC
Internally, current limited to 30mA (Maximum)

The minimum output voltage and minimum output current required from the encoder to turn on an input is 3.0VDC and 7.3mA.

Pins 15 and 16 are shield termination pins and are internally connected. (See the High-Speed Encoder Module schematic in Figure 9.) They provide a location for connecting the shields of the cables from the encoder. One of these pins should be connected to the system's single point ground or chassis ground. It is recommended that pin 16 be connected to single point ground.

3.0 COUNTER

Square waves from the encoder are recorded by a 16-bit up/down counter. If the encoder is properly phased, a square wave that corresponds to the positive rotation of the encoder will cause the counter to increment. A square wave that corresponds to the negative rotation of the encoder will cause the counter to decrement.

Encoder Call Routines are available that monitor and manipulate the counter.

4.0 INCREMENTAL ENCODER SELECTION

Incremental encoders have three channels; channel A, channel B, and index. For encoders with differential drivers, each channel has two outputs which form a sink/source pair. The High-Speed Encoder Module will compare the outputs to ensure the validity of the signals. A signal is recognized as valid only when one output is sourcing and the other output is sinking current. When the signal logic level changes, the output polarity changes. Loss of feedback (LOFB) detection is possible with differential encoders.

For encoders with single-ended drivers, each channel has only one output with respect to 0V. Single-ended drivers do not have the noise immunity advantages obtained with differential drivers. Therefore, incremental encoders with single-ended drivers are not recommended for transmission beyond 10 feet.

NOTE

The use of encoders with differential drivers is strongly recommended in all applications.

Feedback signals from either pulse or quadrature type incremental encoders may be monitored by the High-Speed Encoder Module.

4.1 PULSE INCREMENTAL ENCODER

Figure 3 depicts the channel A (the positive rotation channel), channel B (the negative rotation channel), and index signals of a pulse type encoder. When the encoder shaft rotates in a positive direction as shown, a continuous pulse train is present on channel A and no signal (a logic 0) is present on channel B. When the encoder shaft rotates in a negative direction, a continuous pulse train is present on channel B. When the encoder shaft is stationary, no pulse train is present on either channel. A pulse is present on the index output once per revolution of the encoder.

HIGH-SPEED ENCODER MODULE

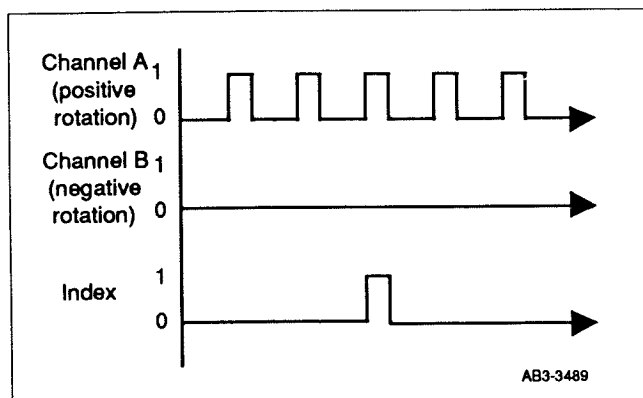


FIGURE 3. PULSE ENCODER SIGNALS

The frequency of channel A and channel B varies according to the resolution (pulses/revolution) and the speed (revolutions/second) of the encoder. For example, if an encoder has a resolution of 2,000 pulses/revolution and the shaft is being rotated at 10 revolutions/second, the frequency of the input to the High-Speed Encoder Module will be 20,000 pulses/second.

The maximum input frequency that can be accommodated by the High-Speed Encoder Module from a pulse type encoder is 250,000 pulses/second. The width of the pulse must be greater than 500 nanoseconds. (.5 μ sec)

4.2 QUADRATURE INCREMENTAL ENCODER

Figure 4 depicts channel A, channel B, and index outputs of a quadrature type encoder. A continuous square wave signal is present on channel A and channel B whenever the encoder shaft rotates at a constant speed. Channel A leads channel B by 90 degrees ($\pm 45^\circ$) when the encoder shaft rotates in the positive direction. Channel A lags channel B by 90 degrees ($\pm 45^\circ$) when the encoder shaft rotates in the negative direction. An on-off signal is present on the index output once per revolution of the encoder. Figure 4 depicts a quadrature type encoder that is rotating in a positive direction.

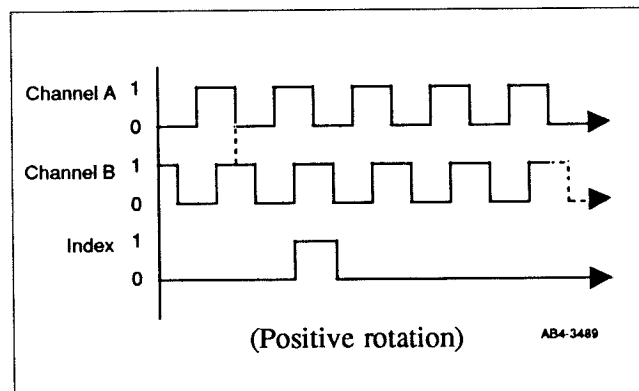


FIGURE 4. QUADRATURE ENCODER SIGNALS

The frequency of channel A and channel B varies according to the resolution (lines/revolution) and the speed (revolutions/second) of the encoder. For example, if an encoder has a resolution of 2,000 lines/revolution and the shaft is being rotated at 10 revolutions/second, the frequency of the input to the High-Speed Encoder Module is 20,000 lines/second.

The maximum input frequency is 250KHz. The maximum counter frequency that can be accommodated by the High-Speed Encoder Module from a quadrature type encoder is:

MODE	MAXIMUM COUNTER FREQUENCY
X1	250,000
X2	500,000
X4	1,000,000

The High-Speed Encoder Module must be placed in either the X1, X2, or X4 mode when used to monitor a quadrature type incremental encoder. The desired mode is selected via software.

Figure 5 illustrates the X1, X2, and X4 modes for quadrature encoders.

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In the X1 mode, the counts/revolution of the encoder is equal to the lines/revolution of the encoder. The counter on the High-Speed Encoder Module will count the number of off-to-on transitions of channel A.

In the X2 mode, the counts/revolution of the encoder is equal to the lines/revolution of the encoder times two. The counter on the High-Speed Encoder Module will count the number of off-to-on and on-to-off transitions of channel A.

In the X4 mode, the counts/revolution of the encoder is equal to the lines/revolution of the encoder times four. The counter on the High-Speed Encoder Module will count the number of off-to-on transitions of both channel A and channel B and the number of on-to-off transitions of both channel A and channel B.

The High-Speed Encoder Module occupies four memory locations. The eight board-mounted address switches must be set for the lowest of the four addresses desired. Table 1 contains the address switch settings for the 60

When using Software Solutions, only the addresses within the dashed box in Table 1 are available.

Always check the module switches to be sure you know which position is off and which position is on before setting the address.

TABLE 1. ADDRESS SWITCH SETTINGS

HIGH-SPEED ENCODER MODULE

6.0 HARDWARE INTERFACING

IMPORTANT

Wiring for the High-Speed Encoder Module should be separated from the "noisy" wiring (AC power, 24VDC, motor current wires, etc.) by at least 6 inches or routed through a separate metal conduit.

The High-Speed Encoder Module interfaces with an encoder through a 16-pin connector. The type of driver on the encoder determines how the encoder will be connected. Figure 6 shows the connections corresponding to an encoder with a single-ended driver and an encoder with a differential voltage driver.

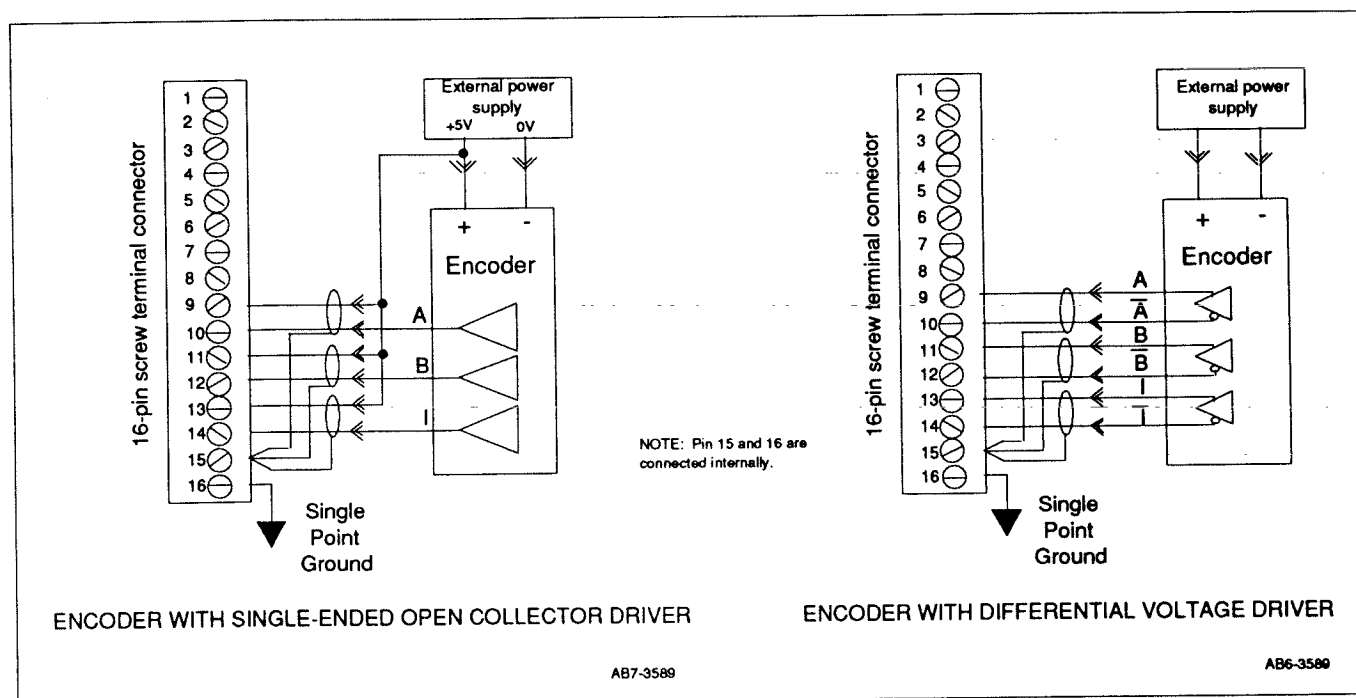


FIGURE 6. 16-PIN CONNECTIONS WITH SINGLE-ENDED AND DIFFERENTIAL DRIVERS

Typical drivers used in various encoder applications include:

Drivers	Types
Differential voltage	75183
	8830
	75114
	9614
	7513
	26LS31
Single-ended open collector	7406

NOTE: The High-Speed Encoder Module will not work with a 339 driver.

APPENDIX A

6.1 DIRECTION SENSE

The direction of a differential encoder can be reversed by exchanging A and A $\bar{A}$ with B and B $\bar{B}$.

The direction of a single-ended encoder can be reversed by exchanging A with B.

6.2 INDEX POLARITY

The High-Speed Encoder Module utilizes the positive edge of an index signal rather than utilizing the logic level. Because of this, an encoder can indicate the presence of an index marker with either a logic 1 or a logic 0 signal. There is no need to reverse index polarity.

HIGH-SPEED ENCODER MODULE

6.3 DC INPUT (USED WITH REGISTRATION)

With the High-Speed Encoder Module, the user has the capability of latching a position based on a registration input to the DCIN+ and DCIN- connections (pins 7 and 8 in Figure 2). The selection of the registration mode is done in software. An external registration switch is connected to pins 7 and 8. (See the block diagram in Figure 8.)

The DCIN characteristics are listed below.

Maximum voltage (guaranteed on)	15VDC
Minimum voltage (guaranteed off)	5VDC
Maximum voltage allowed	30VDC
Typical input impedance	2.7K

The optically isolated DC input circuit has a maximum on/off time of 50 microseconds. Because of this fast response time, special care should be taken in routing external wires to it to provide noise immunity. As shown in Figure 7, it is recommended that shielded twisted pair wiring be used.

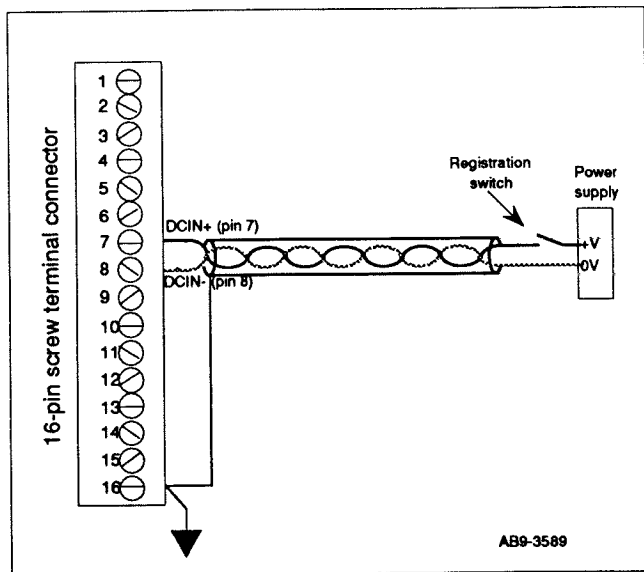


FIGURE 7. DCIN CONNECTION USING TWISTED PAIR WIRING

Figure 8 shows a block diagram of the High-Speed Encoder Module.

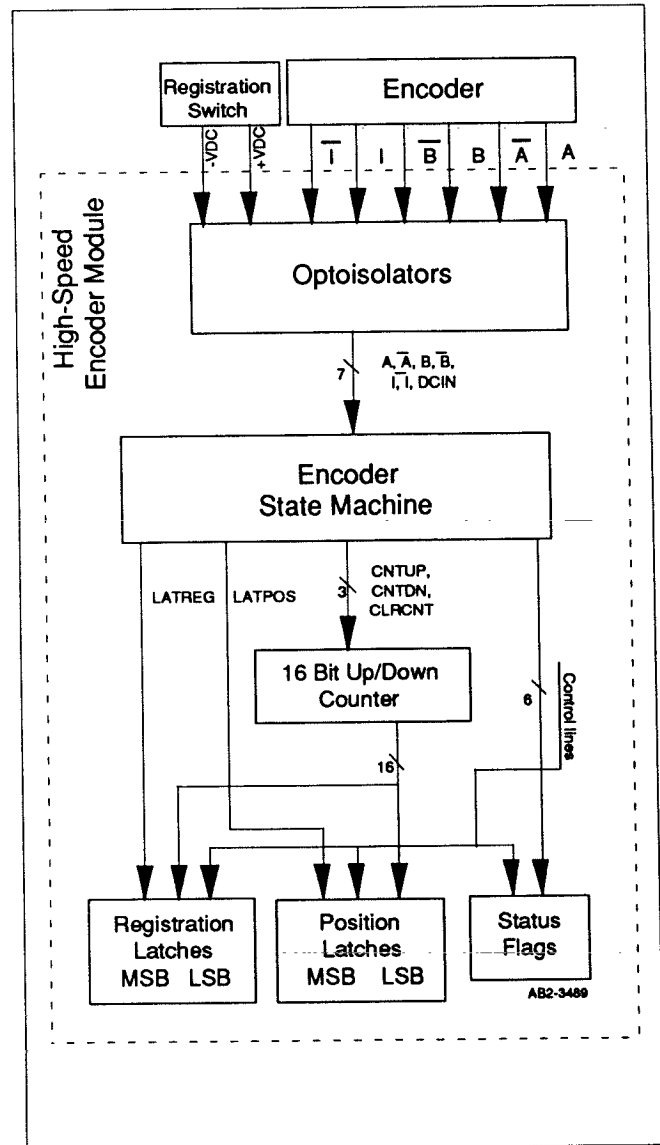


FIGURE 8. BLOCK DIAGRAM

HIGH-SPEED ENCODER MODULE

7.0 INSTALLATION IN RACK

The High-Speed Encoder Module must be installed in the Master Rack of the PiC. The rack is physically keyed to prevent modules from being inserted incorrectly. Set the address switches. (See section 5.0.) Make the necessary connections to the 16-pin connector before applying power.

IMPORTANT

Ensure that power to the rack is off before inserting or removing this or any micro-computer module. Failure to do so may result in permanent damage to the module.

The High-Speed Encoder Module schematic is shown in Figure 9.

HIGH-SPEED ENCODER MODULE

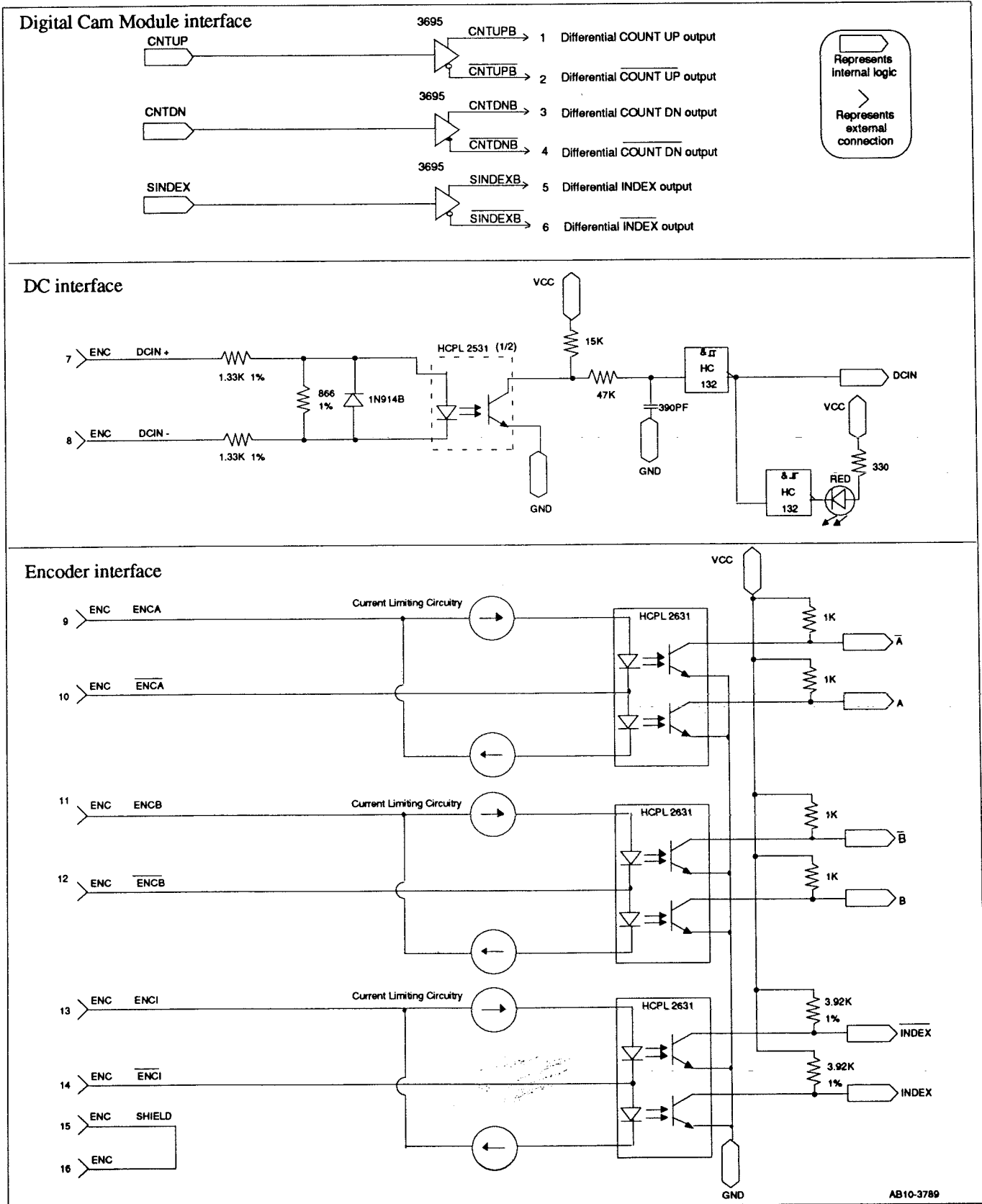


FIGURE 9. HIGH SPEED ENCODER MODULE SCHEMATIC

DATA ACQUISITION MODULE

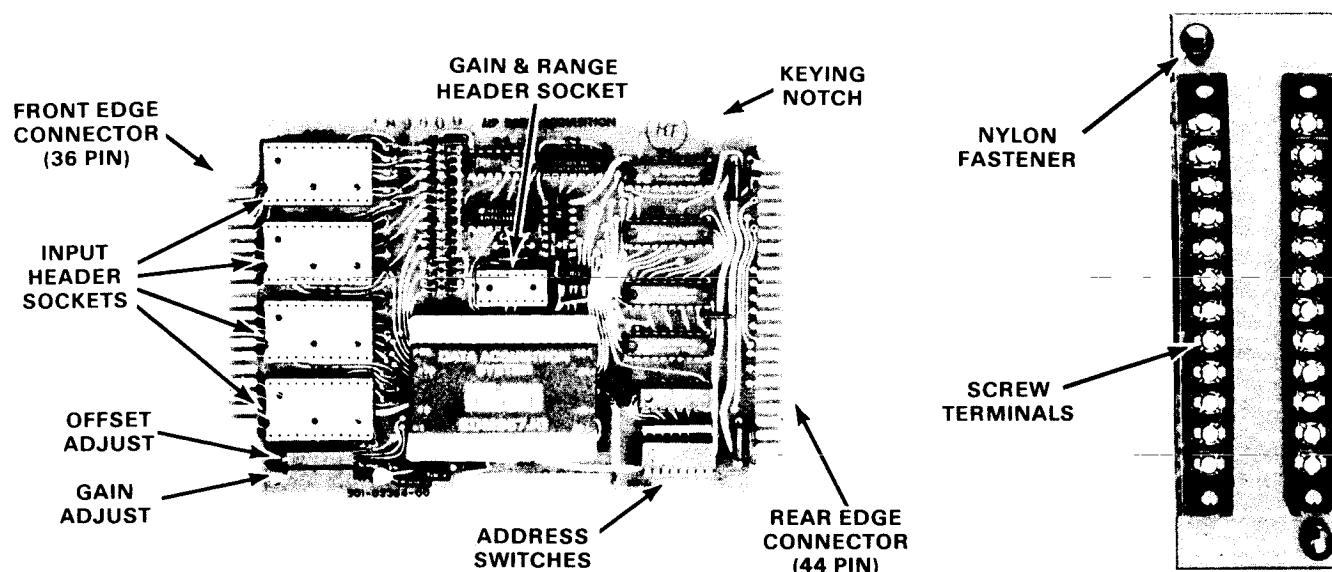


FIGURE 1. DATA ACQUISITION MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

Each Data Acquisition Module (part number 502-02907-20) converts eight analog input levels to digital format for processing by the CPU. Gain control and voltage scaling capabilities enable the module to accept a wide range of analog input levels. The Data Acquisition Module is capable of accepting negative and positive input signals. The presence of the maximum negative input signal results in -2,048 counts, while the presence of the maximum positive input signal results in +2,047 counts. Contained in the module are a socket for gain and range select components, sockets for headers with input conditioning components, a twelve-bit data acquisition device with built-in A/D converter and multiplexing circuitry, and gain and offset potentiometers. Current variations may be used as the input signal through the use of current to voltage conversion components, allowing the use of a 20mA loop standard, for example.

2.0 ADDRESSING

Each Data Acquisition Module occupies four memory locations. The first six Address Switches must be set for the

lowest of the four addresses desired. Table 1 contains the Address Switch settings for the 60 possible beginning address points. Data Acquisition Modules may only be installed in the Master Rack.

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF OFF OFF OFF OFF	2088	ON OFF OFF OFF OFF OFF	2176	ON OFF OFF OFF OFF OFF
2004	ON ON OFF OFF OFF OFF	2092	ON ON OFF OFF OFF OFF	2180	ON ON OFF OFF OFF OFF
2008	ON ON ON OFF OFF OFF	2096	ON ON ON OFF OFF OFF	2184	ON ON ON OFF OFF OFF
2012	ON ON ON ON OFF OFF	2100	ON ON ON ON OFF OFF	2188	ON ON ON ON OFF OFF
2016	ON ON ON ON ON OFF	2104	ON ON ON ON ON OFF	2192	ON ON ON ON ON OFF
2020	ON ON ON ON ON ON	2108	ON ON ON ON ON ON	2196	ON ON ON ON ON ON
2024	ON ON ON ON ON ON	2112	ON ON ON ON ON ON	2200	ON ON ON ON ON ON
2028	ON ON ON ON ON ON	2116	ON ON ON ON ON ON	2204	ON ON ON ON ON ON
2032	ON ON ON ON ON ON	2120	ON ON ON ON ON ON	2208	ON ON ON ON ON ON
2036	ON ON ON ON ON ON	2124	ON ON ON ON ON ON	2212	ON ON ON ON ON ON
2040	ON ON ON ON ON ON	2128	ON ON ON ON ON ON	2216	ON ON ON ON ON ON
2044	ON ON ON ON ON ON	2132	ON ON ON ON ON ON	2220	ON ON ON ON ON ON
2048	ON ON ON ON ON ON	2136	ON ON ON ON ON ON	2224	ON ON ON ON ON ON
2052	ON ON ON ON ON ON	2140	ON ON ON ON ON ON	2228	ON ON ON ON ON ON
2056	ON ON ON ON ON ON	2144	ON ON ON ON ON ON	2232	ON ON ON ON ON ON
2060	ON ON ON ON ON ON	2148	ON ON ON ON ON ON	2236	ON ON ON ON ON ON
2064	ON ON ON ON ON ON	2152	ON ON ON ON ON ON		
2068	ON ON ON ON ON ON	2156	ON ON ON ON ON ON		
2072	ON ON ON ON ON ON	2160	ON ON ON ON ON ON		
2076	ON ON ON ON ON ON	2164	ON ON ON ON ON ON		
2080	ON ON ON ON ON ON	2168	ON ON ON ON ON ON		
2084	ON ON ON ON ON ON	2172	ON ON ON ON ON ON		

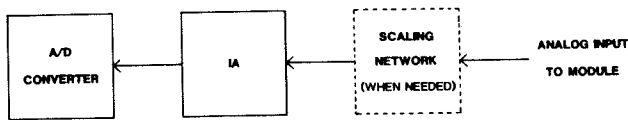
ON OFF ON OFF
OFF ON

TABLE 1. ADDRESS SWITCH SETTINGS

DATA ACQUISITION MODULE

3.0 SELECTION OF INPUT SIGNAL LEVELS

The key to successful use of the Data Acquisition Module is to keep in mind that the Burr-Brown SDM-857 contains an A/D converter that is internally preceded by an Instrumentation Amplifier (IA) with a minimum gain of two. The output of the IA serves as the input to the A/D converter. Thus, the effect of the IA gain on the input signal to the module must be considered when determining the level of input signal to the A/D converter.



NOTE

For maximum feedback accuracy, precision resistors ($\pm 0.1\%$) with a minimum temperature coefficient (<100 PPM/degree C) should be used when configuring the Data Acquisition Module.

3.1 GAIN AND RANGE HEADER SOCKET

The Gain and Range Header Socket on the Data Acquisition Module accepts a 16-pin header plug (G&L Part No. 401-50463-00). The user is able to control gain and range values by connecting appropriate components to the header plug.

3.2 RANGE SELECTION

The A/D converter contained in the Burr-Brown SDM-857 can be configured for a range of either $\pm 5V$ (10V total) or $\pm 10V$ (20V total). The $\pm 5V$ range is selected by jumpering pins 4 and 13 of the Gain and Range Header plug (see Figure 2). The $\pm 10V$ range is selected by jumpering pins 5 and 12. Whichever range is selected for the A/D converter, the maximum output signal from the

IA should equal the extreme limit of the selected A/D input range. Adjustment of the IA output level is done through gain selection and voltage scaling.

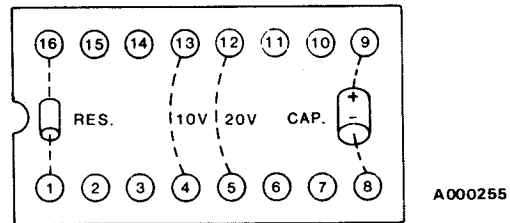


FIGURE 2. GAIN AND RANGE HEADER WIRING

3.3 GAIN SELECTION

The Instrumentation Amplifier (IA) internally precedes the A/D converter in the Burr-Brown SDM857. The IA has a minimum gain of 2, but the gain is user-variable through the installation of a resistor of the appropriate value. Theoretically, the top IA gain is 500. In actual use, the influence of electrical noise in the environment makes a top IA gain of 200 a more realistic value.

The IA gain is increased when the maximum output of the IA (2x the maximum input to module) is less than the limit of the input range for the A/D converter. The necessary gain can be found by using the following formula:

$$\text{Gain} = \frac{A/D r(\text{max})}{V_{in}(\text{max})}$$

$A/D r(\text{max})$ is the upper limit of the A/D converter range and $V_{in}(\text{max})$ is the upper limit of the input signal to the module (in volts).

For example, if the selected A/D converter range is $\pm 5V$, and the input signal is $\pm 1.5V$, the factory adjusted IA gain of 2 will not be adequate. The input signal must be amplified so its range limits are equal to the range limits of the A/D converter. Dividing 1.5 into 5 results in a required gain of 3.33. The resistor value necessary to obtain the correct gain is found with

DATA ACQUISITION MODULE

the following formula:

$$R_{ext} = 20K / (Gain - 2)$$

20K is a constant that reflects the resistance value inherent in the design of the Data Acquisition Module. In this example, $R_{ext} = 20,000 / (3.33 - 2)$; or approximately 15K ohms. The resistor is connected across pins 1 and 16 of the Gain and Range Header plug as shown in Figure 2.

If the minimum gain of 2 is desired, pins 1 and 16 are left open.

3.3.1 IA Settling Time Adjustment

When a gain of 10 or greater is desired, a capacitor must be added to the circuit to permit an increased IA settling time. Capacitor location is shown in Figure 2. The following chart shows the capacitor size necessary with various gain values:

IA GAIN	CAPACITOR SIZE
10-49	.001 uF
50-100	.0022 uF
101-500	.01 uF

3.4 INPUT HEADER SOCKETS

The four input header sockets on the Data Acquisition Module accept 24-pin header plugs (G&L Part No. 401-50211-00). The user connects appropriate components to the plugs to condition the input signal. Each socket allows the user to condition two inputs. All four sockets are identical in configuration. Table 2 shows socket pin utilization.

3.5 SCALING NETWORK

The effect of minimum IA gain on the input signal may result in a signal that exceeds the selected A/D converter range. In such cases, the input signal

Channel	Module Pin	Header Pin	Socket
0IN	18	1	4
0RTN	17	2	4
1IN	15	12	4
1RTN	16	11	4
2IN	13	1	3
2RTN	12	2	3
3IN	10	12	3
3RTN	11	11	3
4IN	8	1	2
4RTN	7	2	2
5IN	5	12	2
5RTN	6	11	2
6IN	4	1	1
6RTN	3	2	1
7IN	1	12	1
7RTN	2	11	1

TABLE 2. SOCKET PIN UTILIZATION

must be scaled down. This is accomplished by inserting a header plug containing appropriate components into the proper input header socket. A voltage scaling network is formed with resistors as shown in Figure 3. The equations used to calculate the proper resistor values are as follows:

$$R2 = \frac{A/Dr(max)}{2I_{in}(max)}$$

$$R1 = \frac{2V_{in}(max)R2}{A/Dr(max)} - R2$$

$A/Dr(max)$ is the upper limit of the selected A/D range in volts. The 2 reflects the minimum IA gain. $I_{in}(max)$ is the maximum input current in amperes. $V_{in}(max)$ is the maximum input signal in volts.

For example, assume a user-supplied power supply is used that provides 12 mA at $\pm 15V$. Using the $\pm 10V$ A/D converter range, $R2 = 10V / (2 \times .012)$, or 417 ohms. $R1 = [(2 \times 15V \times 417 \text{ ohms}) / 10V] - 417 \text{ ohms}$, or 834 ohms.

DATA ACQUISITION MODULE

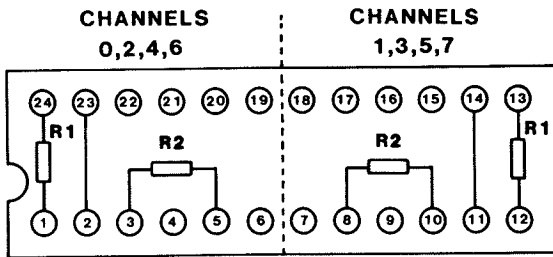


FIGURE 3. INPUT SIGNAL SCALING

NOTE

If input scaling is not desired, replace R1 with a wire jumper and eliminate R2.

4.0 AUXILIARY USE OF INPUT HEADERS

4.1 CURRENT TO VOLTAGE CONVERSION

Current variations can be used as the input to the Data Acquisition Module by configuring the proper input header plug to accomplish current to voltage conversion. This operation is illustrated in Figure 4. The following formula determines the correct value for the resistor R_s :

$$R_s = \frac{A/Dr(\max)}{2 \ln(\max)}$$

$A/Dr(\max)$ is the upper limit of the selected A/D range. The 2 reflects the default IA gain. $\ln(\max)$ is the maximum input current (in amperes). For example, with a selected A/D range of $\pm 5V$, and a maximum input current of 25 mA, $R_s = 5/(2 \times .025)$ or 100 ohms.

4.2 INPUT SIGNAL FILTERING

If it is desired that the input signal be filtered, a low-pass filter can be utilized through the use of a header plug containing an appropriate capacitor as shown in Figure 5. The formula for determining the proper value of capac-

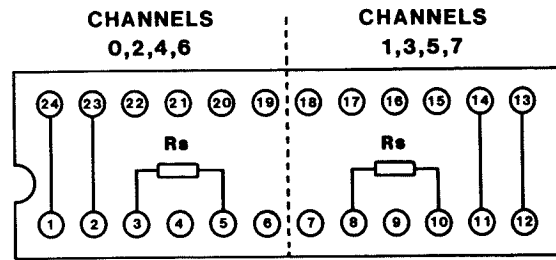


FIGURE 4. CURRENT TO VOLTAGE CONVERSION

itor is:

$$C = \frac{1}{2 \pi FR}$$

F is the frequency above which all other frequencies will be attenuated and R equals 20,000, which is a constant that reflects the resistance value inherent in the design of the module.

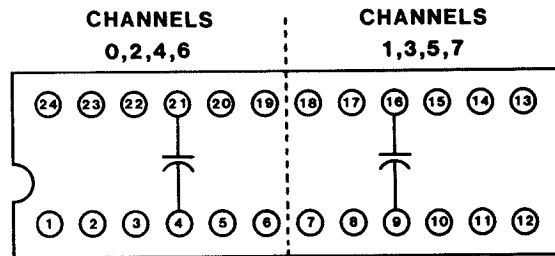


FIGURE 5. FILTERING CAPACITOR

5.0 HARDWARE INTERFACING

5.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the Data Acquisition Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power.

5.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals.

DATA ACQUISITION MODULE

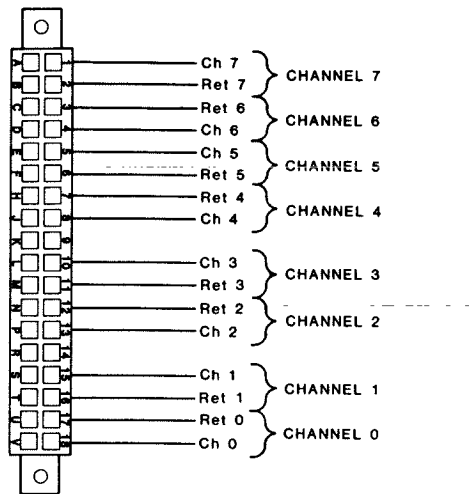


FIGURE 6. CARD EDGE CONNECTOR WIRING

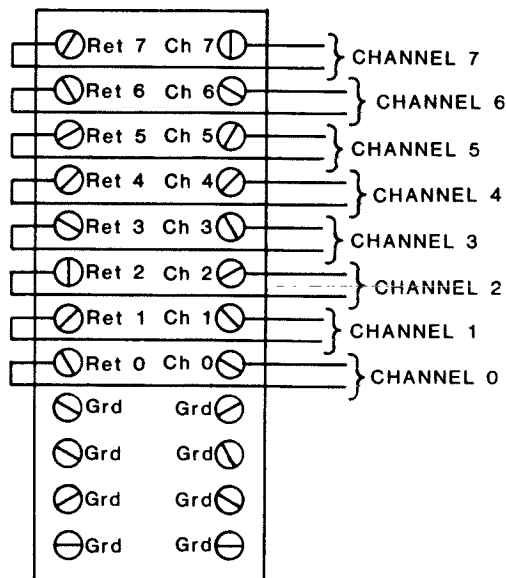


FIGURE 7. FACEPLATE WIRING

5.3 UNUSED INPUTS

Unused inputs should be connected to analog ground on the same module as shown in Table 3.

6.0 INSTALLATION

The Data Acquisition Module may only be installed in the Master Rack. Expansion Racks are used for AC and DC Input/Output modules.

The rack is physically keyed to prevent modules from being inserted incorrectly.

Input	Connect	Socket
0	4 to 22	4
1	16 to 17	4
2	4 to 22	3
3	16 to 17	3
4	4 to 22	2
5	16 to 17	2
6	4 to 22	1
7	16 to 17	1

Return	Connect	Socket
0	21 to 20	4
1	9 to 15	4
2	21 to 20	3
3	9 to 15	3
4	21 to 20	2
5	9 to 15	2
6	21 to 20	1
7	9 to 15	1

TABLE 3. ANALOG GROUND CONNECTIONS FOR UNUSED INPUTS

Set the Address Switches per the instruction in Section 2.0.

Shielded cable, such as Belden 8762S, should be used for transducer wiring. The cable shield should be connected to chassis ground at the transducer end and left unconnected at the programmable controller end. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

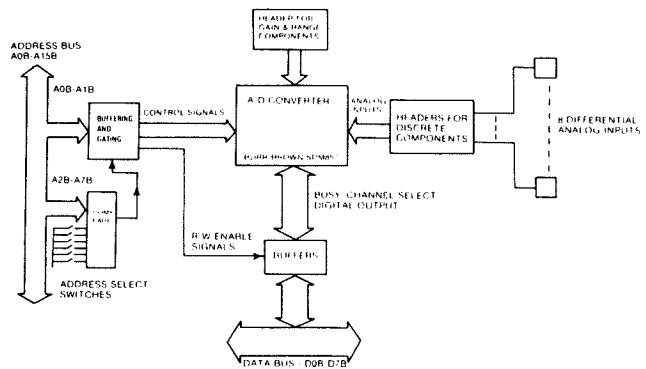


FIGURE 8. BLOCK DIAGRAM

DATA ACQUISITION MODULE

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

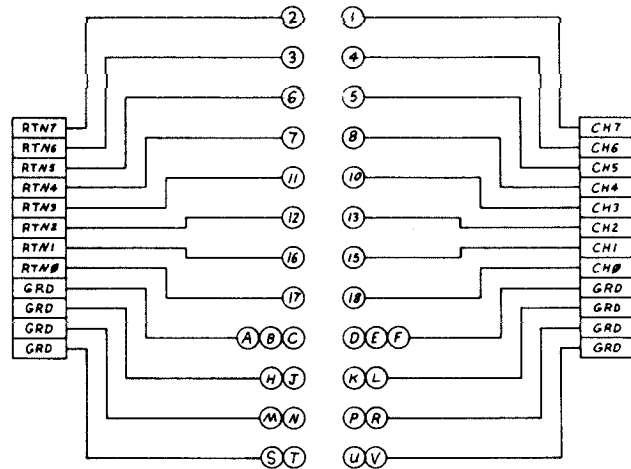


FIGURE 9. FACEPLATE SCHEMATIC

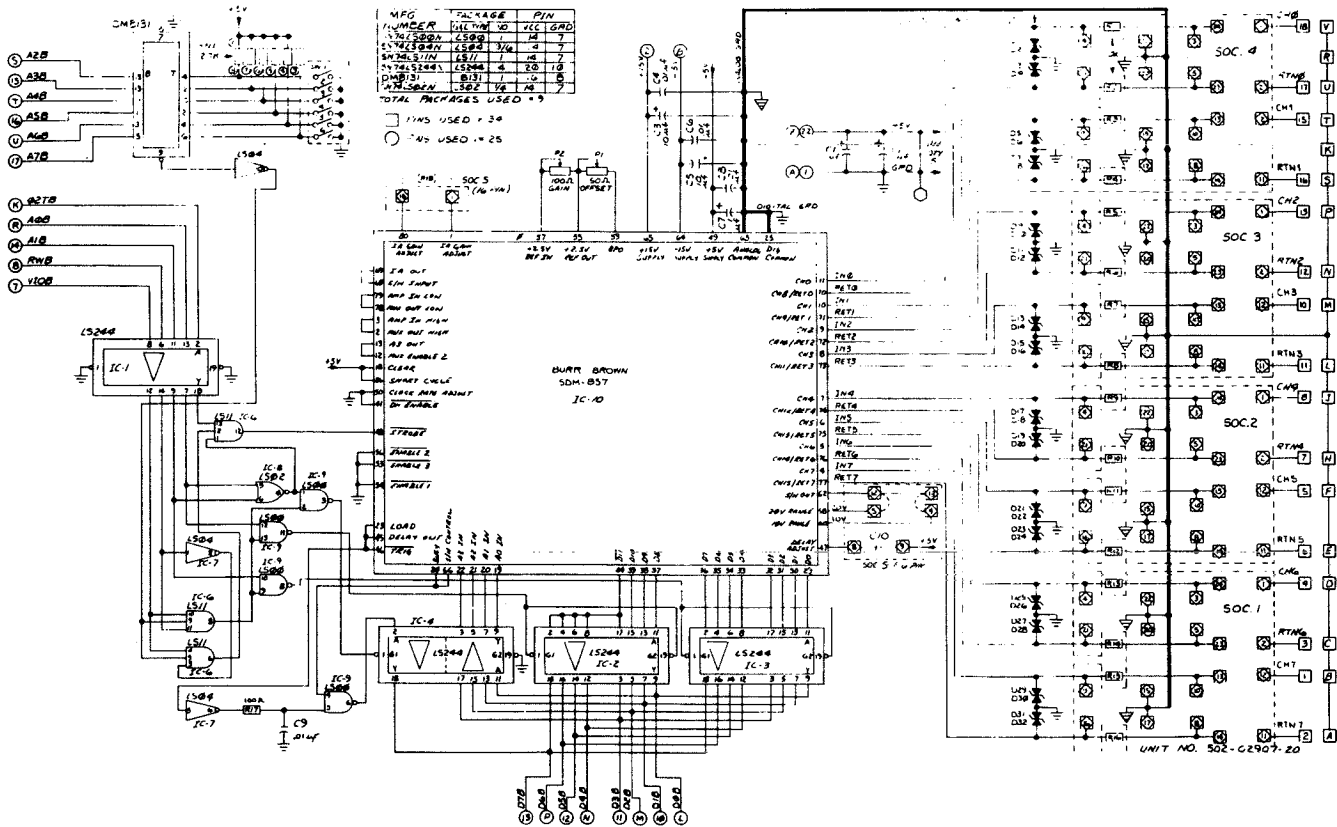


FIGURE 10. MODULE SCHEMATIC

UNIPOLAR DATA ACQUISITION MODULE

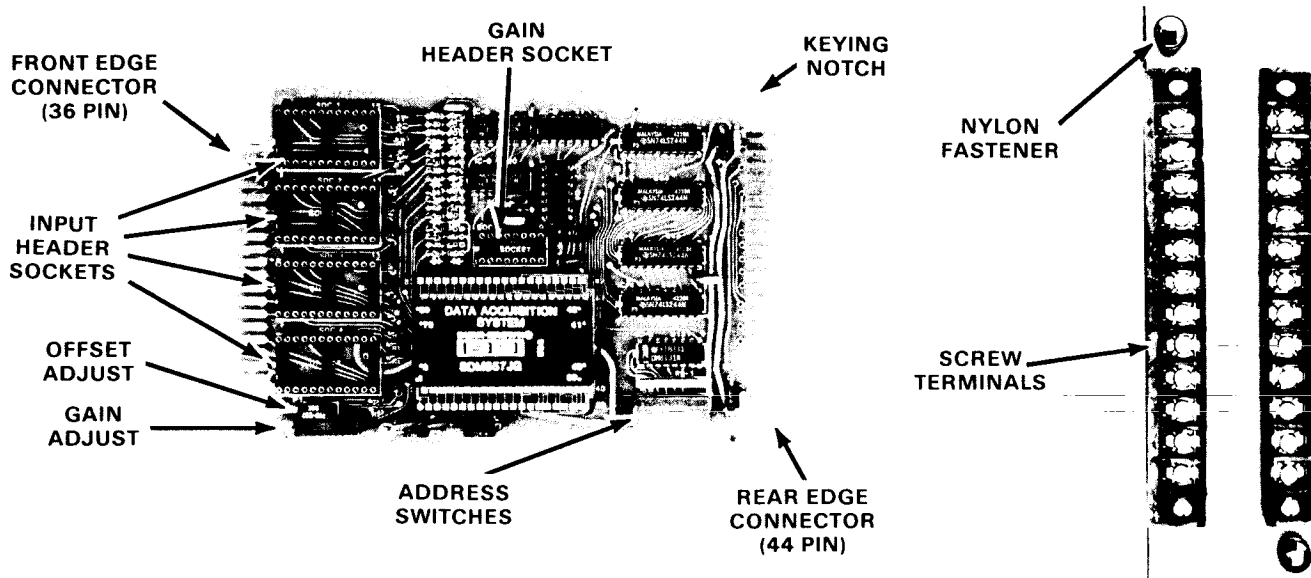


FIGURE 1. UNIPOLAR DATA ACQUISITION MODULE & OPTIONAL FACEPLATE

1.0 INTRODUCTION

installed in the Master Rack.

Each Unipolar Data Acquisition Module (part number 502-03362-00) converts eight analog input levels to digital format for processing by the CPU. Gain control and voltage scaling capabilities enable the module to accept a wide range of analog input levels. The presence of the maximum input level results in 4,095 counts. Contained in the module are a socket for gain select components, sockets for headers with input conditioning components, a twelve-bit data acquisition device with built-in A/D converter and multiplexing circuitry, and gain and offset potentiometers. Current variations may be used as the input signal through the use of current to voltage conversion components, allowing the use of a 20mA loop standard, for example.

2.0 ADDRESSING

Each Unipolar Data Acquisition Module occupies four memory locations. The first six Address Switches must be set for the lowest of the four addresses desired. Table 1 contains the Address Switch settings for the 60 possible beginning address points. Unipolar Data Acquisition Modules may only be

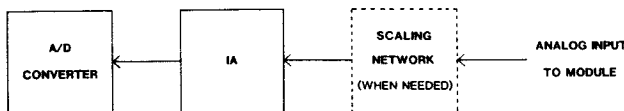
PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF ON OFF ON OFF	2088	ON OFF ON OFF ON OFF	2176	ON OFF ON OFF ON OFF
2004	ON OFF ON OFF ON OFF	2092	ON OFF ON OFF ON OFF	2180	ON OFF ON OFF ON OFF
2008	ON OFF ON OFF ON OFF	2096	ON OFF ON OFF ON OFF	2184	ON OFF ON OFF ON OFF
2012	ON OFF ON OFF ON OFF	2100	ON OFF ON OFF ON OFF	2188	ON OFF ON OFF ON OFF
2016	ON OFF ON OFF ON OFF	2104	ON OFF ON OFF ON OFF	2192	ON OFF ON OFF ON OFF
2020	ON OFF ON OFF ON OFF	2108	ON OFF ON OFF ON OFF	2196	ON OFF ON OFF ON OFF
2024	ON OFF ON OFF ON OFF	2112	ON OFF ON OFF ON OFF	2200	ON OFF ON OFF ON OFF
2028	ON OFF ON OFF ON OFF	2116	ON OFF ON OFF ON OFF	2204	ON OFF ON OFF ON OFF
2032	ON OFF ON OFF ON OFF	2120	ON OFF ON OFF ON OFF	2208	ON OFF ON OFF ON OFF
2036	ON OFF ON OFF ON OFF	2124	ON OFF ON OFF ON OFF	2212	ON OFF ON OFF ON OFF
2040	ON OFF ON OFF ON OFF	2128	ON OFF ON OFF ON OFF	2216	ON OFF ON OFF ON OFF
2044	ON OFF ON OFF ON OFF	2132	ON OFF ON OFF ON OFF	2220	ON OFF ON OFF ON OFF
2048	ON OFF ON OFF ON OFF	2136	ON OFF ON OFF ON OFF	2224	ON OFF ON OFF ON OFF
2052	ON OFF ON OFF ON OFF	2140	ON OFF ON OFF ON OFF	2228	ON OFF ON OFF ON OFF
2056	ON OFF ON OFF ON OFF	2144	ON OFF ON OFF ON OFF	2232	ON OFF ON OFF ON OFF
2060	ON OFF ON OFF ON OFF	2148	ON OFF ON OFF ON OFF	2236	ON OFF ON OFF ON OFF
2064	ON OFF ON OFF ON OFF	2152	ON OFF ON OFF ON OFF		
2068	ON OFF ON OFF ON OFF	2156	ON OFF ON OFF ON OFF		
2072	ON OFF ON OFF ON OFF	2160	ON OFF ON OFF ON OFF		
2076	ON OFF ON OFF ON OFF	2164	ON OFF ON OFF ON OFF		
2080	ON OFF ON OFF ON OFF	2168	ON OFF ON OFF ON OFF		
2084	ON OFF ON OFF ON OFF	2172	ON OFF ON OFF ON OFF		

TABLE 1. ADDRESS SWITCH SETTINGS

UNIPOLAR DATA ACQUISITION MODULE

3.0 SELECTION OF INPUT SIGNAL LEVELS

The key to successful use of the Unipolar Data Acquisition Module is to keep in mind that the Burr-Brown SDM-857 contains an A/D converter that is internally preceded by an Instrumentation Amplifier (IA) with a minimum gain of two. The output of the IA serves as the input to the A/D converter, which is configured for a 0 to +10 volt input. Thus, the effect of the IA gain on the input signal to the module must be considered when determining the level of input signal to the A/D converter.



NOTE

The maximum input signal level for the Unipolar Data Acquisition Module is +5V.

3.1 GAIN SELECTION

The Gain Header socket accepts a 16-pin header plug (G&L Part No. 401-50463-00) with appropriate components for controlling the IA gain. The IA has a minimum gain of 2, but the gain is user-variable through the installation of a resistor of the appropriate value. Theoretically, the top IA gain is 500. In actual use, the influence of electrical noise in the environment makes a top IA gain of 200 a more realistic value.

The IA gain is increased when the maximum output of the IA (2x the maximum input to module) is less than 10V (the limit of the input range for the A/D converter). The necessary gain can be found by using the follow-

ing formula:

$$\text{Gain} = \frac{10\text{V}}{V_{in}(\text{max})}$$

10V is the upper limit of the A/D converter range and $V_{in}(\text{max})$ is the upper limit of the input signal to the module (in volts).

For example, with an A/D converter range of 0V-10V, and an input signal of 0V-1.5V, the factory adjusted IA gain of 2 will not be adequate. The input signal must be amplified so its range limits are equal to the range limits of the A/D converter. Dividing 1.5 into 10V results in a required gain of 6.67. The resistor value necessary to obtain the correct gain is found with the following formula:

$$R_{ext.} = 20K / (\text{Gain} - 2)$$

20K is a constant that reflects the resistance value inherent in the design of the Unipolar Data Acquisition Module. In this example, $R_{ext} = 20,000 / (6.67 - 2)$; or approximately 4.3K ohms. The resistor is connected across pins 1 and 16 of the Gain Header plug as shown in Figure 2.

If the minimum gain of 2 is desired, pins 1 and 16 are left open.

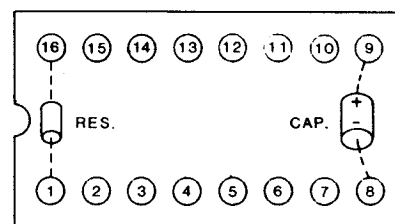


FIGURE 2. GAIN HEADER WIRING

3.1.1 IA Settling Time Adjustment

When a gain of 10 or greater is desired, a capacitor must be added to the circuit to permit an increased IA set-

UNIPOLAR DATA ACQUISITION MODULE

ting time. Capacitor location is depicted in Figure 2. The following chart shows the capacitor size necessary with various gain values:

IA GAIN	CAPACITOR SIZE
10-49	.001 uF
50-100	.0022 uF
101-500	.01 uF

3.2 INPUT HEADER SOCKETS

The four input header sockets on the Unipolar Data Acquisition Module accept 24-pin header plugs (G&L Part No. 401-50211-00). The user connects appropriate components to the plugs to condition the input signal. Each socket allows the user to condition two inputs. All four sockets are identical in configuration. Table 2 shows socket pin utilization.

Channel	Module Pin	Header Pin	Socket
0IN	18	1	4
0RTN	17	2	4
1IN	15	12	4
1RTN	16	11	4
2IN	13	1	3
2RTN	12	2	3
3IN	10	12	3
3RTN	11	11	3
4IN	8	1	2
4RTN	7	2	2
5IN	5	12	2
5RTN	6	11	2
6IN	4	1	1
6RTN	3	2	1
7IN	1	12	1
7RTN	2	11	1

TABLE 2. SOCKET PIN UTILIZATION

3.3 SCALING NETWORK

The effect of minimum IA gain on the input signal may result in a signal that exceeds the A/D converter range. In such cases, the input signal must be

scaled down. This is accomplished by inserting a header plug containing appropriate components into the proper input header socket. A voltage scaling network is formed with resistors as shown in Figure 3. The equations used to calculate the proper resistor values are as follows:

$$R2 = \frac{5V}{I_{in(max)}}$$

$$R1 = \frac{V_{in(max)}R2}{5V} - R2$$

$I_{in(max)}$ is the maximum input current in amperes. $V_{in(max)}$ is the maximum input signal in volts. 5V is the maximum input voltage allowed across $R2$.

For example, assume a user-supplied power supply is used that provides 12 mA at 12V. $R2 = 5V/.012A$, or 417 ohms. $R1 = [(12V \times 417 \text{ ohms})/5V] - 417$ ohms, or 584 ohms.

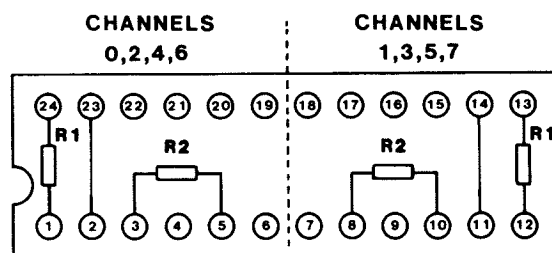


FIGURE 3. INPUT SIGNAL SCALING

NOTE

If input scaling is not desired, replace $R1$ with a wire jumper and eliminate $R2$.

UNIPOLAR DATA ACQUISITION MODULE

4.0 AUXILIARY USE OF INPUT HEADERS

4.1 CURRENT TO VOLTAGE CONVERSION

Current variations can be used as the input to the Unipolar Data Acquisition Module by configuring the proper input header plug to accomplish current to voltage conversion. This operation is illustrated in Figure 4. The following formula determines the correct value for the resistor R_s :

$$R_s = \frac{10V}{2 \text{ lin(max)}}$$

10V is the upper limit of the A/D range. The 2 reflects the default 1A gain. lin(max) is the maximum input current (in amperes). For example, with the A/D range of 0 to +10V and a maximum input current of 25 mA, $R_s = 10V / (2 \times .025)$ or 200 ohms.

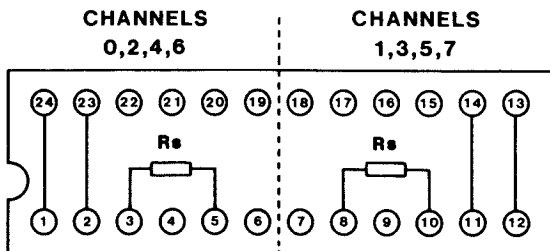


FIGURE 4. CURRENT TO VOLTAGE CONVERSION

NOTE

For maximum feedback accuracy, precision resistors ($\pm 0.1\%$) with a minimum temperature coefficient (<100 PPM/degree C) should be used when configuring the Data Acquisition Module.

4.2 INPUT SIGNAL FILTERING

If it is desired that the input signal be filtered, a low-pass filter can be utilized through the use of a header plug containing an appropriate capacitor as shown in Figure 5. The formula for determining the proper value of capacitor is:

$$C = \frac{1}{2 \pi FR}$$

F is the frequency above which all other frequencies will be attenuated and R equals 20,000, which is a constant that reflects the resistance value inherent in the design of the module.

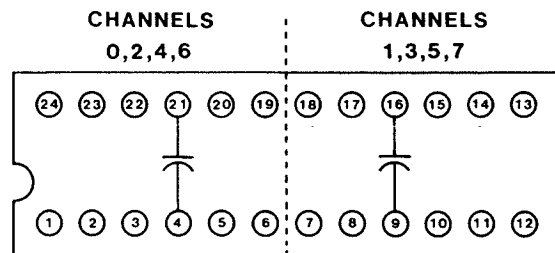


FIGURE 5. FILTERING CAPACITOR

5.0 HARDWARE INTERFACING

5.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the Unipolar Data Acquisition Module to external devices. Phosphor-bronze crimp contacts with gold-over-nickel plating are available. Dummy contacts may be inserted into the connector at unused places for better holding power.

UNIPOLAR DATA ACQUISITION MODULE

5.3 UNUSED INPUTS

Unused inputs should be connected to analog ground on the same module as shown in Table 3.

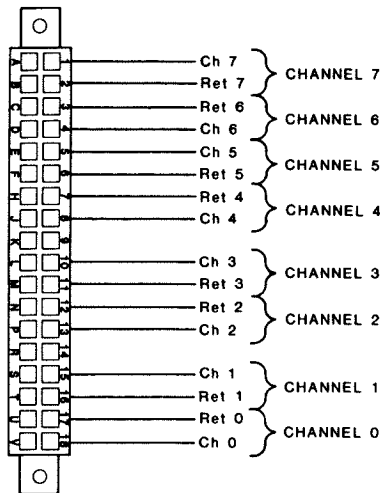


FIGURE 6. CARD EDGE CONNECTOR WIRING

5.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals.

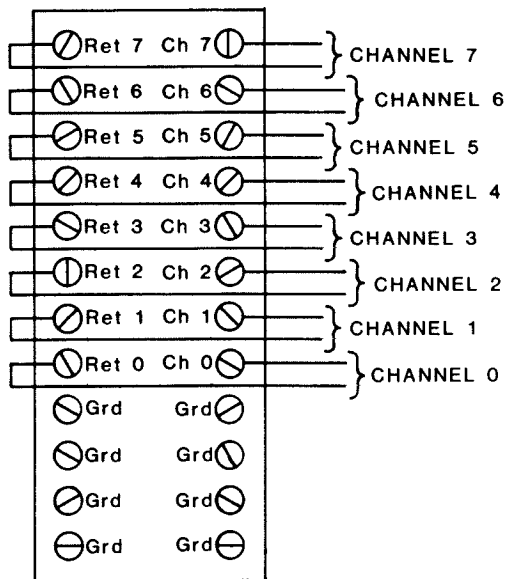


FIGURE 7. FACEPLATE WIRING

Input	Connect	Socket
0	4 to 22	4
1	16 to 17	4
2	4 to 22	3
3	16 to 17	3
4	4 to 22	2
5	16 to 17	2
6	4 to 22	1
7	16 to 17	1

Return	Connect	Socket
0	21 to 20	4
1	9 to 15	4
2	21 to 20	3
3	9 to 15	3
4	21 to 20	2
5	9 to 15	2
6	21 to 20	1
7	9 to 15	1

TABLE 3. ANALOG GROUND CONNECTIONS FOR UNUSED INPUTS

6.0 INSTALLATION

The Unipolar Data Acquisition Module may only be installed in the Master Rack. Expansion racks are used for AC and DC Input/Output modules.

The rack is physically keyed to prevent modules from being inserted incorrectly. Set the Address Switches per the instruction in Section 2.0.

Shielded cable, such as Belden 8762S, should be used for transducer wiring. The cable shield should be connected to chassis ground at the transducer end and left unconnected at the programmable controller end. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

UNIPOLAR DATA ACQUISITION MODULE

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

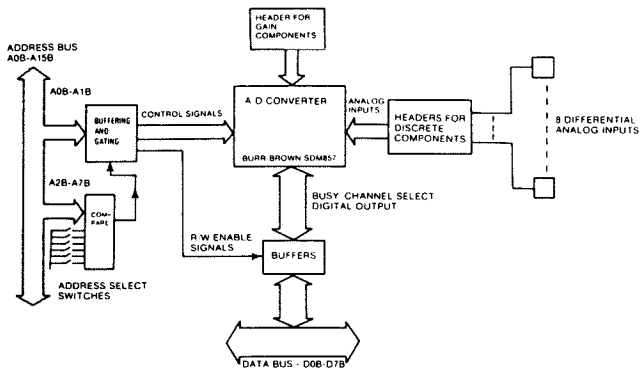


FIGURE 8. BLOCK DIAGRAM

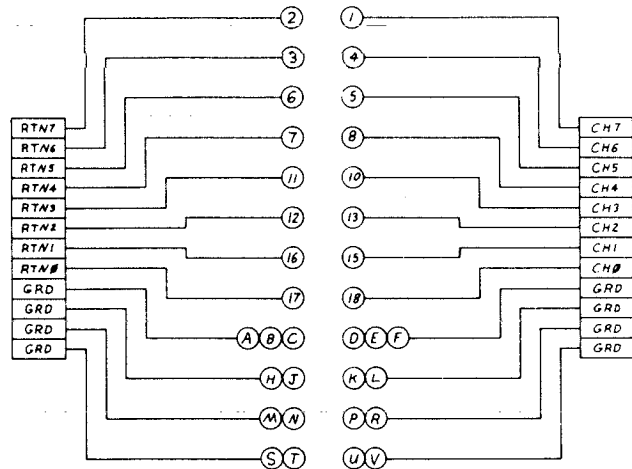


FIGURE 9. FACEPLATE SCHEMATIC

UNIPOLAR DATA ACQUISITION MODULE

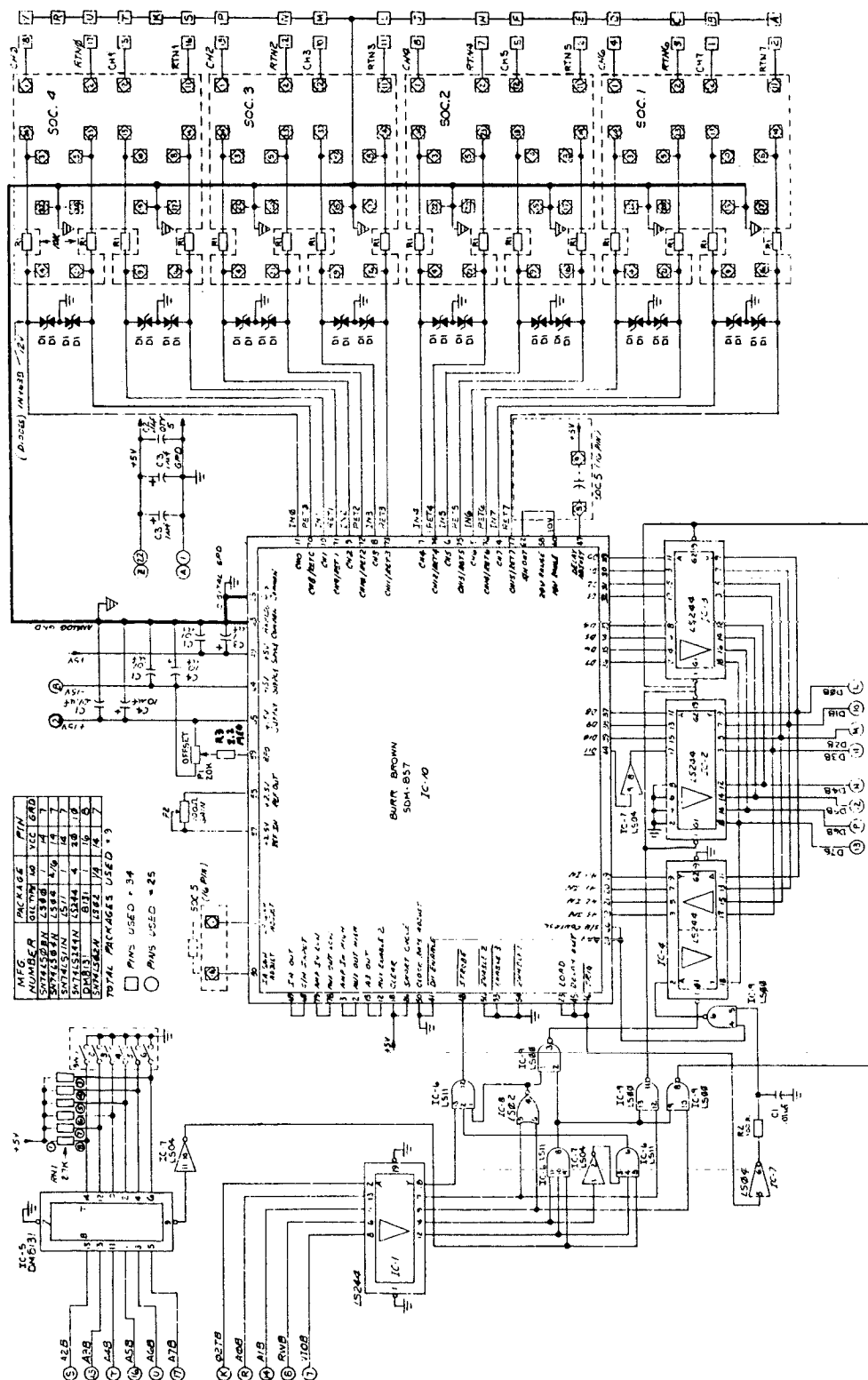
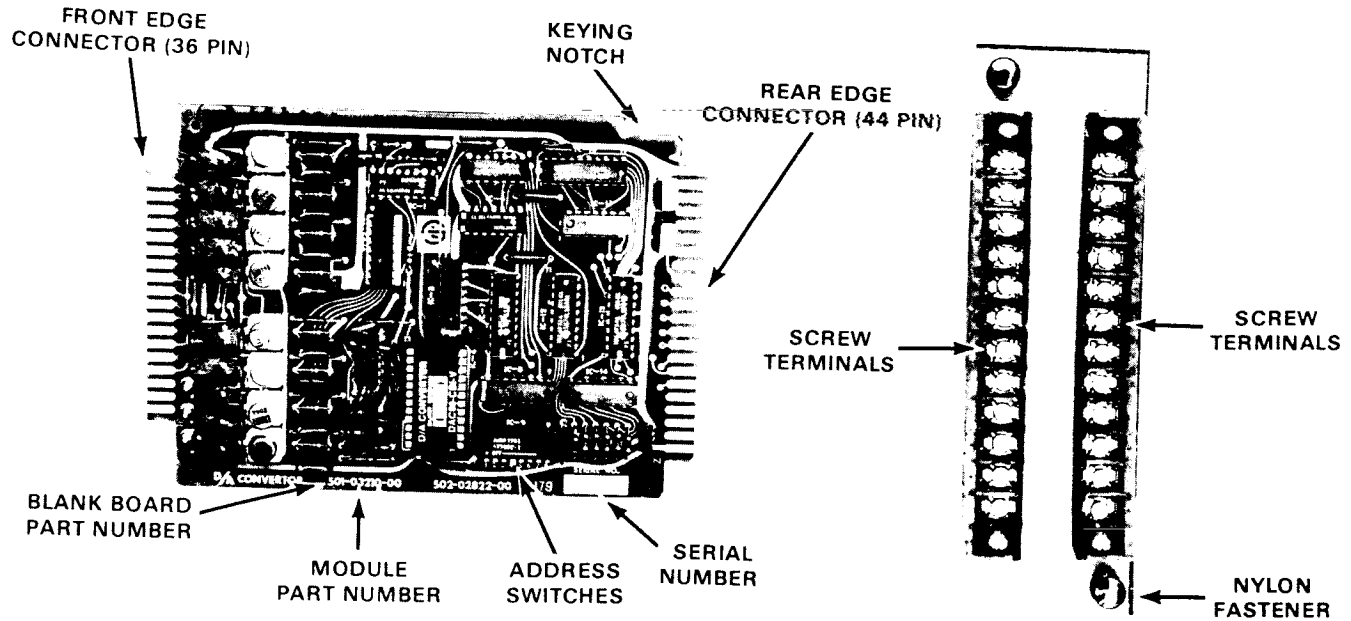


FIGURE 10. MODULE SCHEMATIC



D/A CONVERTER MODULE



EM-160-0

FIGURE 1. D/A CONVERTER MODULE & OPTIONAL FACEPLATE

EM-157-L

1.0 INTRODUCTION

The D/A (Digital-to-Analog) Converter Module contains the circuitry necessary to generate a dc voltage level proportional to the binary number stored into it. The output range of -10 to +10 volts corresponds to the binary equivalent of -2048 to +2047 'counts' input. An analog multiplexer, with sample-and-hold circuits, permits the module to drive eight output channels.

External devices are connected to the module through either a 36-pin card edge connector or a D/A Converter Faceplate. The latter option permits convenient wiring connections to be made to compression screw terminals. A D/A Converter Extender Card is available to facilitate potentiometer adjustment when the faceplate is installed.

2.0 INSTALLATION

The D/A Converter Module may only be installed in the Master Rack. Expansion Racks are used for AC and DC Input/Output Modules.

The rack is physically keyed to prevent

modules from being inserted incorrectly. Set the Address Switches per the instructions in Section 3.0.

IMPORTANT

ENSURE THAT POWER TO THE CARD RACK IS OFF BEFORE INSERTING OR REMOVING THIS OR ANY MICRO-COMPUTER MODULE. Failure to do so may result in permanent damage to the module.

Shielded cable, such as Belden 8762S, should be used for analog device wiring connections. The cable shield should be connected to chassis ground at the Programmable Controller end and left unconnected at the device end. Make wiring connections to and fasten the card edge connector or faceplate before applying power.

The D/A Converter Module interfaces with servo drives or other voltage-controlled devices through either a card edge connector or an optional faceplate connector.

D/A CONVERTER MODULE

2.1 CARD EDGE CONNECTOR

A 36-pin card edge connector may be used to connect the D/A Converter Module to external devices. Phosphor-bronze crimp contacts, with gold-over-nickel plating, are available. Dummy contacts may be inserted into the connector at unused places for improved holding power.

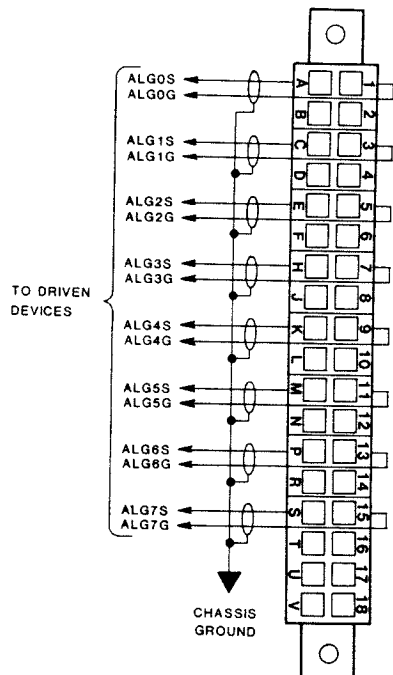


FIGURE 2. CARD EDGE CONNECTOR WIRING

2.2 FACEPLATE CONNECTOR

The Faceplate Connector allows wiring connections to be conveniently made to compression screw terminals. See FIGURE 3.

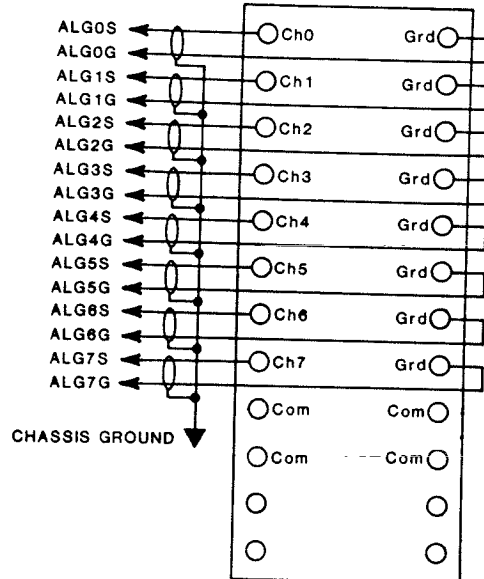


FIGURE 3. FACEPLATE CONNECTOR WIRING

3.0 ADDRESSING

TABLE 1. ADDRESS SWITCH SETTINGS

PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456	PC ADDRESS	SWITCHES 123456
2000	ON OFF	2088	ON OFF	2176	ON OFF
2004	ON OFF	2092	ON OFF	2180	ON OFF
2008	ON OFF	2096	ON OFF	2184	ON OFF
2012	ON OFF	2100	ON OFF	2188	ON OFF
2016	ON OFF	2104	ON OFF	2192	ON OFF
2020	ON OFF	2108	ON OFF	2196	ON OFF
2024	ON OFF	2112	ON OFF	2200	ON OFF
2028	ON OFF	2116	ON OFF	2204	ON OFF
2032	ON OFF	2120	ON OFF	2208	ON OFF
2036	ON OFF	2124	ON OFF	2212	ON OFF
2040	ON OFF	2128	ON OFF	2216	ON OFF
2044	ON OFF	2132	ON OFF	2220	ON OFF
2048	ON OFF	2136	ON OFF	2224	ON OFF
2052	ON OFF	2140	ON OFF	2228	ON OFF
2056	ON OFF	2144	ON OFF	2232	ON OFF
2060	ON OFF	2148	ON OFF	2236	ON OFF
2064	ON OFF	2152	ON OFF		
2068	ON OFF	2156	ON OFF		
2072	ON OFF	2160	ON OFF		
2076	ON OFF	2164	ON OFF		
2080	ON OFF	2168	ON OFF		
2084	ON OFF	2172	ON OFF		

D/A CONVERTER MODULE

The D/A Converter Module occupies four memory locations. The six board-mounted Address Switches must be set for the lowest of the four addresses desired. TABLE 1 contains the Address Switch settings for the 60 possible beginning address points.

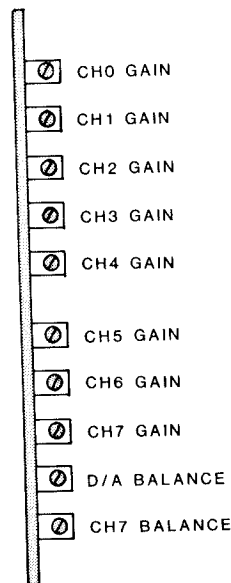


FIGURE 4. CARD EDGE VIEW

4.1 GAIN ADJUST

A multi-turn potentiometer is associated with each D/A channel for the purpose of gain adjustment. The gain of each channel is adjustable from unity (1) to approximately 3.8.

4.2 BALANCE ADJUST

A multi-turn potentiometer is provided so that the D/A may be balanced. This allows 0.0 volts to be output when a binary number of 0 is stored into the module. All eight channels are simultaneously affected by this adjustment.

An additional potentiometer is provided to permit independent balancing of Channel 7. This adjustment does not affect any other channel, and is primarily used for spindle or velocity drives.

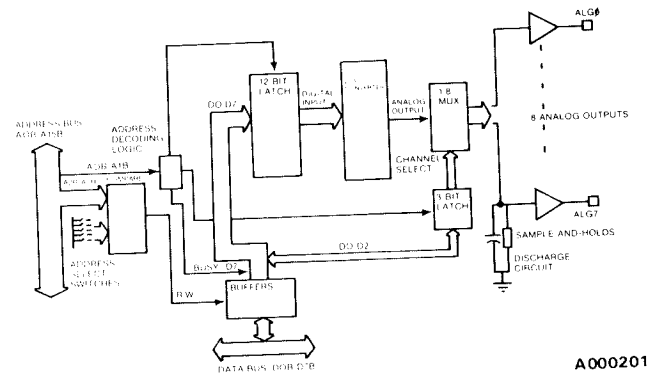


FIGURE 5. BLOCK DIAGRAM

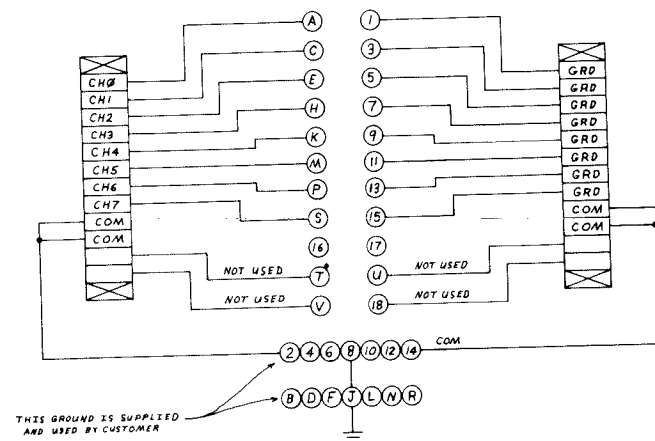


FIGURE 6. FACEPLATE SCHEMATIC

D/A CONVERTER MODULE

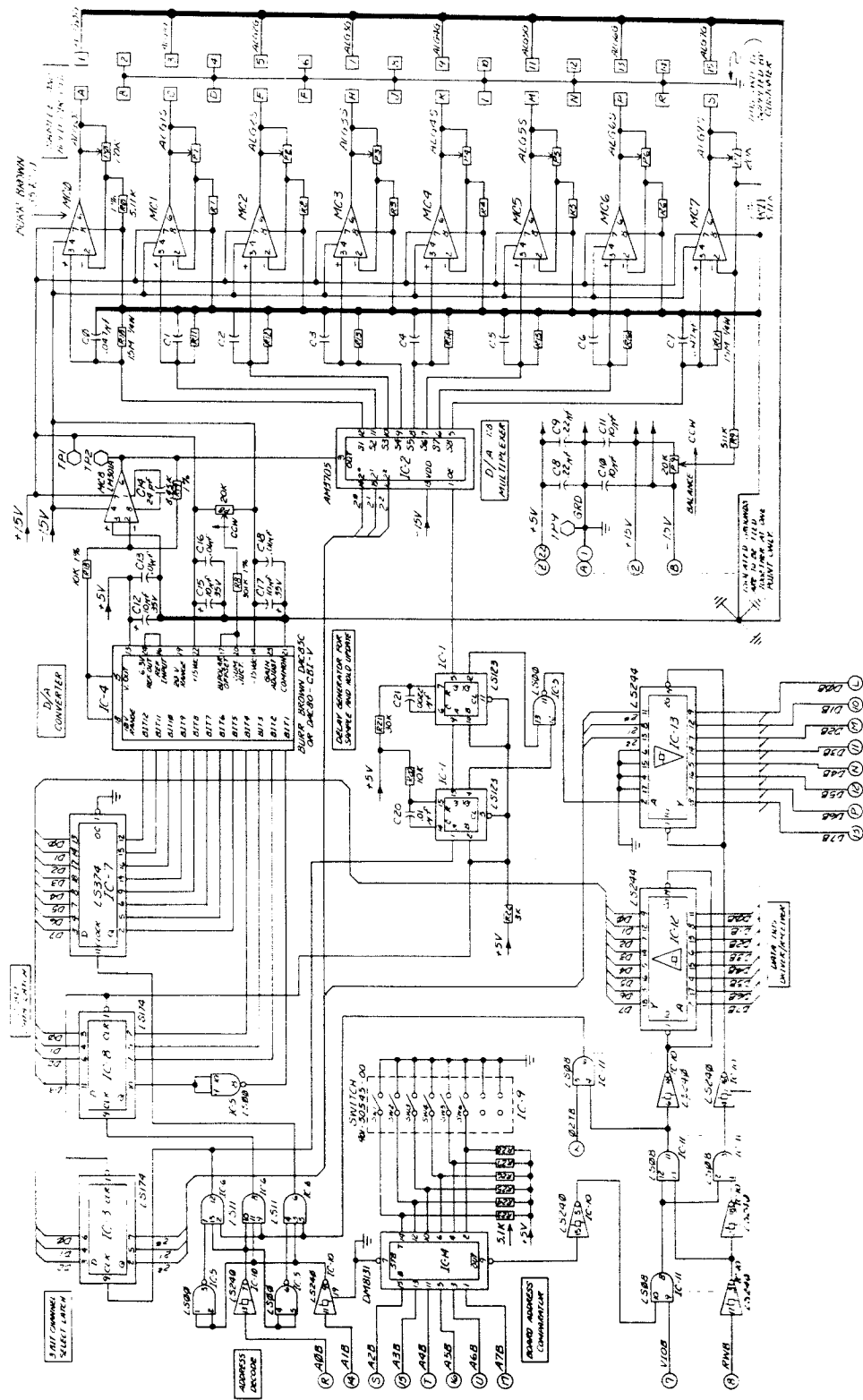


FIGURE 7. D/A CONVERTER MODULE SCHEMATIC

4-20 mA ANALOG OUTPUT MODULE

PHOTOGRAPH NOT AVAILABLE
AT PRINTING TIME

1.0 INTRODUCTION

The 4-20 mA Analog Output Module (part no. 502-03443-00) contains the circuitry necessary to generate a DC current level proportional to the binary number stored in it. The output range of 4-20 mA corresponds to the binary equivalent of 0 to 4,095 "counts" input. There is also an optional output range of 0 to 20 mA. An analog multiplexer, with sample-and-hold circuits, permits the module to drive four channels.

The 4-20 mA Analog Output Module interfaces with servo drives and other current-controlled devices through either a card edge connector or an optional faceplate connector. The faceplate option permits convenient wiring connections to be made to compression screw terminals.

NOTE

DO NOT ADJUST ANY OF THE POTENTIOMETERS ON THIS MODULE. ALL ADJUSTMENTS HAVE BEEN MADE AT THE FACTORY.

The digital and analog sections of the module are isolated by optical isolators. The power for the digital section comes off of the backplane. However, the power for the analog section must be provided by a separate external

power supply wired to the front edge connector of the module. The external power supply must be able to provide +15V @ 175 mA and -15V @ 50mA.

The maximum allowable load per channel is 500Ω.

IMPORTANT

ENSURE THAT POWER TO THE MASTER RACK IS OFF BEFORE INSERTING OR REMOVING ANY MICROCOMPUTER MODULE. Failure to do so may result in permanent damage to the module.

2.0 INSTALLATION

The 4-20 mA Analog Output Module may only be installed in the Master Rack. Extension Racks are used for AC or DC input and output Modules only.

The Master Rack is physically keyed to prevent modules from being inserted incorrectly. Set the address switches as indicated in Section 4 before inserting the module.

With the power off, insert the module into the Master Rack. Attach a card edge connector or faceplate to the front edge of the module. The wiring for the module is described in Section 4.

4-20 mA ANALOG OUTPUT MODULE

3.0 ADDRESSING

The 4-20 mA Analog Output Module occupies four memory locations. The six module-mounted address switches must be set to the lowest of the four addresses desired. See TABLE 1 for the Address Switch settings of the 60 possible beginning address points.

NOTE

The four addresses chosen for this module must not overlap any memory addresses occupied by another module.

PIC ADDRESS	SWITCHES 1 2 3 4 5 6	PIC ADDRESS	SWITCHES 1 2 3 4 5 6	PIC ADDRESS	SWITCHES 1 2 3 4 5 6
2000	ON	2088	ON	2176	ON
	OFF		OFF		OFF
2004	ON	2092	ON	2180	ON
	OFF		OFF		OFF
2008	ON	2096	ON	2184	ON
	OFF		OFF		OFF
2012	ON	2100	ON	2188	ON
	OFF		OFF		OFF
2016	ON	2104	ON	2192	ON
	OFF		OFF		OFF
2020	ON	2108	ON	2196	ON
	OFF		OFF		OFF
2024	ON	2112	ON	2200	ON
	OFF		OFF		OFF
2028	ON	2116	ON	2204	ON
	OFF		OFF		OFF
2032	ON	2120	ON	2208	ON
	OFF		OFF		OFF
2036	ON	2124	ON	2212	ON
	OFF		OFF		OFF
2040	ON	2128	ON	2216	ON
	OFF		OFF		OFF
2044	ON	2132	ON	2220	ON
	OFF		OFF		OFF
2048	ON	2136	ON	2224	ON
	OFF		OFF		OFF
2052	ON	2140	ON	2228	ON
	OFF		OFF		OFF
2056	ON	2144	ON	2232	ON
	OFF		OFF		OFF
2060	ON	2148	ON	2236	ON
	OFF		OFF		OFF
2064	ON	2152	ON		
	OFF		OFF		
2068	ON	2156	ON		
	OFF		OFF		
2072	ON	2160	ON		
	OFF		OFF		
2076	ON	2164	ON		
	OFF		OFF		
2080	ON	2168	ON		
	OFF		OFF		
2084	ON	2172	ON		
	OFF		OFF		

TABLE 1. ADDRESS SWITCH SETTINGS

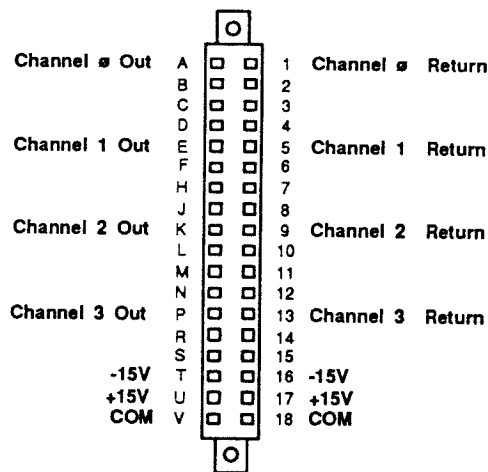
4.0 HARDWARE INTERFACING

Shielded wire, such as Belden 8762S, should be used for analog device wiring connections. The cable shield should be connected at the device end. Make the wiring connections and attach the card edge connector or faceplate to the front of the module before applying power to the Master Rack.

The terminals labeled COMMON are connected together on the module. These may be used as cable shield terminations if one of them is connected to chassis ground on the device connected to this module.

4.1 CARD EDGE CONNECTOR

A 36-pin card edge connector (part no. 401-50657-00) may be used to connect the module to external devices. See FIGURE 1. Phosphor-bronze crimp contacts (part no. 401-50460-00), with gold over nickel plating, are available. Dummy contacts (part no. 401-50459-00) may be inserted into the connector at unused places for improved holding power.



Shields should be tied to chassis or single point ground. Connect unused pins to COM on the Card Edge Connector.

FIGURE 1. CARD EDGE CONNECTOR WIRING

4.2 FACEPLATE CONNECTOR

The optional Faceplate Connector (part no. 502-03444-00) allows wiring to be made to compression screw terminals. See FIGURE 2.

4-20 mA ANALOG OUTPUT MODULE

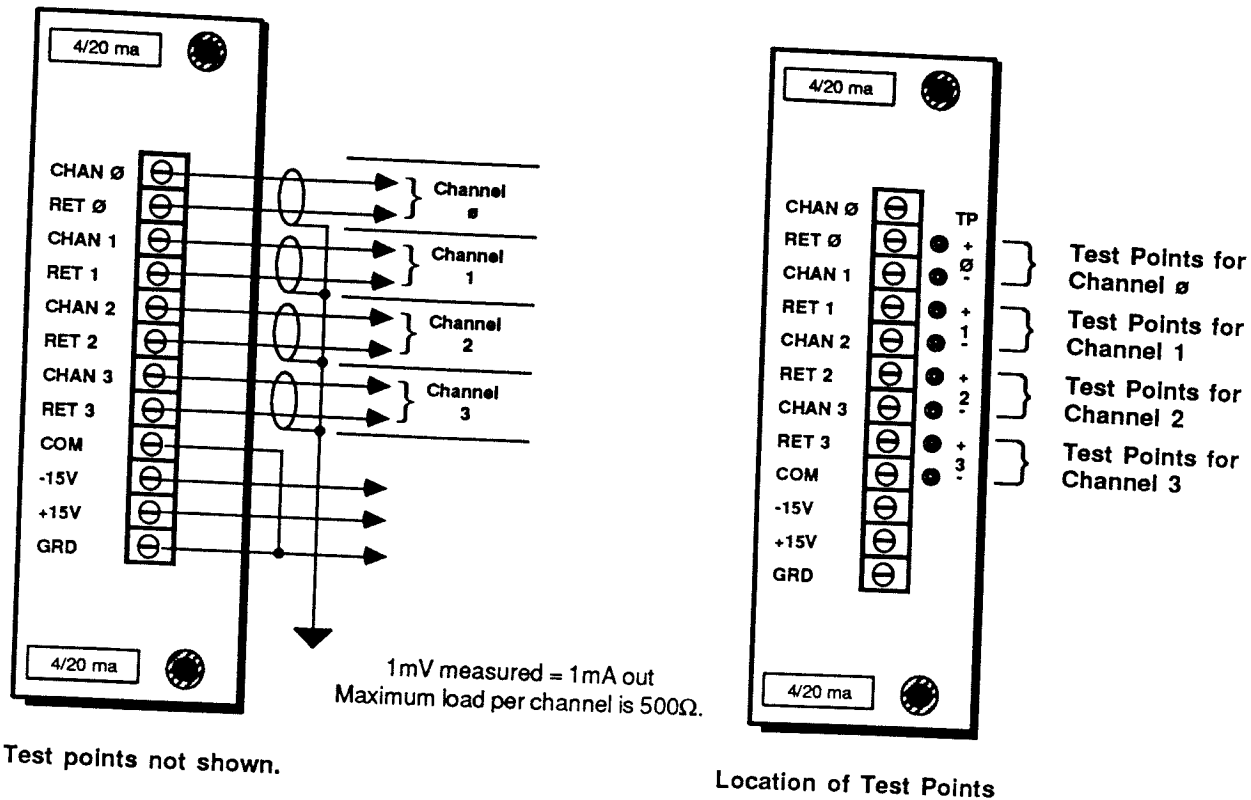


FIGURE 3. FACEPLATE CONNECTOR WIRING AND TEST POINT LOCATION

5.0 CHANGING THE OUTPUT RANGE

The standard output range for each channel on this module is from 4-20 mA. However, the range for each channel can be set to 0-20 mA by changing the position of the Optional Span Jumpers. Each channel is independent of the others (i.e. Channel A can have a range from 4-20 mA and Channel B can have a range from 0-20 mA). FIGURE 3 shows the locations of the jumpers and their settings. Refer to the inset in the illustration for the optional 0-20 mA setting.

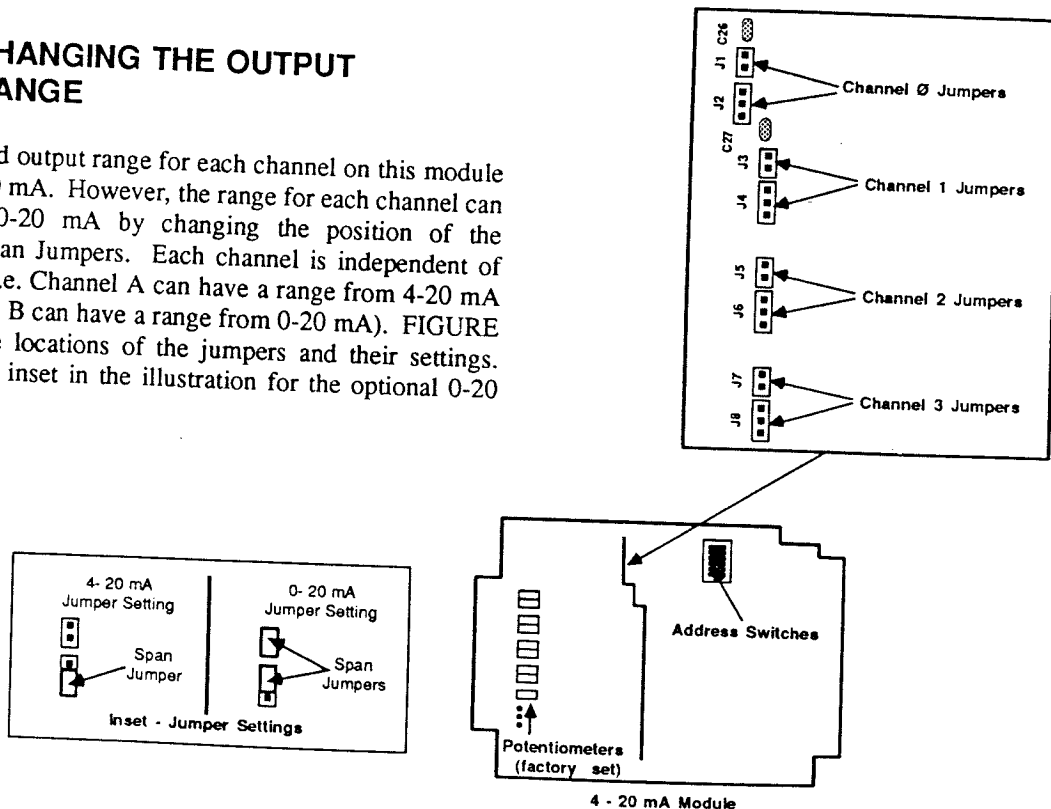


FIGURE 4. JUMPER LOCATIONS AND SETTINGS

4-20 mA ANALOG OUTPUT MODULE

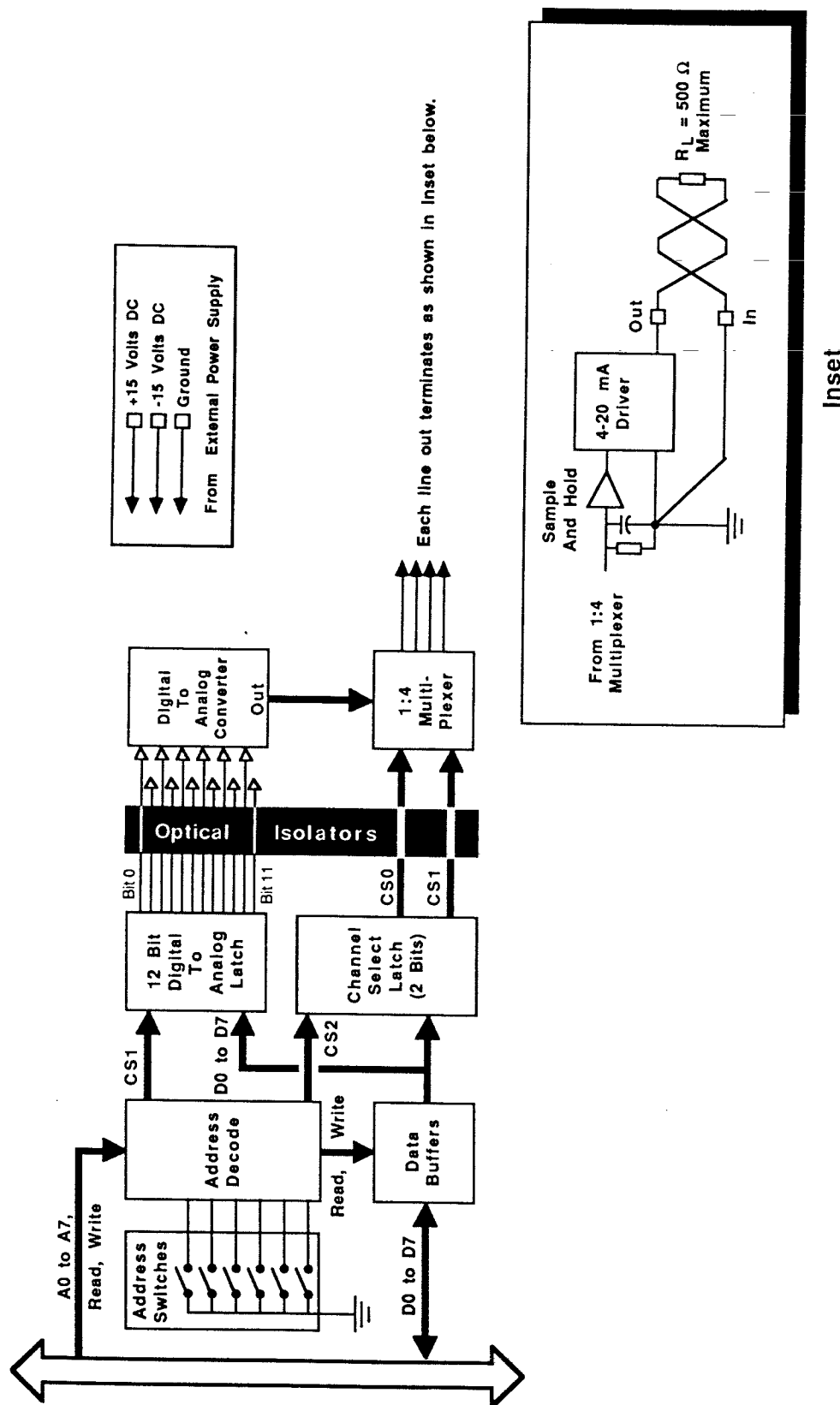


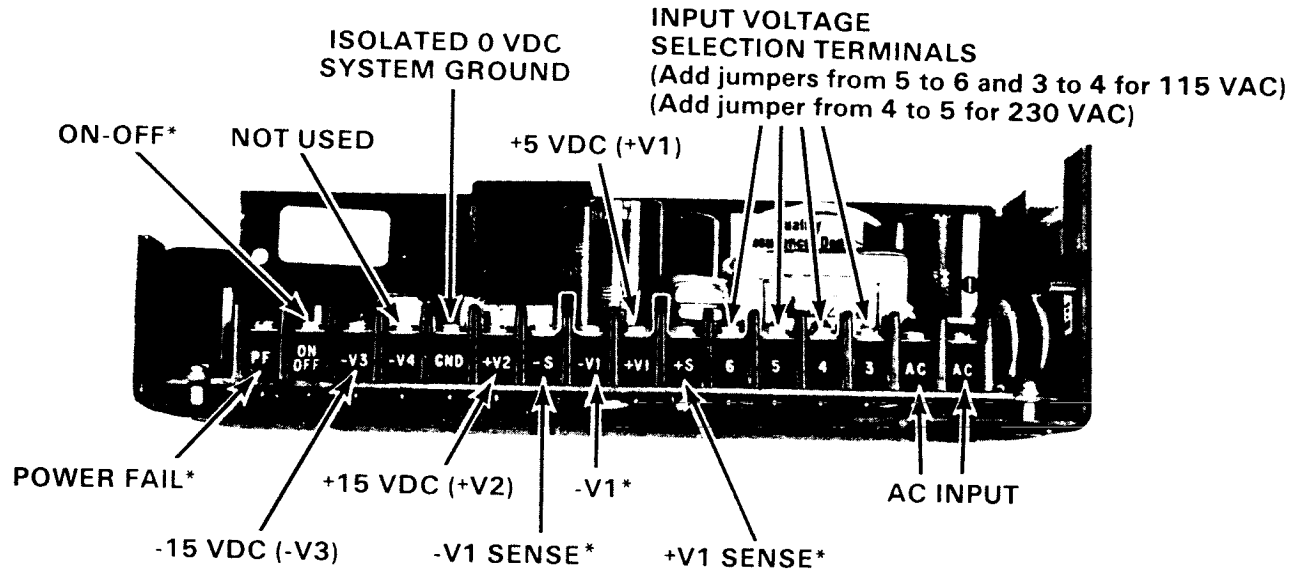
FIGURE 5. BLOCK DIAGRAM

APPENDIX B

POWER SUPPLIES

Handwritten text in a vertical column on the right margin, possibly a list or index, consisting of various symbols and characters.

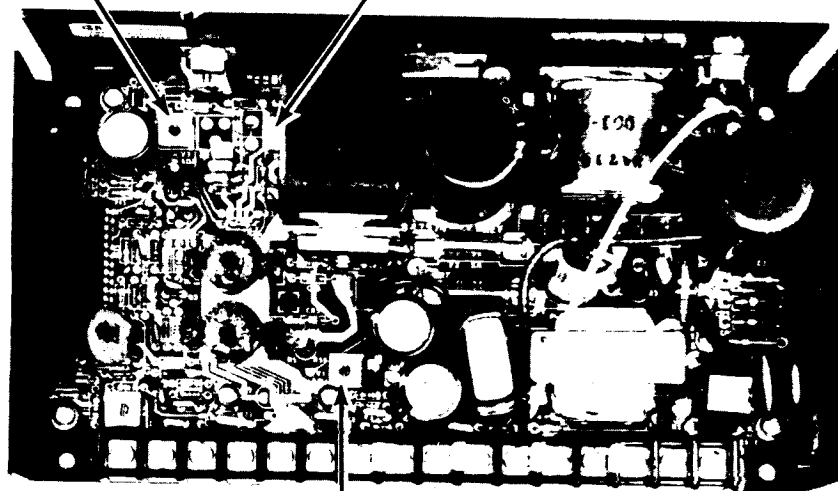
TTM-23-133



*See optional wiring on reverse side.

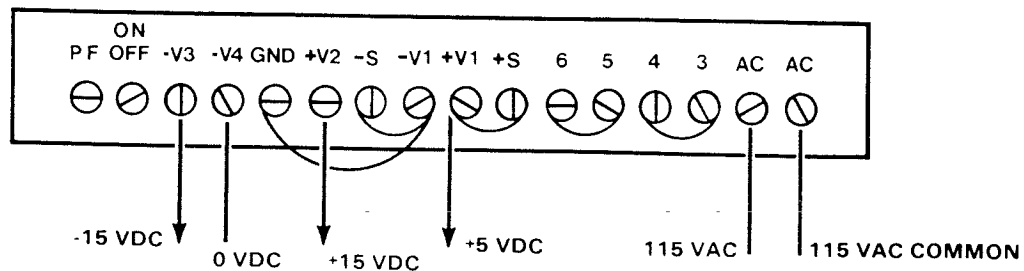
-15 VDC (-V3) ADJUSTMENT

+15 VDC (+V2) ADJUSTMENT



+5 VDC (+V1) ADJUSTMENT

PiC409 POWER SUPPLY WIRING DIAGRAM



OPTIONAL WIRING

NEGATIVE 5 VOLTS

The power supply can provide -5 volts DC or +5 volts DC but not both at the same time. For -5 volts DC, disconnect the jumper from GND to -V1. Connect a jumper from GND to +V1. The -5 volts DC will now be supplied from -V1.

POWER FAIL

Terminal PF supplies a logic 1 for 16 milliseconds if AC power is lost.

ON-OFF

Grounding the terminal labeled ON/OFF will shut off the power supply.

REMOTE SENSE

Local sense is factory installed. If remote sense is desired, disconnect local sense jumpers (-S to -V1 and +S to +V1). Using 22 AWG twisted pair not exceeding ten feet, connect the +S terminal to the positive point on the load and the -S terminal to the negative point on the load.

PiC409 POWER SUPPLY SPECIFICATIONS

OUTPUT POWER

100 Watts Maximum

OUTPUT

+5 Volts DC at 12 Amps
-5 Volts DC at 12 Amps
+15 Volts DC at 1.5 Amps
-15 Volts DC at 1.5 Amps

OVER VOLTAGE

V1 only set at 125% $\pm$ 5%

HOLD-UP TIME

20 msec in regulation minimum, after removal of nominal AC input.

VOLTAGE ADJUST RANGE

$\pm$ 5% minimum V1, V2 and V3

COOLING

Convection

INPUT FUSE

User to supply 4 amp 3AG fuse.

EFFICIENCY

Up to 80%, 65% typical

PARD (ripple and noise)

1% p-p or 50 mV, whichever is higher.

INPUT VOLTAGE

85-130 volts AC or 170-260 volts AC.
47-440 Hz. Input voltage is selectable by jumpers on terminal block.

STORAGE TEMPERATURE

-55°C TO +85°C

LIMITED IN-RUSH CURRENT

The AC input in-rush current is limited to 42A RMS when averaged over one cycle.

LINE REGULATION

0.4% for 10% to full load on V1.
1.0% for 10% to full load on V2
1.0% for 10% to full load on V3.

OVERSHOOT AND UNDERSHOOT

2% maximum deviation with a load change of 25% at 5A/usec. No overshoot or undershoot during AC turn on or turn off.

OPERATING TEMPERATURE

0°C to 50°C full power.

Derates linearly to 50% power at 70°C.

REMOTE SENSE

Remote sense will compensate for up to 250 mV of lead cable drop on main output. Output is internally sensed if the sense leads are opened. Provided on primary output only.

MINIMUM LOAD

3A in V1 required to ensure regulation of auxiliary outputs. However, lack of minimum load will not damage supply.

RECOMMENDED CONTROL TRANSFORMER AND NOISE FILTER

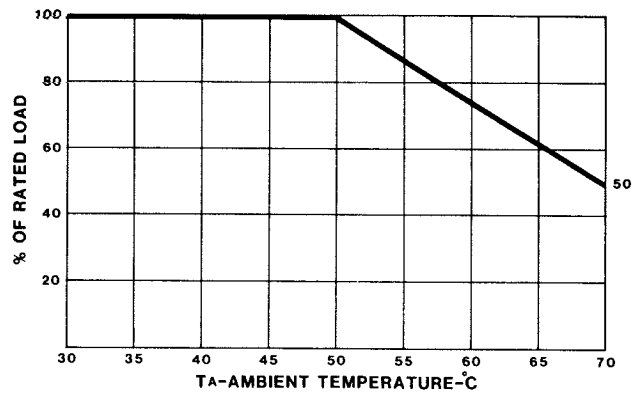
Use a .5 KVA or larger control transformer to isolate grounds.

Use an ISLATROL®¹ No. I-155/U noise filter (G&L part no. 401-53038-00) between the control transformer and this power supply.

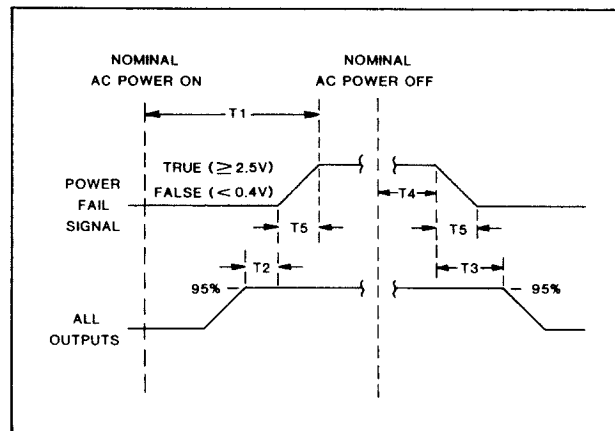
Refer to Section 3 of this manual for more information about control transformers and ISLATROL® FILTERS.

¹ ISLATROL® is a registered trademark of Control Concepts Corporation

POWER DERATING CURVE



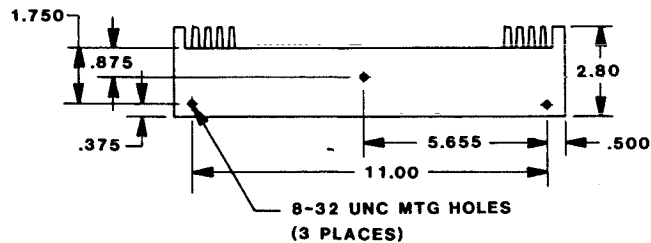
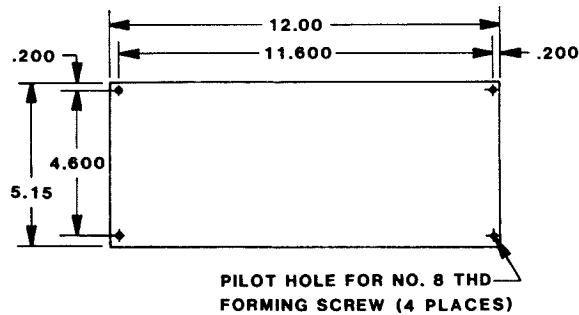
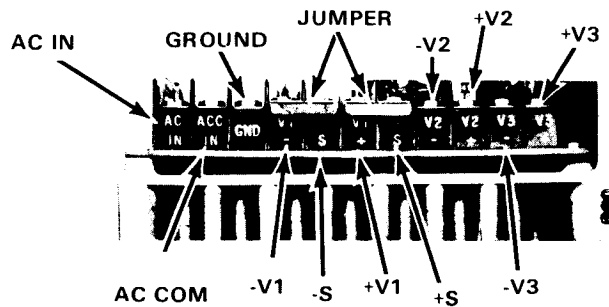
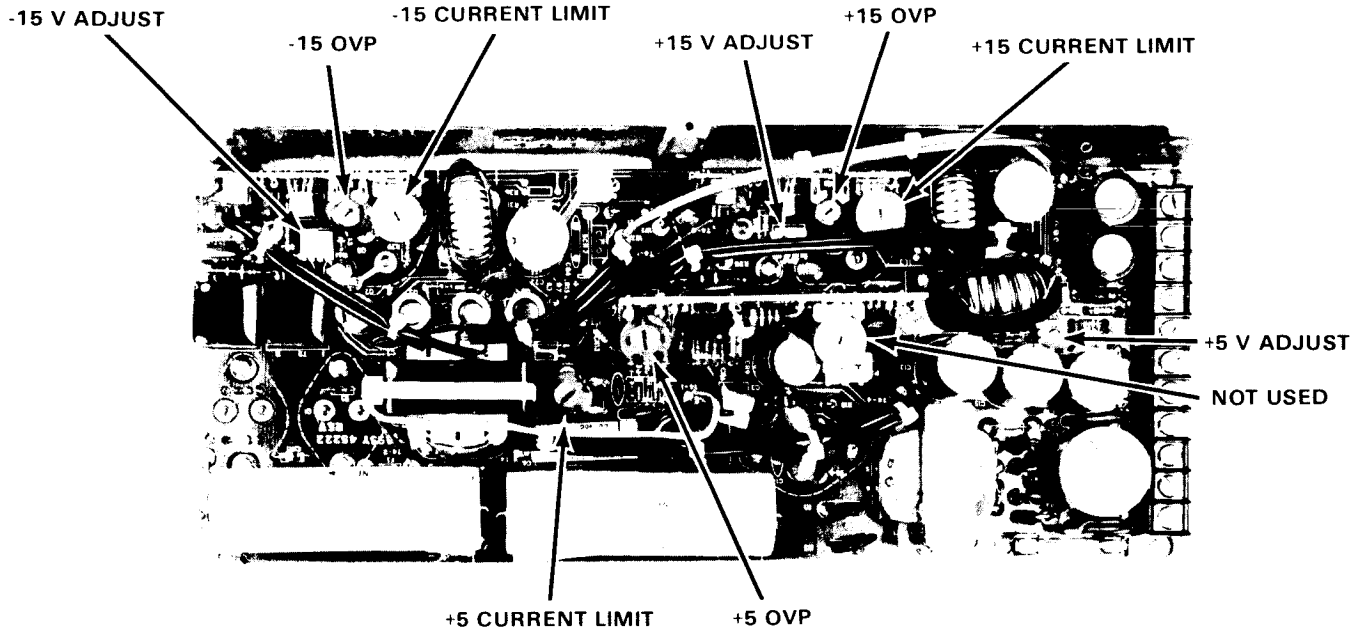
POWER ON/OFF SEQUENCE



T1 < 1.0 Sec.
T2 > 10 mSec.
T3 > 2 mSec
T4 > 16 mSec (T4 > 0 mSec when remote on/off is used)
T5 < 1 uSec
 Power fail (0) sink current = 2 mA maximum
 Power fail (1) source current = 400uA maximum



LH RESEARCH TM23-133/115



LH TM23-133/115 POWER SUPPLY DIMENSIONAL DRAWING

A000158

SPECIFICATIONS

INPUT

115 VAC: 92-130 VAC, 47-450 Hz
230 VAC: 184-260 VAC, 47-450 Hz

OUTPUT

5 VDC at 20 Amp

+15 VDC at 4 Amp

-15 VDC at 4 Amp

Note: a minimum load of 2.5A is required on the 5VDC output to maintain voltage on the other outputs.

REGULATION

Line: 0.4% on each output over entire range.

Load: 0.4% for no-load to full-load on each range.

INTERACTION

0.1% max (static)

RIPPLE & NOISE

5V: 50 mV p-p max

±15V: 100 mV p-p max

OVERVOLTAGE PROTECTION

5V output

OVER/UNDERSHOOT

2% max deviation for a 25% load change at 5A/uS.

RESPONSE

200 uS to 1% after a 25% load change at 5A/uS for 5V output. 50 uS for ±15V outputs.

HOLDUP

Outputs remain in regulation for a minimum of 20 ms after loss of nominal AC power.

TEMPERATURE

Full load 0°C to 50°C with natural convection. Derate to 50% at 70°C.

EFFICIENCY

70% nominal

REMOTE SENSE

Remote Sense will compensate for up to 5% of nominal voltage for load cable loss. Output is internally sensed if the sense leads are open. Remote Sense applicable for the 5V output only.

REMOTE ON/OFF

Power supply is turned on with an open circuit or a TTL logic "1", and is turned off with a TTL logic "0" (0.8V max) sinking 400 uA referenced to 5V output negative sense terminal.

CURRENT LIMIT

All outputs have foldback current limit with automatic recovery after overload is removed.

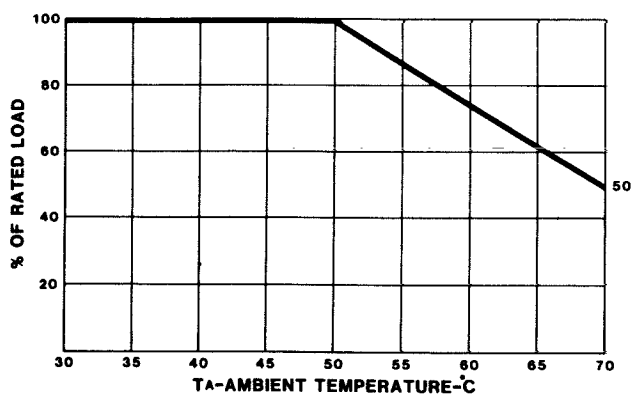
TEMP. COEFFICIENT

±0.0%/°C

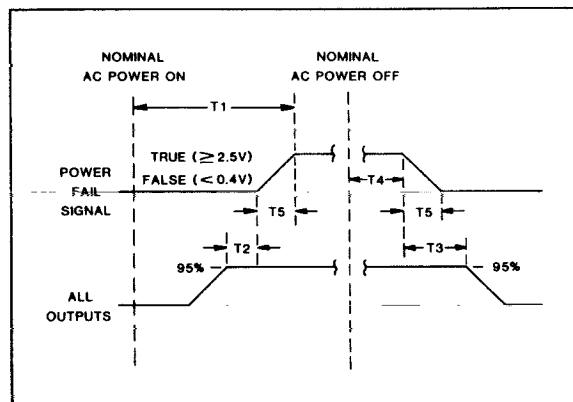
STORAGE TEMP

-55° to +85°C

POWER DERATING CURVE



POWER ON/OFF SEQUENCE



T1 < 1.0 Sec.

T2 > 10 mSec.

T3 > 2 mSec

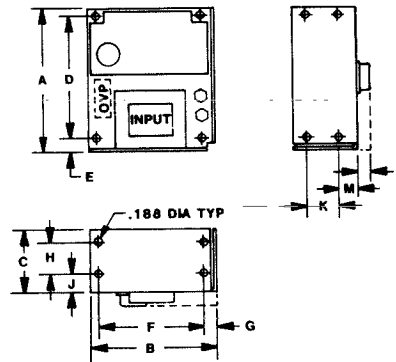
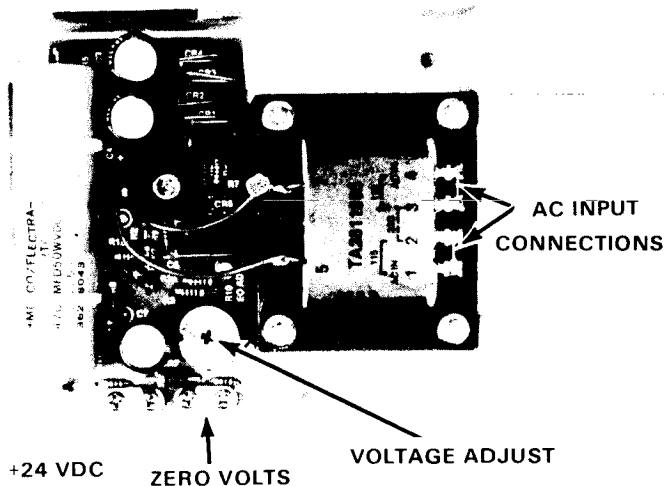
T4 > 16 mSec (T4 > 0 mSec when remote on/off is used)

T5 < 1 uSec

Power fail (0) sink current = 2 mA maximum

Power fail (1) source current = 400uA maximum

POWER/MATE EMA24C



A	5.62
B	4.87
C	2.50
D	4.88
E	.50
F	4.13
G	.50
H	1.25
J	.75
K	1.25
L	.45 MAX
M	.75

A000159

POWERMATE EM-24C POWER SUPPLY DIMENSIONAL DRAWING

SPECIFICATIONS

INPUT

105 to 125 VAC or 210 to 250 VAC at 47 to 63 Hz. Derate output current 10% for 50 Hz operation.

OUTPUT

24 VDC at 2.3A from 0°C to +40°C. Derate from full output at +40°C to 65% at +71°C.

REGULATION

Line: 0.05% for a 10% input voltage change.

Load: 0.1% for a zero to full load change.

RIPPLE

MAX 1mV RMS; typical 3mV p-p.

OVERLOAD PROTECTION

Self-restoring feedback current limiting.

TEMP COEFFICIENT

±0.02%/°C max.

COOLING

Convection

MOUNTING

Any one of three surfaces.

INPUT CONNECTIONS

115 VAC: Jumper transformer terminals 1 and 2, and terminals 3 and 4. Connect AC to terminals 1 and 4. (Figure 1).

230 VAC: jumper transformer terminals 2 and 3. Connect AC to terminals 1 and 4. (Figure 2).

SENSING

FACTORY wired jumpers for local sensing (Figure 3). Remote sensing accomplished by opening jumpers and connecting sense leads to load. (Figure 4.)

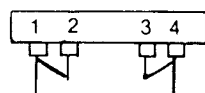


FIGURE 1
115 VAC

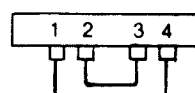


FIGURE 2
230 VAC

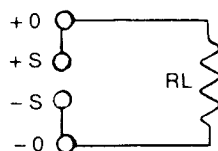


FIGURE 3
Local Sensing

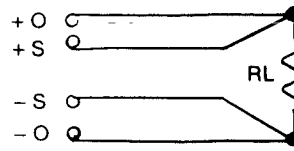
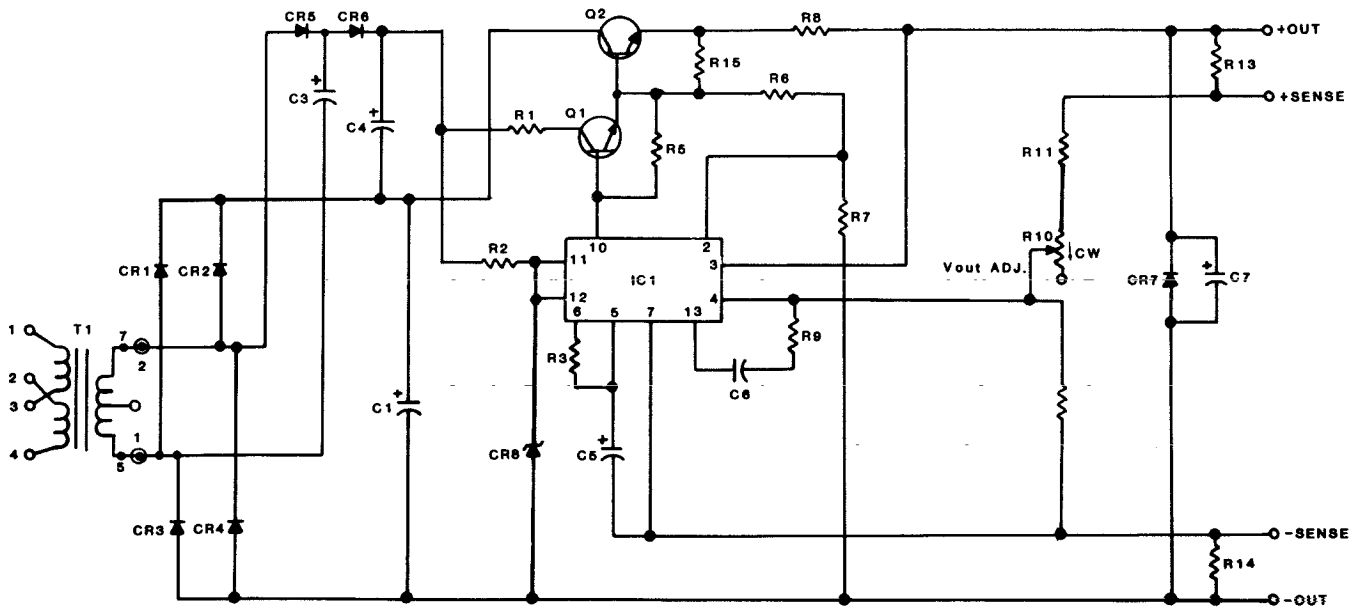


FIGURE 4
Remote Sensing

SCH. PMC
REF. PART NO. DESC.

C1	CE147263	4700 MFG 50V
C3	CE265700	220 MFD 50V
C4	CE625700	220 MFG 50V
C5	CT247500	4.7 MFG 35V
C6	CD310200	0.001 MFD 500V
C7	CE625700	220 MFD 50V
CR1	DR039000	5A 100V
CR2	DR039000	5A 100V
CR3	DR039000	5A 100V
CR4	DR039000	5A 100V
CR5	DR003000	1A 200V
CR6	DR003000	1A 200V
CR7	DR039000	5A 100V
CR8	DZ211600	1N4752AG
IC1	QI001500	IC
Q1	QS055000	2N2102
Q2	QP001300	64502
R1	RE222100	220 OHM 2W 5%
R2	RE215200	1.5K OHM 3W 5%
R3	RC311500	1.15K OHM 2W 1%
R5	RB227200	2.7K OHM 1/4W 5%
R6	RB262100	620 OHM 1/4W 5%
R7	RB212300	12K OHM 1/4W 5%
R8	RF200240	0.24 OHM 3W 5%
R9	RB233200	3.3K OHM 1/4W 5%
R10	RB220201	2K OHM 3W 20%
R11	RC315001	1.5K OHM 1/2W 1%
R12	RC311500	1.15K OHM 1/2W 1%
R13	RB210000	100 OHM 1/4W 5%
R14	RB210000	10 OHM 1/4W 5%
R15	RB222100	220 OHM 1/4W 5%
T1	TA2811905	TRANSFORMER



CONVERTER CONCEPTS VST 75-3799

Power Supply For PiC49

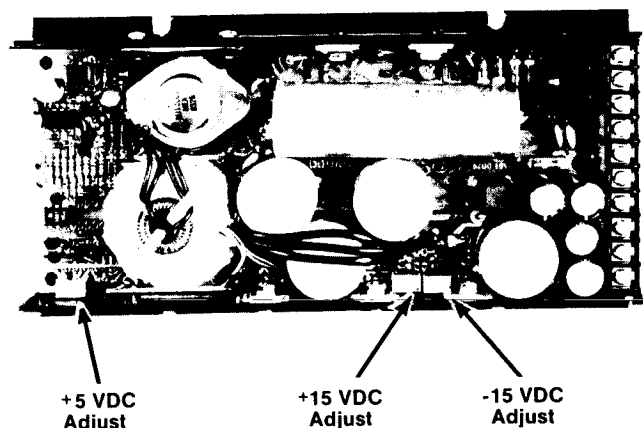


FIGURE 1. POWER SUPPLY ADJUSTMENTS

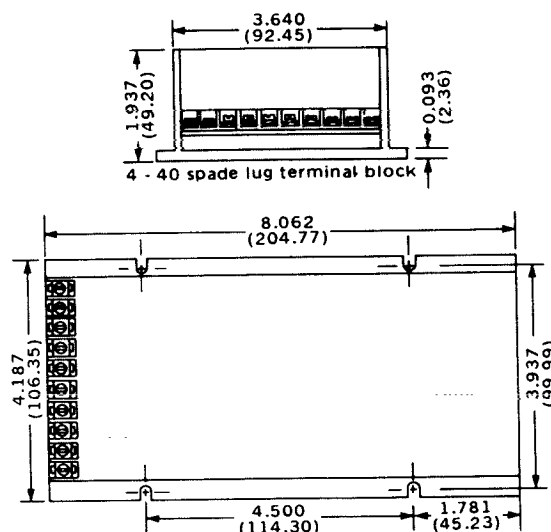


FIGURE 2. POWER SUPPLY DIMENSIONS

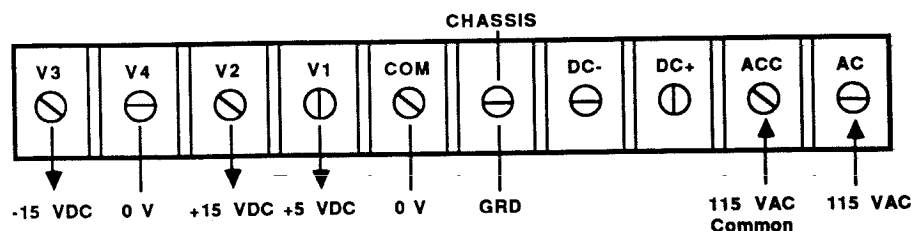


FIGURE 3. POWER SUPPLY WIRING DIAGRAM

PiC49 POWER SUPPLY SPECIFICATIONS

INPUT 90-250 Volts AC, 44-440 Hz OUTPUT +5 Volts DC at 10 Amps +15 Volts DC at 0.8 Amps -15 Volts DC at 0.8 Amps TRANSIENT RESPONSE (all outputs) 2 milliseconds with 50% load change CURRENT LIMIT All outputs have foldback current limit with automatic recovery after the overload is removed.	REGULATION Line: 0.1% for all outputs Load: 0.5% for +5 volts DC output (2 Amps to full load) 0.2% for +15 volts DC output 0.2% for -15 volts DC output RIPPLE AND NOISE 25 mV (all outputs) MINIMUM LOAD A 2 Amp load is required for V1 (+5 volts DC) to ensure proper regulation for V2 (+15 volts DC) and V3 (-15 volts DC). However, the lack of a minimum load will not damage the power supply.	RECOMMENDED CONTROL TRANSFORMER AND NOISE FILTER Use a .5 KVA or larger control transformer to isolate grounds. Use an ISLATROL®¹ No. I-155/U noise filter (G&L part no. 401-53038-00) between the control transformer and this power supply. Refer to Section 3 of this manual for more information about control transformers and ISLATROL® FILTERS. ¹ ISLATROL® is a registered trademark of Control Concepts Corporation





APPENDIX C

WIRING INFORMATION FOR PREVIOUS-STYLE RACKS



WIRING INFORMATION FOR PREVIOUS-STYLE RACKS

A. INTRODUCTION

Currently, a PiC409 rack can be used as either a master rack or an extension rack, depending on how it is configured by the user. Prior to December of 1985, G&L Electronics sold a version of PiC409 rack in which the master rack and extension rack were two separate products and were not interchangeable. The part number for the previous-style master rack was 503-15697-00, and the part number for the extension rack was 503-15699-00. These are the racks that are covered in this appendix. This appendix is for those who need information on configuring the previous-style racks or interconnecting previous-style and current-style racks.

B. PREVIOUS-STYLE MASTER RACK CONFIGURATION

If Extension Racks are going to be used with the system, a Nest Driver Module must be attached to the Master Rack. Remove the Nest Driver Module from its anti-static bag and configure it for the desired number of control relays as indicated in Section B.1. If you do not intend to use Extension Racks, the Nest Driver Module is not required.

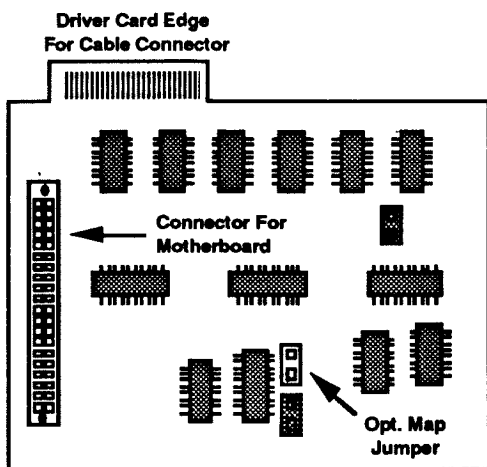


Figure C-1 Nest Driver Module

B.1 Control Relay Size Selection

The user can select the size of the memory area used for control relays. Two thousand control relays are available using the standard PiC configuration. This configuration may be used with up to seven Extension Racks.

An additional 1,024 control relays (for a total of 3,024) may be obtained by designating the I/O addresses reserved for the last four Extension Racks as control relays instead. Another 768 control relays (for a total of 3,792) may be obtained by designating the I/O addresses for all Extension Racks as control relays.

If 2,000 control relays are desired, remove the OPT. MAP jumper from the Nest Driver module. All seven Extension Racks may then be utilized for I/O addresses.

If an additional 1,024 control relays are desired, place the OPT. MAP jumper in position on the module. Only the Master Rack and the first, second and third Extension Racks may be used for I/O addresses.

Do not install the Nest Driver Module if the entire complement of 3,792 control relays is desired. However, with this configuration, only the Master Rack may be used for I/O addresses.

Control Relays Available	Extension Racks Available	Driver Module Configuration
2,000	1 through 7	remove jumper
3,024	1 through 3	jumper in place
3,792	none	Do not use a Driver Module

Table C-1 Nest Driver Module Configuration

Attach the Nest Driver Module to the back of the motherboard's upper nest. Use the built-in connector and the mounting hardware provided.

C. PREVIOUS-STYLE EXTENSION RACK CONFIGURATION

Each Extension Rack requires a Nest Receiver Module. This module must be configured by the user before it can be attached to the PiC's lower nest motherboard. Remove the module from its anti-static bag and set it up as indicated in the following sections.

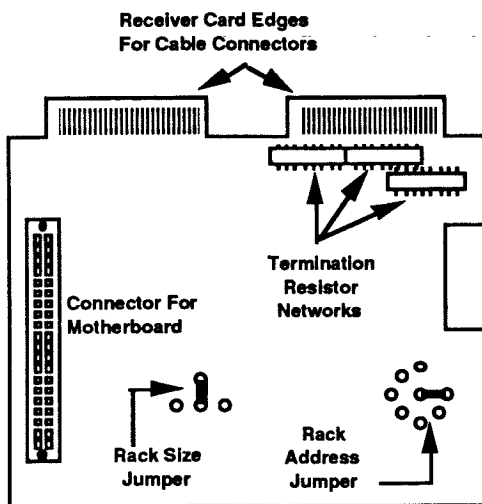


Figure C-2 Nest Receiver Module

C.1 Extension Rack Addressing

Each Extension Rack must be assigned a unique set of addresses. Addressing of the Extension Racks is accomplished by properly positioning the two jumpers on the Nest Receiver Module (Figure C-2). An Extension Rack may be configured for one of seven groups of 256 I/O addresses or for one of 14 half groups of 128 I/O addresses.

C.2 Rack Address Jumper

The Rack Address Jumper can be placed in one of seven positions on the Nest Receiver Module

(Figure C-2). Each position corresponds to a group of 256 addresses as indicated in Table C-2. The first digit of the PiC address is determined by the position of the Rack Address Jumper.

C.3 Rack Size Jumper

The Rack Size Jumper can be placed in one of three positions on the Nest Receiver Module. The "256" position assigns an entire block of 256 addresses to the rack, allowing the rack to electrically accommodate a total of 256 inputs and/or outputs.

If the use of faceplates and low-density circuit modules (such as the 3-Amp DC Output Module) requires much physical space, two racks of 128 inputs/outputs each may be configured to simulate one 256 address rack. In these cases, the Rack Size Jumper is set to L128 (lower 128 addresses) on one rack and U128 (upper 128 addresses) on the other.

Rack	Rack Address Jumper	Rack Size Jumper	PIC Addresses	Maximum I/O Per Rack
Master Rack			2000-2239	240
1st Extension	E	L128	3000-3127	128
	E	U128	3128-3255	128
	E	256	3000-3255	256
2nd Extension	D	L128	4000-4127	128
	D	U128	4128-4255	128
	D	256	4000-4255	256
3rd Extension	C	L128	5000-5127	128
	C	U128	5128-5255	128
	C	256	5000-5255	256
4th Extension	B	L128	6000-6127	128
	B	U128	6128-6255	128
	B	256	6000-6255	256
5th Extension	A	L128	7000-7127	128
	A	U128	7128-7255	128
	A	256	7000-7255	256
6th Extension	9	L128	8000-8127	128
	9	U128	8128-8255	128
	9	256	8000-8255	256
7th Extension	8	L128	9000-9127	128
	8	U128	9128-9255	128
	8	256	9000-9255	256

Table C-2 Rack Extension Selection

C.4 Termination Resistor Networks

Termination Resistor Networks have been inserted into the three sockets located on the Nest Receiver Module (See Figure C-2). These networks must be present only in the last Extension Rack. Remove the networks from the Nest Receiver Modules on all Extension Racks between the last rack and the Master Rack. Use a small screwdriver to gently pry the resistor networks from their sockets.

After setting the two rack jumpers to the proper positions and removing the Termination Resistor Networks (if required) attach the Nest Receiver Module to the lower rack motherboard using the built-in connector and the mounting hardware provided.

D. TERMINATION MODULE

The Termination Module is mounted to the lower nest motherboard of the Master and Extension Racks. The circuitry on the module improves system reliability by terminating the bus signals with the correct impedance. This module requires no adjustments.

E. INTERCONNECTING PREVIOUS-STYLE RACKS

Racks are interconnected in "daisy chain" fashion by flat, 40-conductor cables. Cables in various lengths are available. Short cables should be used to connect racks that are stacked vertically. Longer cables are used to connect racks mounted side-by-side.

On the Master Rack, attach one end of a cable to the card edge on the Nest Driver Module. Attach the other end of the cable to either one of the two card edges on the Nest Receiver Module located on the first Extension Rack.

Additional Extension Racks can be connected to the system by attaching cables between the racks using the card edges on the Nest Receiver Modules. The last Extension Rack in the series will have only one cable attached to it.

IMPORTANT

Keep the interconnecting cables away from all other wiring to prevent electrical interference.

F. INTERCONNECTING NEW AND PREVIOUS-STYLE MASTER AND EXTENSION RACKS

New and previous-style Master and Extension Racks are completely compatible and may be used interchangeably. Connect the 40 conductor interconnecting cables to the appropriate driver or receiver card edges as described in the sections in Section 2 for each rack.

IMPORTANT

Keep the interconnecting cables away from all other wiring to prevent electrical interference.

IMPORTANT

When you have configured the previous-style rack or racks as explained in this section, follow the steps in Section 2 of this manual to supply power to the PiC409. The appropriate procedures begin with Section 2.8.





APPENDIX D

TERMINALS



LEAR SIEGLER ADM-3A

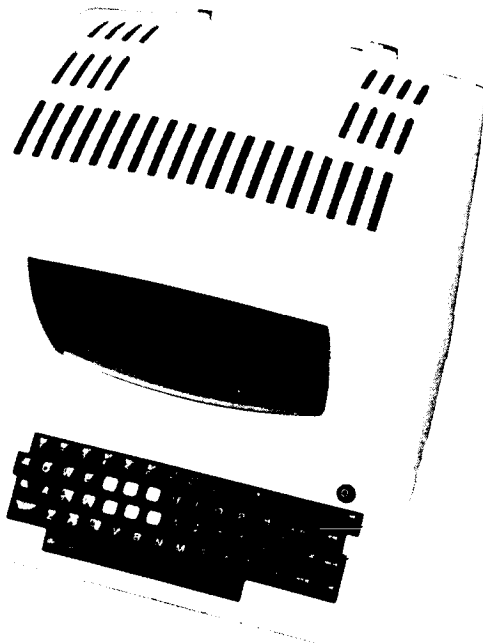
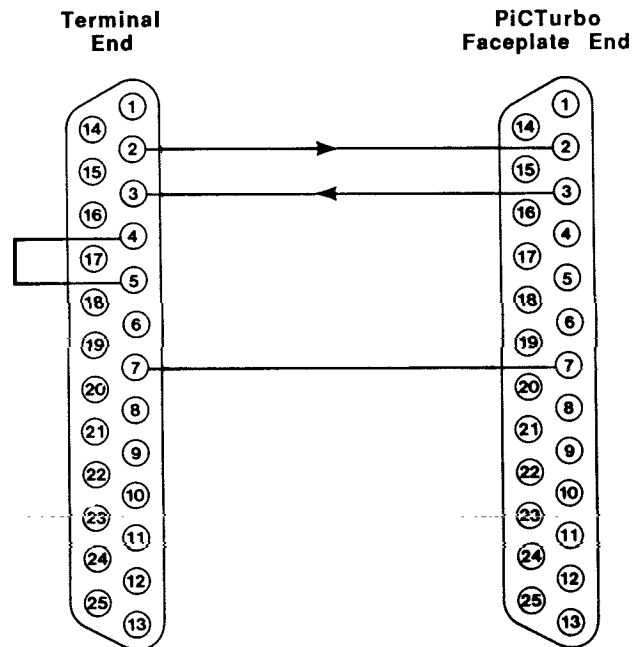


FIGURE 1. ADM-3A



TERMINAL PIN NO.	WIRE DESCRIPTION	PICTURBO PIN NO.
2	Transmit data from Terminal	2
3	Transmit data from PC409	3
7	Signal ground	7
4-5	Jumper	

TERMINAL CABLE SCHEMATIC

A. INTRODUCTION

The Lear Siegler ADM-3A is an interactive device that is used to communicate with the PiC. This instruction sheet briefly describes how to connect, configure, and operate the ADM-3A with the PiC. More detailed information is available in the documentation provided by Lear Siegler, Inc.

B. CONNECTION

B1. TERMINAL CABLE

Data is transmitted between the PiC and the ADM-3A via a terminal cable, part number 503-15725-08, or 503-15725-25 (08 indicates an eight-foot length, 25 indicates a twenty-five-foot length). The terminal cable has a 25-pin plug on both ends. Attach one plug to the Terminal socket on the PiCTurbo Processor. Attach the other end to the Modem socket located on the rear of the ADM-3A.

B2. POWER CABLE

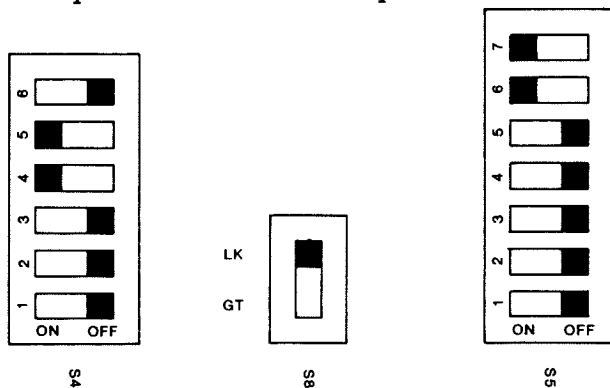
The power cable emanates from the rear of the ADM-3A. After the switches are set as described in paragraph C, plug the power cable into the power source required to operate the ADM-3A. The ADM-3A may be configured to operate with either a 115 volt ac power source or a 230 volt ac power source.

C. CONFIGURATION

The following procedure must be performed to enable communication between the PiC and the ADM-3A:

1. Ensure that the power cable is disconnected from the AC power source.

2. Remove the cover of the ADM-3A. The cover is removed by unscrewing the two slot-head screws located under the front corners of the base. After the screws are removed, lift the hinged cover upwards and rearwards.
3. Fourteen Internal Switches are located near the back edge of the exposed circuit board. The six switches on the left are designated S4, the switch in the middle is designated S8, and the seven switches on the right are designated S5. Depress the sides (ON or OFF) of the S4 and S5 Switches that are darkened in FIGURE 2. Slide S8 upward into the LK position.



Peripheral devices purchased from G&L Electronics for use with the PC409 do not require internal switch adjustments. If this equipment was purchased from a different source, the switches may have to be reset. Refer to the documentation provided with the peripheral equipment for the proper method of locating these switches.

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FIGURE 2. INTERNAL SWITCHES

4. Replace the cover.
5. Twenty Front Panel Switches are located beneath the nameplate, adjacent to the keyboard. A slot-head screw is used to secure the nameplate. Depress the sides (ON or OFF) of the Front Panel Switches that are darkened in FIGURE 3. The lower 11 switches select the desired baud rate. In FIGURE 3, the maximum baud rate of 19200 has been selected. A lower baud rate may be selected, if desired. Replace the

nameplate after the Front Panel Switches are set.

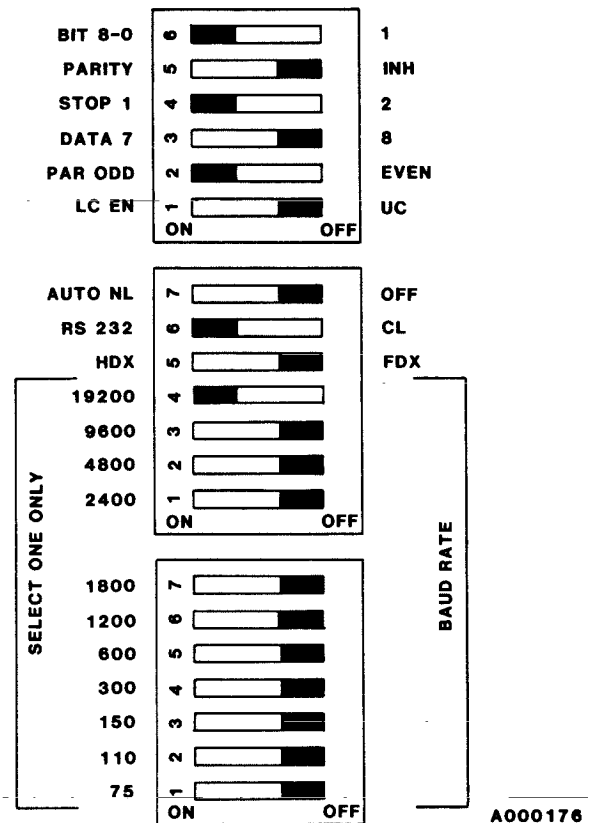


FIGURE 3. FRONT PANEL SWITCHES

6. Set the baud rate for the PiC to the same baud rate as selected for the Lear-Siegler. This is done via the Aux 1 menu as explained in Section 6.8 of the User's Manual.
7. Connect the power cable to the ac power source.
8. Place the POWER Switch, located on the rear of the ADM-3A, in the ON position.

D. OPERATION

After all the connections and switch settings have been verified to be as described in paragraphs B and C, the ADM-3A may be used to communicate with the PiC. The active PiC mode of operation determines what type of information will be transferred between the PiC and the terminal.

TELEVIDEO 910 PLUS

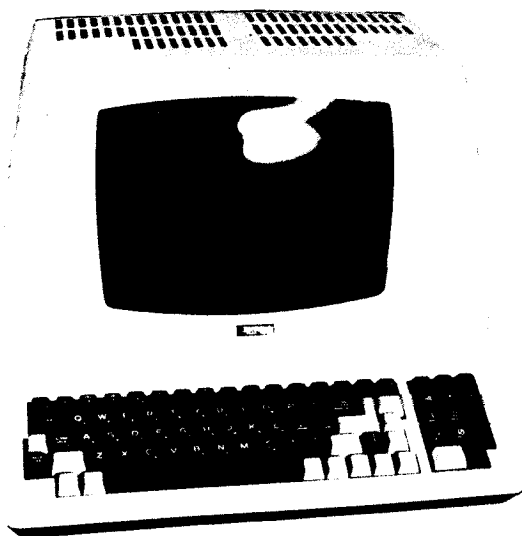


FIGURE 1. 910 PLUS

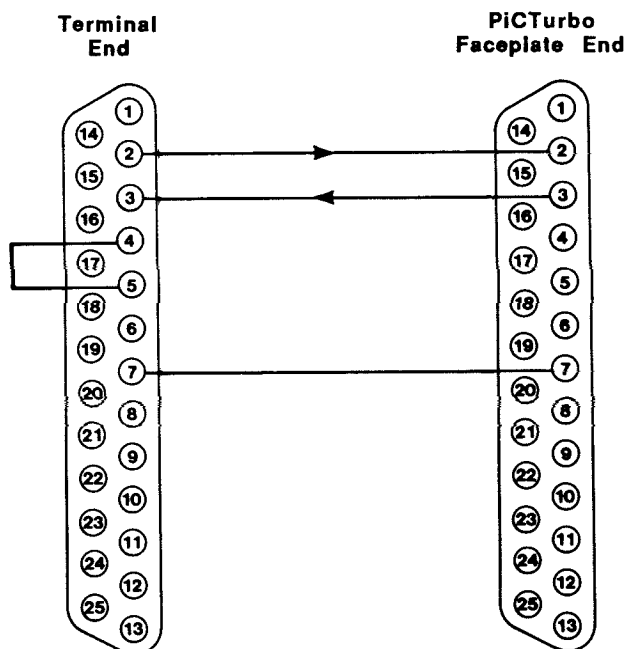
A. INTRODUCTION

The Televideo Model 910 Plus is an interactive device that is used to communicate with the PiC. This instruction sheet briefly describes how to connect, configure, and operate the Model 910 Plus with the PiC. More detailed information about the Model 910 Plus is available in the documentation provided by Televideo, Inc.

B. CONNECTION

B1. TERMINAL CABLE

Data is transmitted between the PiC and the Model 910 Plus via a terminal cable, part number 503-15725-08, or 503-15725-25 (08 indicates an eight-foot length, 25 indicates a twenty-five-foot length). The terminal cable has a 25-pin plug on both ends. Attach one plug to the Terminal socket on the PiCTurbo Processor. Attach the other end to the P3 (RS232) socket located on the rear of the Model 910 Plus.



TERMINAL PIN NO.	WIRE DESCRIPTION	PICTURBO PIN NO.
2	Transmit data from Terminal	2
3	Transmit data from PC409	3
7	Signal ground	7
4-5	Jumper	

TERMINAL CABLE SCHEMATIC

B2. POWER CABLE

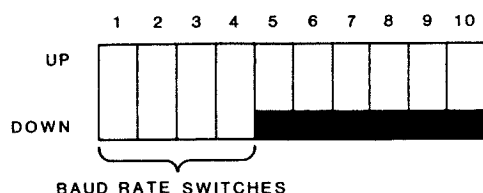
The power cable emanates from the rear of the Model 910 Plus. Plug the power cable into the power source required to operate the Model 910 Plus. The Model 910 Plus may be configured to operate with either a 115 volt ac power source or a 230 volt ac power source.

C. CONFIGURATION

The following procedure must be performed to enable communication between the PiC and the Model 910 Plus:

1. Ten switches are located on the rear of the Model 910 Plus that are designated S1 (BAUD RATE). Depress the side (UP or DOWN) of the S1

(BAUD RATE) Switches that are darkened in FIGURE 2. Switches 1 through 4 should be set according to the desired baud rate.



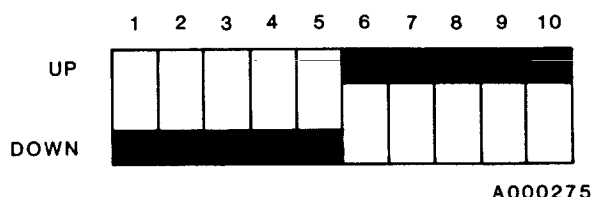
	1	2	3	4	
UP	19200				
DOWN					
UP	9600				
DOWN					
UP	4800				
DOWN					
UP	2400				
DOWN					
UP	1200				
DOWN					
UP	600				
DOWN					
UP	300				
DOWN					
UP	110				
DOWN					

Peripheral devices purchased from G&L Electronics for use with the PC409 do not require internal switch adjustments. If this equipment was purchased from a different source, the switches may have to be reset. Refer to the documentation provided with the peripheral equipment for the proper method of locating these switches.

A000276

FIGURE 2. S1 (BAUD RATE) SWITCHES

- Set the baud rate for the PiC to the same baud rate as selected for the Model 910 Plus. This is done via the Aux 1 menu as explained in Section 6.8 of the User's Manual.
- Ten switches are located on the rear of the Model 910 Plus that are designated S2 (FUNCTION). Depress the sides (UP or DOWN) of the S2 (FUNCTION) Switches that are darkened in FIGURE 3.



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FIGURE 3. S2 (FUNCTION) SWITCHES

- Depress the ALPHA LOCK Key, located on the terminal keyboard, so that all alpha keys transmit codes for upper case characters only.
- Place the POWER Switch, located on the rear of the Model 910 Plus, in the ON position.

D. OPERATION

After all the connections and switch settings have been verified to be as described in paragraphs B and C, the Model 910 Plus may be used to communicate with the PiC. The active PiC mode of operation determines what type of information will be transferred between the PiC and the terminal.

APPENDIX E

GLOSSARY



AC Input Module: Module which senses the presence or absence of various AC signals. The module converts these signals to data levels compatible with the CPU.

AC Output Module: Module which utilizes logic level signals from the CPU to control on-board solid state relays. The relays in turn distribute user supplied AC to the loads.

Acquisition: The process of obtaining information. For example; the Data Acquisition Module collects analog data via an Analog-to-Digital (A/D) converter.

Address: An identification as represented by a name, label, or number for a register, location in storage, or any other data source or destination such as the location of a station in a communication network.

Alternating Current (AC): Current in which the charge-flow periodically reverses direction. Usually expressed in a voltage level such as 120 VAC or 220 VAC.

Ambient Temperature: The temperature in a given environment. For example, the ambient temperature within a control enclosure may be up to 130 °F., while the room ambient temperature is some lesser value such as 75 °F.

American Wire Gauge (AWG): A standard system used to designate the size of electrical conductors. Gauge numbers have an inverse relationship to size, i.e. larger numbers have smaller diameter.

Ampacity: The current carrying capacity of a wire or cable expressed in amperes.

Ampere: A unit of electric current flow equivalent to a charge of 1 coulomb past a given cross-sectional area in 1 second.

Analog Input Module: DATA ACQUISITION MODULE or uP DIGITIZING MODULE. An input module which converts analog signals to digital values.

Analog Output Module: Digital/Analog Converter module. An output module which converts digital (binary) number to an analog signal.

Analog Signal: A continuous signal that depends directly on magnitude (voltage or current) to represent some condition. For example; a voltage could represent the speed of a motor: 5 volts corresponding to 200 rpm, 10 volts to 400 rpm, etc.

ANSI: American National Standard Institute.

Application: Any machine or process which is monitored and controlled by a PC by means of a user program.

ASA: American Standards Association.

ASCII: American Standard Code for Information Interchange. Most commonly used code in data transmission includes 128 upper-and-lower-case letters, numerals, and symbols. Each character is defined by a 7-bit binary number.

Asynchronous: A mode of operation in which performance of the next operation is started by a signal that the previous operation has been completed. Contrast with synchronous, characterized by a fixed time cycle for the execution of operations.

Attenuation: The loss of amplitude in a signal as it is transmitted through a conductor.

Background: Software that has a lower priority and is executed by the PC when higher priority or real-time software is not being executed. Typically, the LDN is processed as background.

Backplane: A printed circuit board into which modules are inserted.

Baud: A baud is defined as the reciprocal of the shortest pulse duration in a data word, including start, stop and parity bits. The term bits per second expresses only the number of data bits transferred per second.

BCD: An abbreviation for Binary Coded Decimal. BCD is a system for representing decimal data in binary code. For example; in BCD, 16 would be represented as 0001 (for 1) and 0110 (for 6).

Binary: Binary refers to the base 2 system of numbering ...0 (0), 1 (1), 10 (2), 11 (3), 100 (4), 101 (5), etc. Binary is a system consisting of only two states: 1 or 0, high or low, ON or OFF, etc.

Bit: An acronym for Binary digit. A bit can assume one of two possible states; such as ON or OFF, high or low, logic 1 or logic 0, etc.

Block Diagram: A simplified schematic diagram.

Boolean Equation: An expression of relations between logic functions.

Breakdown Voltage: The voltage at which a disruptive discharge transpires, either through or over the surface of insulation.

Bus: One or more conductors used for transmitting signals or power from one or more sources to one or more destinations.

Byte: A set of adjacent bits, usually eight, that are operated on as a unit.

Cable: A stranded conductor or a combination of conductors insulated from one another.

Call Routine: A special purpose subroutine which performs a function by manipulating user-defined parameters. A call routine is entered as a statement

in the LDN.

Card: A module or printed circuit board.

Cascading: A programming technique that extends the range of TIMERS or COUNTERS. This extension is achieved by making a succeeding Timer or Counter dependent upon the accumulation of a number of preceding Timers or Counters.

Cassette Tape: A magnetic recording tape permanently enclosed in a protective housing. Cassettes for the PC should be COMPUTER GRADE.

Character: One symbol of a set of elementary symbols, such as a letter of the alphabet or a decimal numeral.

Chattering: Rapid cyclic action within an electromechanical device such as a relay. Chattering can be caused by either a fault in the device or an incorrectly written user program.

Check Sum: A value which is the arithmetic sum of the bytes in a program or signal transmission. The receiving logic computes a check sum of the received bytes and compares the computed check sum with the transmitted check sum.

Clear: To return a memory to a non-programmed state, usually represented as "0" or OFF.

Clock: A pulse generator that provides the basic timing signals to which all system operations are synchronized.

Clock Rate: The frequency at which the clock operates.

CMOS: An abbreviation for Complimentary Metal-Oxide Semiconductor. A family of very low power integrated circuits.

Coaxial Cable: A type of cable having two conductors, one of which forms a common axis. Since one of the insulated conductors completely surrounds the

other, this type of cable neither generates nor is greatly affected by electrical noise.

Code: A system of symbols for representing data.

Color Code: A color system for component identification.

Compatibility: The ability of various units to replace one another with little or no reduction in capability.

Compiler: A program that translates the source program into machine language by selecting appropriate subroutines. The source program is typically the user LDN.

Conductor: A wire or strands of wire which are not insulated from one another, and are suitable for carrying an electric current.

Conduit: Solid or flexible metal or other tubing through which insulated electric wires are routed.

Control Relay: A Control Relay is a coil from which contacts are derived. The contacts of the coil act as controlling elements within LDC's. The Control Relay is often labeled CRXXXX where "XXXX" is the numerical label assigned to the Control Relay and the contacts associated with the coil.

CPU: Central Processing Unit. The logic in a system that fetches, decodes and executes programmed instructions, and maintains the status of the results as programs are executed.

Crosstalk: Electrical noise that occurs as a result of signals in one circuit causing interference with the signals in an adjacent circuit.

CRT Terminal: A terminal containing a Cathode Ray Tube to display programs such as ladder diagrams.

Cursor: A position indicator employed in the display of a video terminal to

indicate a character that is to be corrected or a position to which data is to be entered.

Cycle: 1) A sequence of operations that is repeated regularly. 2) The time required for one such sequence to occur.

Data: Information, such as the state or condition of a device, or a representation of information, such as a signal or a voltage.

Debugging: Process of detecting, locating and correcting mistakes in hardware or software.

Diagnostic Program: A program to help isolate hardware malfunctions in the programmable controller.

Digital Signal: A discrete signal or set of signals that depends on the presence or absence of some quantity (voltage, current, etc.) to represent some condition. Digital signals are often combined into sets that can be interpreted as numbers. For example; binary voltages (either 0 or 5 VDC) in sets of four (XXXX) could represent the numbers 0 to 15 by using the binary system.

Direct Current (DC): An electric current that only flows in one direction.

Documentation: An orderly collection and recording of hardware and software data such as tables, listings, diagrams, etc. Used to provide reference information for PC application, operation and maintenance.

Duct: A wireway with a removable cover.

Duplex: A means of two-way data communication.

Edit: To deliberately modify the user program in PC memory.

EIA: Electronics Industries

Association, an organization that publishes various recommended standards.

Electrical - Optical Isolator: A device that couples input to output by using a light source and detector that are in the same package. Used to provide electrical isolation.

EMI: Electromagnetic interference.

Enclosure: A surrounding case designed to provide a degree of protection for equipment and personnel.

Encoder: 1) A rotary feedback device which transmits a specific code for each position. 2) A device that transmits a fixed amount of pulses for each revolution.

EPROM: Erasable Programmable Read-Only Memory. A memory device that is used for the storage of non-volatile information. ~~Erasable via exposure to short-wavelength ultraviolet light.~~

Even Parity: The condition that occurs when the sum of the number of "1's" in a binary word is always even.

Execution Time: The sum total of the amount of time required to complete a given command.

Fault: Any malfunction that interferes with normal application operation.

Feedback: The signal or data sent to the PC from a controlled machine or process to denote response to the command signal.

Field Wiring: The wiring that connects the switches or contact closures to the input modules, and connects the outputs to the respective loads.

Filter: Electrical device used to suppress undesirable electrical noise.

Flag: Flag is the generic term applied to either control relays or the contacts associated with control relays. Flags

are used to communicate, either from the programmer to the software or from the software to the programmer. For example: The programmer energizes a relay to flag the software that a particular action is desired. At the completion of the selected action, the software energizes a relay to flag the programmer that the task has been completed.

Foreground: Software which has a high-priority, real-time software. Interrupts are used to acquire the CPU and process foreground. Typically servo software operates as foreground.

Force: A mode of operation in the Real Time Debug program that allows the operator (as opposed to processor) to control the state of a contact, variable or coil.

Frequency: The number of times a given event occurs within a specified period. Usually expressed in Hertz (Hz) or cycles per second (cps).

Full Duplex: A mode of communications in which data may be simultaneously transmitted and received by both ends of the circuitry.

Ground: A conducting connection, intentional or accidental, between an electric circuit or equipment chassis and the earth ground.

Ground Potential: Zero voltage potential with respect to earth ground.

Half Duplex: A mode of data transmission capable of communicating in two directions, but in only one direction at a time.

Hard Copy: Any form of printed document such as a ladder diagram.

Hardware: The mechanical, electrical and electronic devices that compose the programmable controller and associated devices.

Hardware Output: A Hardware Output is an output that is directly wired to a physical device. An example of a hardware output would be an AC output module. Hardware outputs differ from internal relays in that internal relays are not directly connected to a physical device.

Hardwired: Electrical devices interconnected through physical wiring.

Hexadecimal: A means of representing all 16 combinations of four bits of information with a single character 0 through 9 and A-B-C-D-E-F.

Hexadecimal	Binary 8 4 2 1	Decimal
0	0 0 0 0	0
1	0 0 0 1	1
2	0 0 1 0	2
3	0 0 1 1	3
4	0 1 0 0	4
5	0 1 0 1	5
6	0 1 1 0	6
7	0 1 1 1	7
8	1 0 0 0	8
9	1 0 0 1	9
A	1 0 1 0	10
B	1 0 1 1	11
C	1 1 0 0	12
D	1 1 0 1	13
E	1 1 1 0	14
F	1 1 1 1	15

Note: Under the binary heading each bit has been given a weighted value, 8, 4, 2, 1. It should be noted that if a binary 1 appears in the "1" column and the "4" column, 0101, you add the weights of the column $1 + 4 = 5$; $1\ 0\ 0\ 1 = 8 + 1 = 9$.

IEEE: Institute of Electrical and Electronics Engineers.

Input Circuit: An input circuit is a real-world device (limit switch, transducer, etc.), the associated wiring and input module point to which it is connected. The input module function is to convert field voltage levels (5, 12,

120 volts, etc.) to proper processor signal levels.

Instruction: A command that will cause the PC to perform one certain prescribed operation.

I/O: An abbreviation for Input/Output. For example; a group of input modules and output modules might be referred to as I/O modules.

Interface: A device that transmits data between two non-compatible subsystems that often cannot be directly wired together.

Internal Relay: An Internal Relay is a memory location that is designated to act as a coil. Typically, internal relays are numbered from 0 to 1999.

Interrupt: A technique used to signal the CPU that a higher priority program requires execution. A requirement of real-time systems.

Jumper: A short length of conductor used to make a connection between terminals.

K: Abbreviation for $2^{10} = 1024$. For example; 2K bytes - 2048 bytes.

Ladder Diagram: A ladder diagram is a complete control scheme, normally drawn as a series of contact circuits and coils arranged between two vertical control supply lines so that the horizontal lines of contacts appear similar to rungs of a ladder. A ladder diagram is normally the reference document used by the operator when entering the control program.

Language: A set of symbols and rules for representing and communicating information (data) among people, or between people and machines.

Latch: A device that continues to store the state of the input signal after the signal is removed. The input state is stored until the latch is reset.

Latching Relay: A relay constructed so that it maintains a given position until released.

Limit Switch: A switch that is actuated by some part or motion of a machine or equipment to alter the electrical circuit associated with it.

Load: 1) A device intentionally placed in a circuit or connected to a machine or apparatus to absorb power and convert it into the desired useful form. 2) To insert data into the PC.

Logic: A means of solving complex problems through the repeated use of simple functions; such as AND, OR, NOT, etc.

LSD/LSB: Least-significant digit, least-significant bit.

LED: An abbreviation for Light Emitting Diode. A solid-state device that emits light when current of the proper polarity is permitted to flow through it.

Machine Code: The symbols that designate a basic computer operation which are to be performed.

Magnetics: Electromechanical devices such as relays or contactors.

Memory: Any device into which a unit of information can be copied, that will hold this information, and from which the information can be obtained at a later date. Synonymous with storage.

Memory Protect: An on-board feature used to prevent alteration of the contents of RAM memory. Also referred to as write protect.

Microprocessor: An LSI device that performs the functions of the CPU and the control unit of a computer. An LSI device is called a microprocessor because of its extremely small size; typically, contained on a single IC chip.

Microsecond: One millionth of a second.

Millisecond: One thousandth of a second.

Modem: Contraction of MODulator/DEModulator. A device that transforms digital information into audio tones for transmission over telephone lines, and decodes the audio signals back into digital information when receiving.

Module: Any assembly of interconnected components that constitutes an identifiable device, instrument, or piece of equipment. A module can be disconnected, removed as a unit and replaced with a spare. A module has definable performance characteristics that permit it to be tested as a unit. A module can be a printed circuit board or subassembly of a larger device, provided it meets the requirements of this definition.

Monitor: The process of determining the state or condition of an input, coil or register. Also, a program used to display or change memory contents, CPU register, etc.

Motor Controller: A device or group of devices that serve to govern, in a predetermined manner, the electrical power delivered to a motor.

MSD/MSB: Most-significant digit, most-significant bit.

Multiplex: To carry out multiple functions simultaneously in an independent but related manner. Multiplexing often involves interleaving or otherwise combining several signals so that these signals may be handled by a single device.

National Electrical Code: A set of regulations, established by the National Fire Protection Association, governing construction and installation of electrical wiring and apparatus. Widely used by state and local authorities.

NEMA Standards: Consensus standards for electrical equipment approved by the majority of the members of the National Electrical Manufacturers Association (NEMA).

Noise: Any unwanted electrical disturbance or spurious signal that effects the operation of a system.

Odd Parity: Condition existing when the sum of the number of "1's" in a binary word is always odd.

Operand: Eight of the two numbers used in a basic computation to produce an answer. For example; in the computation $2 \times 3 = 6$, 2 and 3 are the operands.

Operation Code: The symbols that designate a basic computer operation to be performed.

Output Circuit: An output module point, real-world device (motor starter, digital readout, panel meter, etc.) and associated wiring. The output module function is to convert processor signal levels to field voltage levels.

Parallel: In an LDC, parallel refers to those rungs connected by a branch.

Parameter: A characteristic element, such as a value in a Call Routine.

PC: Abbreviation for Programmable Controller.

Printed Circuit Board: A board on which a predetermined pattern of connections has been formed.

Process: 1) Continuous and regular production executed in a definite manner. 2) A PC application that requires data comparison and manipulation. The PC monitors the input parameters to vary the output values. Contrasted with a machine, a process does not cause mechanical motion.

Processor: The processor performs logic solving, program storage, and special

functions within a programmable controller system.

Program: A plan for the automatic solution of a problem.

Protocol: A defined means of establishing criteria for receiving and transmitting data through communication channels.

Pulse: A brief voltage or current surge of measurable duration.

Rack: A chassis that contains modules.

RAM: Random Access Memory, also referred to as read/write memory. Data can be read or written into RAM on command from the processor.

Real-time: The performance of a computation during the actual time that the related physical process or mechanical action transpires so that results of the computation can be used in guiding the process or action.

Relative Humidity: A ratio which expresses the amount of water vapor in the air divided by the amount that would be present if the air were saturated. Used as part of the environmental considerations for a piece of hardware.

Resolution: A measure of the smallest possible increment of change in the variable output of a device.

Resolver: A device for determining angular displacement.

RFI: Radio frequency interference.

ROM: Read-Only Memory. These memories require a special device to program the chip. A ROM does not require power to retain stored information.

RS-232-C: An EIA standard specifying the interface between data terminals and data communications equipment that employs serial, binary data interchange. Maximum distance - 50 ft.

RS-422: An EIA standard for the electrical characteristics of balanced voltage digital interface. Maximum distance - 4,000 ft.

Scan: Microprocessor-based programmable controllers operate in a sequential manner. The sequence is a combination of the executive and user programs. At the end of both programs, the processor returns to the beginning and the scan begins again.

Scan Time: The time required to make one complete scan through memory and to update the status of all inputs and outputs.

Scratch Pad: Usually a small RAM used to temporarily store operational data required by the processor.

Serial Operation: Type of information transfer whereby the bits are handled sequentially rather than simultaneously. Serial operation is slower than parallel operation for equivalent clock rates. However, only one channel is required for serial operations.

Series: In a coil circuit, series refers to two or more adjacent contacts connected to each other.

Servo Mechanism: A device to monitor an operation as it proceeds, and to make necessary adjustments to keep the operation under control.

Shield: Any barrier to the passage of interference - causing electrostatic or electromagnetic fields.

Signal: The event, phenomenon or electrical quantity that conveys information from one point to another.

Software: Set of instructions that make up one or more programs. Specifically, the program that is inserted into the executive and user memories for the purpose of causing the processor to function in a specific manner.

Solenoid: An electromagnet with a movable core or plunger, which, when energized, can move a small mechanical part a short distance.

Start Up: The time between equipment installation and full operation of the system.

Stepping Motor: A bi-directional, permanent magnet motor that turns through one angular increment for each pulse applied.

Strobe: A signal that causes data transfer to take place between I/O modules and memory.

Subroutine: A program that defines desired operations, and may be included in another program to produce the desired operations.

System: A collection of sub-assemblies combined to work as a coordinated unit.

Tachometer: A device for indicating the speed of rotation.

Thumbwheel Switch: A rotating numeric switch used to input numeric information to the PC.

Toggle Switch: A panel-mounted switch with an extended lever.

Transducer: A device used to convert physical parameters; such as temperature pressure, weight, etc., into electrical signals.

Transfer: The process of moving data; 1) From one device, module or register over one or more data lines to another device, module or register. 2) From input to output.

Transfer Line: A manufacturing system in which individual stations are used for dedicated purposes.

Triac: A solid-state component capable of switching AC.

TTL: Abbreviation for transistor-transistor logic.

Twisted Pair: Two insulated wires (signal and return) that are twisted together. Since both wires have nearly equal exposure to interference, the differential noise is slight.

User Memory: Memory where the customer program is stored.



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PiC409/49

PROGRAMMING MANUAL

For PiCs Utilizing the PiCTurbo Processor

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PiC409/49

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NOTE

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SECTION 1 - INTRODUCTION

1.1 PROGRAMMING THE PiC

The PiC409/49 Programming Manual provides the information necessary to program a PiC and perform related auxiliary functions. The PiC is user-programmed through the use of ladder logic and function statements. The entire control program is referred to as a Ladder Diagram Network, or LDN. The LDN resides in user memory on the PiCTurbo Processor.

Two different methods can be used to create the LDN. It can be created via a personal computer linked directly to the PiCTurbo Processor, in which case the LDN is entered directly into user memory. This is considered on-line programming. The other method is to create the LDN using the GLLADD Ladder Diagram Editor/Compiler function and then load it into user memory on the PiCTurbo Processor. This method is considered off-line programming, since the personal computer can be remote from the PiC while the LDN is being created. In both cases, the LDN is created through the use of commands and symbols.

Once an LDN has been created, it can be recorded and loaded into memory in other PiCs. If on-line programming was used, the LDN has to be recorded from user memory first. If off-line programming was used, a copy of the LDN will already exist on disk. It is a good practice to keep a backup copy of the LDN at all times.

The information in this manual about the instruction set for the PiC applies to both on-line programming and off-line programming. Section 3, *Entering and Editing*, explains how to create the LDN using on-line programming. If you wish to use off-line programming, that is covered in the GLLADD manual in the section on the Ladder Diagram Editor/Compiler.

The standard memory option on the PiCTurbo provides 36K of user memory. The other memory option offers three additional banks of 32K each. A bank select feature (explained in Section 6 of the User's Manual) allows separate LDNs to be entered into each bank.

A feature of PiC programming that is worthy of note is the G&L Call Routine. Call Routines are factory-written subroutines that perform specific control functions. A Call Routine is accessed in an LDN via a statement that calls up the Call Routine by name. Parameters in the Call statement define aspects of the Call Routine for use with the application. Call Routines are purchased in the form of a library of Call Routines. The user utilizes only those that are needed for the application. When Call Routines are purchased, documentation is provided that covers each Call Routine individually.

How the PiC Processes the LDN

The LDN is scanned continuously in the Run mode until power is removed or a new mode is selected. The PiC scans (examines and solves) each Ladder Diagram Circuit (LDC) and statement sequentially from the first to the last. Then the controller returns to the beginning of the LDN and repeats the sequence continuously for as long as it is in the Run mode. Each LDC or statement is read from left to right by the PiC. The result of each circuit or statement is immediately available to all following circuits or statements in the LDN.

The rate at which the entire LDN can be scanned is known as the scan time. Scan time differs for each LDN. The scan time can be measured by several methods (explained in Section 5.7) and is typically stated in milliseconds (thousandths of a second). The scan time is one factor that must be considered in determining the suitability of a PiC for a particular machine or process.

The PiC uses a strobing technique to process input and output data. The state of an output as determined by ladder logic may change repeatedly during a single scan of the LDN. Each state is sent to a latch on the related output module. However, the state of the physical output is determined only when the output latches are strobed. Outputs are strobed immediately after the LDN scan is complete. The states of the physical outputs remain constant until the next strobe signal.

Inputs are strobed similarly. The state of a physical input may change repeatedly during a single scan, but the PiC only "reads" the states of the inputs when their latches are strobed. The inputs are strobed immediately after the outputs are strobed.

The use of strobe signals ensures that all data is transferred simultaneously. Simultaneous data transfer allows all calculations and logic within the LDN to be completed prior to inputting new data or outputting results.

Figure 1-1 is a block diagram of the strobe process. The strobe signals are generated automatically as part of the overall scan process.



Figure 1-1 Strobe Process

1.2 PiC COMPONENTS

Required PiC System Components:

The procedures in this manual require that the following items be available. More information on these components can be found in Section 1.1 of the User's Manual.

1. A master rack including the necessary power supply.
2. The PiCTurbo Processor.
3. Additional modules as required by the application.
4. An IBM or IBM-compatible personal computer.
5. A copy of G&L's GLLADD software, version 2.0 or later.
6. A GLLADD cable. This can be purchased from G&L, or user-fabricated as shown in Appendix B of the GLLADD Manual.

Software Components

Various software components are included on the PiCTurbo Processor that facilitate development of the LDN and application control. The software components are as follows:

1. Runtime

This program controls scanning of the LDN in the Run mode.

2. LDN Compiler

This program converts the LDN into a binary format that the 6809 CPU can understand. The LDN compiler also provides the ability to enter and edit the LDN in the Program mode.

3. Real Time Debug (RTD)

This program provides diagnostic capabilities for system design and maintenance.

4. Programmer's Keyboard Operating System (PKOS)

This program provides the ability to monitor and modify hexadecimal data.

5. Message Formatter

This program enables the user to enter and delete video messages.

6. Start-Up Diagnostics

This program tests various functions on the PiCTurbo Processor. The Start-Up Diagnostics program is performed following a power-on, a reset, or when they are initiated from the Diagnostics menu in Aux 2.

7. Call Routine Installer

This program allows Call Routines to be loaded into user memory, and allows the loaded Calls to be installed.

Memory Map

The 6809 CPU on the PiCTurbo Processor can address up to 64K bytes (1K = 1024, 1 byte = 8 bits) of memory addresses. The memory map (Figure 1-2) shows where the various software components reside within the 64K byte boundary.

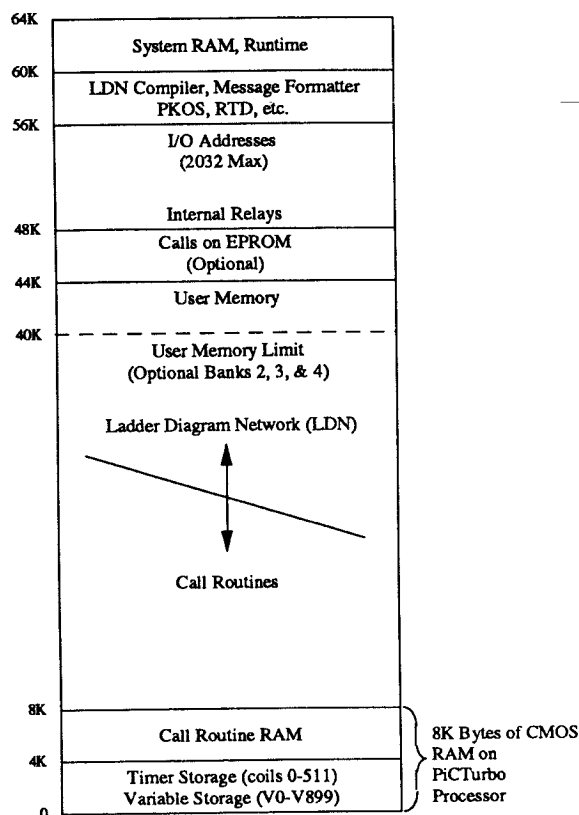


Figure 1-2 PiC Memory Map

1.3 THE PiC409/49 PROGRAMMER'S MANUAL

The PiC409/49 Programmer's Manual explains how to create a Ladder Diagram Network (LDN), which is the user-written program that allows the PiC to carry out its control functions. Auxiliary functions that are used in creating an LDN are also covered in the Programmer's Manual. The sections are presented in the sequence in which they should be read and followed. Information on readying the PiC for operation is provided in the PiC409/49 User's Manual.

NOTE

This manual is designed for use with a PiC that utilizes a PiCTurbo Processor. **This manual does not provide the information necessary to use a PiC system that does not contain the PiCTurbo Processor.** That information is in the standard version of the PiC409 Family User's and Programming manuals.

Programmer's Manual Contents

The following list indicates the sections contained in this manual and their contents:

1. Introduction
Provides general information regarding the PiC and this manual.
2. Runtime Initialization
Explains how to initialize the Runtime software, which allows you to enter the Program mode.
3. Entering and Editing
Covers the commands used in entering and/or editing an LDN.
4. Instruction Set
Provides information on the symbols, statements and programming conventions used in creating the LDN.
5. Application Examples
Illustrates programming practices through actual LDN segments.
6. Real Time Debug
Covers the use of the RTD Call Routine.
7. Call Routine Installer
Explains how to load and install Call Routines.

8. Message Formatter

Provides information on using the Message Formatter.

9. Appendixes

These provide a number of programming related charts for user-documentation of the control programming and information that assists in programming.

1.4 SAFETY-RELATED INFORMATION

This manual should be completely read and understood prior to programming the PiC. Observe all federal, state and local safety standards that are pertinent to this piece of equipment.

CAUTION, IMPORTANT and NOTE blocks will be found throughout this manual. The following is a depiction of how these items appear and the associated definition of each:

CAUTION

Programming procedures, practices, etc., which may result in personal injury or loss of life if not carefully followed.

IMPORTANT

Programming procedures, practices, etc., which may result in damage to the equipment or data if not employed.

NOTE

Programming procedures, practices, etc., which are essential to emphasize.

SECTION 2 - RUNTIME INITIALIZATION

2.1 INTRODUCTION

This section explains how to initialize Runtime. Runtime is software resident on the PiCTurbo Processor that controls the scanning of the LDN in the Run mode. Runtime is automatically downloaded into user memory when the Program mode is entered. The first time the Program mode is entered, certain parameters that define aspects of the LDN being programmed must be defined by the user. This is what the Runtime initialization performs.

The parameters defined through initialization remain in effect from that point on. They also remain with the LDN when it is recorded and are loaded into user memory with the LDN.

Runtime initialization is done for the following purposes:

1. It defines parameters when the Program mode is entered for the first time.
2. It allows you to redefine existing Runtime parameters.

The Runtime initialization procedure for each is explained in this section.

Some of the Runtime parameters pertain to elements of the LDN that may not be familiar to you, such as nonvolatile variables or retentive control relays. Most of these are explained in Section 4. The Runtime parameters that are defined through Runtime initialization are as follows:

1. Which bank the LDN will reside in.
2. The number of nonvolatile variables.
3. The number of retentive control relays.
4. The control relay/extension rack I/O relationship.
5. The size limit of the LDN.
6. The highest bank used.
7. The bank (or banks) that are to be write-protected.

8. The baud rate of Port 0 when the LDN is run.
9. Whether or not the LDN is to auto-start when power is applied to the PiC.

2.2 DISPLAYING THE AUX 1 MENU

Most of the PiC programming functions begin with the Aux 1 menu displayed. There are two basic methods to display the Aux 1 menu. The first method is for those who are familiar with the various PiC menus and are already using them. The second method is for those who are displaying the Aux 1 menu from the GLLADD level and are unfamiliar with the process.

Method One

If you are already using the various menus, you can display the Aux 1 menu from another menu by pressing "CTRL-Q".

Method Two

1. Ensure that the GLLADD cable is connected from serial communications port 1 on the personal computer to the Terminal socket on the PiCTurbo Processor faceplate.
2. Bring up the GLLADD main menu (it has the heading "G&L PiC Ladder Development System). Refer to the GLLADD manual if you are unfamiliar with GLLADD.
3. Press function key F5. Information will be displayed under the line "PiC Remote Control Mode". This information applies to PiCs that do not use a PiCTurbo Processor. Disregard the information and press any key.
4. Answer the prompts regarding the user authorization code entry. When the code is correctly entered, the Aux 1 menu will be displayed.

2.3 ENTERING THE PROGRAM MODE

1. With the Aux 1 menu displayed, enter a "2" (to select the Program mode) and press Return. The Program mode will be entered.

If the PiC responds with the following message, -- Runtime must be initialized.

```
PICTURBO COMPILER 1.X
(C) 1988, G&L AMCA
```

```
BANK 1
```

```
CSM ERR!
>>...
```

If the CSM ERR is not displayed, Runtime has already been initialized. If you wish to change some of the existing Runtime initialization parameters, refer to Section 2.5.

2.4 FIRST-TIME INITIALIZATION PROCEDURE

This procedure follows the same sequence as the prompts you will encounter during the initialization process. Each step shows the prompt, then explains the possible responses and how you would choose which response to make.

This procedure begins with the Program mode displayed.

1. CSM ERR! >>....

Enter "/INIT".

2. >>...INITIALIZE RUNTIME? Y-N

Enter a "Y" and press Return.

3. INVALID USER MEMORY!
CLEAR MEMORY? Y-N (IF INVALID
USER MEMORY SELECT "Y")

Enter a "Y" and press Return.

4. IN WHICH BANK (1,2,3, or 4) WILL
THIS LDN RESIDE?

Enter the desired bank number, press Return. --

5. NUMBER OF NON-VOL. VAR. =X
HOW MANY NONVOLATILE VARIABLES
(STARTING WITH VARIABLE V0)?

The numbers "1" though "900" correspond to variables V0 through V899. For example, enter "1" to make variable V0 non-volatile. Enter "10" to make variables V0 through V9 non-volatile. Entering "900" will make all of the variables in the system non-volatile. Entering "0" will define all variables (V0 through V899) as volatile.

Enter the desired number of nonvolatile variables and press Return.

6. NUMBER OF NON-VOL. CRS. =X
HOW MANY RETENTIVE RELAYS
(STARTING WITH RELAY 512)?

The numbers "1" though "1000" correspond to relays 512 through 1511. Enter "1" to make relay 512 retentive. Entering "200" will make relays "512 through 711 retentive, and entering "1000" will make the maximum number of relays (relays 512 through 1511) retentive. Entering "0" will define all relays (512 through 1511) as non-retentive.

Enter the number of retentive control relays desired and press Return.

7. CONTROL RELAY MEMORY SELECT.

1. CR 0 TO 1999.
 2. CR 0 TO 1999 PLUS 6000 TO 9255.
 3. CR 0 TO 1999 PLUS 4000 TO 9255.
 4. CR 0 TO 1999 PLUS 3000 TO 9255.
- SELECT 1 TO 4.

Options 1-4 define the relationship between the number of extension racks used in a system and the number of available control relays. The I/O addresses reserved for extension rack I/O can be used as control

relays if the extension rack or racks are not present in the control system. Which option you select depends on the number of extension racks being used in your control system.

The available options indicate the following:

1. CR0 TO CR1999

Extension racks present: 7
Control relays available: 2000
(0-1999).

2. CR 0 TO 1999 PLUS 6000 TO 9255.

Extension racks present: 3
Control relays available: 3024
(the standard 2000, plus 6000-6255, 7000-7255, 8000-8255, and 9000-9255).

3. CR 0 TO 1999 PLUS 4000 TO 9255.

Extension racks present: 1
Control relays available: 3536
(the standard 2000, plus 4000-4255, 5000-5255, 6000-6255, 7000-7255, 8000-8255, and 9000-9255).

4. CR 0 TO 1999 PLUS 3000 TO 9255.

Extension racks present: 0
Control relays available: 3792.
(the standard 2000, plus 3000-3255, 4000-4255, 5000-5255, 6000-6255, 7000-7255, 8000-8255, and 9000-9255).

Enter the desired number (1-4) and press Return.

8. AVAILABLE MEMORY = XXXXX
SIZE LIMIT OF LDN = X
ENTER SIZE LIMIT OF LDN IN K
BYTES (>=2)

The value XXXXX equals the total number of bytes of user memory available. The maximum value possible for Bank 1 is 36K. The maximum for the other banks is 32K.

The number entered as the size limit of the LDN cannot exceed the total user memory available in your PiC. If the LDN limit is less than the total user memory available, the remaining memory can be used for data

storage without the risk of the LDN overlapping into it.

Enter the number of K bytes to be dedicated to the LDN (2K is the minimum) and press Return.

9. BANK ONE SELECTED. ENTER
HIGHEST BANK TO BE USED (1,2,3,
OR 4) .

Enter the highest bank to be used and press Return. If your PiCTurbo Processor does not have the multiple-bank option, enter a "1".

10. WRITE PROTECTION MENU.

WRITE PROTECT ALL OF BANK 1
(Y OR N) ?

If your PiCTurbo Processor contains the four-bank memory option, the prompt you see will ask if each of the four banks should be write-protected. This write-protection differs from that carried out via Aux 2 in Section 6 of the User's Manual. This write-protection is specific to the LDN and will be included as one of the initialization parameters when the LDN is recorded. The write-protection carried out via Aux 2 applies to the PiCTurbo Processor, rather than the LDN.

Enter "Y" to memory protect all of Bank 1, or enter "N" to not memory protect Bank 1, and press Return.

11. BAUD RATE OF TERMINAL PORT WHEN
THIS LDN RUNS.
1. 300 BAUD
2. 1200 BAUD
3. 2400 BAUD
4. 4800 BAUD
5. 9600 BAUD
SELECT DESIRED BAUD RATE.

Enter the number (1-5) that corresponds to the baud rate desired for the Terminal Port when this LDN runs and press Return. The default baud rate (which can be changed through Aux 2) is 9600. The

baud rate defined here is only in effect while this LDN runs.

12. DO YOU WANT THIS LDN TO AUTO START ON POWER-UP? (Y OR N)

Enter the character ("Y" or "N") that indicates your preference. Enter a "Y" if you want the PiC to begin execution of the LDN immediately upon power-up. Enter an "N" if you want the PiC to wait until it is put in the Run mode to execute the LDN.

13. RUNTIME INITIALIZATION COMPLETE!
PICTURBO COMPILER VER 1.X
(C) 1988 G & L AMCA

BANK 1
>>...

This indicates that the initialization procedure has been completed. You may now enter an LDN if one does not currently exist or edit the existing one. For instructions on entering or editing an LDN, refer to Section 3.

2.5 REDEFINING RUNTIME INITIALIZATION PARAMETERS

The parameters that are defined during Runtime initialization can be redefined by repeating the initialization process. However, there are some differences in the early menus and the correct user responses. This procedure covers the differences between the first-time initialization and an initialization that is carried out to redefine existing parameters. Each step shows the prompt, then explains the possible responses and how you would choose which response to make.

This procedure begins with the Program mode displayed.

1. >>...
Enter "/INIT".

2. >>...INITIALIZE RUNTIME? Y-N

Enter a "Y" and press Return. All of the existing Runtime initialization parameters will be displayed.

3. DO YOU WANT TO MODIFY SETTINGS? (Y OR N).

Enter a "Y" and press Return.

3. CLEAR MEMORY? Y-N (IF INVALID USER MEMORY SELECT "Y")

Enter an "N" and press Return.

Enter a "Y" at this point only if you want to erase the contents of user memory, which would delete the entire LDN.

From this point the menus and responses are the same as in Section 2.4 *First-Time Runtime Initialization*. Please continue by following those procedures beginning with Step 4.

2.6 DISPLAYING THE RUNTIME INITIALIZATION PARAMETERS

This procedure will enable you to display the Runtime initialization parameters without redefining any of them. In this way you can determine the parameter values that have been defined. Each step in the procedure shows the prompt, then explains the proper response.

This procedure begins with the Program mode displayed.

1. >>...
Enter "/INIT".

2. >>...INITIALIZE RUNTIME? Y-N

Enter a "Y" and press Return. All of the existing Runtime initialization parameters will be displayed.

3. DO YOU WANT TO MODIFY SETTINGS?
(Y OR N) .

Enter an "N" and press Return. The ">> . . ." prompt will be displayed and the PiC will be ready to receive a command.



SECTION 3 - ENTERING AND EDITING

3.1 INTRODUCTION

This section explains the commands that are used to enter and/or edit an LDN.

The command set for entering/editing an LDN allows you to do the following things :

1. Enter the LDN, or insert new LDCs or statements into an existing LDN ("I" key).
2. Assign a name to the LDN ("N" key).
3. Edit a numeric entry or variable label as it is being entered ("DEL" key).
4. Change modes, abort a partially entered LDC or statement, or abort a command ("ESC" key).
5. Display the LDN on the computer monitor ("P" key).
6. Move an LDC or statement from one location to another in the LDN ("M" key).
7. Delete parts of the LDN ("D" key).
8. Allocate memory necessary for loading Call Routines.
9. Select the timer increment for timer coils ("CTRL-T" keys).

The standard PiCTurbo Processor provides one 36K bank of user memory. One PiCTurbo option includes an additional three 32K banks of user memory. Bank Select allows the programmer to select which bank is active. In this way, a bank can be entered in order to load an LDN into the bank, or an existing LDN in a bank can be accessed for editing.

3.2 ENTERING THE PROGRAM MODE

1. Display the Aux 1 menu. If you are not familiar with the procedure for doing this,

refer to Section 2.2 of the Programming Manual.

2. Enter a "2" (for Program mode) and press Return. The Program mode will be entered.

If the display responds with the following message, the PiC is ready to respond to entering and editing commands.

```
PICTURBO COMPILER 1.X  
(C) 1988, G&L AMCA
```

```
BANK 1  
>>...
```

If you receive the checksum error message (CSM ERROR) in addition to the prompt ">>..." when entering the Program mode, the system must be initialized as described in Section 2.

Note that Bank 1 is indicated as the active bank in the Program mode entry prompt. If your PiCTurbo Processor has the multiple bank option, you will need to activate each bank that you are going to enter an LDN into before you enter the LDNs. The Bank Select feature is explained in Section 6.10 of the User's Manual.

3.3 THE COMMAND SET

This section explains the commands used in programming the PiC.

NOTE

A number of the programming commands require that the ">>..." prompt be displayed before the command is entered. The ">>..." prompt is obtained by pressing the ESC key.

Function	Press	Description
Insert LDCs or Statements	I	This command is used to enter the LDN, as well as to insert new LDCs or statements during editing. To insert one or more LDCs and/or statements: 1. With the ">> . . ." prompt displayed, press "I". The following prompt will be displayed: INSERT AFTER #". 2. Press "B" to insert at the beginning of the LDN (use this option when entering a new LDN). OR Enter the number of the existing LDC or statement the insertion is to follow. OR Press "E" to insert at the end of the LDN.

Function	Press	Description
Name LDN	N	The LDN name may contain up to fifteen characters. Any alphanumeric characters may be used in the name. 1. With the ">> . . ." prompt displayed, press "N". The PiC will display NAME =. 2. Enter the name of your choice and press Return. The name can be changed at any time by repeating the naming process and assigning a new name.

Function	Press	Description
Change a numeric entry or variable label being entered.	DEL	The delete function allows a variable label or numeric entry to be deleted while the cursor is still at that location during entry. The DEL feature must be implemented before the Return key is pressed to complete the current entry. When DEL is pressed, <<-- is displayed at the point it was pressed and the cursor jumps down one line. 1. With the cursor still in the location of the incorrect entry, press DEL. 2. Enter the correct entry and continue programming.

Function
Escape

Press
ESC

Description

Pressing ESC does one of three things, depending on the programming function that is being carried out at the time.

1. If you are not in the middle of entering a command or making an entry, press ESC to exit the active mode. The prompt ****ESC**** followed by **">> . . ."** indicates the PiC is ready to receive a programming command.
2. If an entry (LDC or statement) is only partially entered (Return has not been pressed), press ESC to delete all of the partially entered LDC or statement. The prompt **BLK DEL!** indicates deletion. The Insert mode remains active after ESC is pressed.
3. If a command key has been pressed and you wish to abort the command without carrying it out, press ESC.

The prompt ****ESC**** followed by **">> . . ."** indicates the command was aborted. You can then enter another command.

Function
Display (print) LDN
on screen.

Press
P

Description

To display the LDN:

1. With the ">> . . ." prompt displayed, press "P". The prompt PRINT AT # will be displayed.
2. Press "B" to start the display at the beginning of the LDN

OR

enter the number of a statement or LDC to be displayed.

3. Press Return.
4. Press any non-numeric key to scroll one line at a time.

Press any numbered key from 1 to 7 to display the same number of lines at one time.

Press the "0" (zero) key to scroll through the entire LDN. While scrolling, press any key except ESC to stop scrolling.

Function
Move LDCs or
Statements to
Another Location in
the LDN

Press
M

Description

1. With the ">> . . ." prompt displayed, press "M". The prompt MOVE BLOCK # will be displayed.
2. Enter the number of the LDC or Statement being moved and press Return. The prompt MOVE BLOCK # XXX . . . AFTER # will be displayed.

You now have three options. Enter a "B" to move the item to the beginning of the LDN. Enter an "E" to move the item to the end of the LDN. Enter the number of the LDC or Statement the item is to placed after.

3. Press the Return key. A successful move will result in an OK being displayed.
-

Delete LDCs or Statements

D

Before using the Delete command, ensure that a copy of the LDN has been made. A deleted LDN (or any portion) is not recoverable.

1. With the ">> . . ." prompt displayed, press "D". The prompt
DELETE BLOCK # will be displayed.
2. Enter the number of the LDC or Statement to delete and press Return.

OR

Enter the number of the first LDC or statement in a block to be deleted, enter a comma or hyphen, enter the number of the last LDC or Statement in the block, and press Return.

3. A successful deletion results in an OK prompt.

The PiC automatically enters the Insert mode after a deletion. LDCs or statements inserted immediately after a deletion will occupy the location vacated by the deleted LDCs or statements. If no LDCs or statements are to be inserted, press the ESC key to exit the Insert mode.

Function

Allocate Call
Routine Memory

Press

A

Description

Call Routines that are used in an LDN must reside in user memory. The allocation procedure reserves an area of memory to receive the Call Routines. To determine the number of bytes required for a specific Call Routine, refer to the Call Routine Manual Table of Contents.

1. With the >> . . . prompt displayed, press "A". The following prompt will be displayed:

CALL SPACE = YY BYTES FROM
\$XXXX TO \$XXXX
NEW SIZE =

YY = bytes of memory currently
allocated for Call Routines.
\$XXXX = hex memory addresses.
 2. Enter the number of bytes you wish to allocate and press Return. The PiC will display the new allocation byte number and hex addresses.
-

Function
Change Timer
Increment

Press ----
CTRL T

Description

The time value for a timer coil (explained in Section 4) is defined in terms of the current time increment. Pressing CTRL-T allows you to change the timer increment either from 100 msec to 10 msec or from 10 msec to 100 msec, depending on which is active when the CTRL-T is pressed. Whenever user memory is initialized, the timer increment is automatically set to 100 milliseconds.

To determine which timer increment is currently active, press "P" and "B" to display the ladder from the beginning. At the beginning of the LDN, the timer increment is indicated after TIME = .

1. With the ">> . . ." prompt displayed, hold the CTRL key down and press "T". The PiC will display the following:

TIMER INCREMENT VALUE
CHANGED TO X MILLISECONDS

The X indicates the new timer increment.

SECTION 4 - INSTRUCTION SET

4.1 GENERAL

The symbols and statements used to create LDNs are called the instruction set. This section introduces the G&L instruction set and provides examples that show how the instruction set is used. Some of G&L's instruction set uses common ladder logic practices and some uses approaches that are unique to G&L. For this reason, even experienced ladder logic programmers would benefit from an understanding of this section.

Refer to Section 5, *Application Examples*, for examples of LDN use.

4.2 THE LDN

The entire PiC control program is called a *Ladder Diagram Network*, or LDN. The LDN is made up of Ladder Diagram Circuits and statements. The LDN is continuously scanned from top to bottom. Each rung or statement is solved from left to right. The result of each logic solution is immediately known to the entire LDN. The PiC, however, only recognizes the results when the related rung or rungs are read during a scan.

A *Ladder Diagram Circuit*, or LDC, is a section of the LDN that controls a coil. An LDC can consist of one or more horizontal lines of control logic. What defines an LDC is that the action of all the connected lines of logic control a common coil. The horizontal lines of control logic in an LDC are called *rungs*. They are covered in the following section.

NOTE

LDCs and statements are scanned sequentially. Their sequence in the LDN is what determines when each LDC or statement is scanned. The numerical value assigned to a coil or statement has no effect on when that control element will be read in the LDN.

The state of a coil is determined by the status of the contacts in the rungs connected to the coil. As the LDN is scanned, any reference to a specific coil, such as a contact with the identical numeric label, will reflect the current state of the coil.

4.3 LDN RUNG

A rung consists of a series of contacts that terminates in either a coil or a branch. Coils are always used to terminate the first rung of an LDC. Branches terminate rungs below the first rung in an LDC. Branches are explained in Section 4.4.

Rung Limitations

A single rung may contain a maximum of seven contacts. An LDC may contain a maximum of eight parallel rungs.

Rung Origination

All rungs must start on the extreme left side of the LDC. All rungs must start with a contact in contact position #1. A rung may not start with a branch from a previous rung. Figure 4-1 illustrates an acceptable LDC. Figure 4-2 shows an unacceptable LDC.

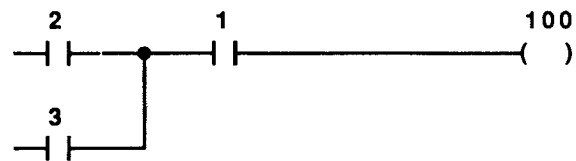


Figure 4-1 Proper Branch Usage

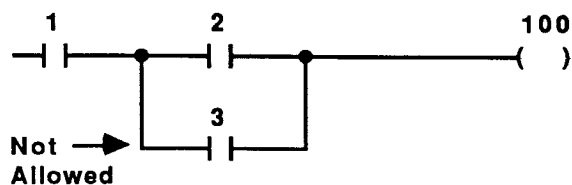


Figure 4-2 Illegal Branch

Rung Termination

A rung may be terminated only once. A branch may connect parallel rungs in only one location. Several branches may start in a rung but each branch must terminate at a different rung. Figure 4-3 illustrates acceptable circuits. Figure 4-4 illustrates a circuit which is contrary to the rung termination rule.

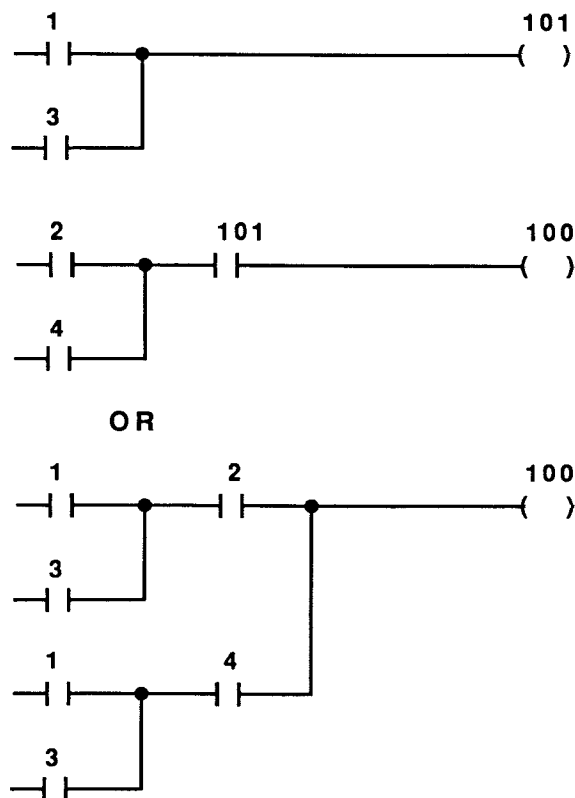


Figure 4-3 Proper Rung Termination

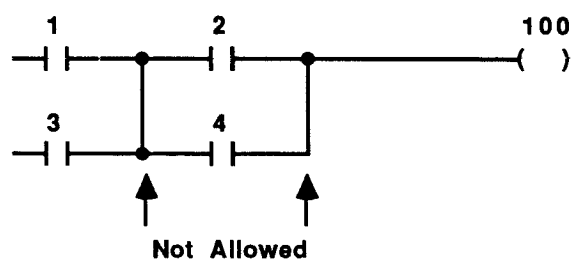


Figure 4-4 Improper Rung Termination

Rung Closure

Contacts may not be entered after terminating a rung. A rung is terminated when a branch that is routed down to it from a higher rung is terminated. A new branch may be made from a terminated rung to a succeeding rung. Figure 4-5 illustrates an acceptable circuit. Figure 4-6 illustrates a circuit that fails to follow the termination rules.

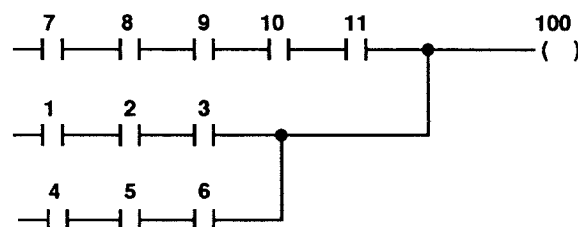


Figure 4-5 Proper Contact Termination

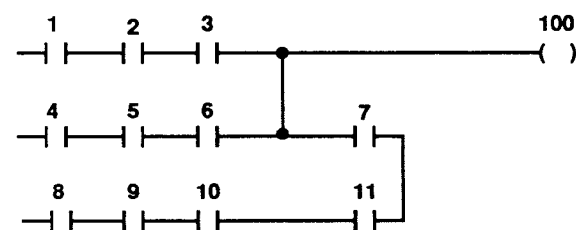


Figure 4-6 Improper Contact Termination

4.4 BRANCHES

A branch is used to connect parallel rungs in an LDC. Parallel rungs provide the logical "OR" function. Continuity in either one or both parallel rungs can satisfy circuit continuity up to the point of the branch. Figure 4-7 illustrates the simplest form of parallel rungs and the keystrokes necessary to generate the LDC. If either contact 1 or contact 2 or both contact 1 and 2 are closed, there will be circuit continuity (coil 100 will be energized).

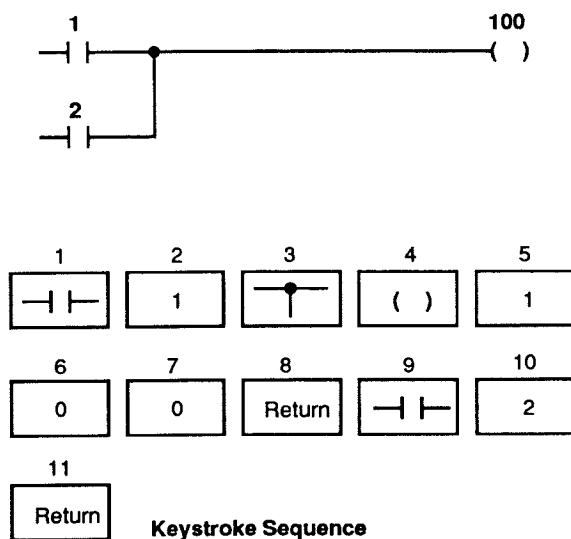


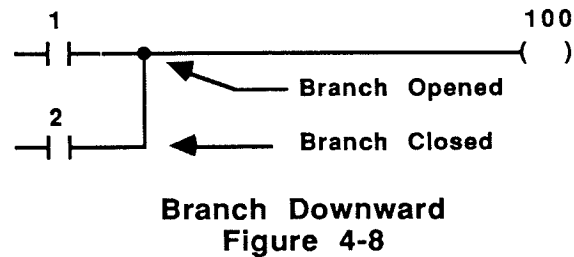
Figure 4-7 Parallel Rungs with Branch

The format used for branching follows a number of specific rules. The ladder diagram software will not allow entry of an LDC that does not follow these rules. Branching rules are described in the following sections.

Branch Downward

Branches must be downward. The keystroke that represents the branch must be entered in the upper rung of a parallel pair of rungs. Figure 4-8 illustrates the downward branching concept. Rung 1 (the uppermost rung) contains contact 1, a branch and coil 100. Rung 2 (the lower rung)

contains contact 2. The branch terminates at rung 2. The branch is closed by the return keystroke that follows the contact entry.



Branch Termination

Branches are closed in order from left to right. A branch may not crossover one rung to get to another rung. Figure 4-9 shows an acceptable LDC. Figure 4-10 illustrates an LDC that does not follow the rule.

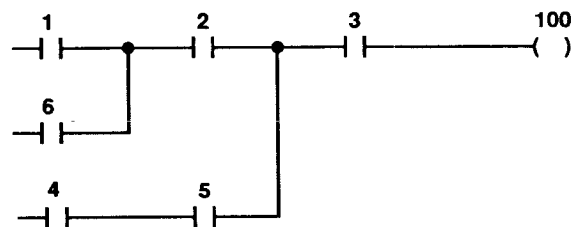


Figure 4-9 Proper Branch

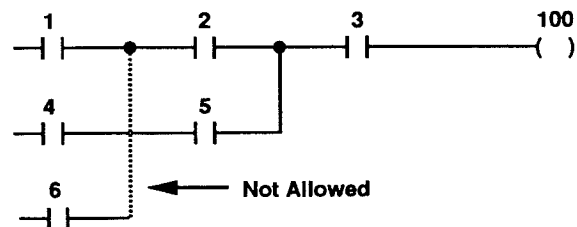


Figure 4-10 Improper Branch

4.5 CONTACTS

NOTE

When programming contacts or coils, always press the symbol key first, then enter the numeric label.

Ladder logic contacts function just as physical contacts do. When a contact is closed, "current" can flow through it. When a contact is open, "current" cannot flow. The ladder logic contacts, of course, do not pass real current, but their state (open or closed) does act upon the other components in the circuit. If all the contacts in series with a coil are closed, that coil will be energized. If any of the contacts in series are open, that coil will be de-energized. In this way the ladder logic contacts perform control functions in a ladder logic circuit.

Contacts are available as normally open (N.O) or normally closed (N.C). N.O contacts do not provide circuit continuity until closed. N.C. contacts provide circuit continuity until opened. Whether a contact is N.O. or N.C. depends on which symbol is chosen (N.O. = -| [-, N.C. = -|/[-) when the contact is entered into the LDN.

Contacts can be associated with inputs or coils, depending on the contacts are labeled. For example, if an input is addressed at 2000, and a N.O. contact in an LDN is labeled 2000, then the state of the input (on or off) will control the state of the N.O. contact labeled 2000 (input on = N.O. contact closed, input off = N.O. contact open).

Contacts are associated with coils in a similar way. If a coil is labeled 500, then any contact in the LDN that is labeled 500 will change states according to the state of coil 500. For example, if coil 500 is energized, a N.C. contact labeled 500 will open. If coil 500 is de-energized, a N.C. contact labeled 500 will close.

Refer to Figure 4-11 for an illustration of the continuity concept. Assume contacts 2, 3 and 4 are closed; therefore, coil 100 is energized. If one

contact opens, the circuit is no longer continuous. If continuity is lacking, the coil will de-energize.

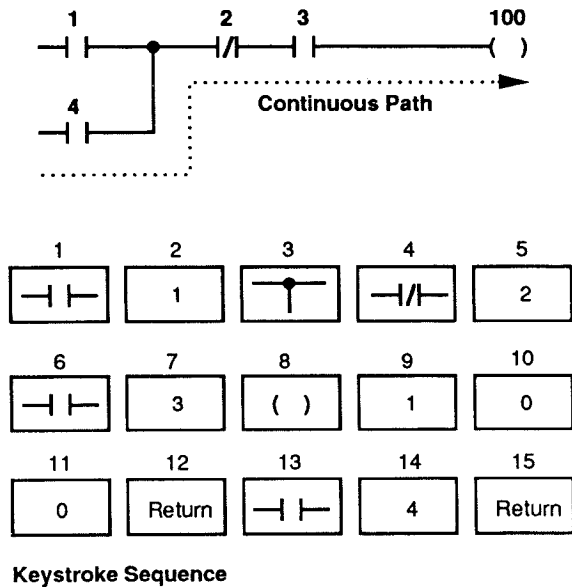


Figure 4-11 Circuit Continuity

4.6 COILS

A ladder logic coil symbolizes the coil found in the old hardware relays. When the coil was energized, the associated contacts in the relay either opened or closed, depending on their state at rest (N.O or N.C.). When the coil was de-energized, the associated contacts changed states accordingly.

NOTE

The terms "control relay" and "relay", when used in this manual, refers to both a coil and one or more contacts.

In ladder logic use, a coil is the conclusion of a series of logic-related conditions. The state of a coil (energized or de-energized) depends on the state of the contacts or statements that control it.

A coil in ladder logic can be used to represent physical outputs (lamps, solenoids, motor starters, etc.), internal relays (used specifically to control associated contacts in the LDN, or to perform timer functions (described later in this section).

The state of the coil is dependent upon the contacts within the LDC. A coil will be energized if a continuous path of closed contacts exists from the extreme left side of the LDC to the coil within the LDC. If a continuous path does not exist (or an existing path is broken) the coil within the LDC will be de-energized.

Coils are labeled with unique integers. The number selected as the coil label is dependent upon the coil type; i.e., output coil, internal relay or timer. For instance, in order to control the DC Output labeled 2028, the LDN would include a rung terminating with a coil labeled 2028 (for your convenience, Appendix C contains Control Relay Allocation charts). The contacts controlled by a coil must have the same label as the coil. Coils may have an almost unlimited number of corresponding N.O. and N.C. contacts.

IMPORTANT

Call Routines or other software may use control relays that are numbered from 1501 to 1999. For this reason, Giddings and Lewis recommends that these control relays not be used in LDNs. The control relays that can be used in customer LDNs are listed in Table 4-2.

A partial list of control relays dedicated to use by the PiC system is given in Appendix H. These control relays are often incorporated into Call Routines. The applicable system control relays are noted in the documentation for each Call Routine.

Retentive Relays

Control relays can be defined as retentive during Runtime initialization. The state of a retentive relay will be maintained even when power to the PiC is turned off. Non-retentive relays are

cleared to the de-energized state when power to the PiC is turned off.

4.7 TIMER COILS

Two types of timer coil are available, as explained below.

TE Coils

A time delay to energize (TE) coil energizes when all required logic conditions are met *and* a user-defined time has elapsed. Once energized, the TE coil will remain energized until a contact opens in the series path that controls the TE coil. No time delay occurs during the transition from the energized to the de-energized state of the TE coil.

TD Coils

A time delay to de-energize (TD) coil de-energizes when its associated circuit no longer has continuity *and* a user-defined time has elapsed. Once de-energized, the TD coil will remain de-energized until a series path of closed contacts is formed in the circuit that contains the TD coil. No time delay occurs during the transition from the de-energized to the energized state of the TD coil.

Timer Increments

The time-out value defined for a timer coil is defined in times of the active timer increment. Two increments are available, .10 seconds (100 milliseconds), and .010 seconds (10 milliseconds). The range of values that can be assigned to a timer coil is 0-65529. If the .10 second increment was active and a time-out value of 143 was assigned to a timer coil, the actual assigned time would equal 14.3 seconds. If the .010 second increment was active and 143 was assigned, the actual assigned time would be 1.43 seconds.

This time-out ranges this relationship results in are as follows.

1. Using the .10 second (100 millisecond) increment results in a range from a minimum of 0.0 seconds to a maximum of 6552.9 seconds.
2. Using the .010 second (10 millisecond) increment results in a range from a minimum of 0.0 seconds to a maximum of 655.29 seconds.

Changing the Default Time Increment for Timers

The default time increment is .10 second. To change the time increment, enter the Program mode and simultaneously press the "CTRL" and "T" keys. The time increment will change from the one increment to the other, depending on which is active when the keys are pressed. More information on this procedure can be found in Section 3.3.

NOTE

The time increment selected applies to all timers within the LDN. CR 1992 is energized when 100 millisecond increments are active and de-energized when 10 millisecond increments are active.

Variable vs. Fixed Delay Time

Delay time is determined in one of the following two methods:

1. Fixed delay time - A fixed delay time requires entering an integer value from 0 to 65,529 in the time entry area for the timer coil.
2. Variable delay time - A variable delay time requires entering a variable in the time entry area for the timer coil. The variable value must be in the range from 0 to 65,529. The variable must be defined prior to the associated timer coil in the LDN (see Section 4.8 Variables).

Regardless of which method is employed, the number used represents tenths or hundredths of a second. The ladder software places the decimal point internally. For example: Entering 105 will result in a delay of 10.5 seconds if the .10 increment is active.

When using variables to designate delay times, ensure that the variable remains in the range from 0 to 65,529. If the variable goes beyond that range, the time delay will not function properly. If a delay greater than 6,552.9 seconds is desired, then cascading multiple timers is advised. If the variable changes during the timing cycle to a value less than or equal to the elapsed time, the coil will undergo a transition to the opposite state on the next scan.

CAUTION

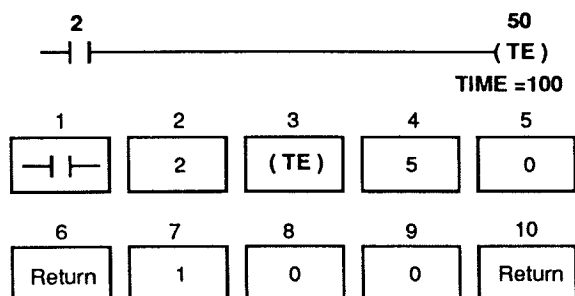
Failure to remain in the proper variable time range (from 0 to 65,529) could cause unexpected operation, which may result in a hazardous operating condition.

Timer Coil Labels

Timer coils are assigned labels, ranging from 0 to 511. Contacts corresponding to timer coils must be assigned the same label as the timer coil. A timer coil may have a nearly unlimited number of corresponding N.O. and N.C. contacts.

When entering an LDC that contains a timer, the key representing the timer must be pressed prior to the key(s) used to enter the numeric label that is assigned to the coil. After the RETURN key is pressed, a prompt for the time value is automatically generated.

Figure 4-12 illustrates an LDC that contains a timer and the keystroke sequence that is necessary to generate the LDC.



Keystroke Sequence

Figure 4-12 Example Timer Coil

4.8 VARIABLES

Variables are labels that are assigned to integer numeric values that may change as the LDN is being executed. Variable labels consist of a single letter (V) followed by a number (from 0 to 899). This provides a total of 900 variables, from V0 to V899.

Rules for the use of Variables

Each variable occupies three bytes of memory. This allows variables to equal an integer value within the range +8,388,607 to -8,388,608. The numeric value of a variable is determined within a statement. A variable may be assigned a value by the following methods:

1. A variable may equal a constant; e.g. $V1=5$
2. A variable may equal another variable; e.g. $V1=V5$
3. A variable may equal the solution of an arithmetic statement; e.g. $V1=V2+10$
4. A variable may be used by a Call Routine (see CALL Statements under Section 4.*) to store data. The documentation accompanying the Call Routine software will explain the use of variables within that routine.

Non-Volatile Variables

Non-volatile variables are the same as regular variables, with the exception that their contents will be retained when power is removed.

The number of non-volatile variables desired is defined during Runtime initialization. This is covered in Section 2.3.

NOTE

Non-volatile variables are predominantly used for constants such as machine references, etc. The values are entered and seldom modified. When a variable is modified, such as in a LET statement, the result of the LET statement is transferred to the variable storage area.

Transfers are accomplished one byte at a time. Since a variable occupies three bytes of memory, a number of steps transpire during a transfer. In the event that the power is removed, the transfer may not be completed. Therefore, to avoid this situation, exit the Run Mode prior to removing power.

4.9 STATEMENTS

A statement is used to perform arithmetic and advanced control functions. The statements that are available are: LET, SET, GOTO and CALL. This section provides a description of each of these statement types.

Each statement must begin with a unique, four-digit statement number. The statement number must be in one of two ranges: 2300 to 2999 or 3300 to 3999. These ranges allow a total of 1400 unique statements. Appendix B provides a statement allocation worksheet. Using this programming aid will help you avoid duplication of statement numbers; a condition which the PiC automatically rejects.

NOTE

Statement numbers are used as reference labels. The PiC and programmer both utilize these reference labels for editing, programming, etc. **The statement number does not infer a numerical sequence.**

For example; an LDN may have statement 2500 before statement 2300. The order in which statements are entered, not the statement number, determines the sequence of execution.

IF-THEN Qualifier

An element of the instruction set frequently used with a statement is the IF-THEN qualifier. The IF-THEN qualifier allows the programmer to use conditional statements. The format of conditional statement is depicted in Figure 4-13.

The PiC automatically generates the word IF when a contact is entered immediately after a statement number. The word THEN is generated automatically when the CALL, GOTO, LET, or SET key is pressed after the contact number.

The logic of a conditional qualifier is that IF condition "A" is true (contact closed) THEN perform action "B". The IF-THEN is used when a CALL, GOTO, LET or SET statement is to be executed only when the conditional contact is closed. When the conditional (IF) contact is open, the statement will not be executed. If a statement is to be executed each ladder scan, do not use the IF-THEN qualifier.

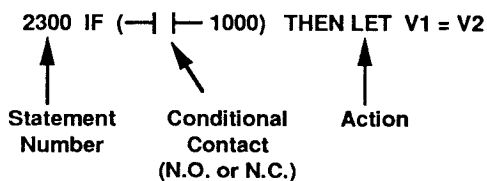


Figure 4-13 IF-THEN Format

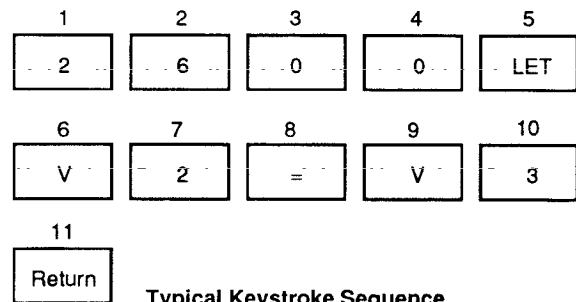
LET (Arithmetic) Statement

The LET statement is used to perform addition "+", subtraction "-", multiplication "*" or division "/". Only one operation may be performed per statement. Figure 4-14 illustrates typical uses of the LET statement and the keystroke sequence used to enter a typical LET statement.

2500 IF (—|— 1500) THEN LET V1 = V2

↑
Optional
Conditional
Contact

2600	LET V2 = V3
2700	LET V4 = 5
2800	LET V6 = V6 + 1
2900	LET V7 = V8 * 6
2950	LET V9 = V10 / 5



Typical Keystroke Sequence

Figure 4-14 LET Statement Format

NOTE

A statement such as LET V2=V3 actually causes the addition LET V2=V3+0 to be performed.

The PiC performs only integer arithmetic. Integer arithmetic involves whole numbers only. In the

case of the PiC, the range of allowable values is -8,388,608 to 8,388,607.

The PiC uses a system known as triple precision, two's complement arithmetic. Triple precision means three bytes (24 bits) of information represent numbers in the PiC. The extreme left (24th) bit represents the sign (+ or -) and the remaining 23 bits represent the magnitude (size) of the number. The three bytes are stored in three consecutive memory locations. The manner in which the arithmetic is performed is invisible to the user.

Integer arithmetic does not allow fractions, decimals, remainders or exponents. Scaling (explained in Section 4.12) is used to overcome some of these limitations.

Coil 1999 (CR 1999) sets to indicate an overflow condition. Overflow can result from any of the following:

1. Addition: result greater than 8,388,607.
2. Subtraction: result less than -8,388,608.
3. Divide by zero: undefined operation.
4. Multiplication: result greater than 8,388,607 or less than -8,388,608.

You can monitor the state of CR 1999 in the LDN to see if one of the above conditions exist. Coil 1999 will remain energized for the remainder of the scan. The overflow relay (CR 1999) will be reset at the beginning of each scan.

SET Statement

The SET statement is used to make relational (magnitude) comparisons of variables and constants. The operators available are as follows:

=	EQUAL
<	LESS THAN
>	GREATER THAN
<=	LESS THAN OR EQUAL
>=	GREATER THAN OR EQUAL
<>	NOT EQUAL
×	NOT EQUAL

The SET statement has the format shown in Figure 4-15. Figure 4-15 also includes the keystroke sequence required to enter the SET statement.

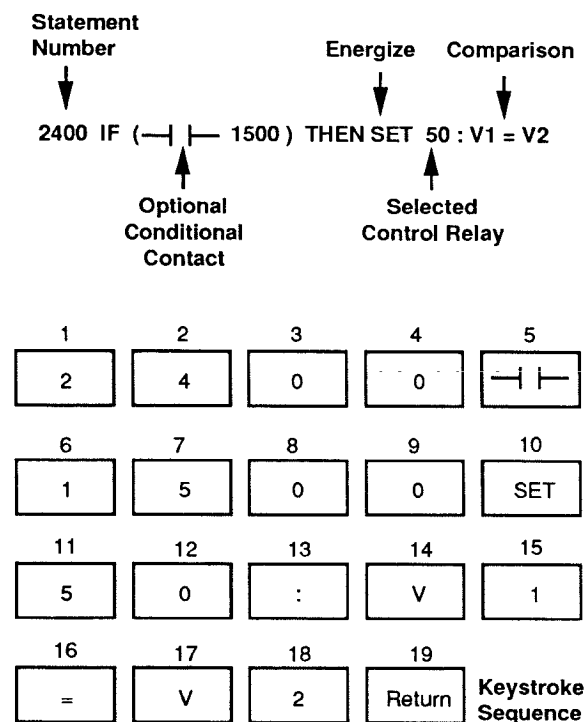
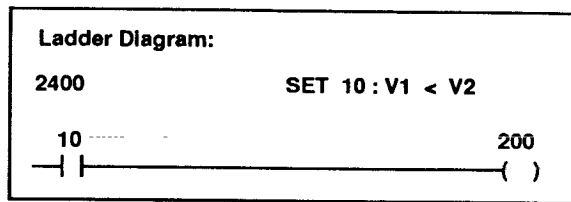


Figure 4-15 SET Statement Format

When the result of the comparison is true, the selected coil will be energized. The contacts associated with the selected coil are used either to control other coils or the conditional contacts of IF-THEN qualified statements. Figure 4-16 illustrates the use of the SET statement.

NOTE

When the conditional contact in a SET statement is not closed, the coil state will remain unchanged regardless of the comparison result.



Result:

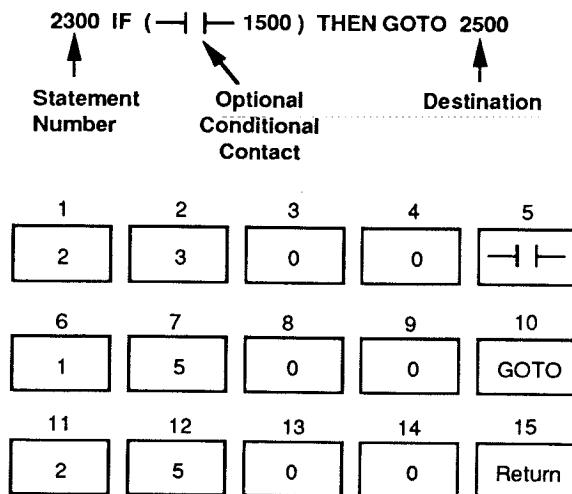
If V1 is less than V2, then Coil 200 will be energized.

If V1 is greater than or equal to V2, then Coil 200 will not be energized.

Figure 4-16 SET Statement Uses

GOTO Statement

The GOTO statement is used to control the sequence in which the LDN is executed. The GOTO statement is entered as shown in Figure 4-17. The GOTO may be written in a manner that will cause a specified statement or LDC to be executed next. See Figure 4-18 and Figure 4-19 for examples of GOTO statements.



Keystroke Sequence

Figure 4-17 GOTO Statement Format

As shown in Figure 4-18, if contact 1500 is closed, then the scan will skip statements 2600

and 2700. Statement 2800 will be executed immediately after statement 2500.

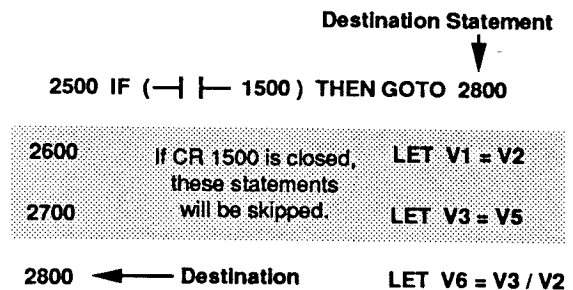


Figure 4-18 GOTO Statement Number

As shown in Figure 4-19, if contact 1500 is closed, then the scan will skip statements 2600, 2700 and 2800. The LDC that contains coil 50 will be executed immediately after statement 2500.

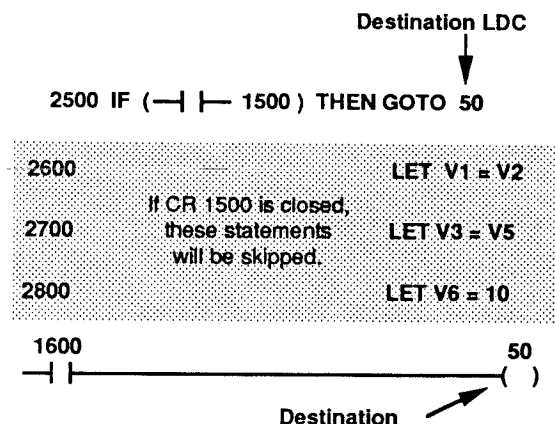


Figure 4-19 GOTO LDC

Care should be exercised when using the GOTO statement. G&L strongly recommends that you do not use a GOTO to scan a previous statement or LDC. If a GOTO statement goes back in the ladder and is executed every time it is encountered, the remainder of the LDN will never be executed. Refer to Figure 4-20 for an example of an improperly used GOTO statement.

be executed. Refer to Figure 4-20 for an example of an improperly used GOTO statement.



Figure 4-20 Incorrect GOTO Usage

As shown in Figure 4-20, when statement 2700 is executed, the scan returns to statement 2600. This looping will continue to be repeated, thereby preventing the remainder of the LDN from being executed. The Scan Loss light will illuminate to indicate that the PiC is not completing the scan sequence.

NOTE

If a Scan Loss occurs as a result of an improperly employed GOTO statement, the user must perform the following steps:

1. Leave the RUN Mode and enter the PROGRAM Mode.
2. Alter the LDN (via the PROGRAM Mode) to alleviate the problem.

If an LDN is run that contains a GOTO statement with a non-existent destination, Control Relay 1991 will set. If the user has Call Routine D120, the statement number of the statement which is incorrect can be transferred to a variable and displayed.

CALL Statement

CALL statements are used to access Call Routines. Call Routines are subroutines that provide advanced control capabilities without

requiring the user to write all the software involved. Call Routines are available for purchase from G&L. Documentation is included with each G&L PiC Call Routine package.

Use of the CALL statement is illustrated in Figure 4-21. Parameters associated with a Call Routine may be decimal or hexadecimal numbers, variables, coil numbers, I/O, etc. The contents of the parameters are defined in the Call Routine documentation.

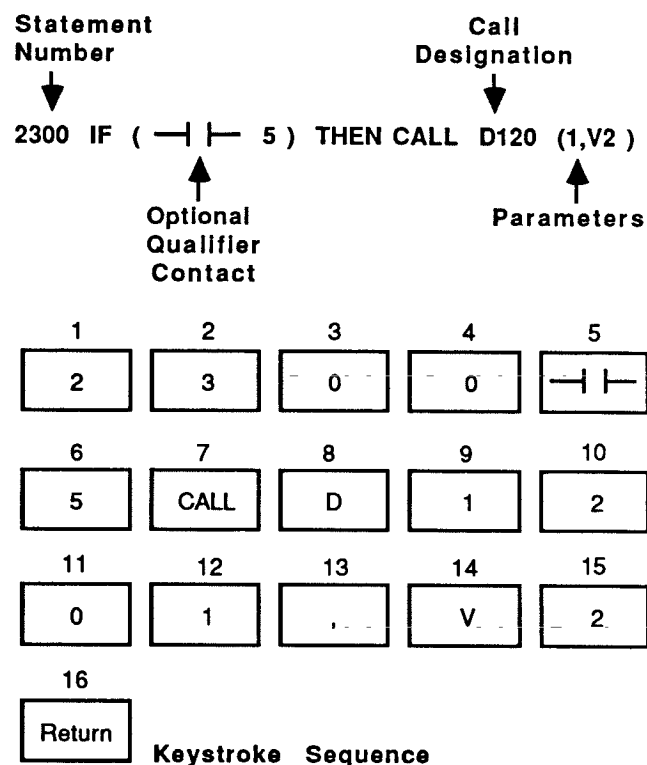


Figure 4-21 CALL Statement Format

4.10 SUMMARY

Figure 4-22 shows an expanded example of the LDN format. Table 4-1 shows a summary of the instruction set. Table 4-2 shows numbering rules pertaining to LDN construction.

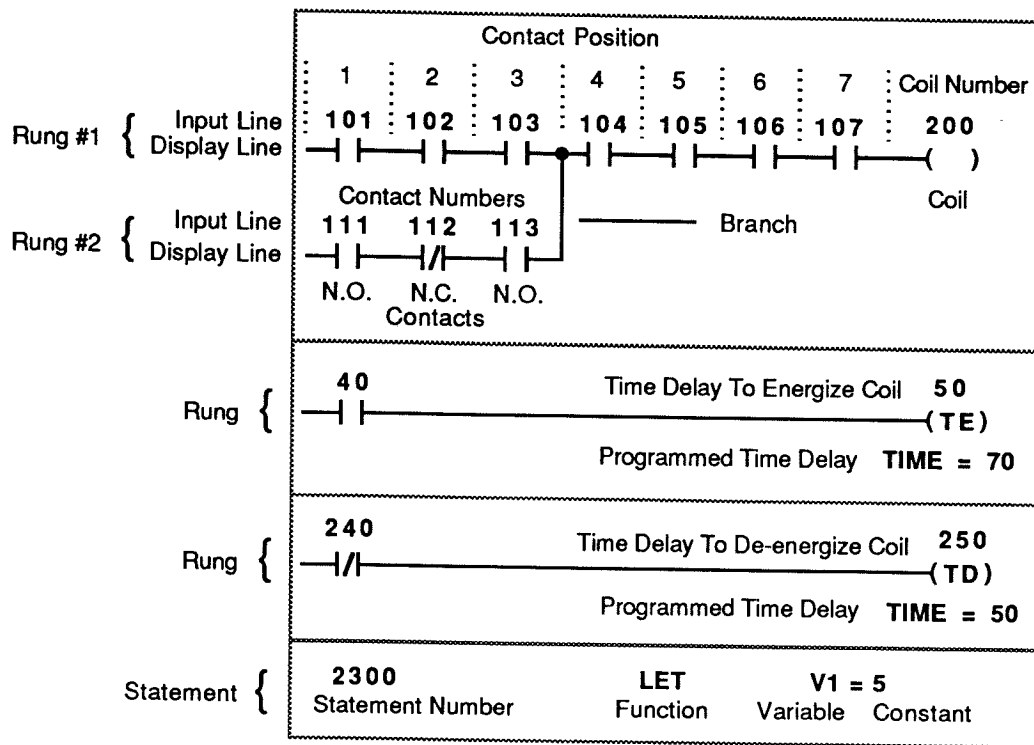


Figure 4-22 LDN Format Example

Symbol	Terminal Key	Function
	F	Normally Open Contact
	G	Normally Closed Contact
	R	Branch
()	T	Coil
(TE)	Y	Time Delay To Energize Coil
(TD)	H	Time Delay To De-Energize Coil
	S	CALL Statement
	C	SET Statement
	X	GOTO Statement
	D	LET Statement

Table 4-1 Instruction Set Summary

<u>LDN Element</u>	<u>Range of Acceptable Numbers</u>
Variables	V0-V899
Control Relays or Timers	0-511
Control Relays only	512-1500
Control Relays when corresponding extension rack is not present	3000-3255 4000-4255 5000-5255 6000-6255 7000-7255 8000-8255 9000-9255
Statement Numbers	2300-2999 3300-3999

Table 4-2 Numbering System for use in LDNs



SECTION 5 - APPLICATION EXAMPLES

5.1 INTRODUCTION

This section contains examples of Ladder Diagram Circuit construction. Each example depicts a complete circuit that performs a specific function. The text and illustrations explain each example and how it is used. The LDCs in this section are merely a sample of commonly used circuits and should not be construed as a complete set of all possible circuits.

5.2 ONE-SHOT

A "one-shot" is a circuit that is intended to operate an output (either a hardware output or a control relay) for the duration of only one scan.

Different types of one-shots exist for different applications. For example; the circuit in Figure 5-1 is useful for initializing a software routine. Call Routines A and B will be executed only on the first scan of the PiC; on subsequent scans, Call Routines A and B will not be executed because of the energized state of control relay 1000.

Any number of Call Routines may be one-shot by this method. The circuit containing coil 1000 must appear after the Call statements. Also, control relays 1000 and 1001 must not be affected by any other circuits. The one-shot is simple since all control relays are de-energized before the first scan.

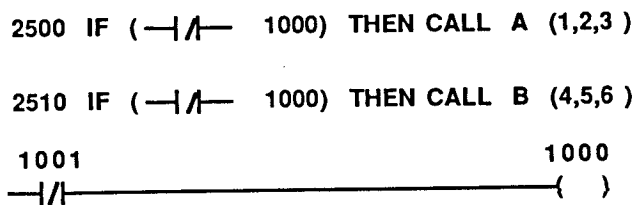


Figure 5-1 Call Routine One Shot

Another type of one-shot creates an output that lasts the duration of one scan when an input is energized. For example, if a switch is connected to input 2000 and execution of a Call Routine based on the closure of that switch is desired, the circuit of Figure 5-2 can be used. Energizing

input 2000 will energize control relay 100 for the duration of the scan. Control relay 100 will also be de-energized for all successive scans, regardless of whether or not input 2000 remains energized.

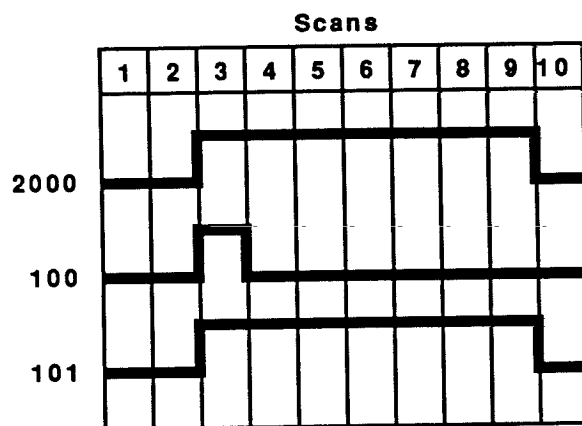
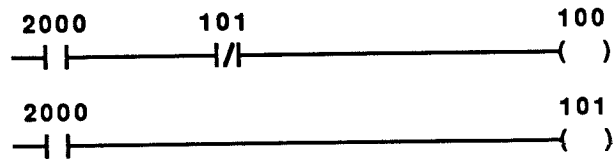


Figure 5-2 Switch One-Shot

5.3 COUNTER

The circuit described here will count the number of times an input is actuated, up to a maximum of 8,388,607 counts.

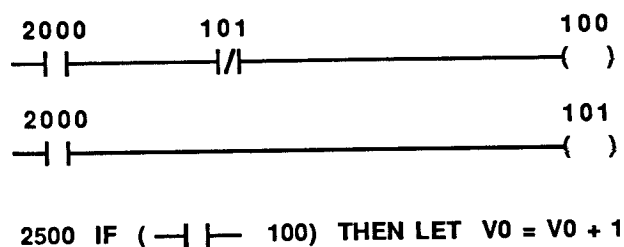


Figure 5-3 Counter

In the circuit of Figure 5-3, the number of actuations of input 2000 are counted in variable VO. Control relay 101 is the one-shot of input 2000; used here to ensure that the variable is incremented only once each time input 2000 is energized.

5.4 FLIP-FLOP

The flip-flop described here causes an output to change state each time an input is energized. De-energizing the input has no effect on the output. In the circuit of Figure 5-4, control relay 200 is the output. On the first energization of input 2000, 200 turns on. Note that control relay 100 is a one-shot of input 2000.

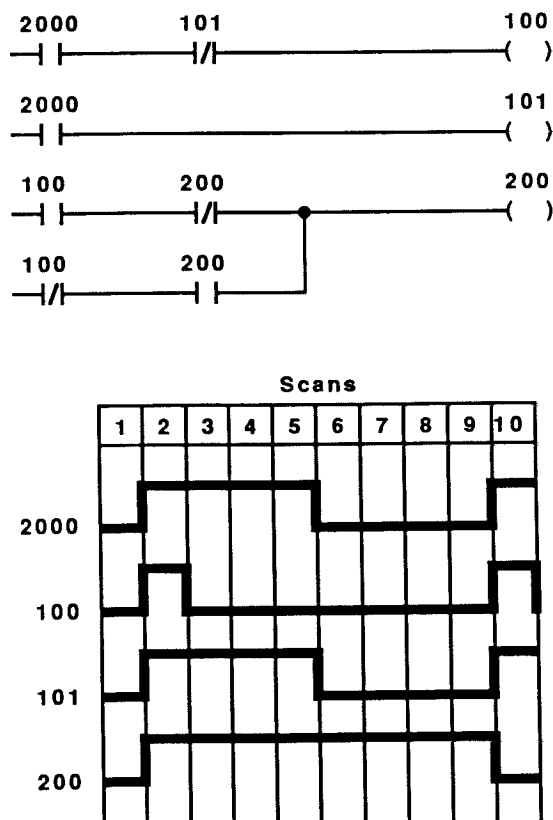


Figure 5-4 Flip-Flop

5.5 LATCHED RELAY

The circuit shown in Figure 5-5 causes control relay 100 to become latched in the energized state if input 2000 is energized. If input 2000 becomes de-energized, control relay 100 will continue to stay latched. Control relay 100 can only be unlatched by energizing input 2001 (or a loss of power).

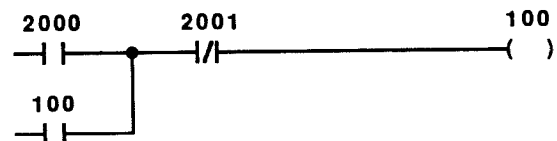


Figure 5-5 Latched Relay

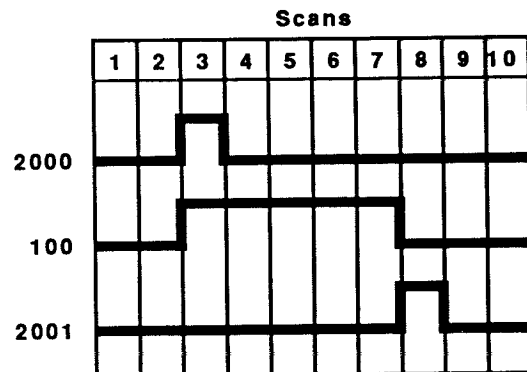


Figure 5-6 Latched Relay Timing

5.6 SCAN STEPPER

The circuit in Figure 5-7 causes six control relays (100 through 105) to become energized sequentially. Control relay 100 is energized for the duration of one scan. On the next scan, control relay 100 is de-energized and 101 is energized. The process continues through control relay 105; the process then starts over at 100. Input 2000 must be activated to permit the stepper to run. Control relay 200 is a one-shot of input 2000.

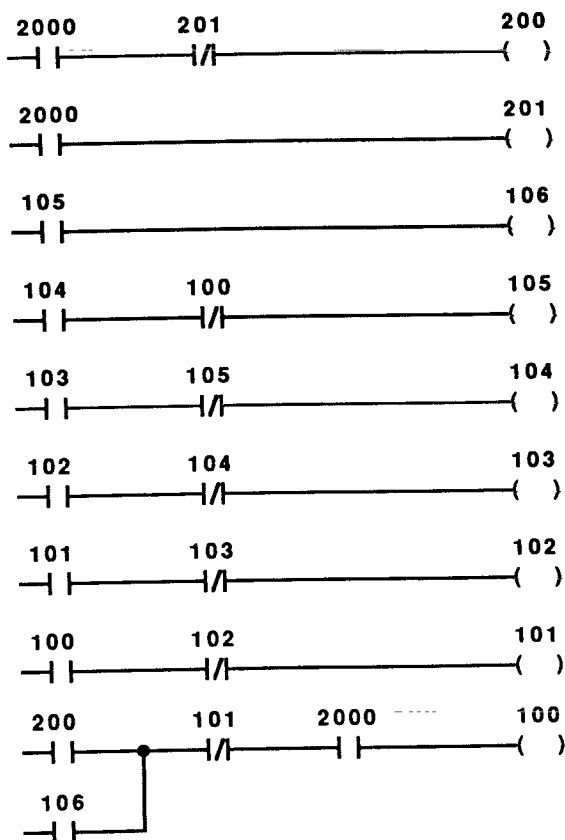


Figure 5-7 Scan Stepper

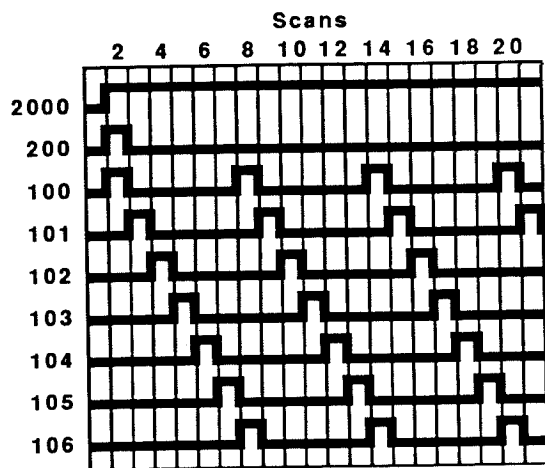


Figure 5-8 Scan Stepper Timing

5.7 SCAN TIME MEASUREMENT

There are a number of methods for measuring the time required for the PiC to complete a scan of the user's Ladder Diagram Network (LDN). One of the simplest methods is shown in Figure 5-9. Output 2008 will "flip-flop" or toggle off and on with each scan. An oscilloscope connected to output 2008 will display a square wave with a one-cycle period of two scans.

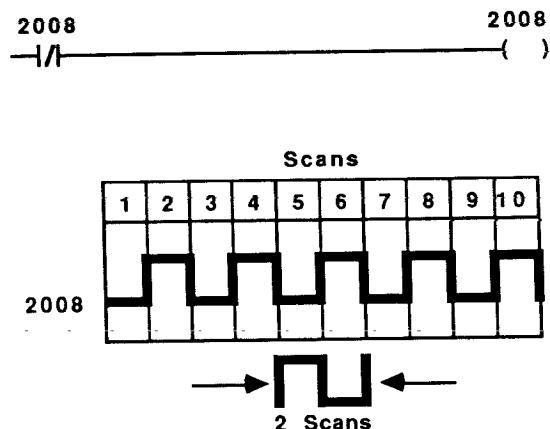


Figure 5-9 Oscilloscope-Measured Scan Time

Another method may be used that does not depend upon external test equipment. The circuit in Figure 5-10 will cause output 2008 to be energized for one scan each time ten scans have elapsed. If output 2008 is wired to a lamp, each flash will represent ten scans. Scans must be relatively long (about 40 milliseconds or more) to give the lamp sufficient time to reach a good brightness level.

2500 LET V0 = V0 + 1

2510 SET 100 : V0 = 10

2520 IF (— | — 100) THEN LET V0 = 0)



Figure 5-10 Lamp-Measured Scan Time

The method illustrated in Figure 5-11 places the average scan time (in milliseconds) into variable V1, which is upgraded every 5 seconds. The LDN is computing the following:

$$\frac{5000 \text{ milliseconds}}{5 \text{ seconds}} \div \frac{\text{No. of Scans}}{5 \text{ seconds}} =$$

$$\frac{5000 \text{ milliseconds}}{5 \text{ seconds}} \times \frac{5 \text{ seconds}}{\text{No. of Scans}}$$

Each time a new value is computed for V1, variable V0 is cleared and the process is started over.

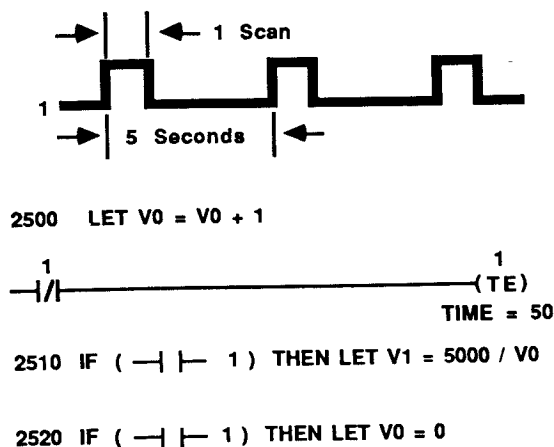


Figure 5-11 Average Scan Time

5.8 TIMERS

Two timers are supported by the PiC: time delay to energize (TE), and time delay to de-energize (TD). Figure 5-12 illustrates how the timers operate through the use of a timing diagram.

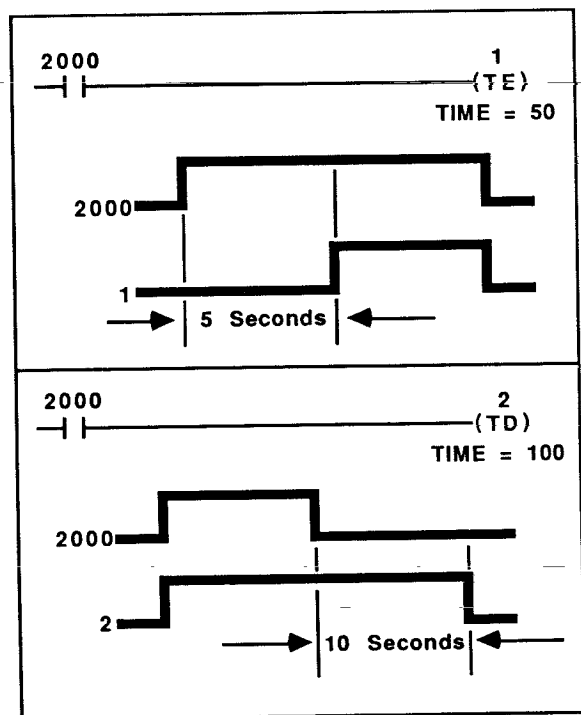


Figure 5-12 TE and TD Timers

The timers are programmed in 1/10 second increments (in the default mode). Therefore, a delay of five seconds exists between the energizing of timer 1 and the closing of the associated contacts in Figure 5-12. A delay of ten seconds exists between the de-energizing of timer 2 and the opening of the associated contacts.

If a TE relay is placed in a circuit with an associated normally closed contact, a repetitive pulse results. An example of this is shown in Figure 5-13.

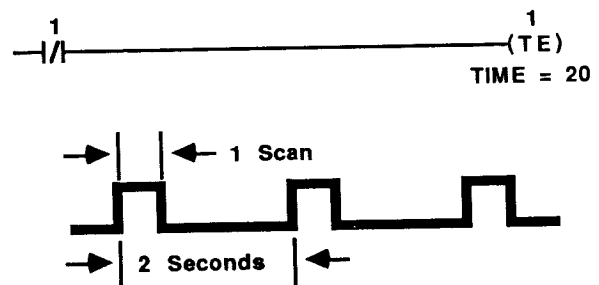


Figure 5-13 Pulser

On the initial scan in Figure 5-13, timer 1 is energized and begins timing. The timing continues through subsequent scans until two seconds have elapsed. At this point, the timer "operates"; and for the remainder of the scan, all contacts labeled "1" will be energized. On the subsequent scan, the timer is de-energized and the cycle repeats.

5.9 ACCUMULATED TIME

The amount of time that an input is energized is measurable by means of the circuit in Figure 5-14. Energizing input 2000 causes a TE timer to start; when the timer reaches one second, variable V0 is incremented. On the subsequent scan, the TE relay drops out.

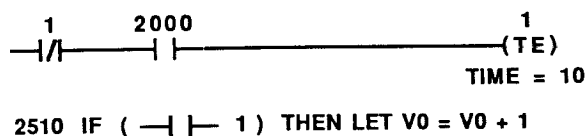


Figure 5-14 Time Measurement

On the following scan, the timer starts again.

NOTE

This circuit loses the time occupied by one scan each increment. A larger value for TE would be beneficial for accuracy if long time measurements are anticipated.

5.10 NUMERIC KEYBOARD

A simple method of interfacing a numeric keyboard to the PiC is shown in Figure 5-15. The use of 16 DC inputs is required to interface to a numeric keyboard as shown.

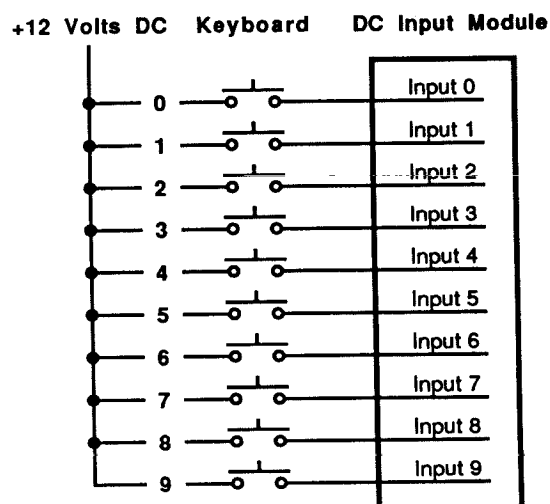
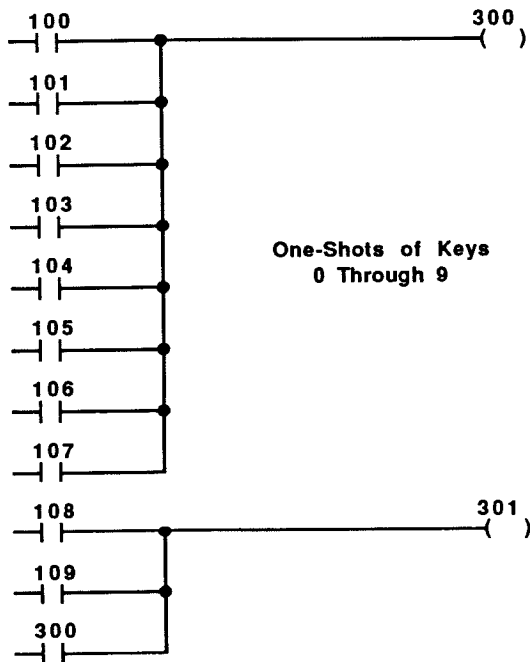


Figure 5-15 Keyboard Interface

The ladder diagram network in Figure 5-16 permits a series of keystrokes to be read and saved in variable V26. Shown in Figure 5-16 are ten one-shots of the "0" through "9" keys; the one-shots are considered to be coils 100 through 109, respectively.

Pressing any key causes variable V0 to be set to some value from 0 to 9 through statements 2500-2590. Statement 2600 multiples V26 by 10. Statement 2610 adds the value of the key just pressed to the old value. Therefore, pressing keys "7", "5" and "0" causes the number 750 to appear in variable V26.



```

2500 IF ( —|— 100 ) THEN LET V0 = 0
2510 IF ( —|— 101 ) THEN LET V0 = 1
2520 IF ( —|— 102 ) THEN LET V0 = 2
2530 IF ( —|— 103 ) THEN LET V0 = 3
2540 IF ( —|— 104 ) THEN LET V0 = 4
2550 IF ( —|— 105 ) THEN LET V0 = 5
2560 IF ( —|— 106 ) THEN LET V0 = 6
2570 IF ( —|— 107 ) THEN LET V0 = 7
2580 IF ( —|— 108 ) THEN LET V0 = 8
2590 IF ( —|— 109 ) THEN LET V0 = 9
2600 IF ( —|— 301 ) THEN LET V26 = V26*10
2610 IF ( —|— 301 ) THEN LET V26 = V26+V0

```

Figure 5-16 Numeric Keyboard LDN

5.11 SCALING

Scaling is a technique used to modify values so that those values fall within a selected range. Scaling is also used to establish a weight for a value, such as ones, tens, hundreds, etc. The following examples illustrate some scaling applications:

Example 1: Assume that V4 is a variable that represents the tens units in a thumbwheel switch bank. The variable V4 will be input from the thumbwheel as a digit between 0 and 9. The statement "2300 LET V4=V4*10" gives V4 a tens unit weight, i.e. 0 to 90.

Example 2: Assume that V5 is a variable that must be scaled down (proportionately reduced). The variable initially has a range from 0 to 2000 and the desired range is 0 to 500. The statement "2400 LET V5=V5/4" scales values of V5 so that the values have a range of 0 to 500.

Example 3: Assume that a number such as 3.14 is required as a multiplier. Since the PiC uses whole numbers only, 3.14 cannot be entered directly. The following sequence of statements illustrates one alternative.

```

2500 LET V6 = V6 * 314
2501 LET V6 = V6 / 100

```

If V6 originally equalled 365, the result would be 1146. Notice that the multiplication precedes the division.

Assume that a problem requires using a number that is too large when scaled. For example; scaling pi to four decimal places results in the number 31415. Using a multiplier this large would limit the range a variable could have to ± 267 . For example; in the following equations, V6 is limited to ± 267 .

```

2600 LET V6 = V6 * 13415
2601 LET V6 = V6 / 10000

```


To expand the range of the variable to ± 26715 and retain significance, use the following method:

```
2500 LET V4 = V6 * 314
2501 LET V4 = V4 / 100
2502 LET V5 = V6 * 15
2503 LET V5 = V5 / 10000
2504 LET V5 = V4 + V5
```

NOTE

The methods used in Examples 3 and 4 may be used to retain significance to the desired number of places, as long as the variable range $+8,388,607$ to $-8,388,608$ is maintained for each calculation.

Example 4: Assume that a greater degree of significance is required from a division. The PiC will truncate all remainders. This means that only the whole number portion of a result is saved. A division such as $19/5$ will result in an answer of 3. The following statement sequence can be used to generate a more significant answer.

```
2400 LET V5 = V5 * 10
2401 LET V5 = V5 / 5
```

V5 will now contain a whole number result that is expressed in tenths. That is, if the original value of V5 was 19 the result would be 38 (tenths). The programmer must remember that the result is in tenths, since the PiC only sees the two digit whole numbers (in this case 38).



SECTION 6 - REAL TIME DEBUG

6.1 INTRODUCTION

The Real Time Debug (RTD) Call Routine provides diagnostic capabilities that are helpful in system design and maintenance. RTD provides two basic functions. First, it displays any selected ladder diagram circuit (LDC) within the LDN. The displayed LDC shows the status of contacts and coils, power flow, variable contents, and actual and programmed timer values. Second, RTD enables you to change the contents of variables, redefine timer values, and allows coil and output disabling and forcing.

NOTE

The PiC must be in the Run mode in order for RTD to be active.

6.2 DISPLAY OPTIONS

Real Time Debug can be used with one of three display options. These options include a CRT Monitor, an RS-232C Video Display/Keyboard Unit (G&L supports the Lear-Siegler) or an IBM (or compatible) personal computer. The options, with associated hardware requirements, are detailed below.

Option 1-CRT Monitor

Hardware Requirements:

- 1 CRT Monitor.
- 1 G&L Video Memory Module Addressed at #2232 or a G&L Video Memory Module with Real Time Debug PROMs Addressed at #2232 .
- 1 Video Interface Module Addressed at #2228.
- 1 RS-232C Keyboard.

Option 2: Video Display/Keyboard Unit

Hardware Requirements:

- 1 RS-232C Video Display/Keyboard Unit (Lear-Siegler or Televideo).

Use the communications cable supplied with the Lear-Siegler or Televideo to connect it to the Terminal port on the PiCTurbo Processor faceplate. If the screen only displays a cursor in the upper left corner at first, press the space bar to bring up the menu. If the PiC is in the Run mode when the video display unit is connected, the LDN will be displayed immediately.

NOTE

Information necessary to configure the Lear-Siegler and Televideo for use with the PiC can be found in Appendix D of the User's Manual.

Option 3 - IBM or Compatible Personal Computer

This option requires that the personal computer be running G&L's GLLADD software, version 2.0 or higher. The personal computer must be connected to the Terminal port on the PiCTurbo Processor faceplate. Use a GLLADD (serial communications) cable to link the computer and the PiC.

6.3 INSTALLING REAL TIME DEBUG

The Real Time Debug Call Routine (Library Number C912) resides in memory on the PiCTurbo Processor. Therefore, it does not have to be loaded into user memory as the other Call Routines do. However, the RTD Call Routine must be installed before it can be used. Refer to Chapter Seven - Call Routine Installer for the correct procedure.

NOTE

If you are using the G&L PiCMotion software package, *do not call RTD in the LDN*. RTD is software-selected in PiCMotion through the use of a PiCMotion window.

6.4 PARAMETERS

The RTD Call Routine has only one parameter. However, the Call Routine must be called twice within the ladder diagram; the first time at the beginning of the LDN and the second time at some point following the first call. The two calls of the routine require separate parameter values in each call. The first call defines desired user options. The second call sets the update time the routine will use during each scan of the ladder diagram.

Parameter for the First Call to RTD

The options available for the first Call parameter are shown in Table 6-1. For the column A or B selection in each row, assign the decimal number that is indicated in column C. The six column C selections must be added together; the sum yields the first Call parameter.

Row	Column A	Column B	Column C
1	No Video Memory Module or a Video Memory Module that does not contain the optional RTD PROMs	Video Memory Module with the optional RTD PROMs	Column A=1 Column B=0
2	CRT Monitor	Video Display Keyboard Unit or IBM personal computer	Column A=2 Column B=0
3	Cursor active	N/A	Column A=4
4	Software slicing	N/A	Column A=8
5	Output forcing	No output forcing	Column A=16 Column B=0
6	TeleVideo Terminal or IBM PC	Lear Siegler, CRT Monitor, or IBM PC	Column A=32 <u>Column B=0</u>

To determine the first Call Parameter, total Column C.

First Call Parameter=?

Table 6-1 Options for the First Call to RTD

Example - For a system with:

No Video Memory	Column A = 1
IBM PC	Column B = 0
Cursor active	Column A = 4
Software slicing	Column A = 8
Output forcing	Column A = 16
IBM PC	Column B = 0

1st Call Parameter: $1 + 0 + 4 + 8 + 16 + 0 = 29$

All things considered, "29" is the value most often used as the parameter in the first call to RTD.

The first Call of the routine must be one-shot (only called for one scan in the ladder diagram). The Call must be placed at the beginning of the ladder diagram and be followed by a one-shot statement. Figure 6-1 depicts an example first Call to C912 followed by a one-shot ladder diagram circuit. The proper format for the second Call to C912 is also shown.

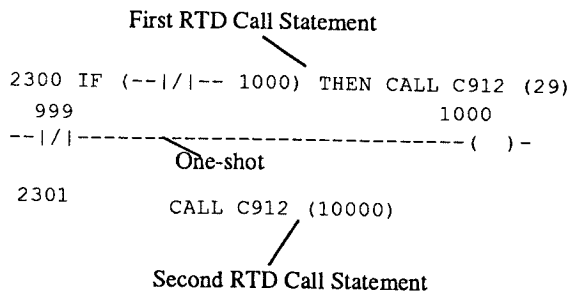


Figure 6-1 RTD Call Statements

Parameter for the Second Call to RTD

The parameter for the second RTD Call establishes the time in microseconds that the RTD Call Routine will utilize on each scan of the ladder diagram. If allowed to be completed every ladder scan, the routine would increase the scan time beyond an acceptable level.

The method used to permit only portions of the Call Routine to be executed each scan is called

software slicing. Software slicing allows a certain number of instructions to be completed during each ladder diagram scan.

The second RTD Call statement (illustrated in Figure 6-1) must be called each scan. The programmed time of the second Call's parameter must be between 256 and 65,535. Programming this value above 65,535 will energize the data error flag (1972) and the routine will not execute.

A parameter of 10000 in the second Call to C912 (RTD) would cause 10,000 microseconds of each scan to be devoted to RTD. The value of 10,000 microseconds (programmed as 10000) is the most commonly used value in the second Call to RTD.

6.5 SCREEN DISPLAY

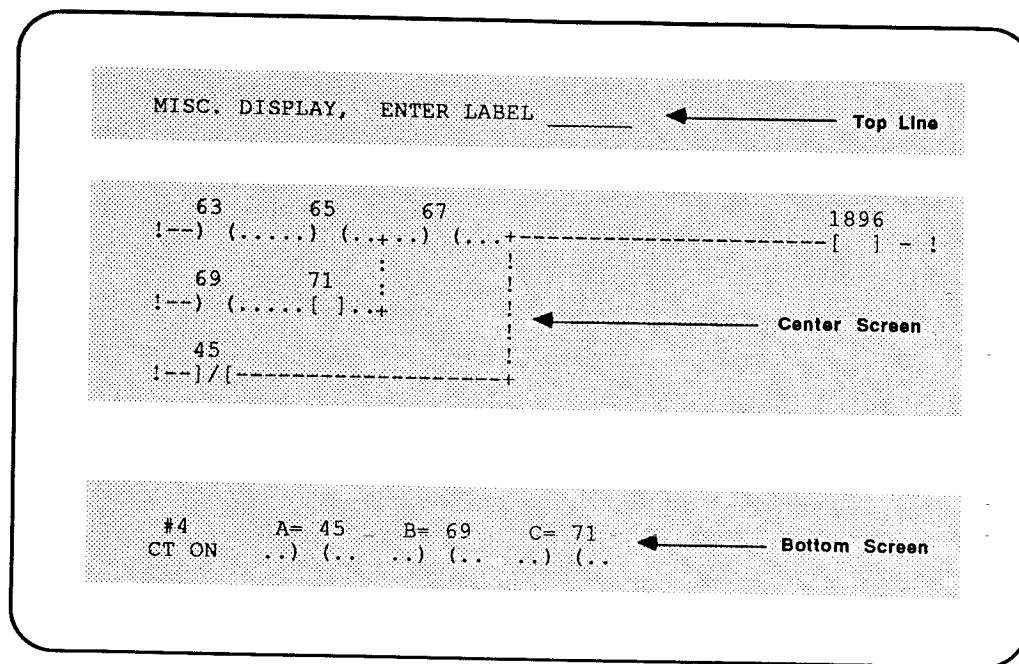
The RTD Call Routine produces a display of the LDN while the LDN is running. Information relevant to the ladder diagram and the execution of the RTD Call Routine will also be displayed.

Screen Divisions

The screen display is divided into three sections by the RTD Call Routine: top line, center screen and bottom screen. The top line displays prompts and operator entries or it may be blank. The center screen displays one LDC or statement of the LDN. The bottom screen displays the line number of the ladder diagram, CT ON or extinguished (to indicate forcing on or off respectively) and the miscellaneous display entries: "A" through "G". Figure 6-2 depicts a typical RTD screen display.

Energized/De-Energized Items

Connecting lines with power flow are indicated by bright dashed lines. Lines without power flow are indicated by dim dotted lines. Energized contacts and coils are indicated by bright square style brackets, or] [. De-energized contacts and coils are indicated by dim rounded parentheses, or (), as shown in Figure 6-3.



RTD Screen Display
Figure 6-2

6.6 MISCELLANEOUS KEY COMMANDS

RTD provides a number of functions that are initiated from the keyboard. The key commands are explained in this section. A summary of the key commands can be found in Table 6-2. It is recommended that you read this section thoroughly before referring to the table, however, since the command explanations in this section contain information that is not repeated in the summarized table.

Print (Display) Command

The Print Command is used to select one LDC or statement within the LDN for display. Use the following procedures to utilize the Print Command:

1. Press the "P" key. (The display response is a top line prompt; START DISPLAY AT #.)
2. Press one of the following: —

- a. "B" key - to display the first LDC or statement of the LDN.
- b. The coil number of the LDC to be displayed followed by pressing the RETURN key.
- c. The timer coil number of the LDC to be displayed followed by pressing the RETURN key.
- d. The statement number of the statement to be displayed followed by pressing the RETURN key.

Next Line Command

Press the "N" key to display the next LDC or statement on the center screen.

Last Line Command

Press the "L" key to display the previous LDC or statement on the center screen.

Miscellaneous Command

The Miscellaneous Command is used to select individual contacts, coils, external outputs, timers or variables for continuous display in the bottom portion of the screen. Up to seven selections, corresponding to the letters "A" through "G", may be made for continuous display. Use the following procedure to utilize the Miscellaneous Command:

1. Press the "M" key. The following prompt will appear on the top line of the screen:

MISC. DISPLAY, ENTER LABEL.

2. Press a letter key, "A" through "G". The letter pressed will be displayed on the top line followed by an equal (=) sign.
3. Enter an individual contact number, coil number, external output number, timer number or a variable followed by a Return.
4. The following information will be displayed on the bottom screen:
 - a. The letter chosen for the display ("A" through "G").
 - b. The number of the contact or variable.
 - c. The associated contact symbol or the contents of the variable.

Individual contacts, coils, external outputs and timers are shown as contact symbols. Variables are shown with the decimal value.

New data may be entered to any miscellaneous display letter by repeating the Miscellaneous Command entry procedure.

A miscellaneous display may be eliminated by pressing the "M" key, pressing one key ("A" through "G") and then pressing the Return key.

The top line prompt, MISC. DISPLAY, ENTER LABEL, can be extinguished by pressing the ESC key.

If invalid data is entered after a miscellaneous letter selection, the data will be extinguished and the prompt will reappear when the Return key is pressed. Variables selected above the variables programmed in the ladder are considered invalid data. However, contact, coil, output or timer numbers will be accepted as valid data regardless of whether or not these numbers are referenced in the programmed LDN.

6.7 FORCING FUNCTIONS

The forcing functions provide the ability to change programmed variable and timer values, and disable and force coils and external outputs. The forcing feature must be activated via the parameter for the first call to the RTD Call Routine. A summary of the forcing function key commands can be found in Table 6-2. It is recommended that you read this section thoroughly before referring to the table, however, since the explanations in this section contain information that is not repeated in the summarized table.

Screen Display

The bottom screen display, CT ON, indicates forcing is active. The absence of the message CT ON indicates forcing was not selected in the first Call parameter; and, therefore, is not active.

Contact Forcing

Contact forcing is defined as the ability to force the energizing or de-energizing of internal relays 0 through 1999. Contact forcing is performed using RTD while operating in the PiC Run Mode. Use the following procedure to utilize contact forcing:

1. Use the Print command to display the LDC or Statement containing the contact you want to force (press "P" followed by the coil or statement number and a Return).

2. Press the "M" key (miscellaneous display) and enter one of the letters "A" through "G" that you want to use to designate for the contact. Enter the contact number followed by a Return.
3. When the contact appears at the bottom of the screen, Hold down the CTRL key and press the letter designated for the contact ("A" through "G"). The display will show the contact changing from a de-energized state to an energized state or from an energized state to a de-energized state.

NOTE

The contact will remain forced until the contact is forced again. If the contact is controlled by a coil or a statement within the ladder, the contact will be forced for one ladder scan only.

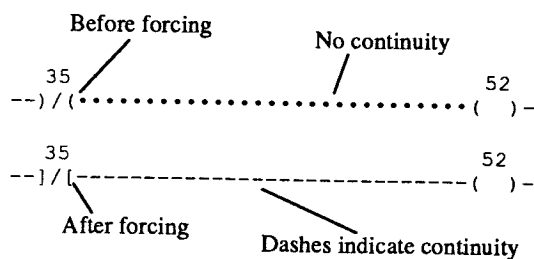


Figure 6-3 Contact Forcing Example

Disabling and Enabling a Coil or Output

A coil or external output must be disabled before forcing can be implemented on that coil or external output. Disabling is defined as disconnecting an LDC's control contacts from its coil or external output. Use the following procedure to utilize the Change Disable State function. The same procedure is used to disable or enable a coil or output.

1. Use the Print command to display the LDC containing the coil or output that you want to disable or enable (press "P" followed by the

coil or statement number, then press Return).

2. Hold the CTRL key down and press the "T" key. The display on the top line will read:

"CHANGE 'DISABLE' STATE Y - N?".

3. Press the "Y" (yes) key. The screen will indicate if the coil is disabled by a disconnected power line from the controlling contacts to the coil or external output.

NOTE

A disabled coil or output remains a permanent part of the LDN until the coil or output is re-enabled.

Search Command (For Disabled Coils)

The Search Command is used to search through the LDN for disabled coils and disabled external outputs. Use the following procedure to utilize the Search Command:

1. Use the Print command to display the first line of the LDN (press "P" followed by the "B" key to indicate you want to start from the beginning of the LDN).
2. Press the "O" key. The center screen will display the first disabled coil or external output in the LDN.
3. Each time you press the "O" key, the next disabled coil or external output will be displayed. This will continue until all of the disabled coils or external outputs in the LDN have been displayed.

Forcing Coils and External Outputs

Coils and external outputs may be forced, on or off, directly from the keyboard when using Real Time Debug. Prior to forcing, coils or external outputs must first be disabled. The procedure for disabling a coil or external output was covered earlier in this section. If forcing is attempted without disabling the coils or external outputs, the change in condition from forcing will be transitory as the PiC will update the LDN in addition to the forcing operation. Use the following procedure to utilize the coil and external output forcing functions:

1. Use the Print command to display the LDC containing the coil or output that you want to force (press "P" followed by the coil, timer coil or statement number and a Return).
2. Hold the CTRL key down and press the "T" key. The display on the top line will read:

"CHANGE 'DISABLE' STATE Y - N?".
3. If the coil or external output is already disabled, press the "N" (no) key. If it is not disabled, press the "Y" (yes) key. The screen will indicate that the coil is disabled by a disconnected power line from the controlling contact to the coil or external output.
4. Press the "M" key (miscellaneous display) and enter one of the letters "A" through "G" that you want to use to designate for the coil or external output. Enter the number of the desired coil, timer coil or external output followed by a Return.
5. When the item appears at the bottom of the screen, hold down the CTRL key and press the letter designated for the coil or output ("A" through "G"). The display will show the coil or external output changing from a de-energized state to an energized state or from an energized state to a de-energized state.

NOTE

Unless the coils and external outputs use the retentive relay Call Routine to retain their condition, all coils and external outputs will return to a de-energized condition if power is removed from the PiC.

Changing Programmed Timer Values

In Real Time Debug, a timer LDC is displayed as a normal LDC with controlling contacts and the timer coil. Directly below the coil symbol are the subscripts TL and TA. TL represents the time limit programmed and TA the time accumulated.

The time limit value may be reprogrammed to a new value. The valid range of timer limit values is 0 through 65,529. The programmed value will remain as a permanent time limit unless it is reprogrammed with a different value. Use the following procedure to program a time limit value:

1. Use the Print command to display the LDC containing the timer coil you want to reprogram (Press "P" followed by the number of the timer coil, then press Return).
2. After the LDC with the timer coil is displayed on the center screen, hold the CTRL key down and press the "Y" key for TE coils or the "H" key for TD coils. The display on the top line will read: "ENTER NEW TIME LIMIT."
3. Enter a new time limit and press the Return key. The new value will be displayed below the timer coil next to the letters TL.

NOTE

If the time limit for a timer coil is a variable instead of a constant (for example: "V12" instead of "250"), the time limit is changed by forcing the variable. Variable forcing is described later in this section.

Time-Energized (TE) Coils

The time limit (TL) is the amount of time power must be applied to the TE coil before the coil will energize. The accumulated time (TA) is the actual amount of time that power has been applied to the coil from a controlling contact. When the values of TA and TL are equal, the coil will energize.

Time-De-Energized (TD) Coils

The time limit (TL) is the amount of time power must be removed from the TD coil before the coil will de-energize. The accumulated time (TA) is the actual amount of time that power has been removed from the coil by a controlling contact. When the values of TA and TL are equal, the coil will de-energize.

Variable Forcing

Variable contents may be forced to change content value. However, this does not inhibit other parts of the LDN from updating variables. As a result, some variables will only be forced for one scan; at which time the variable contents will return to the original value.

To avoid this, you can de-energize the conditional contact for the LET statement(s) controlling the variable or bypass the LET statement(s) controlling the variable with a GOTO statement.

The range of variable values is +8,388,607 to -8,388,608. Variable values outside this range will not be accepted as valid data.

NOTE

Variable values may be either in decimal or hexadecimal form. Using the hexadecimal form requires the number to be preceded by a "\$" sign.

Use the following procedure to utilize the variable forcing function:

1. Press the "M" key. The following top line prompt will appear on the top line of the screen:

MISC. DISPLAY, ENTER LABEL.
2. Press a letter key, "A" - "G". The letter pressed will be displayed on the top line followed by an equal (=) sign.
3. Enter the number of the variable you want to force and press Return.
4. The following information will be displayed on the bottom screen:
 - a. The letter chosen for the display ("A" through "G").
 - b. The number of the variable.
 - c. The contents of the variable shown in a decimal value.
5. When the variable appears at the bottom of the screen, Hold down the CTRL key and press the letter designated for the variable ("A" through "G"). The top line will display the following message:
"ENTER DATA FOR VARIABLE 'XX'."
6. Enter the desired value for the variable and press the Return key. The new value will be displayed at the bottom of the screen.

NOTE

This forced variable value will remain until the LDN updates the variable or you force it to another value.

Unless this variable was designated as a non-volatile variable, its value will be reset to 0 (zero) if power is removed from the PiC.

Function	Key(s) to Press	Description of Function
Display (print) LDC or Statement on Screen	P	To display an LDC or statement on the screen: 1. Press the "P" key. 2. Press the "B" key to start the display at the beginning of the LDN OR enter the statement number of LDC number to display. 3. Press the Return key.
Display Next Line	N	Press "N" to display the next LDC or statement of the LDN.
Display Last Line	L	Press "L" to display the previous LDC or statement of the LDN.
Miscellaneous Display Command	M	To display individual contact, coil, external output, timer variable information on the bottom screen, press the "M" key. After the prompt "MISC. DISPLAY, ENTER LABEL", enter a label ("A" through "G") for the item followed by the number of the item to display (e.g. A="V1" for variable V1, or B="2000" for output 2000) and press the Return key.
Forcing Contacts, Coils and Variables	CTRL A through CTRL G (See Description)	To force a contact, coil, or variable hold down the control (CTRL) key and press the key corresponding to the desired label ("A" through "G"). Note: Coils must be disabled before forcing them.
Change Coil Disable State	CTRL T	Use the display command ("P" key) to display the LDC containing the coil you want to change. To change the disable state of the coil, hold down the control (CTRL) key and press the "T" key. An enabled coil will change to the disabled state and a disabled coil will change to the enabled state.

Real Time Debug Commands
Table 6-2.A
 (continued on next page)

Function	Key(s) to Press	Description of Function
Change a Programmed Timer Value	CTRL Y for TE Timer Coils	Use the display command ("P" key) to display the LDC containing the timer coil you want to modify.
	CTRL H for TD Timer Coils	To change the programmed timer value for a TE timer coil, hold down the control (CTRL) key and press the "Y" key. Enter the new programmed time limit and press the Return key.
		To change the programmed timer value for a TD timer coil, hold down the control (CTRL) key and press the "H" key. Enter the new programmed time limit and press the Return key.
Search for Disabled Coils	O	To search for disabled coils, display the first line of the LDN on the screen (press "P" followed by "B"). Press the "O" key to display the first disabled coil. Press the "O" key each time you want to display the next disabled coil.

Real Time Debug Commands
Table 6-2.B



SECTION 7 - CALL ROUTINE INSTALLER

7.1 INTRODUCTION

This section explains the use of the Call Routine Installer. A Call Routine Installation Worksheet is included at the end of this section to allow the installed Call Routines to be documented. Please make as many copies of the worksheets as necessary to allow you to document the Call Routines you will be installing. It is important that a record be kept of which Call Routines were installed and the order in which they were installed.

Call Routines are subroutines that can be purchased from G&L. They allow advanced control functions to be performed without requiring the user to carry out the necessary programming. Call Routines can be purchased in two forms, either on a floppy disk or in an EPROM contained on the PiCTurbo Processor.

The Call Routine Installer allows the user to choose the Call Routines needed for a specific application from the PiC409 Call Routine Library. By placing only the needed routines in user memory, memory is conserved. Call Routines may be changed at any time by repeating the installation process.

The Call Routine installation procedure consists of three steps:

1. User memory must be allocated for the Call Routines. This step is not necessary if programming is being done off-line (the LDN is created and stored on disk rather than being entered directly into user memory).
2. The desired Call Routines must be stored in user memory either by loading them from floppy disk or by ensuring that the Call Routine EPROM is a part of the PiCTurbo Processor in the system.
3. The Call Routines must be "installed". This step builds up the necessary tables that allow the user LDN to access the Call Routines.

NOTE

The Real Time Debug (RTD) Call Routine is included with all PiCTurbo Processors. This Call Routine is unique because it cannot be copied into user memory. Install Real Time Debug (Library Number C912) using the procedures in Section 7.4, *Installing Call Routines*.

7.2 LOADING CALL ROUTINES FROM FLOPPY DISK

This procedure allows you to load Call Routines from a floppy disk into user memory in the PiC. The procedure assumes that you are using an IBM or IBM-compatible personal computer and GLLADD software to communicate with the PiC.

1. Allocate sufficient memory to receive the Call Routines being loaded. The Allocate command is explained in Section 3.
2. Display the Aux 1 menu.
If you are unfamiliar with the required procedure, refer to Section 2.2.
3. Enter a "6" and press Return to display the Aux 2 menu. The PiC will display the following menu:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I/O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

4. When the AUX 2 Menu appears on the screen, remove the GLLADD disk from the

system drive (if you are using a dual floppy system, this will be drive A) and replace it with the floppy disk containing the Call Routines.

5. Enter a "3" and press Return to select the Call Routine Installer from the AUX 2 Menu. The following will be displayed:

```
GIDDINGS & LEWIS PICTURBO
CALL ROUTINE INSTALLER (C) 1988
VERSION 1.X
```

*

6. Press "L" key to load the first Call Routine.
7. When the computer asks for a file name, enter the name of the Call Routine to be loaded (for example: "A110" or "D120"), followed by a Return.
8. Repeat this process until you have loaded all of the Call Routines needed for your LDN.
9. When the desired Calls have been loaded, press ESC to return to the "*" prompt. Replace the Call Routine Disk in the system drive with your GLLADD disk.

The Call Routines are now ready to be installed as described in Section 7.4.

NOTE

If insufficient user memory was allocated before loading the Call Routines, the following error message will be displayed:

___ BYTES ALLOCATED ___ REQUIRED.

Enter the Program mode and allocate the additional memory required. Reenter the Call Routine Installer and enter "/L" (SLASH key, L key) in response to the asterisk prompt: *. This allows the user to continue loading Call Routines without starting over.

7.3 CALL ROUTINES STORED IN EPROM

If the PiCTurbo Processor version that includes Call Routines on EPROM is being used, the Call Routines do not have to be copied into user memory. The memory allocation can be set to "0" and the Call Routines can be installed as described in Section 7.4.

7.4 INSTALLING CALL ROUTINES

Other than the RTD Call Routine (C912), Call Routines that are going to be used in an application must be installed. Use the following procedure to install Call Routines.

1. Display the Aux 1 menu. If you are unfamiliar with the procedure for doing this, refer to Section 2.2.
2. Enter a "6" and press Return to display the Aux 2 menu. The PiC will display the following menu:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM
MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I/O TABLE BACK-
UP
- 6 - DIAGNOSTICS

SELECT (1-6)

3. Enter a "3" and press Return to select the Call Routine Installer. The following will be displayed:

```
GIDDINGS & LEWIS PICTURBO
CALL ROUTINE INSTALLER (C) 1988
VERSION 1.X
```

*

4. Enter an "I" (for Install). The PiC will display the following:

INSTALL CALL 1 LIBRARY NUMBER?

5. Enter the library number of the first Call Routine to be installed and press Return.

The PiC will display the accompanying version and group numbers; then it will prompt for the next call.

6. Continue entering the library numbers of the Call Routines to be installed (and pressing Return) until they are all installed.
7. Before concluding the Install process, fill out the Call Routine worksheet at the back of this chapter. The Call Routine worksheet provides a record of which Call Routines were installed and the order in which they were installed. This record is required in case you ever need to update or reinstall the Call Routines.

When filling out the worksheet, *list the Call Routines in the same order that they were installed!* The Call Routines must be installed in the same sequence as the original procedure or the LDN will not be compatible with the Call Routines.

8. Press ESC to exit the Install process.

7.5 REINSTALL PROCEDURE

Additional standard or non-standard Call Routines may be added to user memory at any time. However, because Calls have already been installed, the Install command is locked out. To install additional calls, the Reinstall command is used. First the Call Routines that were previously installed are reinstalled by the PiC, then the PiC prompts the programmer to add the new Call Routines to the existing list.

Before using the Reinstall process, make certain that the additional Call Routines to be installed have been loaded into user memory from disk or are on the PiCTurbo Processor Call Routine EPROM. Carry out the following procedure to reinstall the Call Routines.

1. Access the Aux 2 Menu from the Aux 1 Menu.

2. Choose Selection 3 (Call Routine Installer) from the Aux 2 Menu and press Return. The following will be displayed:

```
GIDDINGS & LEWIS PICTURBO  
CALL ROUTINE INSTALLER (C) 1988  
VERSION X.X
```

*

3. Type "R" (for Reinstall) and press Return. The PiC will scroll to display the Call Routines that have already been installed. While this process takes place, the Call Routines listed are being reinstalled.

The last entry in the list of reinstalled Call Routines is as follows:

CALL X LIBRARY NUMBER?

4. Enter the library number of the first additional Call Routine to be installed and press Return. Entering a duplicate library number will result in an error message.

The PiC will display the accompanying version and group numbers; then it will prompt for the next call.

5. Continue entering the library numbers of the Call Routines to be installed until they are all installed.

6. Before exiting the reinstall process, add the new Call Routines to the Call Routine worksheet at the back of this chapter. The Call Routine worksheet provides a record of which Call Routines were installed and the order in which they were installed. This record is required in case you ever again need to update or reinstall the Call Routines.

When filling out the worksheet, *list the Call Routines in the same order that they were installed!* The Call Routines must be installed in the same sequence as the original procedure or the LDN will not be compatible with the Call Routines.

7. Press ESC to exit the Reinstall process.

7.6 UPDATING CALL ROUTINES IN USER MEMORY

Call Routines in user memory can be updated by replacing them with the newer versions. The newer versions of the Call Routines can be loaded from a floppy disk. To update existing Call Routines, follow steps 1 through 6 and then choose option one or option two to finish.

1. Make a backup copy of your LDN before you begin.
2. Enter the CALL ROUTINE INSTALLER from the AUX 2 mode.
3. Reinstall by entering "R" and press Return. A list of the Call Routines that are presently installed will scroll on the screen.
4. On the Call Routine Worksheet found at the end of this chapter, write down the Call Routines that are presently installed in the same order in which they appear on the screen. This is the order in which they reside in user memory.
5. Press "ESC".
6. Enter "/INIT". This brings up the following message (referring to steps 1 and 4 above):
INITIALIZING THE CALL ROUTINE INSTALLER AFTER INSTALLING AND
DEVELOPING AN LDN IS NOT RECOMMENDED. IF IT MUST BE DONE MAKE SURE
A BACKUP OF THE LDN EXISTS AND THAT THE INSTALLER WORKSHEETTS HAVE
BEEN FILLED OUT.
ARE YOU SURE?

Enter a "Y" and press Return.

Go on to step 7 in option one or two on the next page.

CONTINUE WITH OPTION ONE OR TWO BELOW.

Option One (PiC)

7. If using calls on disk, they must now be loaded following the procedure in Section 7.2.

For calls on EPROM, proceed to step 8.

8. Enter "I" for install. The PiC will display the following message:
INSTALL CALL 1 LIBRARY NUMBER?
9. Referring to your worksheet, enter the number of the first Call Routine to be installed and press Return. The PiC will display the accompanying version and group numbers; then it will prompt you for the next call.
10. Continue to enter library numbers of the Call Routines to be installed (pressing Return after each one) until they are all installed. *Make sure that the calls are entered in the same order they had been in user memory and that no calls are missed!*
11. Press ESC to exit the Install mode. CTRL Q will return you to the main menu. Make a backup copy of the updated program.

Option Two (Using GLLADD)

7. Return to the main menu with CTRL Q. Enter the Program mode. Enter "A" for allocate, enter the number "0," and press Return.
8. Return to the main menu with CTRL Q. Record the LDN using a different name than the backup copy. The link table is now empty so do not attempt to run your program.
9. Return to GLLADD with ALT F10. Select the Edit function (F1). Follow the GLLADD prompts.
10. Enter the AUX function (F8). Select Install Call Routines (F5). Follow the GLLADD prompts. Respond to install individually (I).
11. Type in the names of the calls. *Make sure that the calls are entered in the same order they had been in user memory and that no calls are missed!* When all the calls have been re-entered, load the LDN back into PiC memory through the AUX 1 mode. Go to the Call Installer and do a Reinstall (R). This will adjust the links to the actual addresses in the PiC.

7.7 ERROR MESSAGES

Table 7-1 shows error messages, the modes where these messages occur and a suggested cause of the problem.

<u>Error Message</u>	<u>Mode</u>	<u>Remedy</u>
Error 1 CALLS ALREADY INSTALLED USE REINSTALL	Install Mode	Use "R" key instead of "I" key.
Error 2 THIS CALL ALREADY INSTALLED	Install and Reinstall Modes	No further action required.
Error 4 CALL BINARY CHECKSUM ERROR	Install, Reinstall, Copy, and Load Modes	Call G&L Electronics factory.
Error 5 CALL BINARY NOT FOUND	Install, Reinstall and Copy Modes	Load Call Routine into user memory.
Error 6 CALL IN THIS GROUP ALREADY INSTALLED	Install and Reinstall Modes	This Call is incompatible with a previously installed Call. Do not install this Call or clear existing Calls and replace them with compatible Calls.
Error 7 NOT ENOUGH ASSIGNABLE RAM	Install and Reinstall Modes	You have too many Call Routines loaded into user memory. Clear Calls and load only the ones that you need for your LDN.
Error 8 FOREGROUND LINKAGE TABLE FULL	Install and Reinstall Modes	You have too many Call Routines that require foreground linkages. Use fewer Call Routines.
Error 9 TAPE I/O ERROR	Load Mode	This error indicates a bad Call Routine disk. Use another copy of the Call Routines.
Error 11 CALL ALREADY IN USER MEMORY	Load or Copy Modes	No further action required.

**Table 7-1.A Error Message Indications
(continued next page)**

<u>Error Message</u>	<u>Mode</u>	<u>Remedy</u>
Error 12 BYTES ALLOCATED BYTES REQUIRED	Load or Copy Modes	Insufficient memory space was allocated for Call Routines. Go to the PROGRAM Mode and allocate more memory using the "A" (allocate) command. Return to the Call Routine Installer and enter a "/L" if you are loading from disk.
Error 13 COPY TO USER MEMORY FAILED	Load or Copy Modes	Turn memory module write-protect switch off. If it is already off, replace memory module.
Error 14 SINT ERR	Any Mode	Correct problem with serial communications interface.

Table 7-1.B Error Message Indications

Call Routine Worksheet

Call Routine	Library Number	Version	Description	Memory Used (Bytes)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

SECTION 8 - MESSAGE FORMATTER

8.1 INTRODUCTION

This section explains the use of the Message Formatter. The Message Formatter is a program that arranges user-defined messages in PiC memory. The Message Formatter resides in EPROM on the PiCTurbo Processor.

Messages are used in conjunction with Call statements in the LDN and can be formatted in ASCII (American Standard Code for Information Interchange) or hexadecimal form. They are referenced by user-assigned message numbers and can be sent out the serial port. They are typically displayed on a CRT or keyboard/video display programming terminal (G&L supports the Lear Siegler). Messages are stored in user memory above the LDN memory area.

Features of the Messages Formatter include the ability to insert, delete, edit, renumber, and print up to 255 messages. Messages may be up to 254 characters in length.

NOTE

Messages created using the Message Formatter are controlled by certain Call Routines. Refer to the PiC409 Family Standard Call Routine Manual for application notes concerning the Message Call Routines.

8.2 ENTERING THE MESSAGE FORMATTER

1. Display the Aux 1 menu. If you are not familiar with the procedure for doing this, refer to Section 2.2.
2. Enter a "6" and press Return to display the Aux 2 menu. The PiC will display the following menu:

AUX 2 MENU

- 1 - MESSAGE FORMATTER
- 2 - TERMINAL BAUD RATE AND SYSTEM MEMORY CONFIGURATION
- 3 - CALL ROUTINE INSTALLER
- 4 - BANK SELECT
- 5 - VARIABLE, CR OR I\O TABLE BACK-UP
- 6 - DIAGNOSTICS

SELECT (1-6)

3. Enter a "1" and press Return to select the Message Formatter. The following will be displayed:

GIDDINGS & LEWIS PC409
MESSAGE FORMATTER VERSION 1.X

#

4. You are now ready to enter the desired commands and messages. The necessary procedures are explained in Section 8.3.
5. To exit the Message Formatter, hold down the CTRL key and press "Q". You will return to the Aux 1 Menu.

8.3 KEY COMMANDS

Message Formatter functions are initiated via key commands. The cross hatch (#) prompt indicates the Message Formatter is ready to receive a command. If incorrect entries are made or if additional information is required, the PiC will provide prompts to assist in proper message creation.

A summary of the key commands can be found in Table 8-2. It is recommended that you read this section thoroughly before referring to the table, however, since the command explanations in this section contain information that is not repeated in the summarized table.

Insert (I Key) Command

The I (Insert) command is used to create new messages. You must first select an identification number for the message (between 1 and 255). If the message number already exists in memory, an error message will be displayed.

After the prompt "#", press the "I" key, enter an identification number for the message and press the Return key.

Type in the message that you want to use. Up to 254 characters are permitted. Return characters can be used for messages that contain more than one line.

When your message is complete, press the ESC (escape) key. The PiC will display the message to verify that it is in user memory.

The following example illustrates the keystrokes required to create a new message. The number 10 was selected as the identification number and the message itself is "THIS IS MESSAGE 10."

NOTE

Although both upper and lower case characters are permitted, use the upper case mode when creating messages for a video monitor (CRT) using the G&L Video Memory and Video Interface Modules. True lower case letters are not available with this equipment setup.

Both upper and lower case characters are permitted when using a programming terminal with lower case capability.

PiC Prompt	Response
#.....	Type "I", type "10", press Return
10*	Type "THIS IS MESSAGE 10", press ESC

PiC display: "10 THIS IS MESSAGE 10".

Delete (D Key) Command

This command is used to delete messages created by the insert command. Only one message may be deleted at a time. To delete a message, press the "D" key and type in the message number after the "#" prompt. The PiC will acknowledge that

the message was deleted. If the message number entered does not exist in memory, an error message will be displayed.

The following example shows the keystrokes required to delete a message. In this case, the message identification number is 20.

PiC Prompt	Response
#.....	Type "D", type "20", press Return

PiC display: "MESSAGE DELETED".

#

Edit (E Key) Command

You can change an existing message by using the Edit command. To edit a message, press the "E" key followed by the message number and a Return.

The message number and the message will appear on the screen.

Retype the message with the changes that you want to implement. When you are finished, press the ESC (escape) key to enter the new message into user memory.

The following example shows the keystrokes required to edit example message 10. The message will be changed from "THIS IS MESSAGE 10" to "THIS WAS MESSAGE 10."

NOTE

If no message exists in user memory for the number you entered, the error message "MESSAGE DOES NOT EXIST" will be displayed on the screen.

PiC Prompt

Response

#.....Type "E", type "10", press Return

10 THIS IS MESSAGE 10

10*.....Type "THIS WAS MESSAGE 10", press ESC

PiC display: "10 THIS WAS MESSAGE 10".

Renumber (R Key) Command

This command is used to change the identification number of a message in user memory. To renumber a message, press the "R" key and type in the message number followed by a Return after the prompt #. The prompt "CHANGE TO?" will appear. Enter the new message number and press the Return key. The message and its new number will be displayed on the screen.

The following example shows the keystrokes required to renumber a message. In this case, the message 10 will be renumbered to message 100.

NOTE

The PiC will display an error message if you attempt to renumber a message that does not exist or if you renumber a message to another number that is already in use or out of range.

PiC Prompt	Response
#.....	Type "R", type "10", press Return
CHANGE TO?	Type "100", press Return

PiC display: "100 THIS WAS MESSAGE 10".

Print (P Key) Command

The Print command will display your messages on the screen. After the prompt "#", press the "P" key followed by the number of the message you want to display. Press the Return key. The message will be displayed.

If the message does not exist in user memory, the error message "MESSAGE DOES NOT EXIST" will appear on the screen.

To display all of the messages in user memory, enter a "0" (zero) instead of a message number. The print command is the only command that will recognize "0" as a valid message number entry.

Help (H Key) Command

This command lists the Message Formatter commands. Press "H" followed by a Return to display the following list on your screen.

I:	INSERT
D:	DELETE
E:	EDIT
R:	RENUMBER
P:	PRINT (display)
F:	FORMAT CRT
CONTROL X:	ENABLES HEXADECIMAL DATA ENTRY

Format (F Key) Command

The FORMAT Command allows you to change the size of the characters displayed on a video monitor (CRT). This command applies only to messages displayed on a video monitor using the G&L Video Memory and Video Interface Modules.

After the prompt "#", press the "F" key followed by a Return. The current format will be displayed and a menu of popular display configurations will be presented. You can choose a new configuration by entering the menu choice followed by a Return or retain the current format by entering only a Return.

Options 1, 2 and 3 can be used to select the following formats.

Option 1 - 16 horizontal lines with 32 characters per line.

Option 2 - 18 horizontal lines with 40 characters per line.

Option 3 - 16 horizontal lines with 64 characters per line.

If you do not want to change the present format, press the Return key without entering any number.

If a configuration not available on the menu is desired, select option 0 followed by a Return. When the prompt "CRT*" appears, you must make exactly 17 entries from the CRT Constants Table (Table 8-1). Non-hexadecimal characters are ignored. After each set of two digits is

entered, only the ESC, DEL, or Comma keys are accepted.

The following example illustrates the keystrokes required to display messages in a format consisting of 16 horizontal lines with 40 character per line.

PiC Prompt	Response
#.....	Type "F", press Return
CRT CONFIGURED 32 X 16	
CONFIGURE CRT - CHOOSE ONE OF THE FOLLOWING:	
0:	USER DEFINED CONSTANTS
1:	32 X 16
2:	40 X 18
3:	64 X 16
CARRIAGE RETURN: ACCEPT CURRENT FORMAT	
ENTER NUMBER:.....	Type "0", press Return
CRT*	Type the following: \$31,\$28,\$2B,\$42,\$10,\$07,\$10, \$10,\$00,\$0E,\$00,\$0E,\$00,\$00, \$00,\$00,\$55,ESC
CRT CONFIGURED 40 X 16	
#	

DEL Command

The DEL (delete) command allows you to delete unwanted message or command characters. It is especially useful for correcting errors made while typing in messages.

Escape (ESC Key) Command

Pressing the ESC Key terminates an Insert or Edit command and enters the new message into memory. The ESC Key is also used to return to the command level when the user is being

prompted for a message number. If the ESC character (Hex \$1B) must be included in a message, the Hexadecimal Data Entry Mode must be used.

Hexadecimal Messages (CTRL X) Command

Hold down the CTRL (control) key and press the "X" key to enter the Hexadecimal Data Entry Mode. This command is used only in the Insert or Edit modes.

12.576 MHz Crystal (same as supplied with standard G&L Video Interface Modules)

32 Characters per line 8 horizontal lines

\$27,	\$20,	\$22,	\$42,	\$08,	\$01,	\$08,	\$08,	\$00,	\$1C,	\$00,	\$1C,	\$00,	\$00,	\$00,	\$00,	\$D3

32 Characters per line 10 horizontal lines

\$27,	\$20,	\$22,	\$02,	\$0A,	\$0A,	\$0A,	\$0A,	\$00,	\$1B,	\$20,	\$0E,	\$00,	\$00,	\$00,	\$00,	\$D3

40 Characters per line 16 horizontal lines

\$31,	\$28,	\$2B,	\$42,	\$10,	\$07,	\$10,	\$10,	\$00,	\$0E,	\$00,	\$0E,	\$00,	\$00,	\$00,	\$00,	\$55

40 Characters per line 20 horizontal lines

\$31,	\$28,	\$2B,	\$42,	\$14,	\$0A,	\$14,	\$14,	\$00,	\$0B,	\$00,	\$0A,	\$00,	\$00,	\$00,	\$00,	\$55

80 Characters per line 24 horizontal lines

\$63,	\$50,	\$55,	\$45,	\$19,	\$02,	\$18,	\$18,	\$00,	\$09,	\$00,	\$09,	\$00,	\$00,	\$00,	\$00,	\$1D

6.288 MHz Crystal

16 Characters per line 8 horizontal lines

\$13,	\$10,	\$12,	\$41,	\$08,	\$01,	\$08,	\$08,	\$00,	\$1C,	\$00,	\$1C,	\$00,	\$00,	\$00,	\$00,	\$D3

32 Characters per line 16 horizontal lines

\$27,	\$20,	\$22,	\$42,	\$10,	\$07,	\$10,	\$10,	\$00,	\$0E,	\$00,	\$0E,	\$00,	\$00,	\$00,	\$00,	\$13

16.000 MHz Crystal

80 Characters per line 20 horizontal lines

\$65,	\$50,	\$55,	\$48,	\$14,	\$09,	\$14,	\$14,	\$00,	\$0B,	\$00,	\$0B,	\$00,	\$00,	\$00,	\$00,	\$1B

90 Characters per line 24 horizontal lines

\$70,	\$5A,	\$62,	\$49,	\$19,	\$02,	\$18,	\$18,	\$00,	\$09,	\$00,	\$09,	\$00,	\$00,	\$00,	\$00,	\$1C

116 Characters per line 25 horizontal lines

\$90,	\$74,	\$7C,	\$4B,	\$1C,	\$02,	\$19,	\$19,	\$00,	\$08,	\$00,	\$08,	\$00,	\$00,	\$00,	\$00,	\$1E

TABLE 8-1 CRT CONSTANTS

Function	Key(s) to Press	Description of Function
Insert New Messages	I	Press the "I" key and enter the message number followed by a Return. Type in the message. Press ESC to finish.
Delete Messages	D	Press the "D" key and enter the number of the message to delete. Press the Return key.
Edit Messages	E	Press the "E" key followed by the message number. Press the Return key and type in a new message. Press ESC to finish.
Renumber Messages	R	Press the "R" key followed by the existing message number. Press the Return key and type in a new message number. Press the Return key.
Display (print) a Message	P	Press the "P" key followed by the message number and a Return. To display all of the messages, press the "0" (zero) key instead of a message number.
Display Command List (Help Screen)	H	Press the "H" key followed by a Return. A list of the Message Formatter commands will be displayed on the screen.
Configure Message Display Unit	F	To configure the message display format, press the "F" key followed by a Return. Enter the number (from 0 to 4) or a Return as shown in the configuration menu. Entering a 1, 2, or 3 will select the format indicated in the menu. Entering a "0" requires typing in 17 hexadecimal entries. Press the Return key to leave the format as it is.
Delete a Character	DEL	Press the DEL key to delete the character immediately to the left of the cursor. Enter the correct item in its place.
Enter Hexadecimal Data	CTRL X	To enter hexadecimal data instead of standard ASCII characters, hold down the CTRL key and press "X" just before inserting characters. Entries must be valid hexadecimal numbers. Hex entry works with the Insert and Edit commands.

Table 8-2 Message Formatter Commands

8.4 HEXADECIMAL DATA ENTRY

Hexadecimal data may be entered directly as a message while in the Insert or Edit modes. This mode of entry allows the user to incorporate non-standard ASCII and control characters into a message. This is accomplished by responding to the Insert or Edit prompts "*" with a "Control X" (hold down the CTRL key and press the X key) before entering your message characters (or data).

Message Data must than be entered in two-digit hexadecimal form with a comma separating each item. The PiC automatically generates a dollar sign (\$) symbol to indicate a hex entry. The message will be displayed on the screen in hex form when the ESC key is pressed.

The following example demonstrates how to insert a hexadecimal message. The message identification number will be 20 and the message itself will be the hexadecimal data 1B, 38. The PiC generates the "\$" symbol that indicates a hex entry.

PiC Prompt	Response
#.....	Type "I", type "20", press Return
20*	Press CTRL, type "X", then "1B,38", press ESC

PiC display: "20 \$1B,\$38".
 #

NOTE

Do not use the Hex character \$FF in a hexadecimal message.

8.5 ERROR MESSAGES

The error messages listed in Table 8-3 will appear if an incorrect entry is made or if there is insufficient memory.

NOTE

A Message Overflow occurs when the number of characters entered in the Insert or Edit modes exceed 254 (including Returns). If an Out of Memory error occurs in the Insert or Edit modes, the message will not be created. Other provisions must be made if more message storage is desired, such as deletion of unimportant messages, combining several messages into one, or adding more memory.

8.6 MEMORY CONSERVATION

Use of the lowest message numbers is encouraged. Using the highest message number (255) will result in the allocation of 510 bytes of additional memory, as compared to an allocation of only 2 bytes of additional memory for the lowest message number (1). This is in addition

the memory required for the messages and other program overhead. Actual memory usage may be computed by using the following formula:

$$M = (N*2) + (X) + (T) + 25$$

Where M = The total number of bytes allocated to the message file.

N = The highest message number used.

X = The actual number of messages created.

T = The number of message characters entered.

Error Message	When Used	Remedy
MESSAGE ALREADY EXISTS	Insert, Renumber	Enter an unused message number.
MESSAGE DOES NOT EXIST	Delete, Edit, Renumber, Print	Enter the number of an existing message.
MESSAGE OVERFLOW	Insert, Edit	Limit message to 254 characters or less.
OUT OF MEMORY	Insert, Edit	Add more memory, use lowest message numbers, clear unnecessary data.
REENTER NUMBER OR ESC	Insert, Delete, Edit, Renumber, Print	Enter correct number or the ESC key to quit.
NUMBER OUT OF RANGE	Insert, Delete, Edit, Renumber, Print	Use a message number from 1 to 255.
INVALID ENTRY	Insert, Delete, Edit, Renumber, Print	Enter valid characters (or hex data if applicable).

Table 8-3 Error Messages



APPENDIX A

VARIABLE ALLOCATION CHART



VARIABLE ALLOCATION CHART

Fill in the variable numbers used in your LDN as shown in the example.

EXAMPLE

VARIABLE ALLOCATION CHART

Program Name 68L Ladder Diagram

VARIABLES 300 THROUGH 399

3 _ _	0	10	20	30	40	50	60	70	80	90
0	300					350	360			
1	301					351	361			
2	302					352	362			
3	303					353	363			
4						354	364			
5		315				355	365			
6		316				356				
7		317				357				
8						358				
9						359				

VARIABLE ALLOCATION CHART

Program Name _____

VARIABLES 0 THROUGH 99

0 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 100 THROUGH 199

1 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 200 THROUGH 299

2 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLE ALLOCATION CHART

Program Name _____

VARIABLES 300 THROUGH 399

3 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 400 THROUGH 499

4 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 500 THROUGH 599

5 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLE ALLOCATION CHART

Program Name _____

VARIABLES 600 THROUGH 699

6 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 700 THROUGH 799

7 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

VARIABLES 800 THROUGH 899

8 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

APPENDIX B

STATEMENT NUMBER ALLOCATION CHART



STATEMENT NUMBER ALLOCATION CHART

Fill in the statement numbers used in your LDN as shown in the example.

EXAMPLE

STATEMENT NUMBER ALLOCATION CHART

Program Name 68L Ladder Diagram

STATEMENT NUMBERS 2300 THROUGH 2399

23 _ _	0	10	20	30	40	50	60	70	80	90
0	2300	2310	2320	2330	2340	2350	2360	2370	2380	
1	2301					2351	2361			
2	2302					2352	2362			
3	2303					2353	2363			
4	2304					2354				
5	2305					2355				
6	2306					2356				
7	2307					2357				
8						2358				
9						2359				

STATEMENT NUMBER ALLOCATION CHART

Program Name _____

STATEMENT NUMBERS 2300 THROUGH 2399

23 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 2400 THROUGH 2499

24 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 2500 THROUGH 2599

25 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBER ALLOCATION CHART

Program Name _____

STATEMENT NUMBERS 2600 THROUGH 2699

26 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 2700 THROUGH 2799

27 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 2800 THROUGH 2899

28 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBER ALLOCATION CHART

Program Name _____

STATEMENT NUMBERS 2900 THROUGH 2999

29 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 3300 THROUGH 3399

33 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 3400 THROUGH 3499

34 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBER ALLOCATION CHART

Program Name _____

STATEMENT NUMBERS 3500 THROUGH 3599

35 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 3600 THROUGH 3699

36 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 3700 THROUGH 3799

37 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBER ALLOCATION CHART

Program Name _____

STATEMENT NUMBERS 3800 THROUGH 3899

38 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

STATEMENT NUMBERS 3900 THROUGH 3999

39 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

APPENDIX C

CONTROL RELAY ALLOCATION CHART



CONTROL RELAY ALLOCATION CHART

Fill in the control relays used in your LDN as shown in the example.

EXAMPLE

CONTROL RELAY ALLOCATION CHART

Program Name 60L Ladder Diagram

CONTROL RELAYS 300 THROUGH 399

3 _ _	0	10	20	30	40	50	60	70	80	90
0	300	310	320	330	340	350				
1	301					351				
2	302					352				
3	303					353				
4	304									
5	305		325	335	345	355				
6	306									
7	307									
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 0 THROUGH 99

0 _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 100 THROUGH 199

1 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 200 THROUGH 299

2 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 300 THROUGH 399

3 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 400 THROUGH 499

4 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 500 THROUGH 599

5 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART _

Program Name _____

CONTROL RELAYS 600 THROUGH 699

6 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 700 THROUGH 799

7 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 800 THROUGH 899

8 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 900 THROUGH 999

9 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1000 THROUGH 1099

10 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1100 THROUGH 1199

11 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 1200 THROUGH 1299

12 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1300 THROUGH 1399

13 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1400 THROUGH 1499

14 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 1500 THROUGH 1599

15 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1600 THROUGH 1699

16 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1700 THROUGH 1799

17 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART

Program Name _____

CONTROL RELAYS 1800 THROUGH 1899

18 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 1900 THROUGH 1999

19 _ _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 3000 THROUGH 3099

30 _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 3100 THROUGH 3199

31 __	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 3200 THROUGH 3255

32 __	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 3000 through 3255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 4000 THROUGH 4099

40_	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 4100 THROUGH 4199

41__	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 4200 THROUGH 4255

42__	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 4000 through 4255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 5000 THROUGH 5099

50_	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 5100 THROUGH 5199

51__	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 5200 THROUGH 5255

52__	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 5000 through 5255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 6000 THROUGH 6099

60 _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 6100 THROUGH 6199

61 _	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 6200 THROUGH 6255

62 _	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 6000 through 6255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 7000 THROUGH 7099

70_	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 7100 THROUGH 7199

71__	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 7200 THROUGH 7255

72__	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 7000 through 7255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 8000 THROUGH 8099

80_	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 8100 THROUGH 8199

81_	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 8200 THROUGH 8255

82_	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 8000 through 8255 are available for control relays only if they have not been assigned as I/O addresses.

CONTROL RELAY ALLOCATION CHART*

Program Name _____

CONTROL RELAYS 9000 THROUGH 9099

90 __	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 9100 THROUGH 9199

91 __	0	10	20	30	40	50	60	70	80	90
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

CONTROL RELAYS 9200 THROUGH 9255

92 __	0	10	20	30	40	50
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						

*Addresses 9000 through 9255 are available for control relays only if they have not been assigned as I/O addresses.



APPENDIX D

ERROR MESSAGES



SYSTEM ERROR MESSAGES

Error Message	Caused By	Corrective Action
SSE Error	Statement Syntax Error. Invalid or improper data entered	Reenter using correct data or format.
DUP Error	Attempting to enter a coil or statement number already used in a ladder diagram.	Assign a new number to the statement or coil.
LDN Error	Invalid or missing op code.	Reload LDN from tape or disk.
MKB Error	Memory check did not indicate memory in full 1 K increments.	Replace memory module(s).
CSM Error	Memory check-sum error. Invalid or missing user's program in memory.	Reload LDN from tape or disk or reinitialize the PIC and reenter the LDN.
OVF Error	Program too large for available memory.	Turn write protect switches off, install more memory or shorten program.
WRT Error	System cannot write into memory location. The location will be displayed in the hexadecimal format.	Replace memory modules
Not Found	System not able to find coil or statement identified by number entered.	Use proper number to identify coil or statement.
Invalid User memory	Entering runtime initialize portion of compiler with a checksum error active.	You must clear user memory while in the runtime initialization mode.
ALOC Error	Allocation in excess of 32,768 bytes.	Allocate Call Routine memory within 32K.
INV Error	Timer number in excess of 511.	Assign a timer number within 511 limit.
SOR Error	Statement number not between 2300 to 2999 or 3300 to 3999.	Assign proper statement number within correct range.
	Call Routine not installed.	Install the Call Routine.
SINT Error	RS-232C Module not addressed at #2236.	Change address of RS-232C Module to #2236.
	Printer not on line.	Check printer connection. Turn SEL on.



APPENDIX E

EXECUTION TIMES AND MEMORY USAGE



EXECUTION TIMES AND MEMORY USAGE

Instruction	Execution Time in Microseconds (μ SEC)	Size (bytes)
SET Statement with <, <=, >, >=, <> or ><.	38	22 bytes plus 3 bytes per constant.
SET Statement with = operation.	38	22 bytes plus 3 bytes per constant.
SET Contact Not True	10	22 bytes plus 3 bytes per constant.

LET Statement with addition or subtraction (+ or -).	31	22 bytes plus 3 bytes per constant.
LET Statement with multiplication (*).	94	22 bytes plus 3 bytes per constant.
LET Statement with division (/).	† see below	22 bytes plus 3 bytes per constant.
LET Contact not true.	10	22 bytes plus 3 bytes per constant.

† Any number divided by a one-byte number is executed in 915 μ Sec.
Any number divided by a two-byte number is executed in 399 μ Sec.
Any number divided by a three-byte number is executed in 140 μ Sec.

GOTO Contact true	19	16 bytes
GOTO Contact not true	10	16 bytes

CALL Contact True	Depends on Call	16 bytes plus 3 per parameter plus 3 for each parameter that is a constant.
CALL Contact Not True	10	16 bytes plus 3 per parameter plus 3 for each parameter that is a constant.

NOTE: When used in a statement, constants consume 3 bytes of memory. For example, a Call Routine may have 2 parameters; one a variable and the other a constant. Each parameter consumes 3 bytes and the constant consumes an additional 3 bytes (for a total of 9 bytes).

N.O. or N.C Contacts.	1.67	3 bytes
Coil	1.67	3 bytes
Timer Coil (TE or TD)	43.42	3 bytes
Branch	2.67	4 bytes

EXAMPLE

The following example illustrates a time and memory usage calculation for a typical LDC and statement. Refer to FIGURE 1.

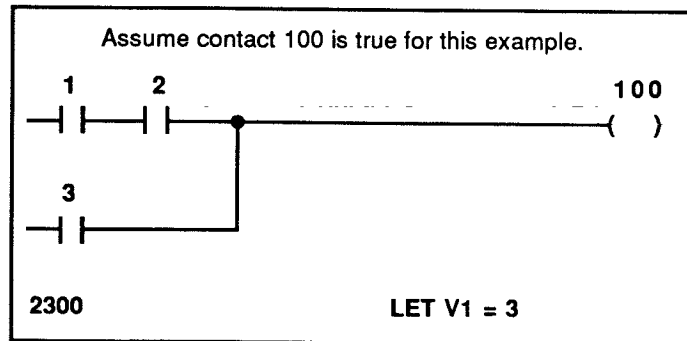


FIGURE 1 TIME-MEMORY CALCULATION

Instruction	Execution Time (uSEC)	Memory Used (bytes)
Contact 1	1.67	3
Contact 2	1.67	3
Contact 3	1.67	3
Branch	2.67	4
Coil	1.67	3
Let	31	22
Constant	—	3
*Implied Constant	—	3
Total	40.35	44

*When a statement such as "LET V1 = 3" is carried out, the PiC actually carries out an implied addition (in this case "LET V1 = 3 + 0"). The implied addition is where the implied constant originates.

APPENDIX F

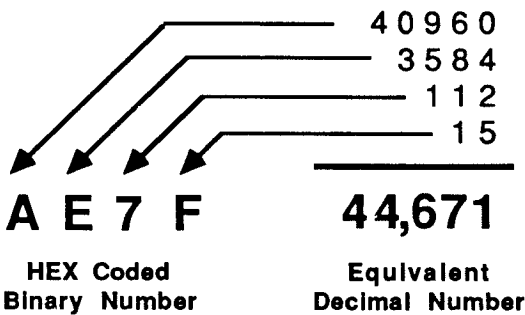
HEXADECIMAL AND DECIMAL CONVERSION



HEXADECIMAL AND DECIMAL CONVERSION CHART

THOUSANDS		HUNDREDS		TENS		UNITS	
HEX	Decimal	HEX	Decimal	HEX	Decimal	HEX	Decimal
0	0	0	0	0	0	0	0
1	4096	1	256	1	16	1	1
2	8192	2	512	2	32	2	2
3	12288	3	768	3	48	3	3
4	16384	4	1024	4	64	4	4
5	20480	5	1280	5	80	5	5
6	24576	6	1536	6	96	6	6
7	28672	7	1792	7	112	7	7
8	32768	8	2048	8	128	8	8
9	36864	9	2304	9	144	9	9
A	40960	A	2560	A	160	A	10
B	45056	B	2816	B	176	B	11
C	49152	C	3072	C	192	C	12
D	53248	D	3328	D	208	D	13
E	57344	E	3584	E	224	E	14
F	61440	F	3840	F	240	F	15

EXAMPLE: Find the decimal equivalent of the Hexadecimal number AE7F.





APPENDIX G

ASCII CODE



ASCII CODE

Decimal Number	HEX Code	Char.	Definition
0	00	NUL	Null
1	01	SOH	Start of Heading
2	02	STX	Start of Text
3	03	ETX	End of Text
4	04	EOT	End of Transmission
5	05	ENQ	Enquiry
6	06	ACK	Acknowledge
7	07	BEL	Bell or Alarm
8	08	BS	Backspace
9	09	HT	Horizontal Tabulation
10	0A	LF	Line Feed
11	0B	VT	Vertical Tabulation
12	0C	FF	Form Feed
13	0D	CR	Carriage Return
14	0E	SO	Shift Out
15	0F	SI	Shift In
16	10	DLE	Data Link Escape
17	11	DC1	Device Control 1
18	12	DC2	Device Control 2
19	13	DC3	Device Control 3
20	14	DC4	Device Control 4
21	15	NAK	Negative Acknowledge
22	16	SYN	Synchronous Idle
23	17	ETB	End of Transmission Block
24	18	CAN	Cancel
25	19	EM	End of Medium
26	1A	SUB	Substitute
27	1B	ESC	Escape
28	1C	FS	File Separator
29	1D	GS	Group Separator

Decimal Number	HEX Code	Char.	Definition
30	1E	RS	Record Separator
31	1F	US	Unit Separator
32	20	SP	Space
33	21	!	
34	22	"	
35	23	#	
36	24	\$	
37	25	%	
38	26	&	
39	27	'	
40	28	(	
41	29	)	
42	2A	*	
43	2B	+	
44	2C	,	
45	2D	-	
46	2E	.	
47	2F	/	
48	30	0	
49	31	1	
50	32	2	
51	33	3	
52	34	4	
53	35	5	
54	36	6	
55	37	7	
56	38	8	
57	39	9	
58	3A	:	
59	3B	;	

ASCII CODE

Decimal HEX
Number Code Char.

60	3C	
61	3D	=
62	3E	
63	3F	?
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y

Decimal HEX
Number Code Char.

90	5A	Z
91	5B	
92	5C	
93	5D	
94	5E	
95	5F	-
96	60	
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m

Decimal HEX
Number Code Char.

110	6E	n
111	6F	o
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	
124	7C	
125	7D	
126	7E	
127	7F	DEL Delete

APPENDIX H

SYSTEM CONTROL RELAYS



SYSTEM CONTROL RELAYS

The following control relays are defined and used in all PiC409 and PiC49 systems. Information on using the system control relays in specific Call Routines can be found in the individual Call Routine write-ups.

Control Relay	Name	Function
1970*	Emergency Stop	Control Relay 1970 energizes when a loss of feedback (in systems utilizing resolvers) or excess following error is detected. Control relay 1875 (Machine On flag) must be energized to detect a loss of feedback. Control relay 1875 is explained in the write-ups for the C260 and C270 series of Call Routines. To reset control relay 1970, correct the condition that caused the fault and set control relay 1971, the Emergency Stop Reset flag. The user must reset control relay 1971 before it can be set again.
1972*	Data Error	Control relay 1972 energizes if the same module is not addressed for all calls, or if the parameters are out of range, or if a parameter is supposed to be a variable and it is not.
1973*	Column too Long	Control relay 1973 energizes if the time required to carry out the foreground routine exceeds the allotted interrupt time.
1975	Interrupts Active	Control relay 1975 energizes when interrupts are running.
1991*	LDN Destination Error	Control relay 1991 energizes if a GOTO statement is used that has a non-existent destination.
1992	TE and TD Time Base	Control relay 1992 energizes when the time base selected for timers is 100 milliseconds. Control relay 1992 de-energizes when the selected time base is 10 milliseconds.
1993	FPA Active	Control relay 1993 energizes if an FPA (Floating Point Arithmetic) Module is present in the system and available to perform the division function. The FPA Module is optional.
1994*	FPA Error	Control relay 1994 energizes if an error is indicated when using the FPA Module.
1999*	Arithmetic Overflow	Control relay 1999 energizes if one of the following conditions results from a LET statement: 1. A result from addition, subtraction, or multiplication that exceeds the range +8,388,607 to -8,388,608. 2. An attempt is made to divide by zero (an undefined operation).

*These control relays are fault indicators. When a fault is detected, the corresponding control relay energizes and program execution exits from the Call Routine and returns to the LDN. When a fault occurs, correct the condition that caused the fault and reset the indicator control relay. Once energized, fault indicator control relays remain energized until they are de-energized by the user. Call Routine D120 can be used to determine the cause of a Data Error.



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