OPERATING and SERVICE MANUAL

for

PROGRAMMABLE DC SYSTEM

MODEL

AT8000

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PROGRAMMABLE DC SYSTEM
AT8000

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WARRANTY

Elgar Corporation warrants each instrument it manufactures to be free from defects in material and workmanship (except fuses) for a period of one (1) year after date of shipment from Elgar to the original purchaser. Elgar's sole obligation during this period is to repair or replace any assembly or component within its instrument found to be defective during the course of normal and intended use. Customer is responsible for normal maintenance. Alteration or removal of the nameplate, improper configuration or operating conditions, misuse or negligence each void the warranty and Elgar's responsibility thereto.

Please specifically note that the instruments Elgar manufactures are capable, under normal operating conditions, to generate hazardous voltages and potentially destructive power to other instrumentation. **ELGAR CORPORATION SHALL IN NO CIRCUMSTANCE BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL LOSS OR DAMAGE OF ANY NATURE RESULTING FROM THE OPERATION OR MALFUNCTION OF THIS INSTRUMENT.** The maximum obligation of Elgar under this warranty shall not exceed the purchase price of the instrument. This warranty is effective in lieu of any or all other obligations or liabilities on the part of Elgar Corporation, its agents or its representatives.

To obtain warranty service, contact Elgar Customer Service at the address below for a RETURN MATERIAL AUTHORIZATION ("RMA") prior to shipping. In-warranty instruments must be shipped pre-paid to Elgar. Elgar will perform the necessary warranty repairs and ship collect (within U.S.A.) back to the Customer. Contact Elgar, its agent or representative, for on-site service or service outside the U.S.A. and out of warranty service.

DO NOT RETURN ANY UNIT TO THE FACTORY WITHOUT AUTHORIZATION FROM ELGAR CORPORATION. Unauthorized returns found to be within specifications will result in inspection fees in addition to applicable freight and handling charges.

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CONTENTS

LIST OF ILLUSTRATIONS

Figure

LIST OF TABLES

Table

SAFETY

BEFORE APPLYING POWER to your System, verify your Model AT8000 Programmable DC Power System is properly configured for your particular application.

WARNING

HAZARDOUS VOLTAGES IN EXCESS OF 230VRMS, 400V PEAK MAY BE PRESENT WHEN COVERS ARE REMOVED. QUALIFIED PERSONNEL MUST USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT. CIRCUIT BOARDS, TEST POINTS AND OUTPUT VOLTAGES MAY ALSO BE FLOATING ABOVE (BELOW) CHASSIS GROUND.

Installation and servicing must be performed by QUALIFIED PERSONNEL who are aware of properly dealing with attendant hazards. This includes such simple tasks as fuse verification and channel reconfiguration.

Ensure that the AC power line ground is properly connected to the Model AT8000 input connector. Similarly, other power ground lines including those to application and maintenance equipment MUST be properly grounded for both personnel and equipment safety.

Always ensure that facility AC input power is de-energized prior to connecting or disconnecting the power cable at P1. Similarly, the Model AT8000 circuit breaker must be switched OFF prior to connecting or disconnecting output power.

In normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on your application configuration, HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY may be normally generated on the output terminals. The Customer/ User must ensure that the output power (and sense) lines be properly labeled as to the SAFETY hazards and any that inadvertent contact with hazardous voltages is eliminated.

Guard against risks of electrical shock during open cover checks by NOT TOUCHING any portion of the electrical circuits. Even when power is OFF, capacitors are well known to retain an electrical charge. Use SAFETY GLASSES during open cover checks to avoid personal injury by any sudden component failure.

SECTION I
GENERAL DESCRIPTION

1.1 INTRODUCTION

* 1 to 6 Channels per Drawer
* Expandable to 16 Channels
* Voltages to 320V
* 1200W per Single Drawer Output Power
* Extensive Display Supports Programming, Status, and Faults
* Easily Reconfigurable V/I Application Ranges
* GPIB (IEEE 488), optional Front Panel Keyboard
* Full ATE Qualified - MATE, CIIL
* Multiple Options - BIT, Polarity relays, Battery Back-up RAM

DESCRIPTION

The Elgar Model AT8000 Programmable DC Power System is a highly flexible precision DC power source designed to serve the challenges of both benchtop and Automatic Test Equipment (ATE) applications. The Model AT8000 System incorporates a highly intelligent built-in user interface with a wide range of available plug-in DC Power Modules to meet your specific DC power needs. The Model AT8000 System simplifies and eliminates the complexities of combining individual DC power sources.

The Model AT8000 basic System is a compact rack mountable master chassis drawer offering convenient front panel control via keyboard and display. Remote programming is via the IEEE 488 GPIB (General Purpose Interface Bus) using ELGAR's ABLE (Atlas Based Language Extension) or CIIL (Control Interface Intermediate Language), as preferred by your application. The Model AT8000 internal processor keeps track of all front panel entries, remote programming, displays, error reporting, BIT (Built In Test), and other processes automatically.

The Model AT8000 System master chassis contains six slots which are filled with DC Power Modules as needed by your application. Each slot containing a master DC Power Module is an independently programmable channel DC power source. Master DC Power Modules are available in eight voltage ranges from 0-7VDC to 0-320VDC. The optional polarity relay enables both plus and minus (+/-) programming without external wiring changes to your load. Excellent precision is always maintained via internal and external (programmable) voltage sensing.

For increased current (power), up to five slave DC Power Modules may be electrically jumpered to a nearby master DC Power Module. The slave modules are identical to the output performance of its corresponding master module but the jumpering allows them to track the master module precisely without requiring a new channel assignment nor separate programming. The master/slave arrangement is completely transparent to the Operator/ Programmer.

Several expansion drawers may be configured together for additional channels and/or increased power per channel. The processor in the master chassis keeps track of everything. Operation is via the same single keyboard and display. Similarly, remote programming is identical via the same GPIB cable and address. Expansion drawers do not have separate keyboards, display, nor GPIB programming. The Model AT8000 System simply refers to each DC Power Module master/slave set as a different channel regardless of the number of modules or expansion drawers installed. The master chassis processor supports up to sixteen independent programmable channels.

A Model AT8000 System consists of one master chassis drawer with one to six channels and may have up to 15 additional expansion chassis drawers containing an overall total of 96 DC Power Modules.

This Section identifies the Model AT8000 options and specifications. Further descriptions of the Model AT8000 DC Power Modules and multiple configurations are included in the INSTALLATION Section. Front panel controls, display and remote programming are found in the OPERATION Section. Additional Sections address theory, maintenance and support documents.

1.2 OPTIONS

Consult Factory for specific part number and application.

CIIL language version with DFI/Shutdown
Front panel keyboard/ display
Built In Test Board for additional V/I output monitoring
Expander Chassis Drawer
Master to Expander Chassis Drawer Interface Cable, J-Box
Master (or Slave) DC Power Module
Master (or Slave) DC Power Module w/Polarity relay
Dummy Module (for internal airflow ducting)
MS connectors (AC Power/Channels) w/mates
Shutdown (ABLE version)
Mating connectors
47-440 Hz Input AC Power
ATE Rack Slides
Cabinet

1.3 SPECIFICATIONS

ELECTRICAL

Output Voltage Range (or compliance voltage in Constant Current mode):

Each DC Power Module has a single output voltage range.

a) 0 to 7VDC
b) 0 to 10VDC
c) 0 to 20VDC
d) 0 to 32VDC
e) 0 to 40VDC
f) 0 to 80VDC
g) 0 to 160VDC
h) 0 to 320VDC

Output Current Range:

Each DC Power Module has a single output current range.

a) 15.0 amperes maximum from 7VDC to 0VDC for the 7VDC module.
b) 12.0 amperes maximum from 10VDC to 0VDC for the 10VDC module.
c) 10.0 amperes maximum from 20VDC to 15VDC and derating linearly to 6.0 amperes maximum at 0VDC for the 20VDC module.
d) 6.25 amperes maximum from 32VDC to 24VDC and derating linearly to 3.75 amperes maximum at 0VDC for the 32VDC module.
e) 5.0 amperes maximum from 40VDC to 30VDC and derating linearly to 3.0 amperes maximum at 0VDC for the 40VDC module.
f) 2.5 amperes maximum from 80VDC to 60VDC and derating linearly to 1.5 amperes maximum at 0VDC for the 80VDC module.
g) 1.25 amperes maximum from 160VDC to 120VDC and derating linearly to 0.75 amperes maximum at 0VDC for the 160VDC module.
h) 0.625 amperes maximum from 320VDC to 240VDC and derating linearly to 0.300 amperes maximum at 0VDC for the 320VDC module.

Full Rated Output Power:

a) 200 watts for the 20VDC, 32VDC, 40VDC, 80VDC, 160VDC, and 320VDC modules.
b) 120 watts for the 10VDC module.
c) 105 watts for the 7VDC module.

Configuration:
Up to six output channels per 5.25" chassis drawer. Internal programmer controls up to 16 output channels among one master and up to 15 extender chassis drawers. All 16 channels are programmed from the master chassis optional keyboard/ display and from a single GPIB bus address. Up to six DC Power Modules per chassis may be connected in master/slave configuration for up to six times the output current per channel.

Voltage Accuracy:
+/-(0.05% of full range voltage + 0.05% of programmed voltage) at 25 degrees C.

Current Accuracy:
+/-(1% of full range current + 0.05% of programmed current) at 25 degrees C.

Load Regulation (Voltage mode):
+/-0.01% of full range voltage as measured at sense point.

Load Regulation (Constant Current mode):
+/-0.01% of rated short circuit current plus 1 milliampere as measured over rated compliance voltage range.

Line Regulation (Voltage mode):
+/-0.01% of full rated output for a +/-10% line voltage change.

Line Regulation (Constant Current mode):
+/-0.01% of full rated output plus 1 milliampere for a +/-10% line voltage change.

Maximum Ripple and Noise (Voltage mode):
1 millivolt RMS or 0.01% of rated output voltage whichever is greater as measured from 20Hz to 5MHz.

10 millivolts peak-to-peak or 0.05% of rated output voltage as measured from 20Hz to 20MHz.

Maximum Ripple and Noise (Constant Current mode):
0.02% RMS of rated short circuit current as measured from 20Hz to 5MHz.

0.1% peak-to-peak of rated short circuit current as measured from 20Hz to 20MHz.

Read-back measurement Accuracy (TST function):
0.5% of full scale above 1% of full scale for voltage.

1% of full scale above 1% of full scale for current.

Stability (after warm-up):
+/-0.01% of rated output for 24 hours at constant temperature, line voltage and load conditions.

Temperature Coefficient:
+/-0.01% per degree C of rated output voltage in Voltage mode.

+/-0.025% per degree C of rated output current in Constant Current mode.

Response to Step Load Current:
Recovers to within +/-0.1% of final value in 300 microseconds with a 10% to 100% step in load current.

Channel-to-Channel Interaction:
Does not exceed specified performance limits of a single module.

Nominal Input Line Voltage:
115VAC or 230VAC as selected by rear panel switch.

Input Voltage Range:
+/-10% of nominal value.

Input Frequency Range:
47Hz to 63Hz

Overvoltage Protection:
Auto-tracking with automatic shutdown at 110% of programmed output voltage for programmed voltages from 10% to 100% of range. In Constant Current mode, OVP tracks to 110% of programmed compliance voltage.

Overcurrent Protection:
Auto-tracking with automatic shutdown at 110% of programmed output current for programmed currents from 10% to 100% of range.

Input Circuit Breaker:
Front panel input circuit breaker is provided for protection and as the ON/OFF power switch.

Fuses:
Each DC Power Module is protected by two fuses located within the module itself.

Fault Detection:
Continuously monitors overvoltage, overcurrent, module malfunction and overtemperature conditions. Includes immediate shutdown and reporting. Built in Test includes Confidence Test. Optional Test Board expands test/ monitoring.

GENERAL

Operating Temperature Range for Altitude to 2000 Feet:
0 to 50 degrees C.

Operating Temperature Range for Altitude to 6000 Feet:
0 to 35 degrees C.

Storage Temperature Range:
-40 degrees C to 75 degrees C.

Storage Altitude:
0 to 50,000 feet.

MTBF:
10,000 hours with six DC Power Modules operating at rated power output and ambient air inlet temperature of 25 degrees C.

Warmup:
30 minutes maximum in 25 degrees C environment.

Life:
5 years minimum.

Humidity:
0 to 95% non-condensing.

Shock Vibration:
MIL STD 810 A & B as applicable to shipment of electrical test equipment.

Efficiency:
50% to 60% at full rated output power at nominal AC input voltage depending upon module voltage.

Insulation Resistance and Dielectric Withstanding Voltage:
50 Megohms at 500 VDC @ 25 degrees C and less than 50% relative humidity.

MECHANICAL

Size:
19 inches (483 mm) wide by 5 1/4 inches (133 mm) high by 21 inches (533 mm) deep for mounting in a standard RETMA rack.

Net Weight:
Approximately 80 pounds (36 kg) with six power modules.

Finish:
Light gray, color number 26408, per FED STD 595 with black silkscreen, color 27038.

Handles:
Front panel mounted lifting handles.

Material:
Steel chassis with aluminum front panel.

Cooling:
Forced air with three (3) internal cooling fans.

Input Power Connection:
Three (3) wire plug type NEMA 5-20P (115 VAC 20 ampere) with six (6) foot power cord hardwired to chassis.

Optional MS type connector, P/N MS3102A-16-10P mounted on chassis. Mating connector MS3106-16-10S, strain relief MS3057- 8A-1. Mating connector provided with instrument. Customer assembles own AC Power input cable using own cable.

Output Power Connection:
Separate four-wire output terminal block per DC Power Module.

Optional MS type connector, P/N MS3102A-16-9S per DC Power Module. Mating connector MS3106-16-9P, strain relief MS3057-8A-1. One (1) set of mating connectors (six channel plus one AC Power Input) provided with instrument.

Remote Programming Connector:
Standard IEEE 488 GPIB female connector.

Remote Chassis Connector:
Parallel connection via 37 pin sub-miniature D type connector. Extender chassis interconnect cable ELGAR P/N 5970138-01.

DFI/ Shutdown Connector:
Five pin Amphenol connector (P/N 126-218) mounted on master chassis rear. Mating connector is Amphenol P/N 126-217. Shutdown is option in ABLE version. DFI/Shutdown combination is available on optional CIIL version only.

PROGRAMMING

Interface:
IEEE 488-1978 GPIB (General Purpose Interface Bus) interface standard including subsets SH1, AH1, T6, L4, SR1, RL1, and DC1. CIIL version replaces SR1 with SR0.

GPIB address set by rear panel DIP switch.
Number of Channels:
Up to 16 channels at a single GPIB address.

Modes of Operation:
a) Voltage Mode: Programmable output voltage with programmable upper current limit.
b) Constant Current Mode: Programmable output current with programmable compliance voltage limit.

Voltage Programming Range:
0 to full scale voltage.

0 to full scale current for the 7VDC and 10VDC modules.

0 to full scale current above 75% of full scale voltage in Voltage mode for 20VDC, 32VDC, 40VDC, 80VDC, 160VDC and 320VDC modules. Refer to "Output Current Range" above for current derating specifications.

0 to 60% full scale current in Constant Current mode for 20VDC, 32VDC, 40VDC, 80VDC, 160 VDC modules. 0 to 48% of full scale current for the 320 VDC module.

Maximum Resolution:
10 millivolts and 10 milliamperes or 1 part in 3972 which ever is less (resolution) for modules of less than 100 volts. 100 millivolts and 10 milliamperes for modules of 100 volts or higher.

Module Identification:
DC Power Module voltage range, current characteristics and options via internal PROM and jumpers.

Language Version:
ELGAR's ABLE (Atlas Based Language Extension).

Optional CIIL (Control Interface Intermediate Language).

SECTION II
CONFIGURATION and INSTALLATION

WARNING
HAZARDOUS VOLTAGES ARE PRESENT WHEN OPERATING THIS EQUIPMENT. READ "SAFETY" NOTE ON PAGE vii BEFORE PERFORMING INSTALLATION, OPERATION, OR MAINTENANCE.

2.1 INTRODUCTION

Your Model AT8000 is configured, calibrated and tested prior to shipment. This instrument is therefore ready for immediate use upon receipt. The following initial physical inspections should be made to ensure that no damage has been sustained during shipment.

CAUTION
Do NOT apply AC input voltage to this instrument nor connect any load(s) without first verifying correct input line voltage and output wiring configuration. This instrument and any external loads or cables may be damaged by improper voltage settings, mixing modules of different channels, cable miswiring, etc.

Next, you MUST become familiar with your particular Model AT8000 configuration. Unlike many instruments, the Model AT8000 may be a single or up to sixteen (16) chassis and be filled with up to 96 DC Power Modules of different voltage ranges and interconnect configurations. The following topics and verification of your particular configuration are necessary prior to connecting cables and applying AC input power.

To simplify this process, the topics are arranged as:

2.2 Unpacking and physical inspection

2.3 Module recognition (master/slave) and interconnect

2.4 Configurations (simple to creative)

2.5 Rear panel controls, switches, chassis interconnects

2.6 Functional check-out

Refer to Appendix B and photocopy it as a Configuration and Functional Verification Checksheet. This checksheet simplifies your Model AT8000 configuration and functional verification process. It also serves as an ideal reference during application hookup and as a permanent maintenance record.

2.2 UNPACKING

INSPECTING THE PACKAGE

Inspect the shipping container before accepting it from the carrier. If damage to the container is evident, remove the instrument from the container and visually inspect it for damage to the instrument case and parts.

If damage to the instrument is evident, a description of the damage should be noted on the carrier's receipt and signed by the driver or carrier agent. Save all shipping containers and material for inspection.

Forward a report of any damage to the Elgar Service Department, 9250 Brown Deer Road, San Diego, CA 92121. Elgar will provide instructions for repair or replacement of the instrument.

Retain the original packing container should subsequent repacking for return to the factory be required. Repacking is straightforward and is essentially the reverse of the unpacking. Should only a sub-assembly need to be repackaged for re-shipment, use the original containers. Elgar will provide shipping instructions and even containers, if necessary.

PRE-INSTALLATION INSPECTION

Inspect the instrument and associated DC Power Modules (if any were shipped separately) for shipping damage such as dents, scratches or distortion.

Remove the DC Power Modules from their shipping containers and inspect each one for damage. There is no need to remove any DC Power Modules already installed in any chassis drawer unless damage is suspected.

Check the rear of the instrument for damage to connectors.

2.3 INSTALLATION

The Model AT8000 is 5 1/4 inches high and is designed to be installed in a standard nineteen (19) inch rack cabinet. Instrument chassis is pre-drilled for rack slide mounting. Rack slides are recommended for periodic maintenance since all normal adjustments are accessible via the instrument top cover. Rack slides are available from Elgar.

CAUTION
AVOID BLOCKING INSTRUMENT AIR INTAKES OR EXHAUST.

Both instrument air intakes are located on the sides near the chassis front. Exhaust is past the heatsinks to the whole rear panel. Avoid blocking these intakes and exhaust. No special vertical separation is required when stacking instruments. However, a 1 3/4 inch vertical space above and below the instrument may improve air intake circulation. Figure 2-1 depicts the locations of air intakes, air exhaust, and rack mounting.

MODULE INSTALLATION

Read this topic only if your DC Power Modules were shipped individually.

Determine which DC Power Modules are to be installed on which channels. The following topics of this section identify types of modules and their possible configurations. Module voltage range is marked on the side of the power transformer towards the front of the module as identified on Figure 2-2.

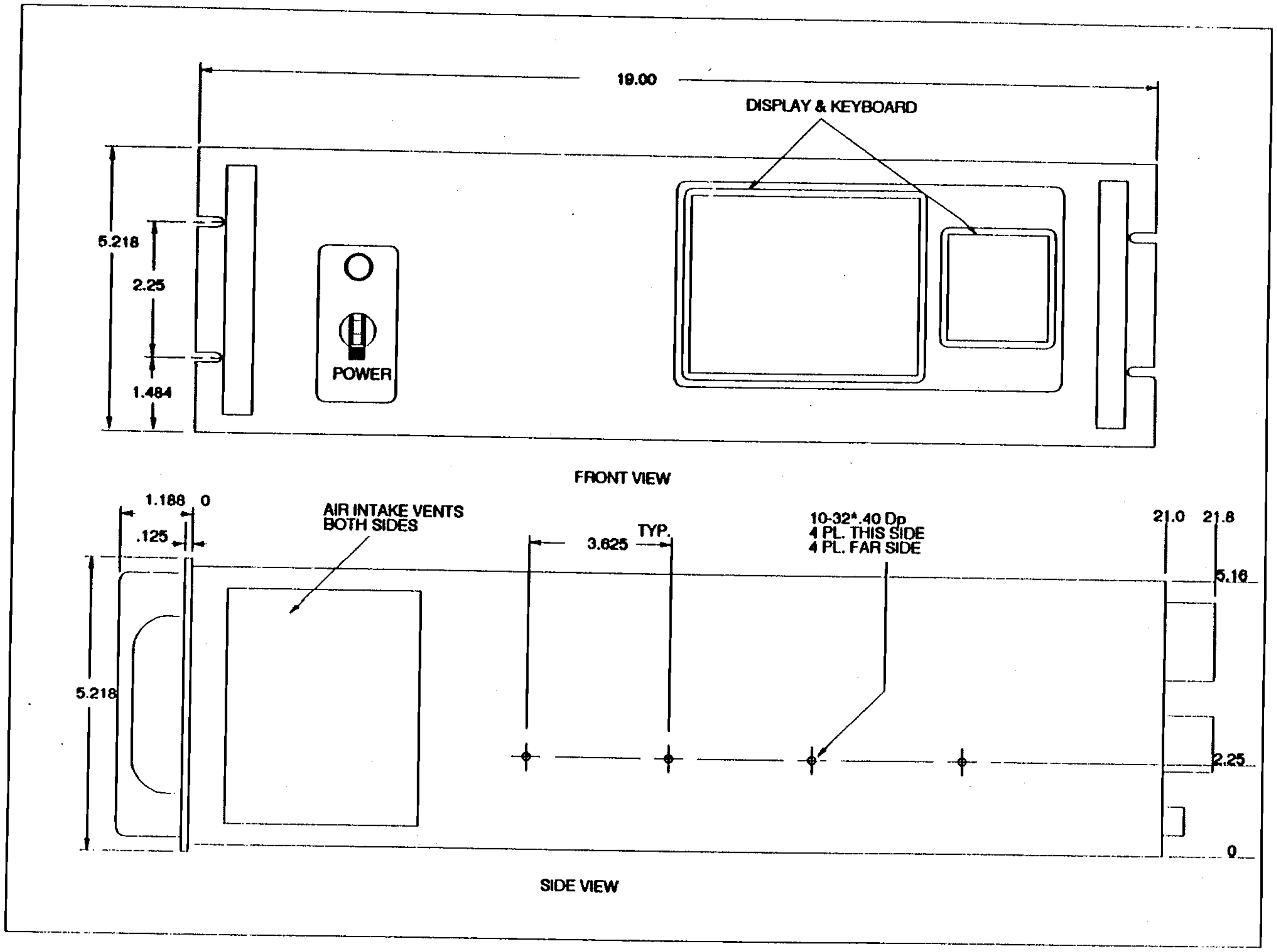

Figure 2-1A
Model AT8000 Installation

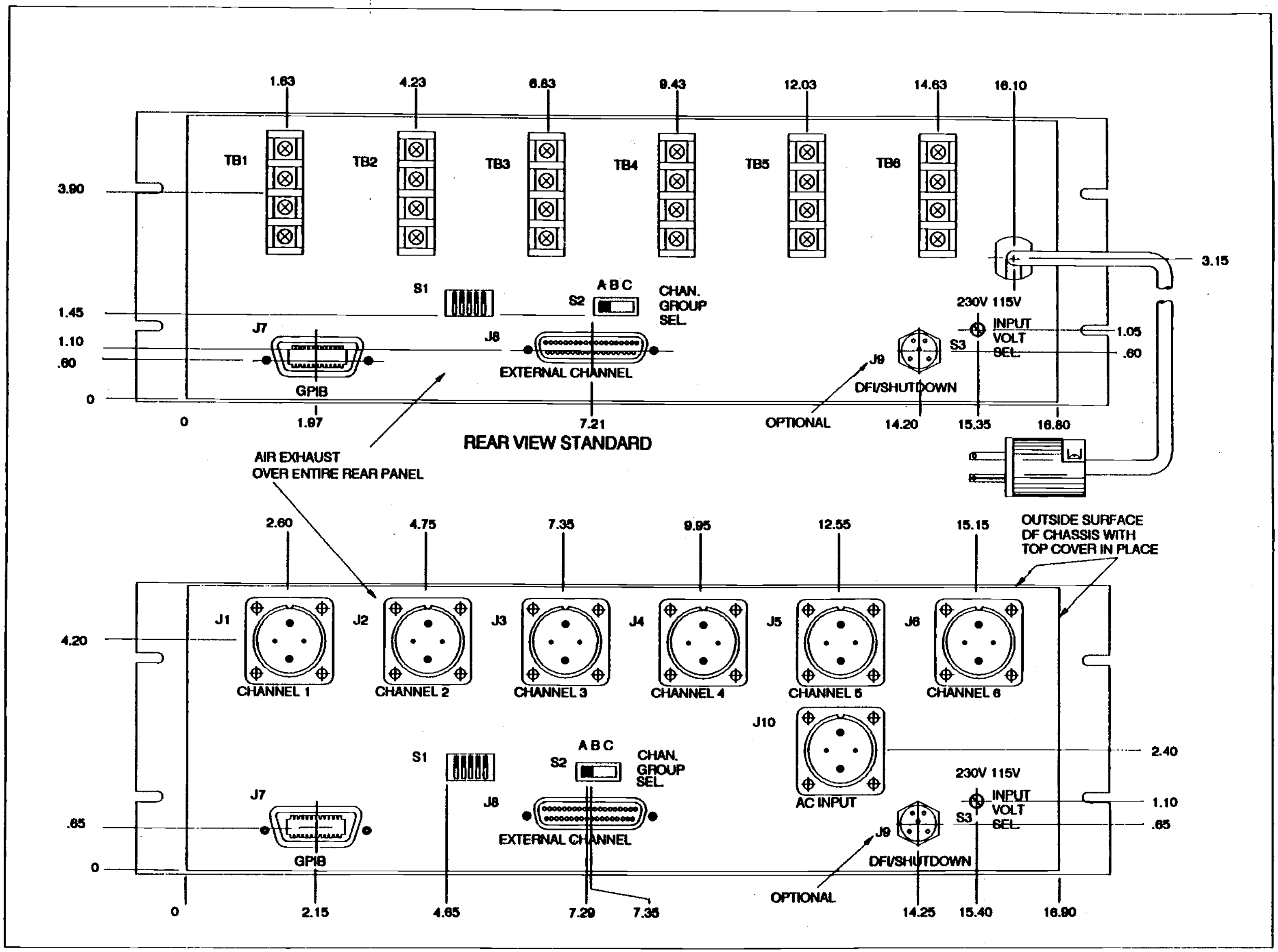

Figure 2-1B
Model AT8000 Installation

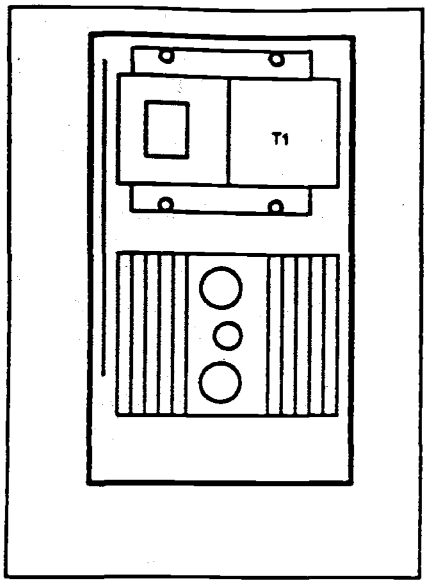

Figure 2-2
DC Power Module Identification

Install DC Power Modules by aligning them with the connector towards the rear of the instrument (refer to Figure 2-3). Then, place the module on the bottom card guide. While holding the module vertically, slide it towards the chassis rear until the connector is fully engaged. After all modules are installed, secure them from sliding back out by installing the two top support brackets. Each bracket has multiple narrow slots to fit the top edge slots of each module.

> Note
> Proper installation with these support brackets is MOST IMPORTANT to prevent the heavy DC Power Modules from creeping out of their rear backplane connectors.

MASTER/SLAVE MODULES

A master/slave module combination is a set of two (2) to six (6) DC Power Modules internally connected together to function as a single channel. One master module is required for each channel. One or more (up to five (5)) slave modules may be installed to interconnect with its respective master module for increased output current (power).

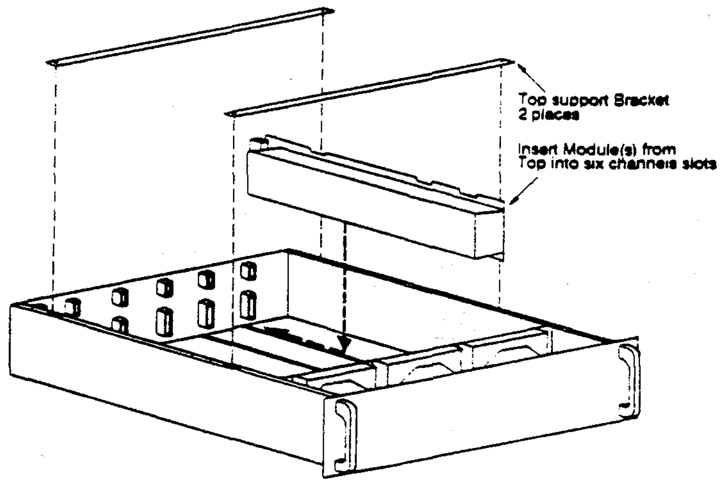

Figure 2-3
DC Power Module Installation

A master module is identified by verifying the presence of integrated circuits U7, U8, U18, U19, and U21 on its DAC board (top most board of the module). Slave modules obtain their programming information via their respective master modules and not from the processor directly. Thus, slave modules do not have these particular integrated circuits installed. Master modules may be factory modified to become slave modules. Refer to Figure 2-4.

The master/slave module combination should be installed into adjacent channel number slots to minimize the length of ribbon cable connecting the modules together. A master module may be installed in any slot relative to its slave modules. A ribbon cable carries programming information from the master module to its corresponding slave modules via their respective J1 IC socket connectors. No output power is present on the ribbon cable.

The location of the master module determines the channel number of the master/slave combination. If a master DC Power Module is installed in slot 1, then its channel assignment is channel 1. Similarly, a master installed in slot 2 yields channel 2, etc. A slave module uses the channel assignment number of its corresponding master, regardless which slot the slave occupies.

Should your Model AT8000 have one or more expansion chassis drawers, you will want to verify (or set) the Channel Group Select Switch located on the rear of the respective chassis. The master chassis processor supports 16 channels no matter how many extension drawers are used. Each channel assignment is determined by the placement of a master module. Slots 1 through 6 corresponds to channels 1 through 6, respectively, when the Channel Group Select Switch is set to position 'A'. To obtain channel assignments 7 through 12, merely set the corresponding Group Select Switch to position 'B'. Similarly, position 'C' corresponds to channels 13 through 16.

It is normal to have any two or more chassis drawers set to the same Group Select Switch position provided that master modules are not placed in identical slot numbers. There is no channel conflict concern if a master of one chassis occupies the same slot number as a slave of another chassis. Repeating, a master module slot together with its chassis Group Select Switch determines the channel assignment. An example of this master/slave channel assignment is in Figure 2-5.

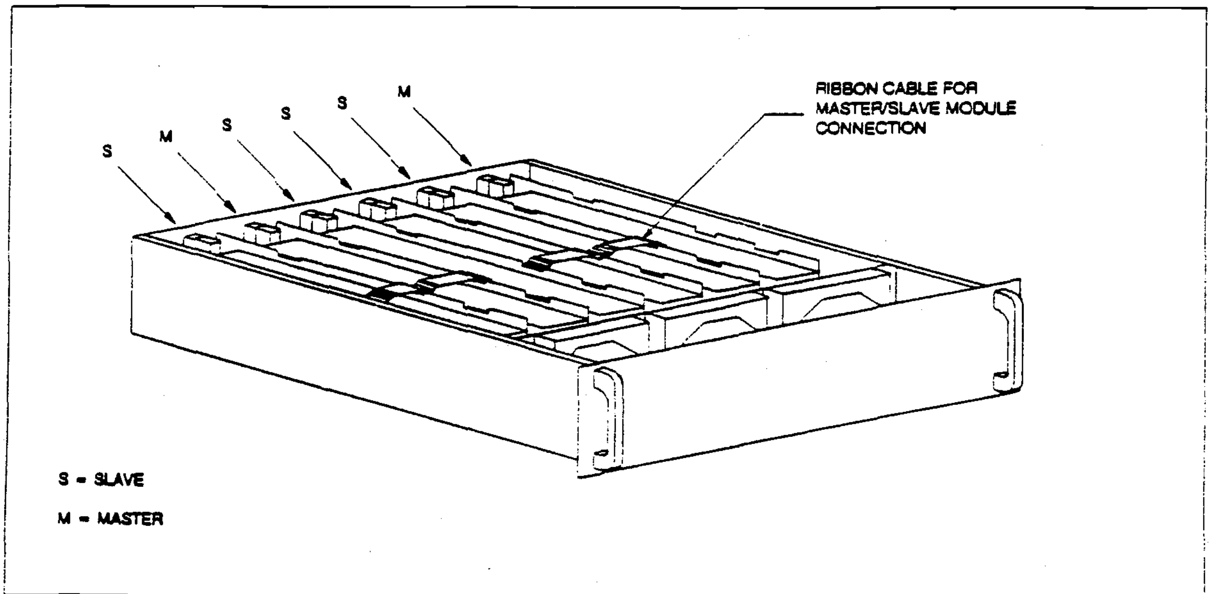

Figure 2-4
DC Power Module Master/Slave Connections

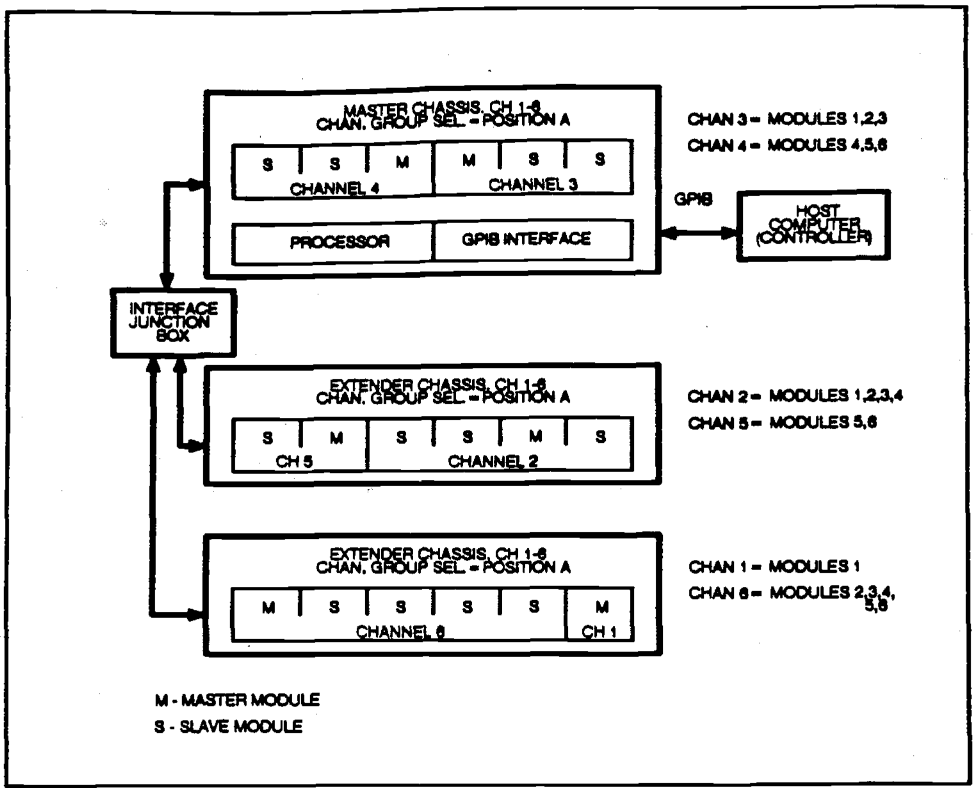

Figure 2-5
Master/Slave Modules

The outputs of the master/slave modules must be connected together in parallel at their respective output terminals and thus provide current that is equal to the current of a single module multiplied by the number of modules in the master/slave combination. This configuration is limited to modules of identical voltage and current characteristics. The remote sense input should be connected only to the master module because it alone senses remotely and regulates both itself and associated slave modules. The remote sense inputs of slave modules are not used.

DUMMY MODULES

A dummy module consists of a vertical board configured as an air flow restrictor. It plugs into the chassis bottom slot and fits into the top brackets as any other module, except it has no electrical connections.

Dummy modules are installed when a chassis is not otherwise fully loaded with six (6) DC Power Modules. Dummy modules redirect forced cooling air towards the real DC Power Module heatsinks and not through the empty space of the chassis.

OUTPUT RELAYS

Each DC Power Module has three sets of output relays - sense, isolation, and polarity. Sense and isolation relays are standard. The polarity relay is optional. These relays are both front panel and remotely programmable. They also automatically respond to fault conditions.

The sense relay selects either external or internal voltage sensing for channel voltage regulation and TeST (monitoring).

The output isolation relay connects or removes (isolates) the DC Power Module output from the User load.

The reverse polarity relay inverts the output voltage (and sense polarity) upon command. This provides both plus and minus (+/-) polarity. This optional relay, if installed, has jumper W9 installed on the DC Power Module DAC Board.

2.4 CONFIGURATION

The Model AT8000 Programmable DC Power System may be factory or field configured to meet any ATE requirement. The Model AT8000 includes a processor, optional front panel keyboard and display, optional BIT (Built In Test) capability, a remote programming interface via GPIB, and up to six DC power channels - all within a single 5 1/4 inch rack mountable chassis.

For simple applications, each slot within the chassis may be dedicated to an individual DC power supply channel. DC Power Modules are installed in these slots. These modules are available in eight (8) ranges from 0 to 7 VDC on up to 0 to 320 VDC and power levels from 105 watts to 200 watts each.

In more complex test systems or burn-in applications, the Model AT8000 controls up to sixteen (16) DC power channels of up to 1200 watts each. Each channel consists of one (1) DC Power Module, or more, connected internally by a ribbon cable as "master/slave." The outputs of the these "master/slaves" are externally paralleled for additive output current. Additional chassis drawers may be added - all controlled via the same intelligent chassis electronics above for a total of 96 power modules or 19.2 kilowatts.

The next topics discuss popular Model AT8000 configurations.

BASIC SYSTEM

A basic Model AT8000 System consists of one (1) through sixteen (16) output channels controlled by the master chassis either from its front panel or remotely via the GPIB. Only one (1) GPIB address (set at the master chassis) is used, regardless of the number of channels installed or the number of chassis used.

The sixteen (16) channel numbers are logically divided into three channel groups:

Group A = Channels 1 through 6
Group B = Channels 7 through 12
Group C = Channels 13 through 16

These groups are set via the Channel Group Select switch (S2) located on the rear panel. Refer to topic 2-5 for further details.

Each 5 1/4 inch high chassis contains up to six power modules and is switch selectable for any channel group. A simplified 16 channel system in three chassis is illustrated in Figure 2-6. Chassis A is the master chassis containing the GPIB interface, processor, and six 200 watt modules individually addressed and selected to be channel group 1-6. Chassis B contains six power modules and is selected to be channel group 7-12. Chassis C contains channel group 13-16.

COMPLEX SYSTEM

The Model AT8000's unique "master/slave" module capability coupled with "master/extender" chassis capability and intelligent internal processor enables more complex DC power applications. The example of Figure 2-7 demonstrates some of this flexibility of the Model AT8000 System.

Channel Groups are not restricted to a single chassis. This example shows channel group 1-6 configured for three separate chassis, A1, A2 and A3. The Channel Group Select switch is set identically in each chassis to position A. Channel group 7-12 is configured only for chassis four (4), but could be configured with as many as six (6) chassis of up to six (6) modules each. Channel group C is configured for chassis five (5) as three (3) single module channels with channel 16 consisting of three (3) modules.

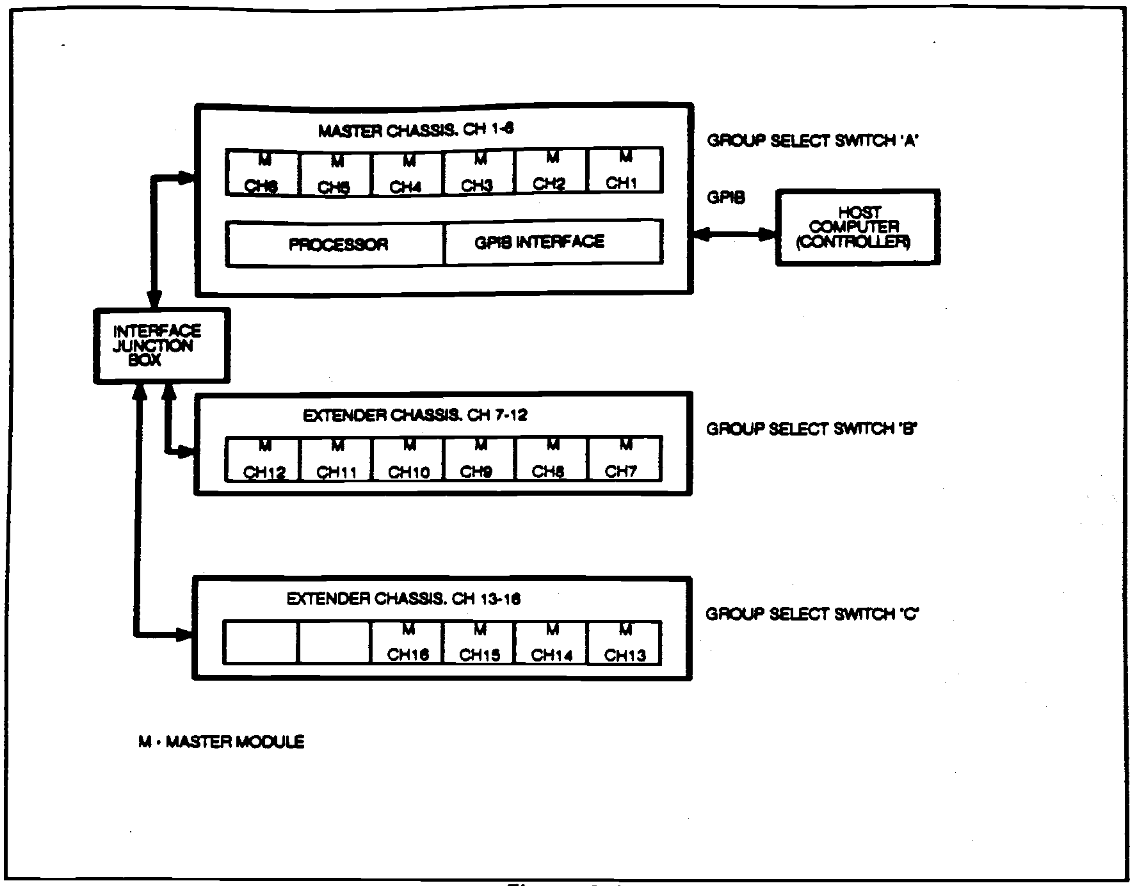

Figure 2-6
Basic System Configuration

SERIES OPERATION

Any master module may have its output connected in series with other master modules to achieve higher output voltages. The only restriction to this configuration is that the MAXIMUM VOLTAGE DIFFERENCE BETWEEN ANY CHANNELS OR CHASSIS MUST BE LIMITED TO 400 VOLTS. Should your application require additional float capability, consult factory. Sense terminals should also be connected in series between the channels with the top and bottom lines connected to the load as in Figure 2-8.

For optimum load regulation in series configurations, sense line resistors should be inserted across the sense lines at the load end of the cable. These resistors do not need to dissipate more than 1 watt and should be selected on the basis of the voltage across them. They must, however, all be of the same Resistance value. This improved series channel configuration is depicted in Figure 2-9.

In any series configuration, the lowest maximum current of any channel sets the maximum current for the series combination. That is, when a 10 ampere channel is connected in series with a 5 ampere channel, the maximum current capability of the combination is 5 amperes.

In Current Limit (CURL), normal constant voltage with upper limit of current, only one channel in the series combination needs to be programmed in Current Limit mode. However, all channels in the series combination may be programmed in Current Limit mode.

In Constant Current (CURR), normal constant current but voltage varies, all channels in the series combination must be programmed in the Constant Current mode.

The programming sequence for series operation channels is no different than for normal stand-alone channels.

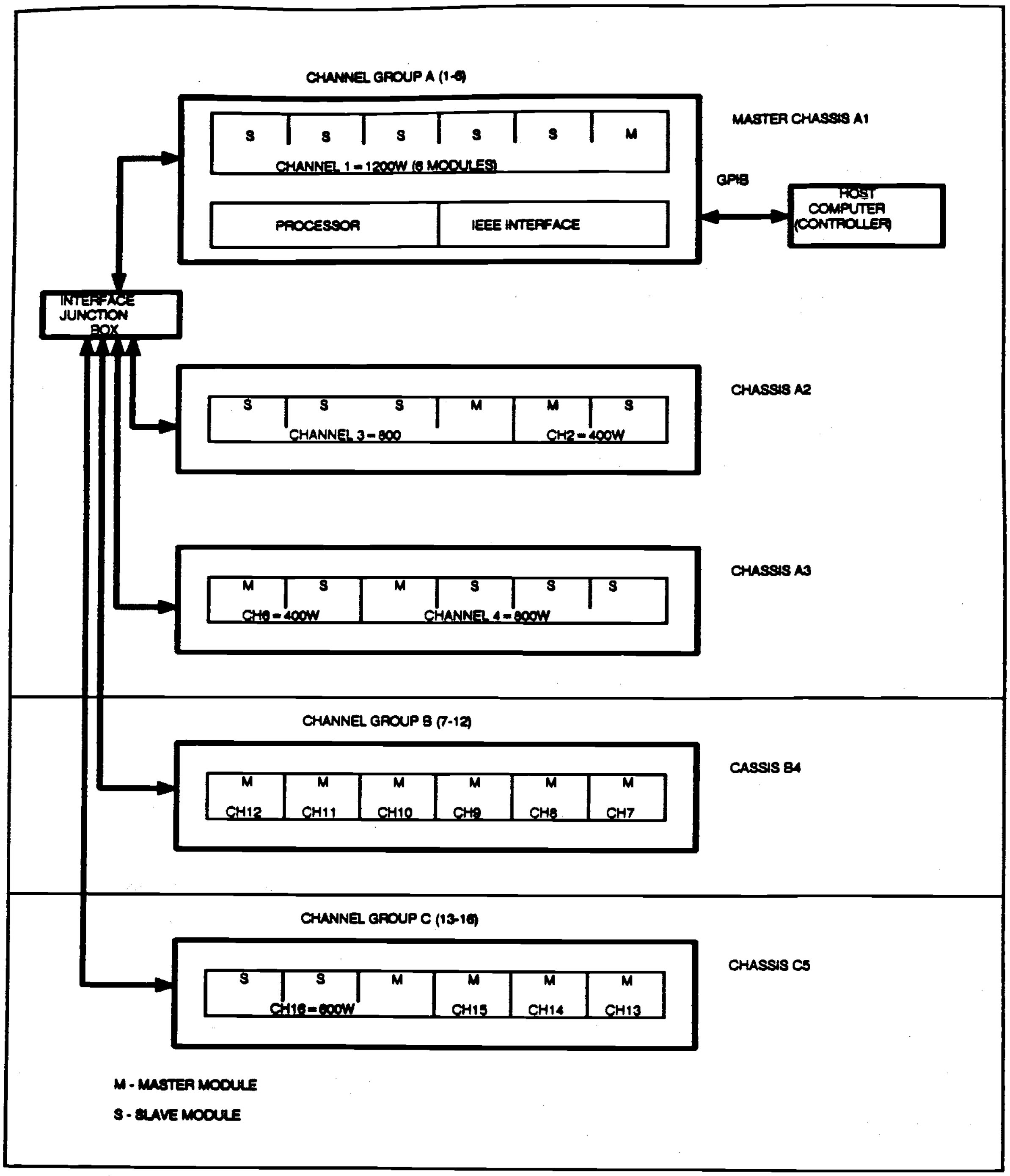

Figure 2-7
Complex System Configuration

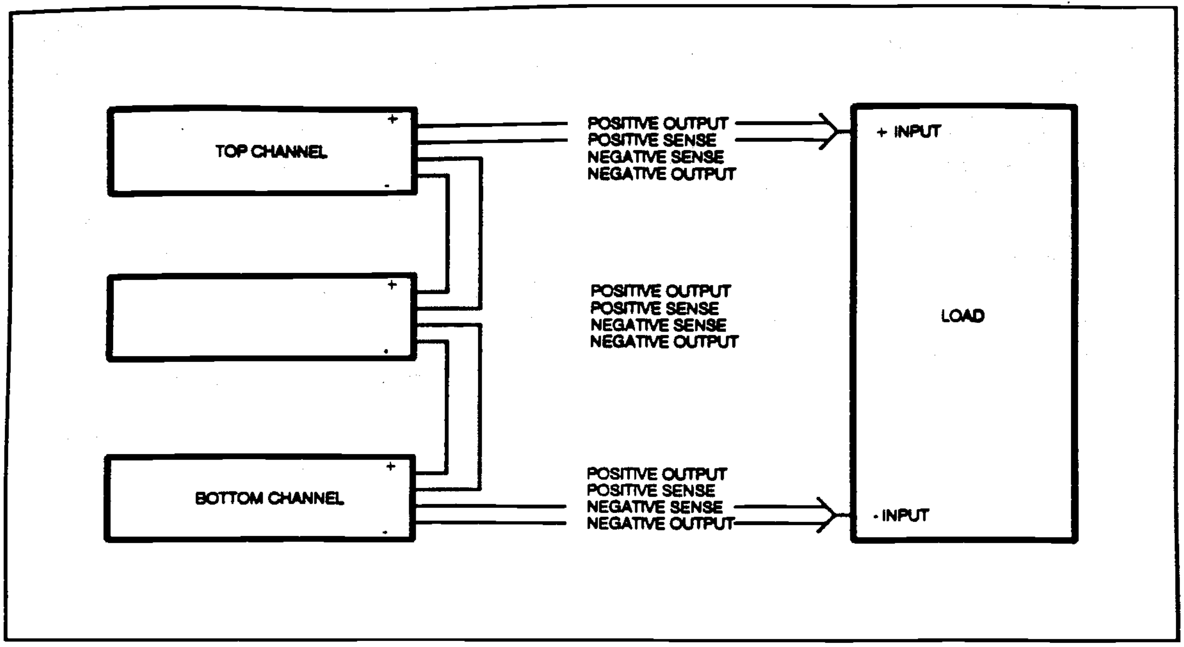

Figure 2-8
System Series Operation

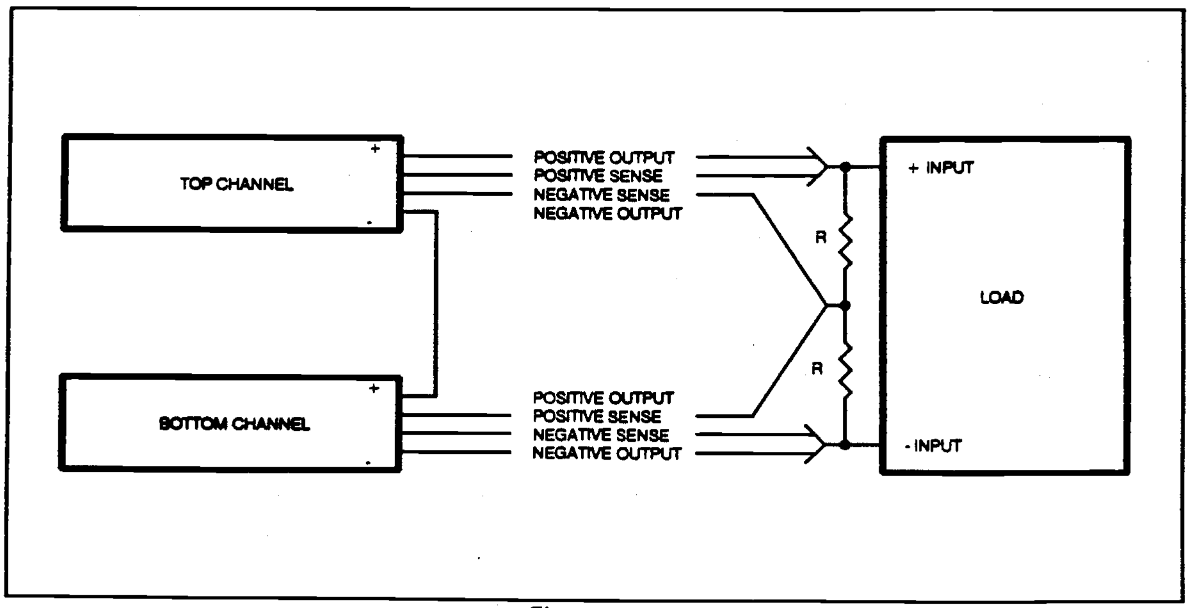

Figure 2-9
System Series Operation
Better Regulation

A channel, as depicted in the two (2) previous figures, may consist of the following:

A. A single master module, or
B. A master/slave module combination operating as a single channel and consisting of two to six modules, or
C. Multiple master modules operating in parallel with the PARallel command. In this case, each master module has its own separate channel number. PARallel configuration is described next. The PAR command (ABLE version only) is described in Section III.

PARALLEL OPERATION WITH MASTER/SLAVES

A channel of a master/slave parallel combination consists of one master DC Power Module with up to five (5) slave DC Power Modules. These modules are internally connected together with a ribbon cable. The location of the master module determines the channel number of master/slave combination. Only the master DC Power Module senses the output voltage and current and regulates itself and all the slave modules. Sense terminals of the slave modules are not used.

A master/slave channel is programmed and responds exactly as a normal single standard master module. The only difference is its higher output current capability. The master/slave output and sense terminal connections are depicted in Figure 2-10.

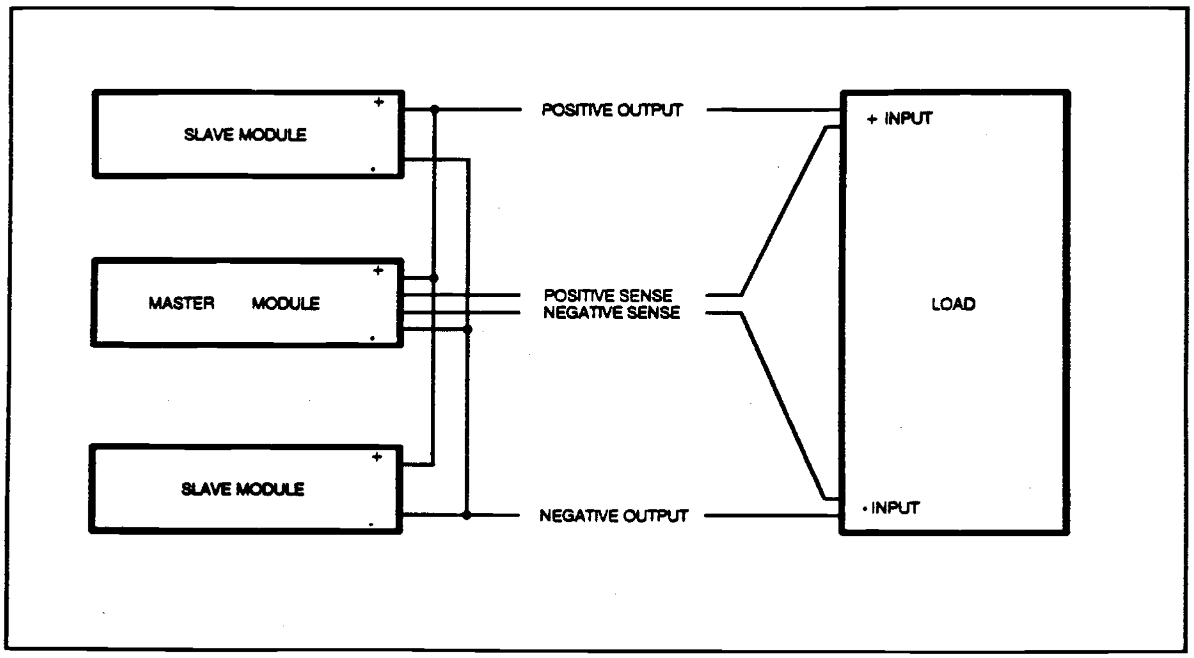

Figure 2-10
System Parallel Operation

PARALLEL OPERATION WITH STANDARD MASTERS

Separate DC channels, with or without slaves, may be connected and used in parallel operation when higher output current is desired. The only exception to this is in remote programming using the CIIL programming language.

The following restrictions should be observed:

1. All channels in the parallel combination MUST be programmed into the same GRoup via the GRP command. If a channel in the parallel combination Crowbars, it will try to sink all the current from the other paralleled channels possibly resusiting in damage to the Crowbar channel. Therefore when a channel shuts itself down due to a failure, it is important to simultaneously shut-down all the other channels in the parallel combination.
2. All channels in the parallel combination MUST have their voltages programmed to the same value.
3. If external voltage sensing is desired, the sense relay should be programmed for external sensing only after the channels are programmed and their output isolation relays have been closed.

There are three ways to parallel channels:

Method 1: Paralleling Using The "PAR" ABLE Language Command

This is the recommended and easiest method of paralleling channels in the current limit mode. It is only available when using the remote controller in the ABLE programming language.

Once the Model AT8000 processor receives the PAR command, it waits until all channels specified in the PAR command are in current limit before it will issue a current limit failure and shut down the channels. For this reason, it should never be used with channels that are programmed in constant current mode (CURR).

CAUTION
CURR channel in parallel

If the PAR command is used with at least one channel in the constant current (CURR) mode, the processor waits until all channels reach their CURL mode current limit before shutting down. Since the channel programmed for constant current (CURR) never reaches current limit, this essentially puts all channels (specified in the PAR command) into the constant current (CURR) mode which will never shut down due to current limit failure. This may result in damage to the load due to overcurrent for an extended amount of time. Therefore, AVOID using CURR MODE with PARALLEL channels where possible.

NOTE
The PAR command, like the GRP command, is automatically reset whenever a run-time fault occurs on that channel, a RST command is sent, a CNF test is performed or the Model AT8000 is powered down. The PAR command must be re-sent after any of these events have occurred.

REMOTE PARALLELING EXAMPLE

To remotely parallel a 20 volt/ 10 ampere module installed in channel 1 with a 40 volt/ 5 ampere module installed in channel 2, the maximum voltage of the pair can be 20 volts and the maximum current can be 14.33 amperes (the 40 volt module when programmed to 20 volts can provides only 4.33 amperes).

The programming sequence should be similar to the following. Note the liberal use of serial poll to assure no syntax or other errors. Use WAIT judiciously to allow for instrument to process GPIB instructions and relays to settle. It is not required to CLS the isolation relays simultaneously as shown below. The two OPN commands could be replaced by CLS.

```
OUTPUT 717 "CNF"                ! Perform Confidence Test
WAIT 500                        ! CNF requires about 70ms plus additional 70ms
                                per installed channel
A=SPOLL (717)                   ! Perform GPIB Serial Poll and return byte
DISP A                          ! 0 = AOK on CNF Test. Refer to Section III if
                                not.
OUTPUT 717 "GRP 1, 2"           ! Assign channels 1 & 2 into same GRouP set
A=SPOLL (717)                   ! Verify if GRP assignment is AOK
DISP A                          ! 0 = AOK
OUTPUT 717 "PAR 1, 2"           ! Parallel assignment set for channels 1, 2
A=SPOLL (717)                   ! Verify if any errors with instrument
DISP A                          ! 0 = AOK
OUTPUT 717 "CH1 VOLT 20 CURL 10 SENS I OPN"
                                ! Set up channel 1 with internal sense
OUTPUT 717 "CH2 VOLT 20 CURL 4.33 SENS I OPN"
                                ! Set up channel 2
A=SPOLL (717)                   ! Check for any errors
DISP A                          ! 0 = AOK
OUTPUT 717 "CH1 CLS, CH2 CLS"
                                ! Connect outputs simultaneously
A=SPOLL (717)                   ! Check instrument
DISP A                          ! 0 = AOK
OUTPUT 717 "CH1 SENS X, CH2 SENS X"
                                ! Now use eXternal SENSe
A=SPOLL (717)                   ! Check instrument
DISP A                          ! 0 = AOK
```

Method 2: Paralleling For Current Limit Without The "PAR" Command

The problem in paralleling channels in current limit (CURL) is the inherent slight unbalance in output current. One channel will provide its full programmed current and shut down due to current limit slightly before the second channel can provide its own current.

To overcome this problem, you must find which channel is the last to provide the output current (the lazy channel). The lazy channel is then the only channel to be programmed in the current limit (CURL) mode and all other channels must be programmed in the constant current (CURR) mode. The disadvantage of this method is that most channels (except 7 and 10 volt modules), lose 40% of their output current capability when programmed in constant current (CURR) mode.

To find the lazy channel, program all the channels to be paralleled in the current limit (CURL) mode and close their output relays with the load applied. When this is done, at least one of the channels is going to fail due to a current limit condition. This (these) channel(s) must then be programmed in the constant current (CURR) mode.

This procedure should be repeated until only one channel (the lazy channel) remains in the current limit (CURL) mode.

Method 3: Paralleling Channels In Constant Current (CURR) Mode

There are no special procedures required when paralleling channels in the constant current (CURR) mode. There is no advantage in using the "PAR" command in CURR. A disadvantage is that most channels (except 7 and 10 volt modules) loose 40% of their output current capability when programmed in constant current (CURR) mode.

Simply program all channels to the same voltage in constant current (CURR) mode and close their output relays. If external sensing is desired, close the external sense relays after the isolation relays have been closed.

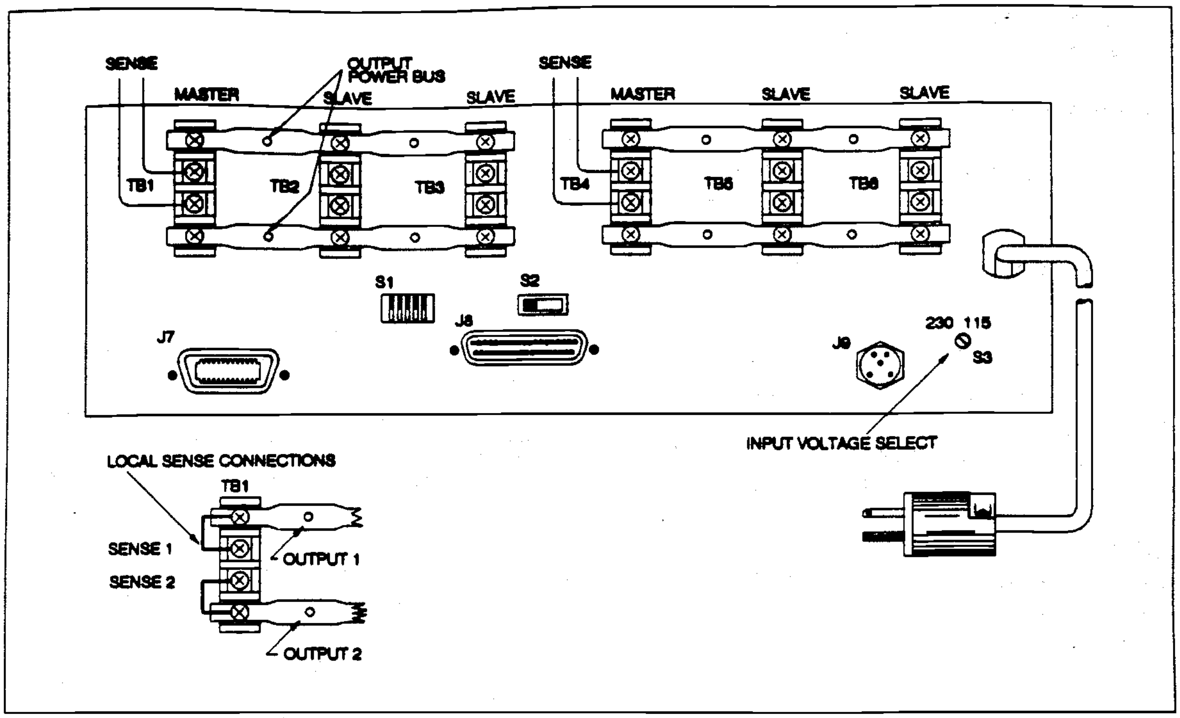

Figure 2-11
Interconnect 2 Master/Slave Channels

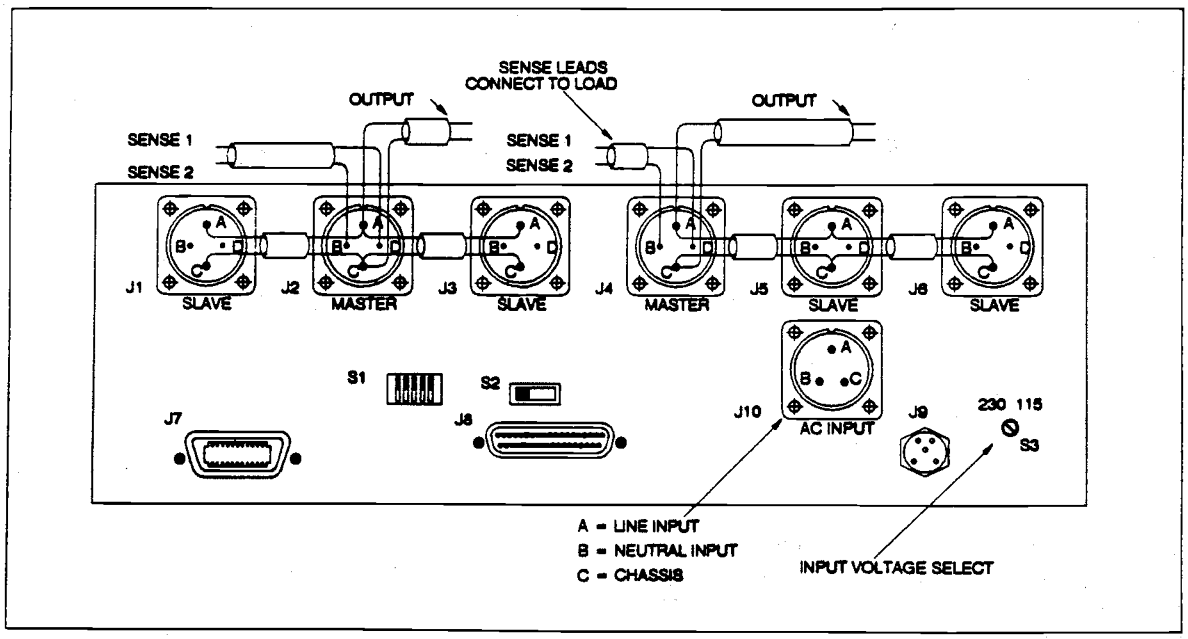

Figure 2-12
Chassis Rear View
2 Master/Slave Channels

2.5 REAR PANEL SWITCHES AND CONNECTIONS

LOAD CONNECTIONS

Each Model AT8000 DC Power Module has its own output power and voltage sense terminals (or MS connector pin assignment). These connections are on the chassis rear on a slot-by-slot basis.

The optional polarity relay automatically switches the output voltage and sense leads whenever a minus polarity is programmed. Rear panel positive/ negative (+/-) signals are internally reversed (+/- goes to -/+).

Electrically, the Terminal and MS connector versions are identical as depicted in Figures 2-11 and 2-12. Elgar ships one mating set of connectors for MS versions.

Terminal Block (standard):

Terminal	Definition
top most	positive output
2nd from top	positive external sense
3rd from top	negative external sense
bottom most	negative output

MS Connector (optional):

Pin	Definition
A	positive output
B	positive external sense
C	negative output
D	negative external sense

Any channel using only a single DC Power Module, both the output power and sense leads are used. Slave module sense leads are never used. A channel uses only the the sense leads of its master module.

In master/slave combinations, outputs power terminals are paralleled via heavy gauge wire or buss bar for increased current (power). The sense terminals are NOT paralleled. In this combination, only the master module sense lead circuit is used. More complex configurations involve DC Power Module combinations in series, series-parallel, and possible channel groups (GRP command).

The User/Installer needs to understand the previous topic examples as well as the particular User application prior to making output and sense connections.

CAUTION
MAXIMUM VOLTAGE DIFFERENCE BETWEEN ANY CHANNELS OR CHASSIS MUST BE LIMITED TO 400 VOLTS. Should your application require additional float capability, consult factory.

Selection of output power and sense line cabling should follow good practice specific to the application. An output cable should be able to carry the full output load current and maximum voltage under worst case conditions of temperature, humidity, mechanical abuse, and effects of long term aging. The sense cable has comparable requirements but the sense current requires a smaller wire gauge. Sense line shielding from stray pickup is more rigorous. General guidelines for designing/ specifying these cables are included in Appendix A.

If sense lines are not externally connected, the Model AT8000 individual channels still regulate output voltage due to internal voltage sense sampling within the master module(s). However, as output current load increases, a channel's internal sense sample is not able to accurately correct for possible IR losses within the output power cable. External voltage sensing at the User load is always preferred, when possible, to cancel the adverse effects of cable losses.

A typical cable installation is depicted in Figure 2-13.

Note
The Model AT8000 is capable of generating high voltages at its output terminals under normal conditions. The installer MUST insure that all cables, sense resistors, bypass capacitors, User load terminal strips/ connectors, etc. are all properly labeled as to the HAZARDS to HUMAN SAFETY, as applicable.

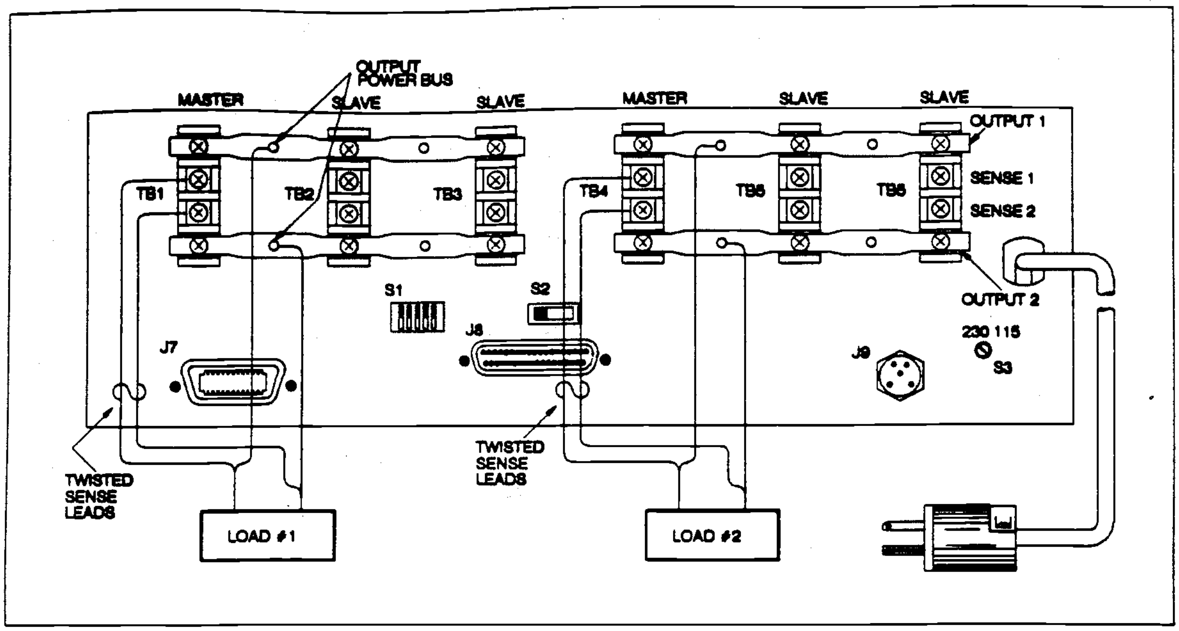

Figure 2-13
Load and Sense Connections

AC INPUT POWER

The Model AT8000 is operated from nominal 115VAC or 230VAC power lines. From the factory, your unit should already be configured for your local AC line voltage and power connector requirements.

The AC line Input Voltage Select Switch (S3), as in Figures 2-11 and 2-12, is located on the rear panel of each chassis. A simple screwdriver is all that is required to select the desired AC line input voltage (115/230 VAC). This same switch is used for both Terminal Block and MS connector versions. No additional AC Input voltage selection is necessary for the DC Power Modules.

CAUTION
DO NOT SELECT LINE VOLTAGE VIA S3 WHILE INSTRUMENT IS PLUGGED INTO AC POWER LINES.

The AC input line ground wire provides safety ground for the instrument chassis.

Standard connector version is a six (6) foot long AC input power cable hardwired into the rear of the chassis. The other end of the power cable is a three (3) terminal twenty (20) ampere male connector labeled NEMA 5-20 (or NEMA 5-20P). This appears very similar to the household NEMA 5-15 (115 VAC, 15 ampere) plug, except ONE pin is turned 90 degrees to indicate its 20 ampere rating. Each chassis has its own separate AC power cable. This connector is shown in Figure 2- 14.

Mating receptacle is a NEMA 5-20R (115VAC, 20 ampere, Receptacle) which accepts both 15 and 20 ampere NEMA plugs.

MS connector version is optional and may be required on certain military systems for both AC input power and channel outputs. AC input power uses the MS3102A-16-10P male connector mounted on chassis rear as seen in Figure 2-12. One required per chassis.

Elgar furnishes one mating connector (MS3106-16-10S, strain relief MS3057-8A-1). These MS connector components are available from Elgar. Customer furnishes own cable and AC plug.

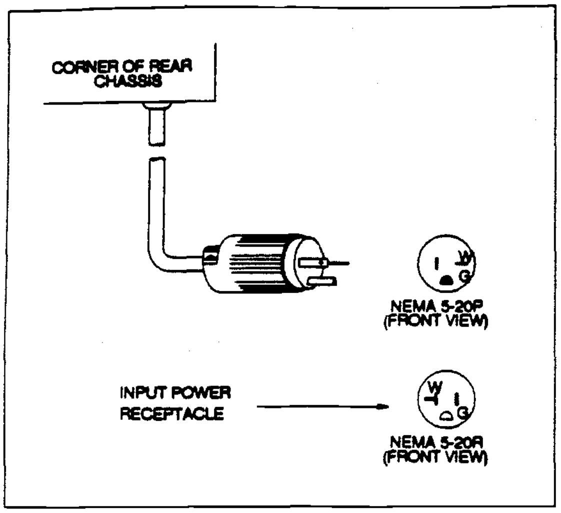

Figure 2-14
Input Power Plug

MS connector AC input line connections:

Pin	Definition
A	Line (BLK)
B	Line (WHT)
C	Ground (GRN), chassis

IEEE-488 INTERFACE

Remote programming, both ABLE and CIIL, use the standard 24 pin female IEEE-488 (GPIB - General Purpose Interface Bus) connector on rear of master chassis drawer. No additional GPIB cable is installed to extender chassis(s) since the master chassis processor communicates from master chassis to each extender chassis via its own 37 pin connector cable(s). GPIB cables are available from Elgar.

Adjacent to the GPIB connector, as depicted in Figure 2-15, is an internally mounted rear panel 5-bit DIP switch. This is the GPIB listen address switch. From the factory, this is set to decimal address 17 as shown in Figure 2-15, but may be readily changed by the User.

This DIP switch GPIB address is valid for all Model AT8000 remote programming regardless of the number of channels installed.

The GPIB address DIP switch may be set to any address from 0 through 30 as per Table 2-1. An UP or ON is interpreted as a logical 1 by the internal processor. AC power must be recycled after changing this DIP switch since it is read only once - during AC power up.

Remote programming via the GPIB for both ABLE or CIIL languages is covered in Section III.

Table 2-1 identifies switch settings for various addresses.

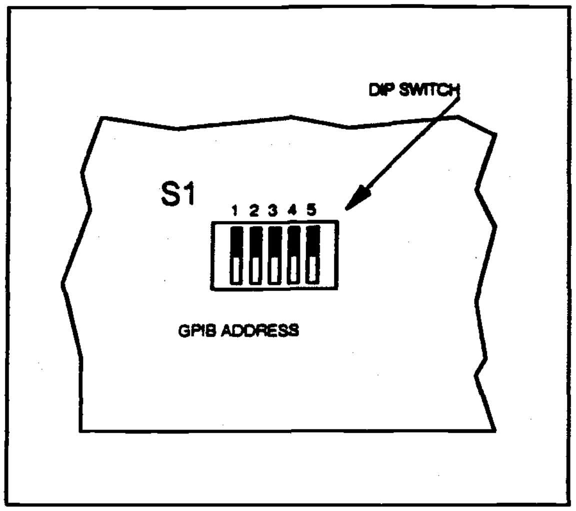

Figure 2-15
Rear Panel View
GPIB Address Switch

ASCII CHARACTER	HEX	DEC	GPIB LISTEN ADDR SWITCH 1 2 3 4 5
<SP>	00	0	0 0 0 0 0
!	01	1	1 0 0 0 0
"	02	2	0 1 0 0 0
#	03	3	1 1 0 0 0
$	04	4	0 0 1 0 0
%	05	5	1 0 1 0 0
&	06	6	0 1 1 0 0
'	07	7	1 1 1 0 0
(	08	8	0 0 0 1 0
)	09	9	1 0 0 1 0
*	0A	10	0 1 0 1 0
+	0B	11	1 1 0 1 0
,	0C	12	0 0 1 1 0
-	0D	13	1 0 1 1 0
.	0E	14	0 1 1 1 0
/	0F	15	1 1 1 1 0
0	10	16	0 0 0 0 1
1	11	17	1 0 0 0 1 (Factory Setting)
2	12	18	0 1 0 0 1
3	13	19	1 1 0 0 1
4	14	20	0 0 1 0 1
5	15	21	1 0 1 0 1
6	16	22	0 1 1 0 1
7	17	23	1 1 1 0 1
8	18	24	0 0 0 1 1
9	19	25	1 0 0 1 1
:	1A	26	0 1 0 1 1
;	1B	27	1 1 0 1 1
<	1C	28	0 0 1 1 1
=	1D	29	1 0 1 1 1
>	1E	30	0 1 1 1 1

GPIB Listen Address Settings
Table 2-1

CHANNEL GROUP SELECT
(Channel Group Select Switch)

Each chassis drawer contains six slots and thus up to six independent channels. Additional chassis drawers may be expanded onto the master chassis for additional slots or channels as explained in the CONFIGURATION topic above.

The Channel Group Select Switch S2 permits slots of a given chassis drawer to be assigned different ranges of channel addresses. The master chassis processor supports up to 16 channels maximum.

The Channel Group Select Switch S2 is located on the rear panel as seen in Figure 2-16. The switch position determines which of three channel ranges are to be assigned to master modules contained within its respective chassis drawer. More than one chassis drawer may share the same S2 switch setting provided that master modules are not installed in identical slots as described in the CONFIGURATION topic above. Slots 1 through 6 are left- to- right as viewed from the rear panel.

Channel Group Switch S2 assignments are:

Position A:
A master module in the leftmost slot becomes channel number 1 (rear panel view). Sequentially counting slots to the right, each slot receives the next channel assignment. Slot 2 is assigned channel 2, slot 3 is assigned channel 3, etc. (if occupied by a master module). The rightmost slot is assigned channel 6 (if occupied by a master module).

Position B:
Similar to position A except channel assignment range from channel 7 (slot 1 - leftmost) up to channel 12 (slot 6 - rightmost).

Position C:
Similar to position A except channel assignment from channel 13 (slot 1 - leftmost) up to channel 16 (slot 4). The two (2) rightmost slots may not be used by master modules. They may remain empty or may be used as slave modules to one or more master module(s) located in the same chassis in slots 1 through 4.

DFI/ SHUTDOWN

In optional CIIL language version, both DFI and Shutdown are included on the same master chassis rear panel connector as seen in Figure 2-17.

In ABLE language version, Shutdown is an option. There is no DFI in ABLE. Shutdown uses the master chassis rear panel connector of Figure 2-17.

The DFI (Direct Fault Indicator) output signal consists of a normally closed relay contacts output. In normal (no run-time error) remote CIIL operation, the relay contacts are open circuit (relay actuated). The contacts latch into the closed position to signal DC power fault conditions such as a loss of AC input power to the Model AT8000. The DFI relay also latches in remote programming to signal power supply channel Crowbar (CROWBAR), current limit (CURL) or an overtemperature (TEMP) failure. Once activated (contacts closed), the DFI relay is reset upon receipt of the STA (status) command from the GPIB controller. The STA (status) command also initiates the Model AT8000 to send an error message via the GPIB.

Shutdown provides the Operator/ Programmer/ controller with the means to immediately reset the Model AT8000 - without waiting for the GPIB. Shutdown uses two pins with an internal isolated soft +5 volts. Momentarily closing the circuit across these two pins via an external relay contact or switch (only) immediately initiates the processor to open all channel relays and reset all setups to zeros (Instrument ReSeT routine). DO NOT ATTEMPT TO GROUND EITHER OF THESE PINS, since this causes a ground loop which may be potentially destructive to the Instrument Processor Board.

DFI/Shutdown connector J9 (Amphenol 126-218), if installed, is located on the master chassis rear panel. User supplied mating connector is Amphenol 126-217. Connector pin assignments are:

Pin	Description
A	DFI relay contact
B	DFI relay contact
C	–
D	Shutdown
E	Shutdown

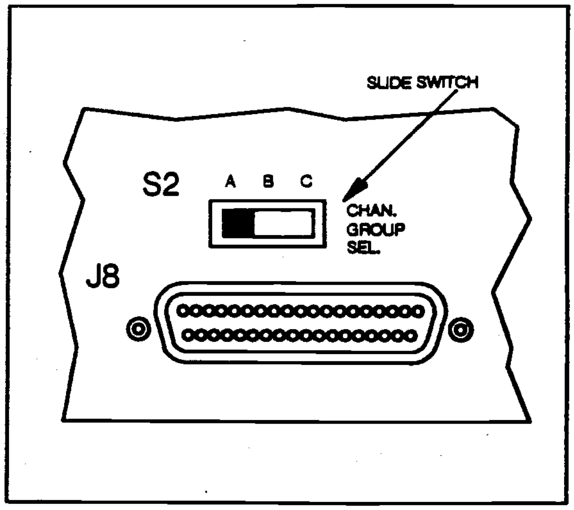

Figure 2-16
Rear Panel View
Channel Group Select Switch

2.6 FUNCTIONAL VERIFICATION

This topic provides both incoming inspection and metrology lab with a simple means of verifying correct Model AT 8000 System configuration. This procedure should be performed upon initial receipt of the DCS (DC Supply) and as a periodic check of the instrument. This procedure is not intended to check 100% of the instrument; rather, it verifies the Model AT 8000 fundamental performance parameters.

The following areas are verified:

1. Self Test:
   Operation of the controller board circuits and front panel display.
2. Confidence Test:
   Crowbar, current limit, test board calibration and voltage accuracy.
3. Channel Configuration:
   Determines which channels are installed, corresponding voltage ranges and other options.
4. Programmed and Measured Voltage:
   Voltage programming and voltage measurement are verified.
5. Current Limit Programming:
   Current limit programming is verified.
6. Remote Programming:
   Remote programming via the IEEE-488 bus is verified.

TEST EQUIPMENT REQUIREMENTS

Equivalent test equipment can be substituted if the exact model and manufacturer as listed below is not available.

Equipment Type	Manufacturer	Model Number
* Oscilloscope	Tektronix	564
* Controller	HP	HP-85
(Or a Computer which is GPIB compatible.)		
* DC Voltmeter	Keithley	197A
(0 to 320V range, 6 digit resolution, 0.01% accuracy.)		
* DC Current Meter		
(0 to 60 Amps or less depending on maximum system requirements, 4 digit resolution, 0.01% accuracy.)		
* DC Resistive Load		
(0 to 60 Amps or less in 0.25 Amp increments.)		

NOTE
This instruments generates voltages hazardous to human safety. You should already be familiar with the SAFETY notice on page iv.

To verify the configuration of this particular Model AT8000, use the following verification procedure and the Configuration and Functional Verification Checksheet found in Appendix B. The Appendix B Checksheet can be photocopied and used to record test results of your Model AT8000 operation.

WARNING:
THIS FUNCTIONAL VERIFICATION MAY ROUTINELY GENERATE VOLTAGES HAZARDOUS TO HUMAN SAFETY. IF YOU ARE NOT ALREADY FAMILIAR WITH THE ATTENDANT HAZARDS AND SAFE OPERATING PROCEDURES INVOLVED, STOP HERE AND ASSIGN THIS TASK TO SOMEONE WHO IS. THIS PROCEDURE, AND THIS MANUAL ARE NOT A TUTORIAL ON SAFETY PROCEDURES FOR HIGH VOLTAGE INSTRUMENT MAINTENANCE AND OPERATION.

LOGGING SYSTEM DATA

Each AT8000 drawer may contain one (1) to six (6) plug-in DC modules of various voltages from 7 to 320VDC and power levels from 105 to 1200 Watts. One or more "Extender" drawers may be interconnected to provide up to 16 channels of DC output.

The following Checksheet contains space for logging data for one "Master" drawer and six DC Modules (channels) which would be the simplest system configuration. Some of the spaces provided are for options which may not be installed in your specific system; these can be ignored.

Additional copies of the Checksheet can be attached for logging Extender drawer data.

Record Data on Appendix B Checksheet:

The following checklist may be used in sequence or in any order that is most convenient.

1. AC Input:
   Check S3 on the rear panel for correct input AC voltage selection, either 115V or 230V. A flat-blade screwdriver is required to change ranges. DO NOT change voltage ranges while the unit is energized. Record on checksheet the selected range: 115V or 230V.

2. Remote Programming Language:
   Verify which programming language is installed, either ABLE or CIIL, by referring to the attached configuration card or packing slip. Record on checksheet.

3. GPIB Address Select:
   Select the Remote IEEE-488 GPIB address at S1 on the rear panel. Record on checksheet.

4. Group Select:
   The Group Select switch, S2, allows the DCS drawer to contain 6 channels of DC power in 3 different groups. If S2 is in "A" position, channels 1 to 6 could be installed; in "B" position, channels 7 to 12, and "C" position, channels 13 to 16. This switch will be set at the factory and should not be changed unless the system is being reconfigured. Record the Group position: A, B or C.

5. Local Control Keyboard/Display:
   The front panel Keyboard allows local programming of voltage and other functions, the display will indicate programmed (or measured) or other information. Refer to the Sections I and II for additional information. Record on checksheet.

6. Test (Built-in-Test):
   Built-in-Test allows voltage, current and other functions to be "Readback" or monitored at the front panel display or over the IEEE-488 bus. Refer to Sections I and II for additional information. Record on checksheet.

7. Output Connections:
   Output connections can be either terminal strips or Mil-Spec type connectors. Refer to Section Topic 2.5 for interface pin definitions. Record type of connections on checksheet.

8. DC Modules Installed:
   This section of the checksheet has space for recording voltage and current, both programmed and measured, of each of the DC Channels that are installed in a particular drawer. All programming will be from the local keyboard except for the remote tests in step 8 j. Refer to Section III for programming and operating instructions. Note that a channel can consist of one Master module and one or more Slave modules. It is important to identify where the Master module is located in the DCS drawer. The following is a list of information that can be recorded for up to six DC Channels:

   a) CNF Test:
      The Confidence (CNF) test is run by the microprocessor when power is applied to the DC drawer. Refer to Section 5.7 for CNF test error codes. If battery back-up option is installed, the CNF test must be initiated from the keyboard by pressing "2ND" and "CNF".

   b) Channel Number:
      The channel number is identified by the internal microprocessor. To identify channel location, maximum voltage and current allowed on that channel, program Channel 1 "VOLT 9999". The front panel display will flash Channel 1 maximum voltage and maximum current. For example "40.00" and "5.00". This data can be recorded on the checksheet. Channels 2 through 6 can be identified in the same way. If "00.00" flashes for voltage and current, this means that no module is installed in that slot or that that channel slot contains a Slave module.

c) Load Relay:
The Load Relay test verifies that the output can be closed and opened. When it is closed the display "CLS" LED will be On and voltage will be connected to the output. Record on checksheet.

d) Maximum Voltage:
Maximum voltage for each DC Module as identified by the internal microprocessor. See step "b" above. Record the maximum allowable voltage for each channel on the checksheet.

e) Programmed Voltage:
Voltage as programmed at the front panel keyboard. Program a voltage within the maximum range of each channel. For example: "15.00" on a 20 volt channel. Record that on the checksheet.

f) Measured Voltage:
Voltage as measured at the rear panel of the DCS. Measure the programmed voltage from step "d" above. Note that voltage can be measured at the display if the DCS has the Test option installed.

g) Programmed Current:
Programmed current can be either Current Limit or Constant Current mode. For this test, we will set a current limit within the current range of a channel as identified in step "b" above. Record the programmed current on the checksheet.

h) Measured Current:
Apply a resistive load to the rear panel terminals. Measure the output DC current at the rear panel for each channel loaded. Note that the current can be measured at the display if the Test option is installed. Increase the current by decreasing the load resistance until the current limit is exceeded. Record on the checksheet.

i) Polarity relay:
The Polarity Relay option test verifies that the polarity of the output voltage can be reversed. Verify that each channel polarity relay is operational. Record on the checksheet.

j) Remote Tests:
The remote tests performed here can consist of all of the tests performed in the previous steps or be as simple as you like. The "CNF" command will verify that the DCS will respond to the IEEE- 488 controller. Refer to Section III for remote programming information.

SECTION III
OPERATION

3.1 INTRODUCTION

The Model AT8000 System controls and display are both straightforward and readily understood after just a brief overview. Simllarly, remote programming via both ABLE (Atlas Based Language Extension) and CIIL (Control Interface Intermediate Language) ATE languages is quick and simple since the Model AT8000 processor transparently takes care of the burdens of protocol, parsing, message format, error checks, and talker response messages back to the host ATE controller.

If you are unsure as to your particular Model AT8000 configuration, simply keystroke what you would like to do. The Model AT8000 either implements your commands or informatively identifies that particular channel's capabilities. Any additive effects of master/slaves is automatically (and transparently) included onto the display.

The internal processor continuously verifies your keyboard entries. Should an entry be inadvertently out of range for a particular channel setup conditions, the processor immediately flashes onto the display the maximum permissible voltage and/or current available. The Model AT8000 does not accept any self destructive setup. However, care must be taken since the wide range output of this instrument can readily generate high voltages at sufficient current to cause great harm to personnel and equipment loads.

Operation of your Model AT8000 is organized into the following topics:

3.2 Power Up/Down
3.3 Progamming Overview
3.4 Local Programming
(keyboard/ display)
3.5 Remote ABLE Programming
3.6 Remote CIIL Programming

WARNING

VOLTAGES HAZARDOUS TO HUMAN SAFETY may be routinely generated at the output terminals. Be familiar with the SAFETY notices of page vii. Use great care when any load is connected to the output of this instrument. The User MUST notify any Operator/ Technician via WARNING signs or labels as to the possible hazards of voltage and current.

3.2 POWER UP/OFF SEQUENCE

STOP

1. READ and VERIFY the message of the above NOTE.
2. Verify the proper INSTALLATION of your Model AT8000 including AC line voltage switch, any chassis drawer interconnects, and output/ sense connections.

Switch POWER to ON for all Model AT8000 extender chassis drawers. The master chassis is powered ON last. It is also normal to switch AC POWER ON to your entire ATE system from a central circuit breaker.

Immediately upon POWER ON of the master chassis, the master chassis processor performs housekeeping on itself and the rest of the System. An initial one-time scan during this housekeeping identifies and records all of the installed channels - regardless of their chassis drawer(s). If an extender chassis drawer POWER ON is late or its AC power is removed at any time, the processor reports those channels as faulty.

If battery backup is not installed, the processor resets all output power modules to open circuit, clears all programming information and initializes the GPIB interface. Next, the processor initiates the Confidence Test on all installed channels and then performs an an instrument reset. Subsequently, the processor continuously performs internal housekeeping and scans for keyboard and remote programming inputs.

The battery backup option retains all channel setup (local and remote programming) information while AC power is OFF and restores these setups after a modified reset process. The Confidence Test is not run since all channel setups would be reset. All output relays are open to avoid any surprise to application loads (E.G. ATE application where a remote main circuit breaker powers up the entire test station at once). The output relays only await an EXeCute (2ND EXC) keystroke to connect to the application load.

To POWER OFF, good practice encourages disconnecting module outputs prior to removing AC power. Conveniently, the CoNFidence Test (2nd CNF or remote programming equivalent) automatically performs this task on all module outputs. This virtually eliminates unpredictable power down output glitches.

3.3 LOCAL/ REMOTE PROGRAMMING

The Model AT8000 System, whether used in local or remote (GPIB) programming, is factory configured for either ABLE (Atlas Based Language Extension) or for optional CIIL (Control Interface Intermediate Language). Front panel operation is identical for either language version. However, the manner of remote programming and of channel operation differs slightly for these two language versions.

The keyboard EXC (EXeCute) and GPIB programming line terminator are equivalent activate codes for the Model AT8000 processor. Whether via a keyboard setup or GPIB programming string, all channel(s) setup (programming) are activated simultaneously. Should output isolation or polarity relays require a change of state, the processor automatically first turns off (voltage and current to zero) on the particular channel(s). Relays are then switched and, after a 30 millisecond delay, all module voltages and currents are re-programmed simultaneously to their previous levels. This automatic sequence eliminates hot relay switching and possible voltage spikes due to contact bounce as seen by the load.

In ABLE language version, all channels are independent. Should a run-time fault on one channel occur, the other channels are not affected unless specifically programmed via the GRP (GRouP) command. GRP is not available from the keyboard. GRP is valuable when multiple DC power channel sets (or groups) are required for your application and all the DC power supply channels of a given set must be simultaneously shut down in the event of a fault on any one supply in the set.

In CIIL language version, all channels shut down in the event of any run-time failure on any channel. No GRP command is available.

Remote programming faults for either language configuration are signaled to the controller via GPIB talk messages from the Model AT8000 processor. The front panel display also alerts the Operator to any faults regardless of origin (keyboard, GPIB, or run-time).

Keyboard operation, ABLE and CIIL languages, and their respective fault handling are separated in the following topics. The flashing front panel display is always available for any faults.

Syntax notation used in this section is:

	Capital letters are required for remote command words and front panel keys.
[ ]	Square brackets indicate optional programming. Text within square brackets is not required for programming.
< >	Angle brackets contain text which defines what it should be replaced by.
|	Vertical bars separate multiple choices of entries available. At least one of the entries must be chosen unless the entries are also enclosed within square brackets.
...	Ellipses indicate an entry may be repeated as needed.

3.4 LOCAL PROGRAMMING (KEYBOARD/ DISPLAY)

For local control, only one keyboard/ display is required on the Model AT8000, regardless of the number of extender chassis drawers installed. The keyboard/ display is an option and is not required for remote (GPIB) operation. The keyboard/ display provides the Operator with local capability for:

1. Programming setup for each channel
2. Initiating self checks and channel monitoring
3. Display of programming and measured channel output activity
4. Alerting the Operator as to error conditions

DISPLAY

Figure 3-1 identifies the key areas of the display. The RMT (ReMoTe programming) LED is illuminated during GPIB control and dark for local (front panel) control. The rest of the display gives complete information on the indicated channel. A flashing display indicates either a channel TEST mode is in progress, a setup oops, or a genuine fault. The next topic discusses ERROR CHECKS. The front panel FAILURE LEDs are in red, all others are green.

KEYBOARD FUNCTIONS

The front panel keyboard implements the familiar calculator-like keypad arrangement of numbers and multifunction keys. The upper half functions are keyed directly, while the lower half functions are immediately preceded by depressing the 2ND key momentarily. For example, an EXeCute is implemented in two keystrokes by depressing the following sequence - 2ND EXC. Figure 3-2 identifies the keyboard functions.

To avoid keyboard entries from inadvertently changing remote programming setups, the ReMoTe MODE LED signals a lockout of keyboard edits. The ReMoTe LED is dark upon POWER ON reset and is activated by the controller addressing the instrument via the GPIB to receive channel setups or instrument System processor commands such as CNF, RTN, PAR, etc.

Full keyboard control is regained by the keyboard entry of 2ND 911. This keystroke sequence is known as keyboard Go To Local (GTL) and is only available in ABLE version (not available in CIIL version). Keyboard GTL is disabled (not available from the keyboard) only if the controller has already sent a GPIB LLO (Local LockOut command). Momentarily removing the GPIB cable or by the remote controller sending the GPIB GTL command also clears the ReMoTe LED (and cancels any LLO command). The keyboard ReTurN and TeST functions select and monitor channels only (no edit), and thus are never locked out.

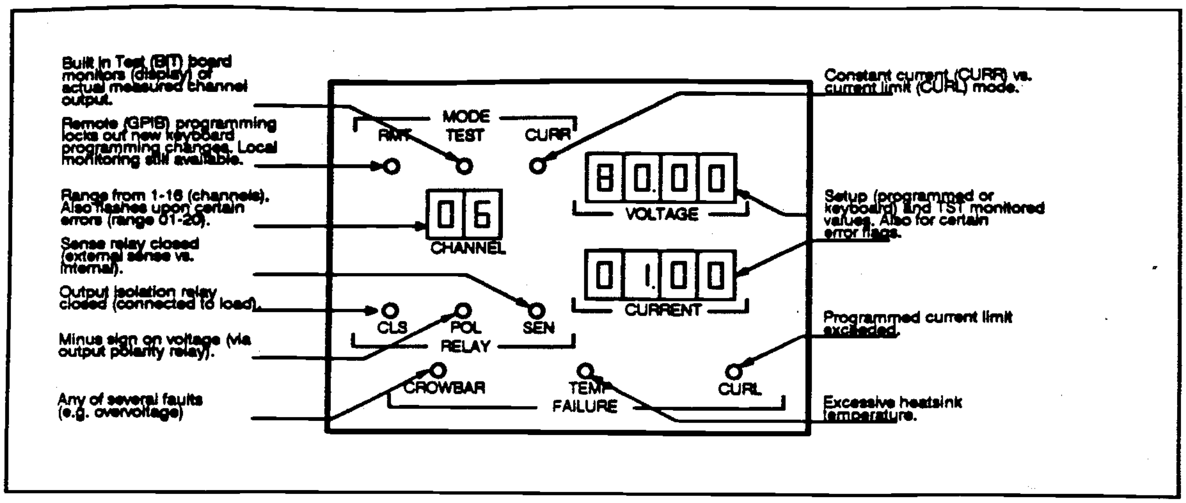

Figure 3-1
Model AT8000 Display

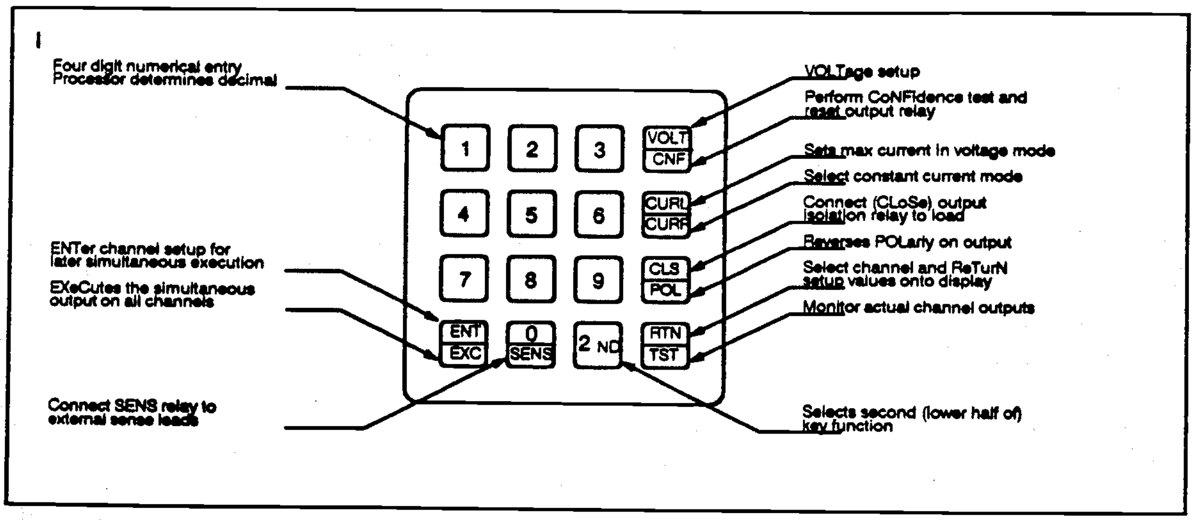

Figure 3-2
Model AT8000 Keyboard Functions

The keyboard provides local Operator control to reset, program, and verify operation of the instrument. These capabilities are broken into two categories - immediate execute and multiple setups for simultaneous execution.

The immediate execute keyboard functions do not use ENT nor EXE. Except for CNF, these do not affect channel programming nor output. The immediate execute functions are: GTL, CNF, TST and RTN.

GTL	Keyboard Go To Local	
Syntax:	2ND 911	
Example:	2ND 911	! ReMoTe LED goes dark. Full keyboard control.
	2ND 911	! No effect since controller had sent LLO already.

Normally, the front panel keyboard is disabled from editing any channel setups once the instrument ReMoTe (RMT) LED is illuminated. The RMT LED is illuminated upon receipt of any GPIB programming strings. The Go To Local (GTL) front panel entry clears the RMT LED. The front panel GTL is identically implemented as the GPIB GTL command.

Keyboard GTL is disabled if a GPIB LLO (Local LockOut) command has been sent by the controller to the instrument. Hint - Most system Programmers prefer not to use GPIB LLO. This gives the freedom of keyboard GTL availability should any front panel tinkering of the instrument be desired. The GPIB LLO is specifically to prevent such front panel tinkering.

Keyboard GTL is available in ABLE version Model AT8000 instruments. It is not available in CIIL version.

CNF	Confidence Test	
Syntax:	2ND CNF	
Example:	2NDCNF	! Initiates Confidence Test and display goes to CHANNEL 01.

CoNFidence Test opens all output isolation relay(s), performs internal calibration and diagnostics, and then re-programs all channels to zeros (described in Section 4-4). This is the quickest way to reset ALL channels. Defaults are:

Channel 01.
Mode and relay LEDs all dark.
Voltage zero and CURrent Limit mode (CURL) of zero.

TST	Test	
Syntax:	2ND TST	<2 digit channel number 00 to 16>
Example:	2ND TST 01	! Monitor CHANNEL 1.
	2ND TST 06	! Monitor CHANNEL 6.

TeST is real time monitoring on the display of actual load current and sense lead voltage for the selected channel, thus TeSTing the channel output. TST automatically displays the selected channel and thereby no RTN selection is required.

The TeST display LED alternates on and off as each new voltage and current value is measured and displayed. This keyboard function is also available while the ReMoTe LED is illuminated. TST requires the Test Board option. TST is canceled automatically upon any keystroke.

Should the TeST display indicate very low current (approximately zero), be suspicious that the channel output isolation relay is not connected (CLS not illuminated). If the channel output isolation relay is not closed (no load), then an internal load resistor simulates approximately a 2% full load and is monitored accordingly on the display.

The TeST display may read very low or improperly low value for voltage and current if the programmed VOLTage and/or current (CURL or CURR) is very low or zero. In some cases, when the CURL limit is set too low, the DC Power Module may go into current limit and illuminate the CURL FAILURE LED.

RTN Return
Syntax: RTN < 2 digit channel number 00 to 16 >
Example: RTN 02 ! Display setup for CHANNEL 2.
RTN 03 ! Display setup for CHANNEL 3.

ReTurN selects a new channel. This is the function used for selecting a new channel for program review and edit. All previously ENTered programming setup for that channel is displayed (as fetched from a 16 channel wide buffer). This enables the Operator to review or modify the setup. This keyboard function is available while the ReMoTe LED is illuminated (local edit of settings is still locked out).

For output load safety and maximum flexibility, it is highly desirable NOT to have the channel outputs responding to every keystroke entry immediately. The Model AT8000 processor instead allows you to select a channel, program it, check for errors, ENTer the setup into a 16 channel wide buffer, repeat this process on the same or another channel, and then finally EXeCute a simultaneous output on all channels. No intermediate aberrations are ever seen by your application load. The internal processor already knows details of itself and installed channels (E.G. voltage ranges, current range, relays, BIT, etc.). It does not permit any faulty or out of performance conditions to harm itself or reach the output terminals.

Two keyboard functions implement this buffering and simultaneous implementation of the setup parameters on each channel - ENT and EXC.

ENT Enter
Syntax: ENT
Example: ENT ! Everything on this channel ENTered.
VOLT 1234 ENT
! VOLTage updated and ENTered.
VOLT 1234 CURL 0123 2ND POL CLS ENT
! Entire setup ENTered.
VOLT 9999 ENT
! OOPS Flashing display. See text.
VOLT 1234 ENT CURL 0012 ENT
! Too many ENTs, but not error.

ENTer accepts the channel setup information (voltage, current limit, output isolation relay, etc.) keystroked onto the display and shifts the channel setup into a buffer for later execution. Any errors within the ENTered setup result in a flashing display and the errors are thrown away without being executed.

If an excessive VOLT, CURR, or CURL is ENTered, regardless of the validity of the rest of the channel setup, the processor does not accept the ENTer immediately. Instead, the display informatively flashes the maximum permitted value. The next keystroke (any, including ENTer) cancels the flashing and restores the last valid channel values to aid proper keyboard programming. This process may be repeated as often as necessary. Persistent errors are displayed after EXeCute. The Model AT8000 does not program any channel with a faulty setup.

Use the ENTer key once upon finishing all keyboard edits on a given channel. It is redundant and a waste of keystrokes to ENTer every individual function. You must use ENTer to save your channel edits before you EXeCute, select monitor (TeST) or select another channel (ReTurN). These three functions, and remote programming, cancels all non-ENTered keyboard edits.

EXC Execute

Syntax: 2ND EXC

Example: 2ND EXC ! All channel setups simultaneously actuated.

RTN 03 VOLT 0500 2ND EXC
! OOPS Forgot to ENT before EXC.

VOLT 0500 ENT 2ND EXC
! VOLTage updated and all actuated.

EXeCute actuates all validly programmed data previously ENTered for all installed channels simultaneously. EXC is not channel dependent. If a channel setup is not ENTered, its previously ENTered value is used.

EXC actuates all the channel setups simultaneously. It is redundant to EXC each channel one at a time unless you specifically wish to actuate them sequentially.

The following DC power supply channel setup parameters apply to each of the installed channels and are edited via the keyboard. The processor already knows each channel's capabilities and options installed.

As indicated above, a flashing VOLTAGE and/or CURRENT display indicates an out of range entry, but the maximum value is being flashed for your information.

If an option is not installed (E. G. POLarity relay), its parameter is ignored and corresponding display LED remains dark.

If you are about to edit several setup parameters on a given channel, there is no need to repeat the ENTer key after each parameter. Instead, wait until the channel setup is complete to save those redundant keystrokes.

The following parameters apply to each of the installed channels. The normal local programming sequence is:

1. Select channel via RTN.
2. Enter function and value (if required).
3. Repeat step 2 for the entire channel setup.
4. ENT.
5. Select another channel as per step 1 and repeat this process.
6. Use 2ND EXC upon completion.

Syntax for keyboard entries requires two digits for the channel (via RTN) entry ranging from 01 through 16. VOLT, CURR and CURL require a four digit entry. The numeric range of the four digit entries and corresponding decimal point is determined by the processor, desired current mode (CURL or CURR) and DC Power Module(s) installed.

VOLT Volt

Syntax: VOLT <number keys> [ENT]

Example:

VOLT 0555 ! 5.55VDC programmed but not yet ENTered.

VOLT 0555 ! 55.5VDC programmed on 100VDC module.

VOLT 1234 ENT
! VOLTage programmed and ENTered.

RTN 03 VOLT 2345 ENT
! New VOLTage ENTered on channel 3.

Selects channel voltage. If accompanied by CURL, the channel maintains this constant programmed VOLTage on its output. If accompanied by CURR, the channel output voltage varies from zero volts up to this maximum VOLTage to maintain constant current (CURR) value. Default VOLTage is whatever appears on display in local control (in remote, default is maximum voltage capability of module).

CURR Constant Current

Syntax: 2ND CURR <number keys> [ENT]

Example:

2ND CURR 0500 ENT 2ND EXC
! 5.00 Amperes in CURR mode at previously setup compliance voltage.

2ND CURR 1500 VOLT 0700 ENT 2ND EXC
! Constant current mode at 15.00 Amperes with compliance voltage of 7.00 VDC.

2ND CURR 9999 VOLT 2800 ENT
! OOPS Flashing display signals maximum current available in CURR mode on this channel at this compliance voltage.

Activates constant CURRent (CURR) MODE LED on display and sets constant CURRent value in amperes. Should be accompanied by VOLT entry. Voltage varies (0V to VOLT) to maintain this constant current.

If setup VOLTage value is zero and instrument is in local (keyboard) control, then the CURR mode compliance voltage is zero and very little current is available in CURR mode (an impractical setup). If in remote, the compliance voltage default significantly differs. Refer to remote programming topic below.

CURL Current Limit
Syntax: CURL <number keys> [ENT]
Example: CURL 0345 ENT 2ND EXC
! Current Limit of 3.45 amperes.
VOLT 0500 CURL 0200 ENT
! 5 Volts at 2 amperes max.
CURL 0000 ENT 2ND EXC
! Probable fault since current limit is set so low.

Activates CURrent Limit (CURL) mode and sets load current fault limit in amperes. Voltage remains constant in CURL. Upon channel load current reaching this value, the FAILURE CURrent Limit (CURL) LED is illuminated and channel output shuts down including opening the output isolation relays.

Use care with CURL setup at or near zero current since even the internal load resistor draws some current. Thus a zero CURL setup value may easily, and properly, cause a CURL failure.

CLS Close
Syntax: CLS [ENT]
Example: CLS ! CLS LED changes state, but not ENTered.
CLS CLS ! CLS LED momentarily changes, but goes back to original state.
RTN 07 CLS ENT 2ND EXC
! Channel 7 output isolation relay toggled to opposite state (CLoSed if relay was open, or open if relay was CLoSed).

CLoSe or open the output isolation relay. An alternate action keyboard function key (just press again to change setup state). If CLoSed RELAY LED is illuminated, then setup is for CLoSed output isolation relay contacts to the external (user) load. Keystroke CLS again for dark CLoSed RELAY to setup for no channel output power to load.

SENS Sense
Syntax: 2ND SENS [ENT]
Example: 2ND SENS ! SENSe relay LED changes state.
2ND SENS ENT
! SENSe relay LED changes state and is ENTered.
2ND SENS ENT 2ND EXC
! SENSe relay LED changed, ENTered and SENS relay actuated to LED indicated position.

SENSe controls internal sense relay to sample output voltage either internally or via external sense leads (User supplied which connect to User load). An alternate action function key. If SENse RELAY LED is illuminated, then setup is for SENSe relay to switch to remote (external) sense lead pickup. Keystroke SENS again for dark SENse RELAY for internal sense voltage.

When sensing internally, the sense point is before the output relays and the load regulation is approximately 20 millivolts per ampere. The actual relay switching occurs simultaneously with the output isolation relay.

POL Polarity
Syntax: 2ND POL [ENT]
Example: 2ND POL ! POLarity LED changes state on display.
2ND POL VOLT 1234 ENT 2ND EXC
! If POL LED is now illuminated, then minus (-) 12.34VDC is actuated. If POL LED is dark, then 12.34VDC is actuated.

POLarity reversed controls the polarity relay to internally reverse both the output and sense leads. An alternate action function key. If POLarity RELAY LED is illuminated, then setup is for minus (-) voltage on terminals. Keystroke POL again for normal polarity at output terminals (POLarity RELAY LED dark). For simplicity, treat POL RELAY as a minus (-) sign for voltage display. The actual relay switching occurs simultaneously with the output isolation relay.

LOCAL PROGRAMMING EXAMPLES

KEYS PRESSED	DESCRIPTION
2ND CNF	! Opens all output relays, performs Confidence Test on all installed channels, and resets all channels to zero.
RTN 05	! Displays last ENTered program values of channel 5.
VOLT 4458	! Programs Voltage to 44.58 volts (on <100VDC modules).
2ND CURR 0245	! Programs Constant Current mode (CURR LED is illuminated) to 2.45 amperes.
2ND POL CLS ENT	! Programs polarity and output isolation relays and stores setup for channel 5.
RTN 02	! Displays the last ENTered values of channel 2.
VOLT 2330	! Programs Voltage to 23.30 volts (on <100VDC modules).
CURL 0457	! Programs Current Limit mode (CURR LED is dark) to 4.57 amperes.
CLS 2ND SENS ENT	! Programs output isolation and remote sense relays and stores setup for channel 2.
2ND EXC	! Actuates all relays and energizes all ENTered channels.
2ND TST 05	! Displays the load voltage and current for channel 5. TEST LED is blinking.

FLASHING ERROR CODES

A flashing error code on the display signals the Operator of a setup or other detected error within the instrument. The processor continuously scans for any detectable fault. Faults originate from the keyboard, channel power module fault flags, BIT (Built In Test) board, and GPIB Interface. Certain faults may actually originate from outside the instrument (E.G. AC line voltage dropout, short circuit at load, or remote programming error). All keyboard and GPIB entries and virtually all other failures are detected before any permanent damage can be done to the instrument.

Run-time errors on ABLE language version instruments affect channels independently. That is, an error on one channel does not effect any other channel. The only exception is if the remote GRouP command has been used to specify a set or sets of channels which must simultaneously shut down in the event of any run-time failure of any channel within their set (GRouP). Default is sixteen (16) independent groups. CIIL language version instruments always shut down all channels for any run-time error is detected.

Pressing ANY key cancels the flashing error display, but not the cause of the error. If an error condition no longer exists, the display returns to normal. The flashing CHANNEL number typically indicates where to find additional FAILURE LED information. ReTurN the flashing channel number to display more information on the failure. Once the cause of the failure is corrected, the channel may be returned to its previous state simply by ReTurNing it (E.G. RTN 03), ENTer (ENT) and EXeCute (2ND EXC).

Flashing Both the Voltage and Current Display

Both the voltage and current display flash whenever the programmed voltage is higher than the maximum voltage range for the channel. The display flashes the maximum values of voltage and current capable on the particular channel including current contributions of any paralleled slave modules. Pressing any key instantly cancels the flashing informative maximums and re-displays the last correct setup for voltage and current thus aiding in quick update of the setup.

Keyboard errors are ALWAYS caught by the internal processor and thus CANNOT damage the instrument. You may experimentally determine the capabilities of your instrument from the keyboard. For voltage and current, simply keystroke any out of range setup value (E.G. VOLT 9999 ENT). The display responds by flashing the maximum installed voltage and current capability on that channel.

Flashing the Current Display

The current display flashes whenever the current being programmed is higher than the maximum current allowed for the programmed voltage. The processor already includes additive current effects of slave modules on the channel. The display flashes the maximum current allowed for the voltage programmed. Any keystroke returns the display to its last correct setup.

Most modules have a derating curve on the current when voltages are less than 75% of full range voltage (7 and 10 volt modules are always 100% - no derating). Thus maximum current is not always available for setup. Also, in the constant current mode (CURR), only 60% of full range current (7 and 10 volt modules are 100%) is allowed for any voltage value. See the Output Current Range under Electrical Specifications in Section I.

Flashing Channel 01 - 16

A flashing CHANNEL number 01 through 16 signals the corresponding channel had either a Confidence Test failure or a run-time failure.

A Confidence Test failure is identified by a VOLTAGE display of "Ex" where "x" is the specific number (1 through 4) of the failed test. See the Confidence Test topic in Section IV for details on these four tests and Section V for corrective action.

A run-time failure has no "E" on the VOLTAGE display. The specific fault is found by displaying the faulty channel. Keystroke RTN yy, where yy is the 2 digit CHANNEL number being flashed. The display then indicates the red FAILURE LED(s) corresponding to a CROWBAR, overTEMPerature, or CURrent Limit.

Flashing ChanneL 17

A flashing CHANNEL number seventeen (17) indicates multiple channel failures - that is, two or more channels have failed. When this happens, it is usually the result of the Confidence Test ("E" included on VOLTAGE display).

To find the failed channel numbers, modules must be removed from the chassis until only one of the failed modules is installed. Section V details this procedure of removing and replacing modules.

Flashing Channel 18

A flashing CHANNEL number eighteen (18) indicates either a Test Board over-run error or a Test Board calibration failure. A Test Board calibration failure only occurs as a result on the execution of the Confidence Test and displays an "E3" on the voltage display.

If this "E3" is not displayed, the Test Board attempted to measure a voltage of five (5) volts or greater. The processor immediately stopped the test and disconnected the input signal to prevent damage to the Test Board A/D converter. Correction of these are discussed in Section V.

Flashing Channel 19

A flashing CHANNEL number nineteen (19) indicates a local keyboard failure. Occasionally a key is pressed incorrectly, keys are pressed too fast or keyboard temporarily malfunctions sending an illegal key code to the processor. If this happens simply ignore the failure and repeat the entry sequence.

Flashing Channel 20

A flashing CHANNEL number twenty (20) indicates the processor detected a momentary AC line voltage dip below approximately 95VAC.

During this dip, the processor temporarily inhibits its own processing to avoid corrupting any channel setups. Suspect your prime AC power cord is loose or prime AC power is underrated for your load.

3.5 REMOTE PROGRAMMING IN ABLE (Atlas Based Language Extension)

This topic applies only to ABLE version language.

The ABLE (Atlas Based Language Extension) via GPIB gives the Programmer a more flexible format for numerical entry over that of the keyboard. Channel numbers do not require the leading zero(s). Other numeric entries use free format defined in the syntax below. In addition, multi-channel control is improved via the GRP and PAR commands. The polarity of voltage entered automatically determines the state of the polarity (POL) relay, thus there is no need for a POL parameter.

There are no ENT or EXC commands in remote programming. The remote programming equivalent is the terminator automatically sent by the controller at the end of the programming string. Programming strings sent via the GPIB to the Model AT8000 must be terminated with either carriage return linefeed (hex 0D 0A) and/or linefeed (hex 0A), and/or the GPIB EOI. Talk strings sent from the Model AT8000 are terminated with the universally accepted carriage return linefeed (hex 0D 0A) and EOI.

Two types of programming instructions are sent to the Model AT8000, commands and channel setup parameters. Commads prepare or fetch information related to the channels on a System level. Channel setup parameters are the specific voltage, current, and relay positions desired on the individual channels.

Syntax applicable to remote ABLE version programming is:

<channel>: One or two digit numeric entry for channel number. A leading zero is not required for single digit channel numbers. "S" indicates all installed channels.

<value>: Numeric entry in free format. no leading zeros required, however a single <space> is required between the parameter and the

first number in the value. Consists of up to six digits and plus optional decimal (.) plus an exponent. May be preceded by optional plus sign (+). A negative sign (-) for voltage implements polarity relay (if installed). No embedded <spaces> nor commas. Exponent is upper case "E" followed by optional plus (+) or minus (-) sign followed by one (1) or two (2) digits.

INSTRUMENT COMMANDS

Instrument commands are GPIB remote programming instructions which reset the channels, fetch specific information about the channels, or configure mutual interaction between (among) channels and thus the instrument System. These particular commands do not generate any DC power supply output nor set up any individual channel parameters. Instead, the commands of this topic aid in the organization or re-organization of channels. In addition, these commands permit the Programmer/ remote ATE controller to "look" at which type of modules are installed, how they are programmed (set up), and what is occurring within the Model AT8000. The following instrument programming commands are not preceded by any CH (CHannel) assignments. A command is sent by itself in a programming string. It may not be combined with any other command nor any channel parameters (channel setup of volts, current, etc.) discussed in the next topic. Note the use of <space> in the following syntax.

CNF Confidence Test
Syntax: CNF
Example: "CNF" ! Perform Confidence Test.

Initiates the Confidence Test to execute on all channels. All relays are opened and, upon completion, all channels are reset to zeros. GRouP and PARallel assignments are reset to sixteen (16) independent channels. Display indicates channel 01 upon completion. CNF cancels any RTN and TST. Confidence Test is discussed in Section 4.4.

RST Reset channel(s)
Syntax: RST <channel> [[, <channel>] ...] ;or
RST S
Example: "RST 4 ! Reset channel 4.
"RST 1, 3" ! Reset channels 1 and 3.
"RST S" ! Reset all installed channels.

Initiates reset routine on specified channels. An "S" specifies all channels. Reset simultaneously opens specified channel relays, programs these channels to zeros, and releases these channels from any GRouP and PARallel assignments.

GRP Group channels
Syntax: GRP <channel> [[, <channel>] ...] ;or
GRP S
Example: "GRP 1, 2, 3" ! Place channels 1, 2 and 3 into a group.
"GRP 4, 5" ! Place channels 4 and 5 into another group.
"GRP 1, 12" ! Remove channel 1 from above group and create new group of channels 1 and 12.
"GRP S" ! Group all channels into one set. Cancel all above group assignments.

Specifies which channels are to be combined into a set. "S" specifies all channels. Should any run-time failure occur on any channel within this set, all channels within the set are shut down simultaneously to protect the external (Customer) load circuit(s) and the associated DC Power Modules. Multiple GRP sets may be specified active at the same time. When any channel is assigned via GRP, that channel's assignment to any other GRP is removed automatically. GRP must be used with PAR command. See below.

CNF cancels all GRP set assignments into 16 independent channels (no GRouPs). RST cancels similarly for all specified channels. Should any run-time fault occur on any channel within a GRP set, all channels within that set are reset and that GRP assignment is canceled.

Example:

Circuit "A" is under test and requires both channels 1 and 2. The circuit must never have only one supply connected in the event of a circuit failure which causes the other supply to go down. Thus a GRP assignment is made for channels 1 and 2. Circuit "B" uses only channels 3 and 4 with identical requirements and thus a separate GRP assignment for channels 3 and 4.

Should any problem occur with either DC power supply channel on circuit "A", that set (group) of channels alone is simultaneously shut down. Circuit "B" is not affected and may continue testing.

PAR Parallel channels

Syntax: PAR <channel> [[, <channel>] ...] ;or
PAR S

Example: "PAR 1, 2, 3" ! Place channels 1, 2 and 3 into a PAR set.
"PAR 2, 6" ! Remove channel 2 from above set and form another set consisting of channels 2 and 6.
"PAR S" ! All channels into one PAR set. Cancel previous assignments.

Specifies to the processor which sets of channels have their outputs connected in parallel for the benefit of additional output current. "S" specifies all installed channels. PAR does not refer to master/slave modules, but rather individual channels whose outputs are paralleled.

Without the PAR command, should high current levels be drawn, normally one of the channels would reach its programmed upper current value and initiate a protective shut down via the internal processor. This further initiates a CROWBAR drawing tremendous current from the other channels in parallel and quickly defeats the purpose of multiple outputs connected in parallel.

With the PAR command, all of the channels within the particular PAR set are allowed to reach maximum programmed current before the processor initiates any protective shut down and signal a fault. The maximum current is equal to the sum total of the installed parallel channels.

PAR is canceled upon any failure within the set (via the reset routine), by a CNF test, and by RST.

Output isolation relays must close and open at precisely the same time by sending the CLS and OPN commands on the same programming line. Since channel outputs are connected together, if any channel's output is actuated before a second channel, the second channel will see a voltage that is higher than its own value and consequently immediately CROWBAR - possibly causing damage to the module.

IMPORTANT

The PAR command must be used with the GRP command to assure that any shut down simultaneously includes all channels within the PAR set.

TST	Test channel(s)	
Syntax:	TST <channel> [[, <channel>] ...] ;or	
	TST S	
Example:	"TST 1"	! Test channel 1.
	"TST 1, 2"	! Test channels 1 and 2.
	"TST S"	! Test all installed channels.

Initiates the Model AT8000 processor and BIT (Built In Test) to measure the actual voltage and current on the specified channel(s). "S" specifies all installed channels. Measurements are made at the sense terminals (internal or external, as setup) for voltage and across an internal current path resistor. The Model AT8000 processor signals completion of the measurements and formation of the TeST measurement string by setting the instrument SRQ status byte (79 decimal).

To receive the measurement string, the controller sends the GPIB talk address to the Model AT8000 and in turn sets itself (controller) to its own GPIB listen address. If the GPIB talk address has been sent to the Model AT8000 prior to completion of the measurement, the SRQ status byte (decimal 79) is not sent. Be sure to DIMENSION the controller's string variable large enough to contain the entire returned TST string message.

TST is canceled by CNF and RST. TST requires the optional Built In Test Board.

The Model AT8000 returns the TST measurements via the GPIB in the following format:

TST: CHnn=PXX.XXV XX.XXA S R[, CHnn ...] (for modules <100 volts)

TST: CHnn=PXXX.XV XX.XXA S R[, CHnn ...] (for modules >= 100 volts)

Where:

nn = channel number 16 down to 01 (as installed),
P = + or - for the state of the polarity relay,
X = decimal number from 0 through 9,
V = Volts,
A = A or C for CURL or CURR respectively,
S = I or X for SENS relay Internal or eXternal,

R = C or O for output Isolation relay CLoSed or OPeN, and
, = separator between channels.

RTN Return channel(s)
Syntax: RTN <channel> [[, <channel>] ...] ;or
RTN S
Example: "RTN 1" ! Form setup string for channel 1.
"RTN 4, 6" ! Form setup string for channels 4 and 6.
"RTN S" ! Form setup string for all channels.

Initiates the Model AT8000 to assemble a string containing programming setup for each of the specified channels. "S" specifies all installed channels. To actually send the string, the Model AT8000 must be sent its talker address via the GPIB.

The returned setup string format is:

RTN: CHnn=PXX.XXV XX.XXA S R[, CHnn ...] (for modules < 100 volts)

RTN: CHnn=PXXX.XV XX.XXA S R[, CHnn ...] (for modules > = 100 volts)

Where:
nn = channel numbers 16 down to 01 (as installed),
P = + or - for the state of the polarity relay,
X = decimal number from 0 through 9,
V = Volts,
A = A or C for CURL or CURR respectively,
S = I or X for SENSe relay Internal or eXternal,
R = C or O for output Isolation relay Closed or Open, and
, = separator between channels.

PWRL Power Limit(s)
Syntax: PWRL <channel> [[, <channel>] ...] ;or
PWRL S
Example: "PWRL 4" ! Form identity string for channel 4.
"PWRL 2, 4" ! Form identity string for channels 2 and 4.
"PWRL S" ! Form identity string for all channels.

Initiates the Model AT8000 to assemble a string identifying the power limits and installed options on each of the specified channel(s). "S" specifies all installed channels. To actually send the string, the Model AT8000 must be sent its talker address via the GPIB.

The returned Power Limit string format is:

PWRL: CHnn=PXX.XXV XX.XXA S R[, CHnn ...] (for modules < 100 volts)

PWRL: CHnn=PXXX.XV XX.XXA S R[, CHnn ...] (for modules > = 100 volts)

Where:

nn	=	channel number 01 through 16,
P	=	+ or - for polarity relay (+ not installed, - installed),
X	=	decimal number from 0 through 9,
V	=	Volts,
A	=	Amperes,
S	=	Sense relay, and
R	=	R for output isolation relay.

VER Version (revision) of instrument firmware
Syntax: VER
Example: "VER" ! Initiates instrument to send VER string.

Initiates the Model AT8000 to assemble a string identifying the ROM firmware revision within the instrument. Available in ABLE only. To actually send the string from the instrument, the Model AT8000 must be sent its talker address via the GPIB.

The returned VER string format is:

VERSION: X.XX
X.XX = firmware version (revision) number.

CHANNEL PARAMETERS

Channel parameters are the actual setup instructions for each specified channel. Everything a channel needs to know is contained herein. Those items regarding interaction between channels is more of an internal system nature and thus part of the above topic on Instrument Commands.

It is not necessary to re-program every parameter within a channel setup. The Model AT8000 remembers its most recent setup. Usually only one or two parameters need to be updated, but the entire setup does not need to be re-programmed.

It is normal to program several to all channels within the same programming string. The Model AT8000 executes the entire string simultaneously, regardless of content or length. any channel parameter, syntax or command error rejects the entire string.

Channel parameters may not be combined with instrument software commands (above topic) within the same programming string. Voltage and current (CURL or CURR) must be programmed within the same string or the processor will provide default values for the unspecified parameter. Note the use of <space> in the following syntax.

Syntax for channel parameters requires a channel (CH) assignment followed by the parameter setup for that channel. Multiple parameters (VOLT, CURR or CURL, relays) or merely one parameter may be included in a single channel's programming string.

Should multiple channels be programmed within one GPIB string, each channel is separated by a comma (,). Individual parameters within a channel setup do not use commas nor any other separator except <space>. Note the careful placement of <space> immediately prior to each parameter.

Syntax is:
<channel> <parameter>[<parameter >...] ;or
<channel> <parameter>[<parameter> ...]
[, <channel> <parameter>[<parameter > ...] ...]

CH Channel number
Syntax: CH <channel> ;or
CH<channel>
Example: "CH 1" ! Channel 1
"CH4" ! Channel 4. Note leading <space> not required.

Channel number is one (1) or two (2) digits to assign channel number from 1 to 16. Leading zero is not required. <space> between CH and channel number is not required. All parameter entries following in programming string refer to this channel until canceled by a new CH assignment. A new CH assignment is required even if same channel is desired in next programming string.

VOLT Voltage
Syntax: VOLT <value>
Example: "CH 16 VOLT 28.55"
! Setup 28.55 volts on channel 16.
"CH 3 VOLT 122.2
! Setup 122.2 volts on channel 3.
"CH2 VOLT -0.352E+2"
! Setup minus 35.2 volts on channel 2.

Set Voltage. VOLT must be followed by at least one <space> and <value>. When VOLT is programmed and current (both CURL or CURR) are not specified, the default is the maximum CURL allowed for the voltage value selected.

CURL Current Limit
Syntax: CURL <value>
Example: "CH1 CURL 4.3"
! Setup current limit of 4.3 amperes.
"CH3 CURL .1E+2"
! Setup current limit of 10 amperes.

Set Current Limit in amperes. Must be followed by at least one <space> and <value>. CURL cancels the constant current (CURR) mode. CURL should be accompanied by a non-zero value, else a CURL error is likely (virtually ANY load draws current, even the internal load). CURL must be accompanied by a VOLT setup or a syntax error is generated.

CURR Constant Current
Syntax: CURR <value>
Example: "CH 1 CURR 12"
! Setup constant current of 12 amperes.

Set Constant Current value in amperes and enter Constant Current mode (CURR LED illuminated). Must be followed by at least one <space> and <value>. When CURR is programmed and VOLT value is not specified, the default condition is the maximum compliance voltage allowed for the channel (module).

CLS Close
Syntax: CLS
Example: "CH 7 CLS" ! Close the output on channel 7.
"CH 2 CLS, CH3 CLS"
! Close outputs on channels 2 and 3.

Set channel to CLoSe its output isolation relay, thus connecting the channel output voltage (and current) to the external load.

OPN Open
Syntax: OPN
Example: "CH 3 OPN" ! Open the output on channel 3.
"CH1 OPN, CH2 OPN"
! Open the outputs on channels 1 and 2.

Set channel to OPeN its output isolation relay, thus disconnecting output power to the external load.

SENS I Sense Internal
Syntax: SENS I
Example: "CH14 SENS I"
! Use internal voltage sensing.

Set channel to open its SENSe relay, thus sense voltage internally. The internal sense point is before the output relays and load regulation is approximately 20 millivolts per ampere.

SENS X Sense eXternal
Syntax: SENS X
Example: "CH12 SENS X"
! Use external voltage sensing.

Set channel to close its SENSe relay. Thus, the channel monitors/regulates voltage at the far end of the sense leads which are normally located at the application (external) load. The SENSe relay automatically remains (switches to) internal while the output isolation relay is OPeN. If the channel is programmed for SENS X, the SENSe relay automatically switches to eXternal when the output isolation relay is CLoSed.

EXAMPLE MESSAGE STRING WITH ABLE

The following are examples of typical programming strings sent to the Model AT8000. Recall that the entire string is processed simultaneously for concurrent changes at the individual channel outputs. Only those parameters requiring to be changed are sent, thus saving programming time.

Example 1:

"CH1 VOLT 12.4 CURL 1.35 OPN, CH 14 CURR .55 VOLT -.276E+2 SENS X CLS, CH 09 VOLT 22.4 OPN SENS I, CH03 CLS CURR 1.12"

Channel 1 to 12.4 volts, current limit of 1.35 amperes, output isolation relay open, and no change to the sense relay.

Channel 14 to 0.55 amperes in constant current mode, compliance voltage (max.) is minus 27.6 volts, external sense relay, and output isolation relay closed. POLarity LED illuminated due to minus (-) voltage.

Channel 9 to 22.4 volts at maximum available (default since unspecified) current, output isolation relay open, and internal sense.

Channel 3 to 1.12 amperes in constant current mode, maximum compliance voltage available (default since unspecified), output isolation relay closed, and no change to sense relay.

Example 2:

"CH4 CLS, CH5 CLS, CH6 CLS"

Causes output isolation relays on channels 4, 5 and 6 to close simultaneously.

Example 3:

```
10 DIM A$[200]
20 OUTPUT 717 "RTN S"
30 ENTER 717; A$
40 DISP A$
50 END
```

Memory within the controller (DIM A$[200]) is reserved to accept the returned string from the Model AT8000. These 200 characters are more than enough for several channels.

The controller outputs the command string onto the GPIB from controller port 7 (the first 7 of 717) and sends the string "RTN S" to the instrument at GPIB listen address 17 (the second part of 717). The string "RTN" initiates the Model AT8000 processor to formulate a string identifying the instrument setup parameters. The "S" tells the instrument processor that all installed channels are to be included within the formulated string.

ENTER 717 enables the instrument at GPIB address 17 (the Model AT8000) to talk while the controller now listens. The Model AT8000 processor now sends its message string on the GPIB to whomever is listening (the controller). The controller places the incoming characters from the GPIB into a string A$. The transfer is completed at the end of the string when the Model AT8000 sends <CR> <LF> (carriage return linefeed).

The controller DISPlays the typical string A$ onto its display as follows:

```
RTN: CH04=-12.35V 04.03A X C,
CH03= +05.00V 10.00A X C,
CH02= +185.4V 00.10C I C,
CH01= +28.00V 03.55A X C
```

NOTE

PWRL and TST have comparable GPIB programming as in this example.

SERVICE REQUEST STATUS BYTES

The Model AT8000 ABLE version sends all of its error and service requests messages via activation of the Service Request (SRQ) on the GPIB. These include programming errors, run-time failures and request to talk its internally formulated message string.

Application software should be written to periodically check for Service Requests (GPIB SRQ flag) after performing Confidence Tests and channel programming. This assures the instrument is completely functional and the programming setups are accepted.

Occasional checks during normal operation verify the presence of any run-time faults. Be sure to allow sufficient processing time (usually just a few hundred milliseconds) within the instrument when programming channel setups and for lengthy activities such as TST and CNF. If insufficient time is allotted prior to reading the SRQ byte, the instrument processor may not yet have completed its processing. Thus, the SRQ byte is not necessarily updated in time when it is read by the controller.

The SRQ message consists of a single byte of information. In the event an old message byte as not been read, the Model AT8000 retains only the most recent one. Upon being read, the SRQ message is cleared and SRQ line released. Serial poll activities are handled separately from normal programming strings. Each controller, and its own language subset, implements the serial poll via different commands. Some treat the SRQ line as a flag for occasional inspection. Others may treat SRQ as an interrupt for immediate polling and thus immediate attention. However, each should return the SRQ status byte to the program for analysis.

Should the received status byte not correctly interpret messages as listed below, suspect that the controller (or its software/driver) is not monitoring all eight data bits on the GPIB. The last three columns of Table 3-1 use the full eight data lines.

Table 3-1 Service Request Messages

SRQ BYTE dec	hex	DESCRIPTION
74	4A	Syntax Error
75	4B	Command Error
76	4C	Input Buffer Overflow
77	4D	Multiple Channel Failures
78	4E	Test Measurement System (BIT) Overflow
79	4F	Send Talk Address So Message May Be Sent

Chan	Crowbar dec hex	CURL dec hex	Not Install dec hex	CNF Test dec hex	Thermal Ovl. dec hex
1	81 51	101 65	201 C9	221 DD	240 F0
2	82 52	102 66	202 CA	222 DE	241 F1
3	83 53	103 67	203 CB	223 DF	242 F2
4	84 54	104 68	204 CC	224 E0	243 F3
5	85 55	105 69	205 CD	225 E1	244 F4
6	86 56	106 6A	206 CE	226 E2	245 F5
7	87 57	107 6B	207 CF	227 E3	246 F6
8	88 58	108 6C	208 D0	228 E4	247 F7
9	89 59	109 6D	209 D1	229 E5	248 F8
10	90 5A	110 6E	210 D2	230 E6	249 F9
11	91 5B	111 6F	211 D3	231 E7	250 FA
12	92 5C	112 70	212 D4	232 E8	251 FB
13	93 5D	113 71	213 D5	233 E9	252 FC
14	94 5E	114 72	214 D6	234 EA	253 FD
15	95 5F	115 73	215 D7	235 EB	254 FE
16	96 60	116 74	216 D8	236 EC	255 FF
multi		237 ED			
BIT	218 DA	238 EE			

multi - multiple channels

BIT - Built In Test board

3.6 REMOTE PROGRAMMING WITH CIIL (Computer Interface Intermediate Language)

This topic applies only to the CIIL version language.

CIIL (Computer Interface Intermediate Language) is a form of generic ATE (Automatic Test Equipment) language which defines the structure of message strings going to and from instruments on the GPIB. This structure encourages certain longevity in programming for interchangeable instruments.

The Model AT8000 System internally supports several channels of DC power supplies. In addition to providing voltage and current, the Model AT8000 orchestrates several activities on an internal instrument system level including fault detection and handling, relay control, BIT (Built In Test), real time monitoring of channel activity, and both setup and error reporting.

For the purposes of CIIL, the Model AT8000 support of internal system activities is via CIIL "opcodes". The Model AT8000 specific instrument operation is defined via the CIIL "noun" DCS (Direct Current Supply). Contents of the programming string relating to instrument operation use terms called "noun modifiers". These latter terms are the familiar VOLT, CURR, etc.

In remote CIIL version, any Model AT8000 run-time fault always sets the DFI (Direct Fault Indicator, a dedicated relay contact) and resets ALL channels. The DFI signals the remote controller that the Model AT8000 has internally detected a fault and automatically shut down all channels. The controller needs to check the DFI periodically and, if flagged, must clear it via the GPIB using the CIIL STA (STAtus) opcode.

CIIL hardware configuration generally uses optional MS type connectors for AC input and DC output/sense. However these MS connectors are not required always. These connectors, including DFI/Shutdown are identified in Sections I and II.

CIIL also has a remote Shutdown input signal pair on the DFI/Shutdown connector. The remote controller or any relay closure may be used to initiate an instrument reset. This reset is comparable to the RST command.

CIIL programming strings use free format numerical entry as defined in the syntax below. The polarity of voltage entered automatically determines the state of the polarity (POL) relay. There is no remote equivalent for PAR (PARallel), PWRL (PoWeR Limit), RTN (ReTurN), nor TST (TeST). There is no separate GRP (GRouP) - all channels are effectively grouped together.

There are no ENT or EXC commands in remote programming. The remote programming equivalent is the terminator automatically sent by the computer at the end of the programming string. Programming strings sent via the GPIB to the Model AT8000 must be terminated with either carriage return linefeed (hex 0D 0A) or linefeed (hex 0A). Talk strings sent from the Model AT8000 are terminated with the universally accepted carriage return linefeed (hex 0D 0A). EOI is not supported in CIIL. Serial poll is not supported in CIIL.

Syntax applicable to remote CIIL programming is:

:CH <channel> Channel assignment consists of a colon immediately followed by CH and a one or two digit numeric entry for channel number. No leading <spaces> permitted for the channel number. No embedded <spaces>. A leading zero is not required for single digit channel numbers. ("S" (all channels) is not permitted in CIIL.)

<value> Numeric entry in free format. No leading zeros required. consists of up to six digits and plus optional decimal (.) plus an exponent. may be preceded by optional plus sign (+). A negative sign (-) for voltage implements polarity relay (if installed). No embedded aces nor commas.exponent is upper case "E" followed by optional plus (+) or minus (-) sign followed by one or two digits.

NOUNS

The CIIL noun "DCS" must be used whenever the programming string contains setup (SET) or reset (RST) of parameters for an individual channel. The noun "DCS" defines that the string contains information which applies only to the Direct Current Supply function (FNC) capability of the instrument.

The Model AT8000 supports no other CIIL function (FNC) noun. Other nouns received by the Model AT8000 generate a syntax error.

OPCODES

Programming strings sent from the controller to an instrument via the the GPIB are referred to as operational codes, or "opcodes" for short. Opcodes command an instrument to perform some internal task or setup. Such a command may involve an overall reset of the instrument, setup of DCS channel parameters, formulate any error response message to send back to the controller, etc.

INSTRUMENT LEVEL

CIIL opcodes which apply to the internal system capabilities of the Model AT8000 and not its specific "DCS" function are simple and brief to program. These five opcodes are: CNF, IST, STA, CLS and OPN.

CNF Confidence Test
Syntax: CNF
Example: "CNF" ! Perform Confidence Test.

Initiates the Confidence Test (described in Section 4.4). All relays are simultaneously opened, tests are performed on all installed channels, channel setups are programmed to zeros, and then channel 01 is displayed. Any fault message may be retrieved via the STA opcode.

IST Internal Self Test
Syntax: IST
Example: "IST" ! Perform Confidence Test.

Identical to CNF above.

STA Status
Syntax: STA
Example: "STA" ! Reset DFI relay and formulate status message.

Initiates the Model AT8000 to reset its DFI flag relay and send any fault message to the controller. The STAtus message contains the most recent fault since the last STAtus opcode command. The STAtus message is reset to a single <space> after sending its fault message.

If no faults occurred, the STAtus message is a single <space>. Refer to STATUS MESSAGES WITH CIIL topic below for a list of available Model AT8000 STAtus messages. The Model AT8000 processor sends the formulated STAtus message upon receipt of the Instrument's GPIB talk address.

CLS Close Output Isolation Relay
Syntax: CLS :CH<channel>
Example: "CLS :CH1" ! Connect channel 1 output to external load.
"CLS :CH16" ! Connect channel 16 output to external load.
"CLS :CH 4" ! OOPS syntax error due to leading <space>.

Closes the output isolation relay on the specified channel, thereby connecting the power supply channel to the external load. The opening and closing of the output isolation relays is considered an internal system activity and not a DCS setup function. A CH0 assignment switches all installed channels simultaneously.

Any associated sense relay switching (via FORW) is performed simultaneously with this opcode. TWOW and FORW sense relay switching may also occur separately via the FNC opcode. However, the sense relay is automatically switched to internal (temporary TWOW) while the output isolation relay is open. If the sense relay is programmed for external voltage sensing (FORW), the sense relay is automatically switched to external simultaneously with CLS.

OPN Open Output Isolation Relay
Syntax: OPN :CH<channel>
Example: "OPN :CH7" ! Disconnect channel 7 from external load.
"OPN :CH16" ! Disconnect channel 16.

Identical to CLS above except opens the specified channel relay and sense relay.

FUNCTIONAL LEVEL

The last five opcodes directly involve the Direct Current Supply (DCS) capability of the instrument. Thus, the CIIL noun DCS is required with these opcodes. These five opcodes perform only two tasks - reset channels and setup channels.

It is simple to reset DCS channel setup parameters (noun modifiers) to startup defaults. The RST opcode performs this task.

To setup channel parameters (called noun modifiers in CIIL) the function (FNC) opcode is required. The FNC opcode is then followed by one or more SET opcodes. Each SET opcode sets up one noun modifier (parameter) of the selected channel.

The Model AT8000 supports only the CIIL noun DCS. Any other CIIL noun generates a syntax error.

NOUN MODIFIERS

Noun modifiers are the parameters (VOLT, CURL, TWOW, etc.) which setup a channel. Since the Model AT8000 is a Direct Current Supply, its noun is DCS. Its noun modifiers are thus parameters of voltage, current, and voltage sense relay selection. The output isolation relay is under instrument system control via the OPN and CLS opcodes.

Noun modifiers are only used one at a time with the SET opcode. Several noun modifiers may be used in the same FNC opcode string since each has its own SET. These noun modifiers are: VOLT, CURL, CURR, TWOW and FORW.

VOLT Volt
Syntax: FNC DCS :CH <channel> SET VOLT <value > [SET ...]
Example: "FNC DCS :CH5 SET VOLT -2.54"
! Set channel 5 to minus 2.54 volts, current limit (CURL) mode at maximum current.

Voltage setup value. Note use of <space> in syntax. When VOLT is programmed without a CURL or CURR, the default is the maximum CURL allowed for the voltage value selected.

CURL Current Limit
Syntax: FNC DCS :CH <channel> SET CURL <value> [SET ...]
Example: "FNC DCS :CH11 SET CURL 1.4E+1"
! Set channel 11 to new current limit of 14 amperes.

Current Limit setup value and enters CURL mode. Note use of <space> in syntax. CURL must be programmed with a VOLT value or a Command Error will be generated.

CURR Constant Current
Syntax: FNC DCS :CH <channel> SET CURR <value> [SET ...]
Example: "FNC DCS :CH3 SET CURR 1.20"
! Set channel 3 to 1.2 amperes in constant current mode and compliance voltage default to maximum of module.

Constant Current setup value and enters CURR mode. Note use of <space> in syntax. When CURR is programmed without a VOLT value, the default is the maximum compliance voltage allowed. Front panel CURR LED is illuminated.

TWOW Two Wire (Internal Voltage Sense)
Syntax: FNC DCS :CH <channel> SET TWOW [SET ...]
Example: "FNC DCS :CH6 SET TWOW"
! Set channel 6 to internal sense.

Selects internal voltage sense relay position. The sense relay is initialized (RST, CNF, RST, and power on reset) to the TWOW position. Only a FORW opcode with an OPN (output isolation relay) opcode changes this sense relay from internal (TWOW). Front panel SEN LED is dark.

RST Reset Channel
Syntax: RST DCS :CH <channel>
Example: "RST DCS :CH12"
! Reset channel 12.

Opens all relays on the specified DCS channel and resets its setup to all zeros. The specified channel is reset to VOLT=0, CURL=max. of installed channel, CURR=0 and CURR mode off, TWOW, and open output isolation relay. CHannel 0 denotes all channels. Note use of <space> separators in syntax.

FNC Function
Syntax: FNC DCS :CH<channel> SET<noun modifier and value> [SET ...]
Example: "FNC DCS :CH3 SET VOLT 5.123 SET CURL 3.21 SET TWOW"
!Channel 3 to 5.123 volts, current limit to 3.21 amperes and internal sense relay.
"FNC DCS :CH15 SET FORW"
! Channel 15 to external sense.

Prefix for programming channel noun modifiers (parameters). FNC is followed by CIIL noun (only DCS) and channel number. Note use of <space> separators. Multiple SET opcodes may included within one FNC opcode command string. Channel noun modifier setups are performed one channel per function string. It is not necessary to repeat the entire channel setup if only one noun modifier (or a few) require updating.

SET Set
Syntax: SET VOLT|CURL|CURR <value> ;or
SET TWOW|FORW
Example: (see FNC above)

Prefix for noun modifiers. Must be part of a FNC opcode structure and may be repeated within this FNC structure. Only one noun modifier is modified (SETup) per SET. Multiple noun modifiers may be modified within a programming string as long as each noun modifier is preceded by its own SET. Note use of <space> in syntax.

SRX Set Maximum
Syntax: SRX <value>
Implemented identically to SET above.

SRN Set Minimum
Syntax: SRN <value>
Implemented identically to SET above.

FORW Four Wire (External Voltage Sense)
Syntax: FNC DCS :CH<channel> SET FORW [SET ...]
Example "FNC DCS :CH12 SET FORW"
! Set channel 12 to external sense.

Selects external voltage sense position. Requires output isolation relay to also be closed (CLS). Sense relay temporarily switches to internal while channel output isolation relay is open (OPN). Front panel SEN LED is illuminated.

REMOTE PROGRAMMING EXAMPLE WITH CIIL

The following CIIL version example demonstrates software design in communicating with the Model AT8000. Good programming layout makes frequent use of the STA opcode to verify for possible instrument setup and run-time errors. The Model AT8000, just as with any other instrument, requires internal processing time, relay settling time, etc. which need to be provided for within the controller software as a WAIT statement. The duration of WAIT is longest for CNF, IST and RST opcodes since multiple activities occur per installed channel. Actual times are best experimentally determined per your particular application.

```
100 DIM A$[200]              ! Reserve memory space for incoming messages.
200 GOSUB 2000               ! Check for any existing STA message.
220 OUTPUT 717 "CNF"         ! Perform Confidence Test.
240 WAIT (600)               ! Give time to perform CNF on all channels.
260 GOSUB 2000               ! Check for any STA due to CNF.
280 OUTPUT 717 "FNC DCS :CH01 SET VOLT 56.37 SET CURL 2.12 SET FORW"
300 OUTPUT 717 "FNC DCS :CH16 SET VOLT -0.5637E+02 SET CURL 1.98"
320 OUTPUT 717 "FNC DCS :CH5 SET CURR 14.95"
340 WAIT (200)               ! Instrument processing and settling (varies).
360 GOSUB 2000               ! Check for any errors.
380 OUTPUT 717 "CLS :CH1"
400 OUTPUT 717 "CLS :CH16"
420 OUTPUT 717 "CLS :CH05"
430 OUTPUT 717 "FNC DCS :CH5 SET FORW"
                             ! External sense.
440 WAIT (250)               ! Plenty of settling time.
460 GOSUB 2000               ! Check for any errors.
480 OUTPUT 717 "RST DCS :CH5"
                             ! ReSeT channel 5.
500 WAIT (200)               ! Allow time for RST process within instrument.
520 GOSUB 2000               ! Check for errors.
1000 END
2000 OUTPUT 717 "STA"        ! Tell instrument to form STAtus message.
2010 INPUT 717 A$            ! Sends GPIB TALK address to instrument.
2020 DISP A$                 ! A$ string should be a <space> if no message.
2030 RETURN
```

STATUS MESSAGES WITH CIIL

The STA opcode enables the Model AT8000 processor to send a status (or fault) message back to the controller. It is important to periodically check the instrument for any faults such as syntax, overtemps, CURLs, etc. Should multiple faults occur, only the most recent is remembered. The DFI (Direct Fault Indicator) flags only run-time faults. Other faults (E.G. syntax) may occur and would go undetected unless checked via the STA (STAtus) opcode.

The STA opcode initiates the Model AT8000 to formulate its status message. Once formulated, only receipt of the instrument's GPIB talk address is necessary to start send the status message. Upon completing the transfer, the Model AT8000 processor resets the status message to a single <space>. Should the remote controller ever receive a status message of just a single <space>, the instrument has no faults to report.

A status message reporting a fault is of the syntax:

F07DCS (<origin>): <text>

Where:

F07	Indicates a CIIL Fault type 07 involving syntax, a CNF/IST failure, or non-catastrophic hardware fault.
DCS	Direct Current Supply (Model AT8000
(<origin>):	Origin of the fault within the DCS. MOD if detected by the internal control section of the instrument (E.G. communication fault, syntax, etc.). DEV if detected by a channel or Test Board. The parenthesis (()) is part of the string.
<text>	Description of fault.

The Model AT8000 supports the following fault messages via the STA opcode:

F07DCS (MOD): COMMAND ERROR	Values out of range.
F07DCS (MOD): SYNTAX ERROR	Programming error.
F07DCS (MOD): CHANNEL NOT INSTALLED	An attempt was made to program a non-installed channel.
F07DCS (MOD): TEST BOARD FAILURE	Test Board failed.
F07DCS (DEV): CONFIDENCE FAILURE :CHxx	Channelxx failed CNF/IST.
F07DCS (DEV): MULTIPLE FAILURES	Multiple channels failed CNF/IST.
F07DCS (DEV): CURRENT LIMIT :CHxx	Output current on channel xx exceeded the programmed CURL value.
F07DCS (DEV): CROWBAR :CHxx	Channel xx activated its Crowbar either due to over-voltage on the output or due to module failure.
F07DCS (DEV): OVER TEMPERATURE :CHxx	Module in channel xx exceeded rated temperature.

3.7 IEEE-488 DEFINITIONS

The Model AT8000 implements the GPIB (General Purpose Interface Bus) for all remote programming and returned messages. GPIB and IEEE 488 are completely interchangeable terms. The Model AT8000 GPIB listen address is set on the rear of its master chassis via a 5 bit DIP switch as described in Section II. Programming of all instrument channels requires only the single GPIB address.

Mnemonics are implemented and behave as defined by the IEEE 488 standard. The Model AT8000 has no special nor unusual GPIB implementation requirements. The mnemonics listed below may change name from controller to controller.

GPIB	MNEMONIC
ATN	Attention
DAB	Data byte
DAC	Data accepted
DAV	Data valid
DCL	Device clear
IFC	Interface clear
MLA	My listen address
MTA	My talk address
REN	Remote enable
RFD	Ready for data
UNL	Unlisten
UNT	Untalk

CIIL version technical implementation of the GPIB is:

Floating point decimal per IEEE 728-1982.
Accepts signed NR1, NR2, and NR3.

End of String: <CR> <LF>

CIIL version complies and conforms to IEEE 488-1978 Standard GPIB (General Purpose Interface Bus).

Implemented subsets of this Standard are described as the following interface functions:

CIIL IMPLEMENTED SUBSETS ON GPIB

SH function	SH1	Source handshake capability
AH function	AH1	Acceptor handshake capability
T function	T6	Talker (basic talker, serial poll, no talk only mode, unaddressed to talk if addressed to listen).
L function	L4	Listener (basic listener, no listener only mode, unaddress to listen if addressed to talk).
SR function	SR0	No service request capability.
RL function	RL1	Remote/ local capability.
PP function	PP0	No parallel poll capability.
DC function	DC1	Device clear and selected device clear capability.
DT function	DT0	No device trigger capability.
C function	C0	No controller capability.

The Model AT8000 CIIL interface is defined as a listen and talk device with remote and local capability. Local lockout of keyboard is automatic whenever the DCS is in the REMOTE mode (RMT LED is illuminated). Both device clear and selective device clear are implemented comparable to the remote RST opcode, but for all channels simultaneously.

ABLE version technical implementation of the GPIB is:

Floating Point Decimal per IEEE 728-1982.
Accepts signed NR1, NR2, and NR3.

Message separator: SR1,

End of string:
<CR> <LF> ;or
<CR> <LF> and EOI ;or
EOI alone

ABLE version complies and conforms to IEEE 488-1978 Standard GPIB (General Purpose Interface Bus).

Implemented subsets of this Standard are described as the following interface functions:

ABLE IMPLEMENTED SUBSETS ON GPIB

SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Talker (basic talker, serial poll, no talk only mode, unaddressed to talk if addressed to listen).
L4	Listener (basic listener, no listener only mode, unaddress to listen if addressed to talk).
SR1	Complete service request (serial poll) capability.
RL1	Remote/ local capability.
PP0	No parallel poll capability.
DC1	Device clear and selected device clear capability.
DT0	No device trigger capability.
C0	No controller capability.

The Model AT8000 ABLE interface is defined as a listen and talk device with remote and local capability. Local lockout of keyboard is automatic whenever the instrument is in REMOTE mode (RMT LED is illuminated.)

Serial poll is supported in ABLE, but no in CIIL. Both device clear and selective device clear are implemented comparable to the remote RST command, but all channels simultaneously.

SECTION IV
THEORY OF OPERATION

4.1 INTRODUCTION

This section describes the Model AT8000 logic boards, DC Power Modules, and their interconnecting signals. In addition, the more complex processor activities are described as they interface with associated logic and analog signals. Topics of this section provide a sound basis for understanding the roles performed by the instrument electronics and should be a precursor to any troubleshooting or maintenance. You should frequently refer to the board schematics as found in Section VII of this manual.

Topics of this section are well advanced of normal Operator/ Programmer activities. Thus, you are presumed to be already familiar with both analog and digital design, associated devices, and terminology. Details of the inner workings of operational amplifiers, octal latches, DACs, etc., are referred to the individual device manufacturer's data books. In the text, a signal name immediately followed by a slash (/) indicates negative logic (low true or active at logical zero).

The following topics are arranged to give a top level view of processor orchestration within the Model AT8000 System. This breaks into internal software "routines" and logic circuit combinations to interactively perform instrument tasks. An understanding of both top level and circuit level activities is most valuable should you find it necessary to investigate any suspected aberration within the instrument.

4.2 SYSTEM OVERVIEW

Figure 4-1 identifies the Model AT8000 System functional relationships. Most notable is the processor participating in virtually every activity. The processor not only initializes the instrument to a safe state, but continuously runs its own internal firmware program to accept inputs (keyboard and remote via GPIB), error check input setups, flag discrepancies, direct setups to the desired channel(s), control precise timing of events within channel modules including switching internal relays, and more.

While outputting DC power on one or more channels, the processor monitors for run-time flags from the channel module(s) should any discrepancy occur. The processor determines the exact nature of any flag and determines the course of action - even to a channel (or channels) protective shut down. Other channels in standby (not outputting) undergo continuous checks by the processor to assure their digital logic and analog readiness. The optional Built In Test (BIT) board performs additional checks.

The display reports local or remote programming setup parameters for any specified channel. Any channel may also have its real time output voltage and current displayed (via RTN). The display also updates the Operator upon keyboard entry errors (by flashing) and other faults (E.G. from Confidence Test routine or overtemp). Remotely, the Operator/ Programmer may query the Model AT8000 for any error flag status message. CIIL configured instruments additionally output a DFI flag to signal any certain significant faults to the ATE controller.

SYSTEM OPERATION

Upon a cold start, the Model AT8000 opens all relays to avoid any output glitches. Both the processor and GPIB interface are initialized. The routine then performs several activities to identify its own contents and assure readiness for operation. The rear panel (backplane) GPIB address DIP switch is read. Next, all sixteen (16) channels are quickly scanned to determine which type of module is installed on a given channel, if any, its associated range, number of slave modules, voltage and current capacities, etc.

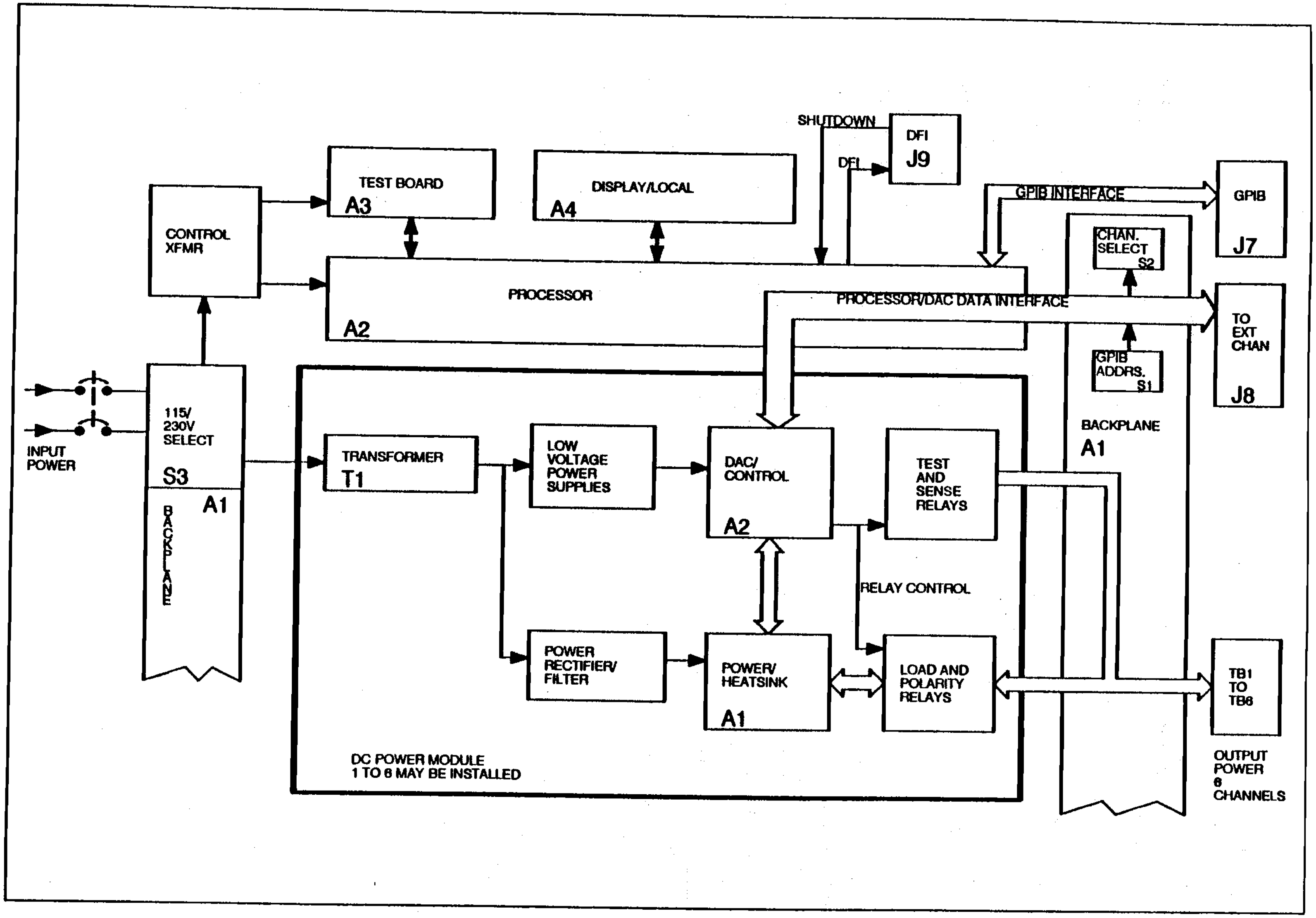

Figure 4-1
Model AT8000 Block Level Diagram

In Model AT8000 Systems with multiple chassis drawers, it is important that all Power switches be On prior to or simultaneously with the master chassis. If any extender chassis is late in being Powered On, the processor presumes it does not exist.

Next, if the battery back-up option is not installed, the Power On routine initiates the Confidence Test which checks all installed channels. Afterwards, all channel setups are zeroed.

If the battery back-up option is installed, the Confidence Test is not performed. Channel output(s) are not yet connected. Thus, no lengthy channel re-setup is required. The processor awaits only a keyboard 2ND EXC (or remote equivalent) to close (if programmed previously) the channel output isolation relays.

The Power On routine exits into the Idle Loop routine. The Model AT8000 remains in this Idle Loop as a continuous scan for inputs and to update instrument activity. This routine scans for flags from both active and inactive channels, retrieves keyboard inputs, supervises Test Board activity, and sends updates to the display. The Idle Loop is momentarily interrupted only to service a remote controller initiated GPIB activity, update channel parameters, update the DFI relay (CIIL only), and perform the Confidence Test.

4.3 INTERCONNECT

The Model AT8000 System master chassis contains all of the electronics to support itself and up to six (6) DC Power Modules. In addition, the master chassis handles all Operator and remote programming interfaces, as well as Built In Test (BIT). The master chassis further contains all the intelligence to connect up to 15 additional extender chassis to expand control over up to sixteen (16) channels or a total of ninety-six (96) DC Power Modules.

Interconnect diagram (6699961) depicts power and signal routing within the master chassis. Included are interfaces to the edge of the chassis such as GPIB, AC power input, DC Power Module outputs, and the External Channel connector. The External Channel connector (J8) is the sole communication link from the master chassis to and from any extender chassis. This intra-chassis instrument communication cable between respective J8 connectors is shown in Drawing 5701000. Should multiple connections be required (for multiple extender chassis), the externally mounted Junction Box parallels these signals.

An extender chassis is identical to the master chassis internal connections, boards, and assemblies except for those functions which are handled exclusively by the master chassis. The extender chassis thus contains:

1. No GPIB connector (J7),
2. No GPIB Address switch (S1), (or if installed, it is not functional),
3. No Processor board (A2), but has an Auxiliary Power Supply (A2),
4. No Built In Test (BIT) board (A3),
5. No Display (and keyboard) board (A4),
6. No Data Fault Indicator (DFI)/ Shutdown connector (J9).

Every chassis (master and extender) has its own AC power input connection. In standard configuration, AC power enters via a permanently tied-in cable. An option uses MS connectors for AC input. In either configuration, each chassis rear panel switch S3 selects between 115 or 230 VAC input line voltage. It is important that S3 be switched only while CB1 is open and the AC input cable is disconnected to avoid switch contact hot switching and possible momentary short circuit of input line voltage. Input line current is routed through both halves of CB1 to assure constant protection regardless of line voltage selected. No additional switching, jumpering, or fuse considerations need to be performed when changing line voltage.

The AC line voltage is then distributed to the six (6) slots for the DC Power Modules. In addition, AC power is provided to the Test Board (A3) to develop internal bias within this board. AC power sent to the Processor Board (A2) develops unregulated voltage to run the chassis cooling fans and develops DC bias for itself, the Display Board (A4), and for portions of the six (6) DC Power Module logic circuits.

In an extender chassis, there is no Processor Board (A2), Test Board (A3), nor Display Board (A4). However, there is still the requirement for unregulated power to operate the cooling fans and regulated power to operate portions of the digital logic within the six (6) DC Power Module slots. In an extender chassis, the Auxiliary Power Supply Board (5690013) replaces the Processor Board (A2) as shown in Interconnect Diagram 6699961, sheet 2.

On the Backplane Assembly (A1), the GPIB Address DIP switch (S1) is active only on the master chassis. The Channel Group Select switch (S2) is on the rear of every chassis (master and extender). Any chassis may have its six (6) slots assigned to Group A (1 through 6), Group B (7 through 12), or Group C (13 through 16).

4.4 CONFIDENCE TEST

The Confidence Test performs four (4) separate tests to verify the readiness accuracy of the Model AT8000 DC Power Modules and its own Built In Test (BIT) function. Test Board (A3) option must be installed for the last two of these tests. The output isolation relays are opened for the Confidence Test and afterwards all channel setups are automatically reset to zeros.

The Confidence Test sequence runs Test #1 on all installed channels, starting with the highest channel number and then stepping down through each of the installed channels. If successful, Test #2 is next run on all channels, and so forth through Test #4. Should any channel fail, the Confidence Test continues with the same Test # until all of the channels are tested or a second failure is detected. A second failure immediately stops the Confidence Test. Should any failure occur, the Test # does not advance. There is no front panel display to indicate the Confidence Test is in progress.

Test #1 - Crowbar Fire Test

The processor sequentially addresses each channel and fires its Crowbar, waits 30 milliseconds and reads the channel to make sure that its Crowbar was activated.

Test #2 - Current Limit Test

The processor sequentially programs each module to 96.22% of full scale voltage and 0.5% of full scale current, waits 5 milliseconds and reads the channel to make sure that it is in the constant current (CURR) mode and that its current limit fail circuitry has been activated.

Test #3 - Test Board Calibration Test

This test reads the reference voltage of the Built In Test (BIT) Board (A3) and verifies it to be within +/-1.13% of the actual voltage. Channels are not stepped since only the Test Board is used. This test takes approximately 7 milliseconds.

Test #4 - Voltage Accuracy Test

The processor sequentially programs each module to 80.56% of full scale voltage and 80.56% full scale current, waits 10 milliseconds and reads it to be within +/- 1.61% of the programmed value. The reading takes approximately 7 milliseconds.

Following these tests all modules are programmed to zero, all relays remain open and the front panel displays channel one (01).

If only one channel fails a Test #, then that channel number flashes on the CHANNEL number display of the front panel. If the Confidence Test was invoked from the remote controller, the processor generates an SRQ (numbers 221 through 236) if in the ABLE version. If configured in CIIL version, the Model AT8000 responds to the STA (status) command with:

F07DCS (DEV): CONFIDENCE FAILURE :CH<CHANNEL>

If more than one channel failed, the processor flashes channel number "17". If the Confidence Test was invoked from the remote controller, the processor generates the SRQ number 237 in the ABLE version. If in CIIL version, the processor responds to the STA (status) command with:

F07DCS (DEV): MULTIPLE FAILURES

4.5 PROCESSOR BOARD

The Processor Board (A2), Assembly Drawing 6699952, plugs into the master chassis just behind the front panel. The processor performs on-board intelligence functions to implement pre-programmed internal routines such as Idle loop described above. This board also communicates with the keyboard/ display, Test Board, rear panel GPIB connector and the rear backplane which contains all the electrical connections for the DC Power Modules. The Processor Board contains the remote programming (GPIB) interface and provides logic bias (some DC power) for portions of the installed DC Power Modules. Signal connections to and from the processor are via convenient ribbon cables.

The Processor Board (A2) is not used in any extender chassis. Instead, it is replaced by the Auxiliary Power Supply (Drawing 6690013). This supply provides voltage for chassis fans and certain bias for DC Power Module logic.

Three (3) jumpers are located in the center of the processor board:

- W1 Not used.
- W2 Dedicated.
- W3 When installed, it prevents programming from the local front panel keyboard. Only the ReTurN and TeST functions are available when this jumper is installed. This is identical to the keyboard effect of being under Remote control, but the RMT (ReMoTe) LED is dark.

CIRCUIT DESCRIPTION

Upon application of AC power, the Processor Board (A2) initiates the Power Up sequence. The RC time constant of pin 10 on RN1 with C18 goes through U10 to generate PUR at pin 4. PUR/ at U10 pin 6 is a negative pulse of approximately 330 milliseconds. This resets the microprocessor (U5) and GPIB interface controller (U6) through their corresponding RST/ inputs.

PUR (the inverse of PUR/) disables drivers U16, U18, U20, U21 and U22 until the microprocessor can reset them to zero. RC circuit of R7 and C12 stretches PUR for an additional 3.3 milliseconds after the microprocessor is reset, thus allowing the microprocessor to start executing its Power Up internal software. During this time, U20 outputs are tri-stated and thus U18, U21 and U22 are not enabled. This prevents these buffers from outputting improper data and eliminates a possible U18 output contention problem on the microprocessor Port A.

U12 is a 32 X 8 byte memory decode fuse-link PROM. Addressing is via the microprocessor address bus 5 MSBs (A8 through A12). Only the 4 LSBs of the PROM are used. PROM output on pin 1 enables access to the memory of U4 RAM. Pin 2 enables the GPIB controller (U8) and all the hardware strobes, latches and buffers. Pins 3 and 4 enable the Low and High EPROMs (U3 and U2) respectively. These latter two devices contain the microprocessor subroutines.

The eight LSBs of the address bus are multiplexed with data on the data bus. U1 is an octal latch which captures and stores this part of the address byte as the microprocessor (U5) outputs the Address Strobe (AS) on its pin 6. The address byte is available for EPROMS (U2 and U3), RAM (U4), GPIB controller (U6) and hardware strobes.

Octal driver U13 momentarily connects the GPIB five (5) bit address switch (S1 of Interconnect Diagram Drawing 6699961) on the Backplane Assembly (A1) and the three (3) jumpers (W1 through W3) on the Processor Board (A2) to the data bus so they can be read by the microprocessor (U5). U13 is enabled by the AND function of the decoded hexadecimal address $200 output out of PROM U12 pin 2 and bit 3 of the address bus.

The GPIB controller (U8) requests microprocessor service by initiating interrupts via the Interrupt Request/ line (IRQ/, U8 pin 9). Each byte communicated to and from the GPIB controller is accomplished via this interrupt process. GPIB tasks such as handshake, protocol and bus commands are automatically handled within the GPIB controller and without microprocessor assistance. U6 and U7 are GPIB transceivers.

U19 is a brute force, one way driver to help the microprocessor drive the data bus to the display board and the various drivers.

U15 is a 3-to-8 decoder which generates various strobes to store information in the display board and other circuits. Hexadecimal addresses $280 through $287 activate outputs Q0 through Q7 respectively. Strobes are active when both the address is selected ($280-$287) and the Data Bus is stable (DS, pin 6 is high) which makes the ICs that are latched by these strobes store the data on the data bus.

In CIIL version, U20 is an octal latch strobed during hexadecimal address $284 by U15. Output bit 7 (U20 pin 9) drives the DFI (Direct Fault Indicator) relay. When high, transistor Q1 actuates relay K1 and opens the contacts. This relay is normally closed until AC power is applied, at which time it opens. It remains open during normal operation and it closes only when the DCS detects a run-time failure while in remote mode. As soon as a CIIL STA (status) opcode is received from the remote controller via the GPIB, the relay is again actuated to its normal open state.

U18 communicates its contents to microprocessor Port A via enabling bit 6 of U20 pin 12. The Display Board (A4) and output of U18 share the microprocessor Port A. Their respective drivers are never enabled simultaneously and thus avoid contention on Port A. MOD INFO, U18 pin 9 is the only input to the microprocessor from all the modules. To access the modules, the microprocessor sends the selected channel address via U21 and U22. Since a DC Power Module has seven (7) addressable feedback data available, a three (3) bit address using lines RDATA, IDATA and VDATA (U16 pins 16, 17 and 18) is also sent. Returned DC Power Module data MOD INFO is buffered via U18. Refer to DC Power Module topic (under DAC Digital) for details.

Test Board (A3) DATA via J4 pin 7 is input to U18 pin 8. This is a twelve (12) bit serial data containing voltage or current information. Corresponding Test Board (A3) BUSY/ arrives via J4 pin 9 and directed to U18 pin 4 as active low indicating the Test Board is momentarily in the midst of taking a measurement and it is not yet ready to advance to the next test function. Refer to Test Board topic for details.

KEYBD RDY, U18 pin 2 signals a keystroke entry has been made but not yet read by the idle loop routine. To read keyboard information, the microprocessor activates READ KEYBD/. This resets KEYBD RDY and places the 8 bit keyboard information on the input bus to Port A. The remaining four (3) inputs to U18 are not used. The keyboard is part of the Display Board topic below.

Output bit 5 (U20 pin 6) enables the two (2) drivers, U21 and U22 for the module channel addresses. These drivers establish which module (via channel slot address and Group Select Switch S2) is enabled.

Output bit 4 (U20 pin 15) is connected to Display Board (A4), but not used.

Output bits 3 through 1 (U20 pins 5, 16 and 2) are not used.

Output bit 0 (U20 pin 19) drives the Output Enable/ of U16.

Port A of the microprocessor (U5 pins 7 through 14) is always an input port and receives the keyboard input information and the output of U18.

Port B of the microprocessor (U5 pins 29 through 36) is always an output port. Bits 4 through 0 of U16 control the DC Power Modules. RDATA (relay data) sends eight (8) bits of relay information. VDATA (voltage data) and IDATA (current data) each send a twelve (12) bit setup value. These three (3) serial signals are accompanied by SHIFTOUT (U16 pin 15), where data is valid on the rising edge of this clock signal. The addressed channel then receives and transfers the data via its Digital To Analog (DAC) board logic. EXC (EXeCute) of U16 pin 14 simultaneously actuates the data sent to the DC Power Module DACs and relay driver. Bits 6 and 5 of Port B are used by Test Board (A3). Bit 7 sends keystroke entries from the Display Board (A4) to the microprocessor (A2). Bit 2 used as RDATA for the DC Power Modules and by the Test Board (A4) STOP signal. U16 is simply a brute force driver for Port B since it drives up to sixteen (16) modules.

Diodes CR3, CR4, CR7 and CR8 and capacitor C2 generate unregulated +24 volts to power the fans and to actuate relays on the DC Power Modules. R1 is the bleeder resistor for C2. Diodes CR1, CR2, CR5 and CR6 produce the full wave rectified signal at 5 volt regulator U23 to power the Processor (A2), Test (A3), and Display (A4) boards and certain digital logic within the DC Power Modules.

In an extender chassis, the Processor Board (A2) is replaced by the Auxiliary Power Supply (Drawing 5690013) to develop these same voltages for the fans and portions of the DC Power Modules.

4.6 DISPLAY BOARD

The Display Board (A4) is only available on a master chassis and plugs into the Processor Board (A2). This assembly (Drawing 6699951) contains both the sixteen (16) button keypad for local programming and the LED display for channel setups, monitoring and error reporting.

KEYBOARD

The sixteen (16) buttons of the KEYBD (keyboard) are implemented in row and column technique. Normally, no key is pressed and the outputs of the KEYBD are pulled softly low by resistor array RN1. Upon any keystroke, momentarily the +5 volts of KEYBD terminal E is impressed on one column pin (F, G, H or J) and one row pin (K, L, M or N). The row and column bits are sent to the input of octal latch U3. The OR gates of U1 simultaneously sense the presence of the keystroke and develop a pulse. RC combination of R2 and C3 de-bounce the keystroke pulse at U1 pin 3 and assure keystroke data is stable. Schmitt output at U4 pin 4 latches the keystroke entry into U3 for temporary storage until read by the processor. U4 pin 4 also fires flip-flop U2 setting KEYBD RDY high to alert the processor that a keystroke has been latched and needs to be read. KBINST is sent upon initial Power Up to reset U2 and thus avoid an invalid KEYBD RDY. Keyboard codes are listed on the schematic.

The processor scans for KEYBD RDY while in its idle Loop routine. Upon detecting KEYBD RDY high, the processor sets READ KEYBD momentarily low to enable the tri-state output of octal latch U3. The eight (8) bits are read via Port A of the processor. READ KEYBD low also resets flip-flop U2 and its KEYBD RDY to low.

DISPLAY

The Display consists of LEDs (Light Emitting Diodes) separated into four functional areas from the prospective of the processor. All display data comes via the BUF DATA BUS from U19 of the Processor Board (A2). The display data is multiplexed onto this bus by the processor and de-multiplexed to its correct destination with the aid of control strobes from U15 of the Processor Board (A2). These strobes are:

LED1	Single LEDs for MODE and FAILURE,
LED2	Single LEDs for RELAY,
DISP1/	Four digits of VOLTAGE and four digits of CURRENT,
DISP2/	Two digits of CHANNEL.

Display LEDs for MODE, FAILURE and RELAY are individually illuminated or dark depending upon the outputs of inverting latches U10 and U9. Each bit on the BUF DATA BUS corresponds to a specific LED when accompanied by LED1 or LED2. Latch U9 is only enabled while LED1 is momentarily high. U10 is similarly enabled only by LED2.

VOLTAGE and CURRENT displays are more complex, but the same straightforward BUF DATA BUS and enable line technique is used. The processor sends the eight (8) bit wide bus message to U5 (addressable seven (7) segment driver) in three parts simultaneously:

Bits 0-3	Four bit decimal value (0 through 9) to display,
Bits 4-6	Three bit address (1 of 8) of display device, and
Bit 8	Enable decimal (.) on display.

Upon receipt of DISP1/, U5 strobes in this eight (8) bit wide message. U5 then decodes the byte and illuminates the corresponding LED device. This process is repeated for each digit. Resistor array RN4 limits segment current to control brightness.

Both digits of CHANNEL number are sent in one eight (8) bit wide byte. The first digit uses bits 6 through 4 of BUF DATA BUS. The second digit uses the four (4) LSBs. DISP2/ latches this eight (8) bit wide message in U7. The output of U7 is separated to U7 and U8 (BCD to seven (7) segment decoders). The outputs of U7 and U8 drive CHANNEL number digits DS2 and DS1. Resistor arrays RN5 and RN6 limit segment current to control display brightness. The circuit of CR2, CR3, R4 and Q1 light the top segment for the number "6".

Flashing the CHANNEL display is accomplished by using the MSB from U6 that would otherwise go to U8. Note - a CHANNEL display of 80, or higher, is not used. When the MSB is high, the RC time constant of R3 and C2 with the output of U4 pin 12 form an oscillator that controls the Output Enables of display decoders U7 and U8.

4.7 TEST BOARD (BUILT IN TEST - BIT)

Test Board (A3) connects to the Processor Board (A2) via a ribbon cable. The Test Board measures voltage and current of the DC Power Modules as well as verifies its own integrity. These readings are required during the Confidence Test routine and TST (TeST) function.

The processor is moderately busy servicing its idle loop by checking channels for any run-time faults, setting relays within the DC Power Modules, and updating the display (TST function) while performing Test Board activities. Normally, the only display indication of Test Board activity during the TST function when the display shows a blinking green TEST MODE LED. The actual blinking directly correlates with the timing of voltage and current measurements.

The Test Board (Drawing 6699950) interfaces with processor digital logic and DC Power Module analog signals (TESTV and TESTI). To avoid undesired analog to digital DC coupling (analog signals may float above or below ground), the Test Board generates its own bias. Two dedicated AC transformer winding are rectified and sent through U14 for +5 volt logic bias. Analog circuit bias is developed via U15 for +15 volts and U16 for -5 volts. Note the difference in digital logic ground verses analog ground symbols on Drawing 6699950.

Five (5) opto-isolators (U9 through U13) electrically isolate the signals to and from the processor. The Test Board floats up or down with the DC Power Module it is testing. Optical isolation prevents this floating ground from forcibly being grounded to the processor ground. Isolators U10 and U11 (BUSY and STOP) do not require fast switching times and thus no base resistors.

The other isolators require faster than 10 microsecond transition time. The processor initiates all Test Board activity including Analog to Digital A/D sampling via STEP. The Test Board sets BUSY when the processor needs to wait for relay de-bounce and data settling before sending SHIFT IN. The processor sends a set of clock pulses via SHIFT IN to synchronize the A/D value into serial stream back to the processor on DATA. STOP resets the Test Board to its cleared state.

Dual timer U5 provides timing pulses for A/D (U2) and controls the setting and re-setting of BUSY via flip-flop U4 (top half). Upon the processor initiating a reading for voltage or current, dual timer U5 receives an upwards going signal at step 1 or step 4 from U7 pin 10. This immediately sends a 400 microsecond pulse from U5 pin 10 to U4 pin 6. The pulse sets BUSY low to the processor signaling that this particular step requires substantial wait time for DC Power Module relays to settle and for the A/D to "auto-zero" itself. The trailing edge of this pulse triggers U5 pin 5.

Output at U5 pin7 initiates a six to seven millisecond duration pulse to the A/D (U2 pin 20). The A/D starts its reading at the end (rising edge) of this pulse. Upon this rising edge of Start, the A/D forces BUSY/ low (U2 pin 22) for 150 microseconds while it takes its analog reading. As Busy/ rises, it resets U4 pin 1 (top half) to force BUSY high to signal the processor that the A/D value is now available for reading. U2 pin 22 simultaneously sets U4 pin 13 (bottom half) low (U4 pin 13 previously high only to select the A/D analog channel 2 during Confidence Test 3).

The Analog to Digital converter (A/D) uses 3 of its internal 4 analog channels. Channel 0 (U2 pin 2) measures TESTV (voltage) from an externally selected DC Power Module channel. Channel 1 (U2 pin 3) measures TESTI (current) similarly except the current is actually a voltage across a sampling resistor on the externally selected DC Power Module channel. Channel 2 (U2 pin 4) measures the Test Board's own calibration voltage sample of 3 volts. This sample verifies proper operation of the Test Board. The output of U1 provides a precision reference voltage of 5 volts for all readings on the A/D.

The circuits of U7 (pins 4 and 11), U6 and U3 coordinate the reading of data from the A/D back to the processor. BUSY to the processor is high signaling that all waiting for delays and reading is completed. Via decade counter (U8) steps 2, 3, 5 and 6, the processor signals U7 (pins 4 and 11) to output the two byte value of the A/D (U2). Step 2 and step 5 signal the A/D (U2 pin 21) to select the eight MSBs of the A/D reading to output (U2 pins 10 through 17) to U3 (parallel/ serial shift register). While U3 receives the MSB parallel byte, the RC delay of R15 and C10 and circuit U6 delay serial shift input (U3 pin 9) from going low by 3 microseconds. Thus data in U3 settles before the processor serially clocks out the A/D MSB byte DATA via a set of clock pulses on SHIFT IN. The A/D LSBs are similarly transferred during step 3 and step 6. CR7 and CR8 assure the trailing edge of U7 pins 4 and 11 are not delayed. Figure 4-2 depicts this Test Board Shift Register Timing.

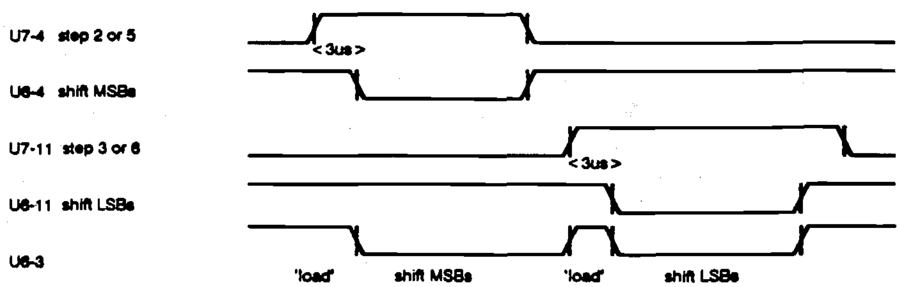

Figure 4-2 Test Board Shift Register Timing

Decimal counter U8 controls the Test Board measurement sequence. The processor initializes decade counter Clear (U8 pin 15) by strobing STOP. This activates Step 0 on the output of U8 (pin 3). The processor increments Test Board activity by sending STEP to the decade counter clock (U8 pin 14).

Step 0 - In its normal cleared or inactive state, opto-isolators U11 and U13 are off. This off state puts a high on both Clear (pin 15) and Clock (pin 14) inputs to U8. An active Clear puts a high on the "0" output of pin 3 which tri-states the outputs of the Analog to Digital (A/D) converter (U2) and pulls D7 (U3 pin 1) low through R37. This forces Q7 (U3 pin 3) low turning off opto-isolator U9 while the Test Board is not in use.

Step 1 - Upon receiving STEP from the processor, U8 state 0 (U8 pin 3) goes low and state 1 (U8 pin 2) goes high. This triggers timer U5. Subsequently, U5 sets BUSY to the processor, takes an A/D reading, and resets BUSY. Mux2 and Mux1 inputs (U2 pins 25 and 24) on the A/D are both at low which selects analog input channel 0 (TESTV).

Step 2 - When the measurement is completed, BUSY is deactivated and the processor signals the A/D to output the most significant 8 bits (MSBs) of its reading (from Step 1) and send it to U3 in parallel via U2 pins 10 through 17. Sel2 input (U2 pin 21) high signals MSBs to the A/D. U6 pin 3 provides a 3 microsecond delay to allow time for settling before setting shift register U3 (pin 9) to serial shift. The processor sends a burst of 8 clock pulses on SHIFTIN to send the serial MSB byte back to the processor on DATA.

Step 3 - After the most significant byte is read, the processor again clocks the counter (U8) which puts a high on output "3" (pin 7). This deactivates the A/D Sel2 (U2 pin 21) to select the 8 LSBs of the measured reading to shift register (U3). As on step 2, U6 pin 3 controls the load and aids the serial shift of U3. Again, the processor sends SHIFTIN clocks to strobe the LSB serial data byte out on DATA.

Step 4 - This step repeats step 1 with the exception that it also activates Mux1 of the A/D (U2 pin 24). This selects A/D analog channel 1 (U2 pin 3) to read current (TESTI) from the DC Power Modules. (Actually, TESTI is a voltage across a resistor in the externally selected DC Power Module).

Step 5 - This step repeats step 2 and provides the most significant byte (8 MSBs) of the current measured to the processor.

Step 6 - This step repeats step 3 and provides the least significant byte (8 LSBs) of the current measured to the processor.

After the processor has read this byte, The processor sends STOP to terminate the TESTV and TESTI measurements. Decade counter (U8) returns to step 0.

Step 7 - This step is only used to read the calibration voltage at the A/D input channel 2 during Confidence Test 3. The processor quickly STEPs decade counter (U8) to step "7" (pin 6), clears it and STEPs once more step 1. In step "7" it clocks the grounded D input of the bottom half of flip-flop U4 which puts a high on its Q/ output (pin 13). This activates the Mux2 input to the A/D (U2 pin 25) and selects the calibration voltage to be measured in channel 2 (pin 4). The same steps 2 and 3 are repeated to read the most and least significant bytes of the calibration voltage.

4.8 DC POWER MODULE

DC Power Modules plug into the Backplane Assembly (A1). Each DC Power Module outputs over a specified range of voltage and power. Master modules have a full compliment of interface electronics to communicate with the processor for setups, report status and errors, and to send TESTV and TESTI to the Test board (A3). The installed slot (J1B through J6B) and Group Select Switch (2) on the Backplane Assembly (A1) determines the channel assignment for processor and Test communication.

Slave modules are identical to master modules except lack this ability to directly receive programming setups from the processor and similarly report errors and status back. Although slave modules lack this channel assignment capability, they receive setups and return status via a ribbon cable connected to their respective master module. Otherwise, slave modules function identically to masters. The output power connections of both master and slave modules are made externally to the chassis on the rear of the cabinet. A DC Power Module consists of three assemblies:

A. Main Module Assembly
B. Digital to Analog Control (DAC) Assembly
C. Heatsink Assembly

MAIN MODULE ASSEMBLY

The Main module board (Drawing 6699959) contains all of the DC Power Module Backplane Assembly (A1) interconnections for both digital and analog data and the input and output power connections of P1A and P1B. AC input line voltage from the 48 pin DIN Backplane slot connector (P1B) provides power to the T1 transformer primary windings. AC input line voltage selection to these primary windings (series or parallel) is determined by the Input Voltage Select Switch (S3) of the rear panel (actually Backplane Assembly A1). The transformer is double shielded to attenuate noise coming in via the AC line. The DC Power Module output voltage range is marked on the side of this transformer.

The secondary of T1 is jumpered differently for various output voltage ranges, allowing it to be connected as a full wave bridge or center-tapped full wave rectifier. Diode bridge CR1 rectifies the secondary AC voltage where it is filtered by C1 and C2 and passed to the heatsink assembly as filtered DC voltage at E16. U1 and U2 provide regulated positive and negative 15VDC to the DAC board for logic power. Q1 and Q2 form a start-up circuit by detecting the loss of AC line voltage from T1 through CR3 and CR4 and firing the overvoltage Crowbar. The Crowbar fires both at AC power up and at AC power down to insure no overshoot occurs at the output terminals under these conditions. Normally, current through the DC Power Module is small at these times so fuses F1 and F2 do not blow.

Heatsink assembly (A1) regulates the DC output voltage in response to control signals from the DAC board. The output from the heatsink is further filtered by capacitor C3 and connected to relays K1 through K4 which are controlled at J2 pin 18 and J2 pin 19 of the DAC board. Relays K1 and K3 isolate the output from the rear panel connector. K2 and K4, when jumpered between E23-E24 and E26-E27, provide reverse polarity on the output connector. When K1 and K3 are open, R2 is connected across the output of the heatsink. This resistor is chosen to draw enough current from the supply to test several conditions of the controls during the Confidence Test.

Relays K6, K7 & K8, provide identical operation of isolation and reverse polarity for the sense leads through control at J2 pins 1 and 2 of the DAC board. The sense lines, coming from K8 are filtered by C13 and connected to a resistor divider consisting of R9 through R12. Resistors R11 and R12 divide down the output voltage to a level usable by the DAC board circuitry. R9 and R10 are protection resistors to limit the output voltage to 10% above the regulated value in case the output sense leads are left open. R4 is a four terminal resistor used to sense the output current. This measured value provides feedback to the controls on the DAC board (A2) via J3 pins 13 and 18.

DIGITAL TO ANALOG CONTROL (DAC) ASSEMBLY

The DAC board (A2) provides bi-directional communications with the processor. It receives addressed serial data from the processor and interprets this data to program and control both output voltage and current. In addition, the DAC board controls output power isolation, polarity reversal and sense lead selection via relays on the main board. It also processes feedback from the heatsink and main board, fires the Crowbar, and reports status back to the processor. Should any slave DC Power Modules be installed, the respective master DAC board controls and reports on all their activities.

Digital Section

Serial programming data is sent to all chassis modules simultaneously from the processor. Similarly, DC Power Module response lines back to the processor are connected in parallel. The processor enables only one (1) channel at a time via the sixteen (16) independent CHAN ADDR lines. From Interconnect Diagram (Drawing 6699961), only one (1) of the sixteen (16) CHAN ADDR lines (depending upon slot number and Group Select Switch S2) is available to a DC Power Module. On the DC Power Module DAC board (Drawing 6699958), its CHAN ADDR enters on P2 pin 16 and enables processor setups to be accepted via U13 and U14. Responses back to the processor are enabled via U21. Only master modules are enabled by the CHAN ADDR lines.

Programming data from the processor board enters the DAC board via P2 and is sent to U13 and U14. If CHAN ADDR is selected (low true) driver U13 is enabled and accepts the voltage (VDATA) and current (IDATA) setups. These are clocked in by the strobes of SHIFT. EXC follows shortly afterwards to simultaneously actuate the setup. Four opto-isolators (U9 through U12) isolate the processor DAC setups from the DAC analog circuits (which could be floating above or below ground potential).

Both voltage (VDATA) and current (IDATA) is sent serially simultaneously to D/A converters U7 and U8 respectively. D/A U7 loads each of bit of VDATA with a clock strobe (SHIFT) and is stored within the D/A as a 12 bit wide value. D/A U8 is similarly loaded with digital IDATA. The processor then sends EXC to simultaneously enable the analog output of the two A/Ds. A/D U7 outputs at buffer amplifier U6 pin 14 to voltage reference level for voltage error amplifier U2. D/A U8 sets its corresponding current reference by a voltage value at the output of U6 pin8. Figure 4-3 depicts the timing relationships for loading these D/As.

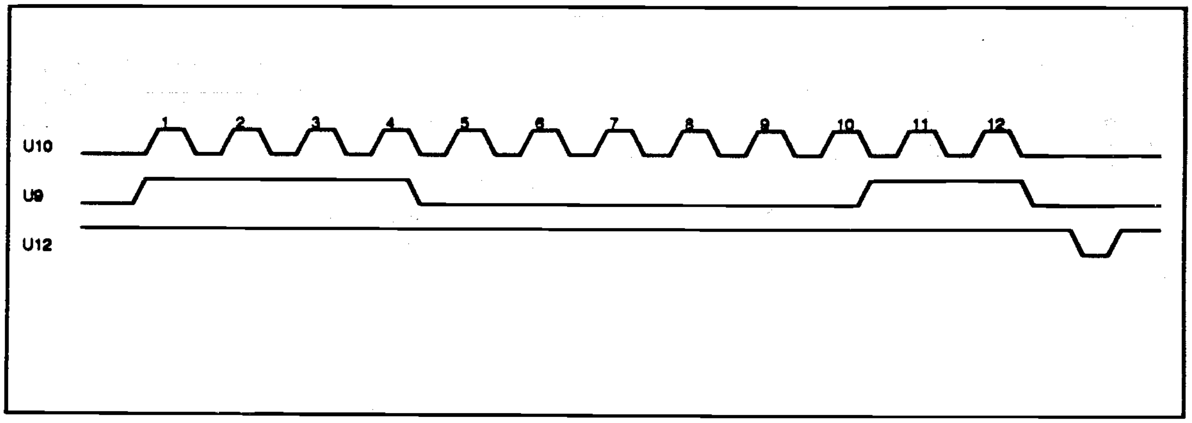

Figure 4-3 D/A Converter Programming Data

When data line (VDATA or IDATA) is high during a leading edge clock (SHIFT) transition, the data bit is clocked into the D/A as logical 1. The above bit stream depicts the binary number 111100000011 (decimal 3843, hex F03) being loaded into the D/A. This corresponds to 96.75% of full scale output voltage (or corresponding current).
Relay driver U14 drives the following:

Relay setup is updated from the processor simultaneously with the two D/As. RDATA (U14 pin 2) contains the bit stream for relays. U14, a serial input 8 bit latched relay driver, uses SHIFT (U13 pin 11) and EXC (U13 pin 9) to load the relay bits and latch its outputs. These inputs are available only when the channel address line on U13 is also active.

Relay driver U14 drives the following:

U14 pin 9	Opto-coupler U5 to fire the Crowbar
U14 pin 10	Unused
U14 pin 11	Output polarity relays K2 and K4
U14 pin 12	Output isolation relays K1 and K3
U14 pin 13	Test relay K5
U14 pin 14	Polarity sense relay K6
U14 pin 15	Local/remote sense relay K8
U14 pin 16	Output of current limit opto-coupler U17

Module Information (MOD INFO) is read by the processor at U21 pin 6. U21 is an 8 input multiplexer whose output (U21 pin 9) is normally tri-stated high. All other channels share MOD INFO. Inputs to U21 include faults, ID and installed relays. The processor sends RDATA, IDATA and VDATA (U21 pins 9, 10 and 11) as a parallel address byte to select the 1 of 8 inputs (D0 through D7). Upon receipt of CHAN ADDR (active low) at multiplexer output enable (U21 pin7), the addressed information is available as as an active low on MOD INFO (U21 pin 6). Addressed inputs to the multiplexer (U21) are:

U21-4(D0)	MFAIL, masterfail input from U20. This is an OR function of the three (3) run-time failures: CURL, OVP and OTMP. If any one of these failures becomes active, then it activates MFAIL. In its Idle Loop, the processor normally only looks at this input. But when it is active, the processor then it reads which of the three (3) run-time failures activated it.
U21 pin 3 (D1)	CURL, current limit status from U17.
U21 pin 2 (D2)	OVP, overvoltage or Crowbar shutdown from opto-coupler U16.
U21 pin 1 (D3)	ID, module identification from PROM U19.
U21 pin 14 (D5)	ISO, when W10 is installed, indicates presence of isolation relays.
U21 pin 13 (D6)	POL, when W9 is installed, indicates presence of polarity relays.

Module ID information is a multi-bit string which contains module range, voltage, current, and current versus voltage derating characteristics. PROM U19 stores this information in a 256 x 4 array. When the processor addresses U21 for the ID information via U21 input D3, it also sends a series of 128 strobes on SHIFT to 12 bit binary counter U18. This increments PROM U19 input address lines and thus its ID information. After each pulse, the processor reads one bit of data from the PROM through the multiplexer (U21) and repeats the process 128 times. This information is read out at startup and stored by the processor for future reference. Jumpers W4 through W8 selects that portion of the PROM that pertains to the module.

Module LEDs DS1 and DS2 are illuminated when the current limit and the Crowbar conditions are active, respectively. These LEDs are also illuminated when the module is first powered up and are then turned off when the processor programs the module to zero. During the Confidence Test, these LEDs are momentarily illuminated as the processor fires the Crowbar and programs the module into a current limit condition. DS1 is illuminated dimly while in constant current mode. In constant current mode, the processor partially turns off opto-coupler U17 by driving its base transistor low so that when the module reaches its programmed current it does not report a current limit failure.

Analog Section

The processor setup DC reference voltages from the D/A converters are available for voltage and current on U6 pins 14 and 8, respectively. The voltage reference of U6 pin 14 is sent to U2 pin 3, one input of the voltage error amplifier. A divided down sample of the output voltage is sensed across R11 of the main board.

This sense voltage goes across protective diodes CR1 through CR4 and is applied to U1 differential amplifier input pins 3 and 5. The sensed voltage of U1 pin 8 output is applied to the opposite input (pin 5) of voltage error amplifier U2.

The output (U2 pin 7) is the amplified difference from the programmed D/A value and actual DC Power Module output (sensed) value. Diode CR7, isolates the output of U2 since this point is used as the voltage control line for the output voltage of the power supply.

Buffer amplifier U2 pin 8 buffers this control line from the output driver transistor Q1. Q1 varies the power supply output voltage by varying the base voltage at E17 on the heatsink assembly transistors. Also on the control line is the output of the current limit amplifier at U3 pin 8, through CR8. The input on this amplifier is the output from the current D/A converter (programmed reference) at U3 pin 9. Its other input U3 pin 10 is the amplified signal from the current sense resistor R4 on the main board. This value is isolated by a differential amplifier at U3 pin 7 since one side of R4 is sensed below ground level. The current summing effect on the control line at input U2 pin 10 limits the output voltage as the programmed current is reached. Should the current decrease, output voltage is allowed to increase to a maximum of its programmed (D/A) value.

Overvoltage and overcurrent protection are accomplished via quad comparator U5. The programmed levels for voltage and current from the D/As are connected to the non-inverting inputs of two comparators U5 pin 5 and U5 pin 7, respectively. The other inputs come from the voltage sense differential amplifier through buffer U2 pin 14 and the current gain amplifier through buffer U3 pin 14. Both outputs are are divided down by 10%.

The outputs at U5 pins 1 and 2 are pulled low whenever an overvoltage or overcurrent condition of 10% or more occurs. These outputs are pulled up through resistor divider R37 and R38 so the input at comparator U5 pin 11 sits at 15 volts when U5 pins 1 and 2 are high and 3 volts when low. The reference level at U5 pin 10 sits at 5 volts, so its output is normally high. U5 pin 13 output drives the Crowbar SCR drive transistor Q3 and the non-inverting input of comparator U5 pin 14 which, when driven low, latches and holds U5 pins 1 and 2 low.

Upon this shutdown condition, two things happen: 1) the Crowbar SCR on the heatsink ssembly is triggered to short circuit the output of the supply, and 2) operational amplifier U4 pin 1 switches through CR9 to pull the control line high and shut down the power transistor base drive (Q1). Should the power transistors be shorted, the SCR immediately blows the input power fuses on the main module board.

Reset of the shutdown condition is initiated by the processor when any valid value is re-entered and executed. The execute pulse (EXC) turns on Q2, whose output connects to inverting input of U5 pin 13 and pulls this input below the other non-inverting input to unlatch comparator U5 pin 14. If conditions reoccur, the above shutdown sequence repeats. In this manner, it is possible to determine if a problem is in the supply or in the load by looking at the output of the module and re-entering and EXeCuting a value.

Outputs of the current and voltage buffers at U2 pin 14 and U3 pin 14 provide the voltage (TESTV) and current (TESTI) values to Test Board (A4). These values are applied to respective voltage dividers and potentiometers and then calibrated to correspond to the actual values. U4 pin 8 is a summing amplifier to add up the current read-out value when modules are paralleled together in a hardware master/slave arrangement. U4 pin 7 inverts the output of the summing amplifier and connects to the Test relay on the main module board.

HEATSINK ASSEMBLY

The heatsink assembly (Drawing 6809940 and 6691059) contains the output power transistors Q3 through Q6. These transistors are connected in parallel with a small emitter resistor in series with each device as a current spreader. These devices are darlington connected with Q2 to provide high current gain. PNP transistor Q1, along with diodes CR1 and CR2 and resistors R1 and R2, form a constant current source as the base drive for the output stage. This source driver allows the input to output voltage difference to vary widely since the output voltage is programmable from 0 to the maximum specified for the module.

Sink driver Q1 on the DAC board pulls down on the source driver collector and the base of the darlington connected output driver Q2 on the heatsink at E17.

The drive voltage, which is two base emitter drops above this voltage, is varied up or down by the DAC board controls to maintain keep the output voltage at precisely the same value as the programmed voltage.

The current source provides enough base current to keep the output transistors from coming out of saturation even at full load current. Diodes CR4 and CR5 provide protection to the module should the input voltage goes below the output voltage or if the output has a reverse polarity applied to it. SCR Q7, is the overvoltage/ overcurrent Crowbar device that shorts the output when triggered at E18.

SECTION V
MAINTENANCE AND CALIBRATION

WARNING

HAZARDOUS VOLTAGES ARE PRESENT WHEN OPERATING THIS EQUIPMENT. READ "SAFETY" NOTE ON PAGE vii BEFORE PERFORMING INSTALLATION, OPERATION, OR MAINTENANCE.

5.1 INTRODUCTION

This section contains procedures for verification of performance, disassembly, troubleshooting and calibration of the Model AT8000 System. The instrument is delivered with all adjustments and calibrations completed. Further adjustment should not be required unless a malfunction occurs or certain critical parts are replaced.

The instrument top cover adjustment holes (six elongated slots corresponding to DC Power Module adjustment locations) are each sealed by calibration labels. Those with QA (Quality Assurance) stamp denote installed DC Power Modules. Good practice encourages re-labeling and QA stamping immediately after any adjustment.

Section II Installation and Check-out contains an instrument verification procedure. This check-out procedure should be performed after any maintenance. Included is a recommended list of test equipment and accessories (e.g. loads) which are also suitable for the procedures here in Section V.

If the procedures of this section and Theory of Operation of Section IV do not provide sufficient information to locate and correct the malfunction, the assistance of the Elgar Customer Service Department should be requested. This instrument should not be returned to the Elgar factory without the express authorization of Elgar or its appointed representative. Elgar cannot assume responsibility for equipment returned without this authorization.

5.2 REPLACEMENT PARTS

Most integrated circuits are installed in sockets for easy removal during troubleshooting. If a spare device is not available, a similar device by another manufacturer may be used. Refer to the Parts List of Section VI and individual manufacturer component data sheet, as required.

5.3 TROUBLESHOOTING ACCESS

Adjustment potentiometers on the modules are accessible through holes in the top cover without the removal of any screws. These holes are covered by calibration seals and adjustments also have QA (Quality Assurance) stamps. Good practice encourages re-sealing and QA stamping immediately after any adjustment.

Removal of the instrument top cover is required for further access to the DC Power Modules, Processor Board (A2), Test Board (A3) and Display Board (A4). To remove the top cover:

1. Disconnect the main AC power plug.
2. Remove all screws from the top cover and lift cover up and out.

To remove the DC Power Modules:

1. Remove the two braces running from side-to-side across the top of the chassis. Each brace has four (4) holding screws. Note that the forward top brace is steel while the rear top brace is aluminum.

2. Slide the DC Power Module to be removed towards the front of the chassis until the connector at the rear of the DC Power Module is disconnected from the backplane.

3. Hold the DC Power Module by its two (2) handles and pull it up slowly. Be careful to avoid scratching its sides or adjacent electronics. The plastic insulating sheet on the back of each DC Power Module aids in minimizing adjacent module chafing. DO NOT REMOVE THIS SHEET.

4. To access both sides of a DC Power Module, you may best remove all other DC Power Modules from the chassis and place the problem unit one of the middle slots such as slot 3 or 4.

To access the digital boards (Processor (A2), Test (A3) and Display (A4)):

1. Remove the eight (8) screws from the front panel cover. Swing the cover forward and down to lay it on its two (2) front handles. When re-installing the front panel, care should be taken to place the wires around the Power On switch in their proper position to avoid interference with the operation of the cooling fans.

2. If a problem is in either the Display or Test Boards, the Processor Board must be partially removed. To do this, remove the four (4) screws and washers on each corner of the Processor Board. Electrically isolate the Processor Board with non-conductive sheeting and make sure it does not touch any conductive material. Carefully move the Processor Board out of the way to expose the Display and Test boards.

5.4 TEST BOARD ADJUSTMENTS

R1 is the Confidence Test (test #3 of 4 tests) calibration reference voltage and should be adjusted to provide exactly 3.000VDC from U2 pin 4 to U2 pin 7.

R2 is the analog to digital converter reference voltage used for all Test Board measurements and should be adjusted to provide exactly 5.000VDC from U2 pin 6 to U2 pin 7.

WARNING

Test Board (A3) operates with three (3) ground references. Carefully use only the text specified measuring points. If DC Power Modules are wired in series or floated above (below) ground, then test equipment chassis ground and Test Board measured ground may be floating by as much as +/- 400 volts. Any attempt to force the three grounds within the Test board to be equal may cause the destruction of the Processor Board (A2) and its GPIB interface. Verify true ground potential before making any connections.

5.5 MODULE ADJUSTMENT DEFINITIONS

The following adjustments are accessible through the instrument top cover. Adjustments R1, R5 and R6 are not performed on slave modules.

When a channel has multiple modules (master/ slave), first the master module is adjusted alone. Then, the first slave is connected and the slave adjustments are made. Each additional slave is connected and adjusted in turn. Adjustments R1, R5 and R6 may be made on the master module at any time and should be verified after the last slave is adjusted.

If any top cover adjustment seal is broken, good engineering practice encourages re-sealing and an appropriate QA stamp.

R1 (front most potentiometer) is the voltage read-out (TST function) control. This is only used if the optional Test Board is installed. This adjustment should be performed only after the output voltage adjustment (R5 and R6) has been made. This adjustment makes the front panel TST function measured voltage "agree" with the actual module output voltage. Adjusted on master modules only.

R2 is the current read-out (TST function) control. This is only used if the optional Test Board is installed. This adjustment should only be done after the output current adjustment (R3 and R4) has been made. This adjustment makes the TST function measured current "agree" with the actual module output current. Adjusted on master and slave modules.

R3 is the maximum output current control. This adjusts the module output current to "agree" with the programmed maximum available current. The module is setup in CURR (constant current) mode for this adjustment. This adjustment interacts with R4, thus R3 and R4 adjustments should be both re-checked. Adjusted on master and slave modules.

R4 is the zero output current control. This adjusts module output current to minimum when the module is programmed to zero output current. This adjustment interacts with R3, thus R3 and R4 adjustments should be both rechecked. Adjusted on master and slave modules.

R5 is the output voltage linearity control. This is adjusted to provide precisely 10% and 50% of the maximum output voltage when the module is programmed to these respective values. This adjustment interacts with R6, thus R5 and R6 adjustments should both be re-checked. Adjusted on master modules only.

R6 is the maximum output voltage control. This adjusts the module output voltage to "agree" with the maximum programmed voltage value. This adjustment interacts with R5, thus R5 and R6 adjustments should both be re-checked. Adjusted on master modules only.

5.6 MODULE ADJUSTMENT PROCEDURE

This procedure is normally performed via the front panel keyboard. If the optional Display Board is not installed, then the keyboard equivalent commands must be sent via the remote controller.

Potentiometers R1 through R6 are located on the DC Power Module DAC board and are accessible through holes of the instrument top cover. Adjustment holes are labeled with each potentiometer function. Adjustments R1, R5 and R6 are not performed on slave modules. (Hint on slave modules, adjust current only.)

When a channel has multiple modules (master/slave), first the master module is adjusted alone. Then, the first slave is connected and the slave adjustments are made. Each additional slave is connected and adjusted in turn. The top cover must be removed to connect each slave ribbon cable back towards its corresponding master module. Adjustments R1, R5 and R6 may be made on the master module at any time and should be verified after the last slave is adjusted.

Adjustment holes in the top cover are covered by calibration seals and also have QA (Quality Assurance) stamps. Good practice encourages re-sealing and QA stamping immediately after any adjustment.

Channel selection is via the following keystrokes where XX is a two digit entry from 01 to 16:

Keystrokes are: RTN XX

Only the master DC Power Module determines the output voltage and current for a channel via its own DAC board. Slave DC Power Modules receive their relay and analog controls via their respective master. Adjustments are made to the master DC Power Modules and not the slaves. Sense lines refer to the terminals of the master DC Power Modules. The slave voltage sense lines are not used.

> **WARNING**
>
> **DC Power Module output voltages may be as high as +/-320 volts plus the effects of floating ground and series outputs from other channels. Carefully use only the text specified measuring points. If DC Power Modules are wired in series or floated above (below) ground, then test equipment chassis ground and measured ground may be floating by as much as +/-400 volts. Always verify true ground potential before making any connections.**

OUTPUT VOLTAGE ADJUSTMENTS

1. Connect a precision voltmeter (at least 5 or more digits of accuracy) to the positive and negative output terminals of the DC Power Module to be adjusted.

2. Program the DC Power Module to maximum voltage, maximum current and close the output isolation relay. If the maximum voltage and current are not known, simply press VOLT 9999 ENT and maximum voltage and current values will flash on the display.

Keystrokes are:
VOLT XXXX CURL XXXX CLS ENT 2ND EXC

NOTE

External sense is not needed for this adjustment. But if it is programmed, make sure that the positive sense terminal is connected to the positive output terminal and that the negative sense terminal is connected to the negative output terminal. If external sense is programmed but not connected, the output voltage will be approximately 10% above the programmed value and unregulated.

3. Adjust resistor R6 (OUTPUT VOLTAGE) until the output voltage matches the programmed value.

4. Program the DC Power Module to 50% of maximum voltage and adjust R5 (VOLTAGE LINEARITY) until the output voltage matches the programmed voltage.

5. Repeat steps 3 and 4 until the output voltages match the programmed voltages.

6. Program the DC Power Module to 10% of maximum voltage. Adjust R5 (VOLTAGE LINEARITY) so the percentage accuracy error is the same at 10% and at 50% of full voltage. Make sure R6 (OUTPUT VOLTAGE) is still adjusted for 100% maximum voltage.

VOLTAGE READ-OUT ADJUSTMENT

This adjustment is performed only if optional Test Board (A4) is installed.

1. Program any DC Power Module to maximum voltage and maximum current.

Keystrokes are:
VOLT XXXX CURL XXXX ENT 2ND EXC

2. Command the display to monitor via the test (TST) mode where XX is the channel number from 00 to 16.

Keystrokes are: 2ND TST XX

3. Adjust R1 (VOLTAGE READ-OUT) until the display VOLTAGE value agrees with the programmed voltage.

If the optional Display Board (A4) is not installed in the instrument, then program the channel to maximum voltage and maximum current via the controller. Program the controller to continuously send the TST command and receive the measurement results. The controller program should display the measurement results on its own screen. Then perform step 3 (above) until the received measurement result matches the programmed voltage.

An alternate method for this adjustment requires first to remove the top cover of the instrument and to connect a voltmeter between P3 pin 16 and P3 pin 14 of the DAC board. Program the module to maximum voltage and maximum current and adjust R1 until the voltmeter reads precisely 4.850 VDC.

OUTPUT CURRENT ADJUSTMENT

NOTE

When adjusting a 7VDC or 10VDC range DC Power Modules, replace all references of 60% maximum current with 100% of maximum current. The 7VDC and 10VDC range DC Power Modules do not require the current derating of higher voltage range units.

1. Connect a current meter, rated to at least 60% of the DC Power Module channel maximum current, to the positive and negative output terminals of the DC Power Module.

2. Program the DC Power Module to maximum voltage, 60% of maximum current in the constant current (CURR) mode and close the output isolation relay. If the maximum voltage and maximum constant current values are not known, simply press VOLT 9999 2ND CURR 9999 ENT and maximum voltage and constant current values will flash on the display.

Keystrokes are:
VOLT XXXX 2ND CURR XXXX CLS
ENT 2ND EXC

NOTE

External sense is not needed for this adjustment, but if it is programmed, make sure that the positive sense terminal is connected to the positive output terminal and that the negative sense terminal is connected to the negative output terminal. If external sense is programmed but not connected, the output voltage will be approximately 10% above the programmed value.

3. Adjust R3 (OUTPUT CURRENT) until the current meter matches the programmed current.

4. Program the module to approximately 5% of maximum current in the constant current (CURR) mode. Adjust R4 (ZERO OUTPUT CURRENT) until the current meter matches the programmed current.

5. Repeat steps 2 and 3 until both meter readings match with programmed current values.

CURRENT READ-OUT ADJUSTMENT

This adjustment is performed only if the optional Test Board (A3) is installed in the instrument. Consult factory if your instrument is configured for CIIL version (GPIB instrument programming language) and does not have the optional Display (A4) installed.

1. The current meter should still be connected from the previous OUTPUT CURRENT ADJUSTMENT or a direct short connected from the positive to the negative output terminals.

2. As from the previous adjustment, program the DC Power Module to maximum voltage, 60% of maximum current in the constant current (CURR) mode and close the output isolation relay. If the maximum voltage and maximum constant current values are not known, simply press VOLT 9999 2ND CURR 9999 ENT and maximum voltage and constant current values will flash on the display.

Keystrokes are:
VOLT XXXX 2ND CURR XXXX CLS
ENT 2ND EXC

3. Command the display to monitor via the Test (TST) mode where XX is the channel number from 00 to 16.

   Keystrokes are: 2ND TST XX

4. Adjust R2 (CURRENT READ-OUT) until the front panel display CURRENT value matches the programmed current.

If the optional Display Board (A4) is not installed and the instrument is configured in ABLE language, the controller may be used to adjust the current read-out. The controller program sets the instrument channel to maximum voltage, 60% of maximum current in the constant current mode and closes the output isolation relay. The controller is next programmed to continuously send the TST command and receive the measurement results. The results should be continuously displayed on the controller's screen. Adjust R2 (CURRENT READ-OUT) until the current measurement result matches the programmed constant current value. For example, if adjusting a 20VDC range module installed on channel number 3, the controller program would consist of something similar to the following:

```
DIM A$[200]
OUTPUT 717 "CH3 VOLT 20 CURR 6
CLS"
OUTPUT 717 "TST 3"
LOOP:
WAIT 1000    ! About 1 sec.
ENTER 717; A$
DISP A$
GOTO LOOP
```

5.7 TROUBLESHOOTING

A thorough study of Section IV Theory of Operation is a prerequisite to servicing or repairing the instrument. Once the circuit theory is understood, the observed symptoms will suggest the procedure to be used in determining which circuit is malfunctioning. Technicians must use good diagnostic and safety procedures to solve problems.

CONFIDENCE TEST FAILURES

Confidence Test failures are recognized by a front panel flashing CHANNEL number and a flashing VOLTAGE value display of an "E" followed by an error code from 1 through 4. The code number identifies which of the four (4) Confidence Tests failed. Confidence Tests are explained in detail in Section IV Theory of Operation.

Run-time failures do not have the "E" on the VOLTAGE display. These are discussed in the next topic.

If your instrument is operating in remote (RMT is illuminated) and in ABLE version (GPIB instrument programming language), the processor activates the GPIB SRQ (service request) line upon a Confidence Test fault. The controller program should check the GPIB SRQ after each Confidence Test to verify if the test was successful. If the GPIB SRQ line is active, the controller must perform a GPIB serial poll to find the requesting instrument on the GPIB. This simultaneously clears the SRQ line and reads back the SRQ byte to the controller. As noted below, and in Section 3.5, the SRQ byte message is quite specific as to the fault detected.

In CIIL configuration, the front panel display of Confidence Test failures are the same. In remote CIIL, the SRQ line is not set and SRQ byte not sent. Instead, the controller program should use STA (STAtus) to recover fault messages from the instrument via the GPIB.

Confidence Test Failure 1 – 16
(SRQ codes 221 through 236)

A flashing CHANNEL 01 through 16 on the display identifies which channel failed the Confidence Test. The "E" and code (1 through 4) identifies which of the Confidence Tests failed.

SRQ byte 221 through 236 correspond to channels 1 through 16, respectively. The remote controller does not know which Confidence Test (1 through 4) actually failed.

Confidence Test Failure 17 (SRQ code 237)

A flashing CHANNEL 17 on the display indicates multiple channel failures. That is, two channels have failed. The Confidence Test stops itself automatically upon detecting the second failure. The "E" code identifies which Confidence Test failed.

To find the failed channel numbers, modules must be removed from the chassis until only one of the failed modules is installed as described below:

1. Turn AC power OFF. Disconnect the input AC line and output loads for safety.
2. Remove the instrument top cover of the chassis and two top braces above DC Power Modules. Refer to Troubleshooting Access topic earlier in this section.
3. Remove any one DC Power Module from the chassis by sliding it forward and pulling it (carefully) up and out.
4. Reconnect the AC input line. Turn AC power ON.
5. Perform the Confidence Test. (Keystrokes are: 2ND TST)

If CHANNEL still flashes 17, then repeat steps 1, 3, 4 and 5.

If CHANNEL does not flash, then all failed modules have been removed.

If CHANNEL flashes a number from 1 through 16, then one of the failed DC Power Modules has been found. Turn AC power OFF and remove the input AC line. Next, remove the failed DC Power Module from the slot whose number is flashing on the channel number display.

FLASHING CHANNEL NUMBER 18 (SRQ Codes 78 and 238)

A flashing CHANNEL 18 indicates a Test Board error within itself. It is either a Test board overrun fault or Confidence Test #3 (internal calibration voltage adjustment reading) failure. These two faults occur only during the Confidence Test. A faulty calibration reading is more likely than the overrun. Thus, a flashing CHANNEL 18 is most likely to be accompanied by a flashing VOLTAGE display of "E3".

An SRQ byte of 78 indicates the Test Board overrun. An SRQ byte of 238 indicates a faulty Test #3 (calibration voltage).

TEST BOARD CALIBRATION FAILURE

This failure occurs while the processor reads the calibrated voltage on the wiper of potentiometer R1 of the Test Board. It should be 3.000 volts DC +/- 1.13%. The failure occurs because the processor reads a value either greater than 3.055 volts or less than 2.945 volts.

The two (2) potentiometers (R1 and R2 on the Test Board) must be precisely adjusted to provide 3.000 volts from U2 pin 4 to U2 pin 7 and 5.000 volts from U2 pin 6 to U2 pin 7 respectively.

If the Test Board still operates in the normal test mode, that is if it can still read the load voltage and current of a module, then the problem is probably restricted to the R1 and R2 potentiometers circuits. Possible causes are:

R1 with broken leads or not adjusted to provide 3.000 volts;
R2 with broken leads or not adjusted to provide 5.000 volts;
CR9 6.9 zener diode;
CR10 6.9 zener diode; or
U1 TLO72 operational amplifier.

TEST BOARD OVERRUN ERROR

This failure occurs when the Test board A/D (U2) measures an analog voltage (TESTV or TESTI) from a DC Power Module that exceeds the full scale value of 4.85 volts with respect to TEST GND.

If this happens on only one DC Power Module, then the problem is probably isolated to that DC Power Module (or channel). As soon as the processor detects this error, it opens the associated DC Power Module test relay to prevent damage to the expensive Test Board A/D. Unfortunately, this automatic safety feature makes it difficult to readily troubleshoot on the Test Board unless a storage oscilloscope (or similar instrument) is available.

These two signals are readily available prior to the DC Power Module test relay K5. These are measured in the DC Power Module itself. TESTV is available on P3 pin 16 and TESTI on P3 pin 15 in reference to TEST GND on P3 pin 14 of the DAC board.

Should the above pins are correct but the Test Board A/D still indicates an overrun, then suspect a faulty K5 test relay on the DC Power Module itself. An open contact on K5 causes the Test Board A/D input to float high to +5 volts DC. Replacement of the the test relay should clear this failure.

CONFIDENCE TEST 'E' CODES

E1 - Crowbar

An "E1" on the VOLTAGE display indicates the Confidence Test # 1 check to exercise the DC Power Module (channel) Crowbar. The processor sets up the channel, fires the Crowbar, and then reads (via MODINFO) the channel's master DC Power Module circuit to verify if the Crowbar was fired.

Several hardware internal and external (output terminal) configuration faults could could cause this failure. The most common of which is blown fuses in the DC Power Module. These fuses are located in rear of the DC Power Module.

Use care with GRP and PAR remote programming commands as they apply to the instrument output configuration. Any parallel (PAR) channels fault which is not properly accompanied by its corresponding GRP set is likely to blow fuses upon certain faults.

E2 - Current Limit

An "E2" on the VOLTAGE display indicates Confidence Test #2 checks on the DC Power Module (channel) current limit (CURL) circuit has failed. The processor programs the DC Power Module to generate a small current through its internal current sampling resistor R4. The programmed current is lower than the actual current draw across the internal load causing a current limit. The processor verifies current limiting (CURL) by reading MODINFO.

This failure usually indicates that the low end of the output current needs adjustment. If this is the case, adjusting the DC Power Module R4 clockwise, usually corrects this problem.

Most DC Power Modules have a zero current offset at the low end such that when they are programmed to zero they will produce a small amount of current. When the offset current is too large the DC Power Module fails this test. If R4 is adjusted too far clockwise, reducing the offset current too much, it activates the Crowbar circuitry. Thus, the adjustment of R4 must be a compromise between these two failure modes.

R4 is properly adjusted by turning it clockwise until the Crowbar justs activates. Then, back it off by adjusting R4 1/4 to 1/2 of a turn counter-clockwise. Potentiometer R3 should be next checked and may need to be adjusted. Refer to OUTPUT CURRENT ADJUSTMENTS topic above.

E3 - BIT

An "E3" on the VOLTAGE display indicates Confidence Test #3 failed to measure an expected 3.0 VDC calibration sample on the Test Board. This check verifies the Test Board is well calibrated and able to properly measure before attempting Confidence Test #4 which measures voltage on each of the installed channels.

Details of the adjustments involved on the Test Board are discussed above in Test Board Calibration Failure.

E4 - Voltage

An "E4" on the VOLTAGE display indicates the Confidence Test #4 check to verify DC Power Module voltage accuracy has failed. The processor programs the channel to about 80% of its full scale and reads the analog voltage (TESTV) via the Test board to verify its accuracy.

The Test Board should be okay since it has already completed its Confidence Test #3 to read a similar internal voltage. The problem is likely associated with the DC Power Module voltage D/A linearity (R5) adjustment or maximum voltage (R6) adjustment. It is also likely to be a mis-adjusted test voltage calibration (R1) which fine tunes TESTV from the DC Power Module. Refer to DC Power Module Adjustment procedure above.

5.8 MISCELLANEOUS FAULTS

The following fault displays may appear similar to those of the Confidence Test, but are distinctively different.

UNABLE TO PERFORM "TST" FUNCTION (SRQ code 218)

If the Model AT8000 refuses to go into the local Test mode (TST), then the processor thinks that either the Test Board or the requested DC Power Module (channel) is not installed.

A non-installed channel is reported by the processor as a flash of zeros on the VOLTAGE and CURRENT display whenever either of these is attempted to be ENTered from the front panel. An improperly seated (ajar from shipping or being dropped) DC Power Module similarly does not communicate with the processor and would appear as not installed.

The Test Board may truly be not installed since it is an option. However the Test Board may be malfunctioning if it is not powered or connected to the processor. Possible causes are:

Power plug not connected– Three pin red molex connector from the transformer should plug into J2 connector of the Test Board. Also verify plug orientation.

Test Board not connected to processor–Test Board ribbon cable should connect to the Processor Board at J4.

FLASHING CHANNEL 19

A flashing CHANNEL 19 indicates a local keyboard input error. It simply means that the processor received an illegal code from the keyboard.

This error code occasionally happens when keys are pressed incorrectly, keys are pressed too fast (simultaneously) or the keyboard temporarily malfunctions. If this happens, simply ignore the error and re-enter the keyboard sequence.

FLASHING CHANNEL 20

A flashing CHANNEL 20 signals the processor has detected a momentary AC power voltage dip. This is not a fault. It is strictly informative to the operator.

The processor continuously monitors the AC power line via an RC circuit in its 5 volt power supply. Should the AC line voltage momentarily dip to about 95 volts AC, the microprocessor immediately shuts itself down for a few milliseconds. During this time, channel setups are untouched so as not to risk contaminating the data should AC line voltage continue to drop (E.G. AC power shut down or drop out). Thus, valid setups are retained in the optional battery back-up RAM.

5.9 FAILURE LED DISPLAY

The following faults shut down the affected channel. The front panel display does not automatically change from its existing CHANNEL display and start flashing the new faulty channel number. Instead, these failures are displayed as single LEDs in the display FAILURE area only upon locally selecting the channel (2ND RTN XX).

CROWBAR

The CROWBAR LED illuminates to indicate the dispayed channel has sensed (internally or externally) 110 per cent (or more) of the programmed voltage. The Crowbar fires immediately upon such an overvoltage condition. It does not matter why or where the overvoltage originated. The Crowbar short circuits the output terminals immediately to prevent damage, then the processor opens the particular channel output isolation relay(s).

It also momentarily fires and upon power up, power down and by command during the Confidence Test. However, the front panel display does not indicate these on the LED display.

If the Crowbar remains active after attempts to re-EXeCute or change its setup, the problem is probably blown fuses in the DC Power Module.

Crowbar will fire if the User load is a battery or a charged capacitor whose voltage is higher than the programmed channel voltage.

Closely inspect connectors and terminals for the insulation effects of oxidation, especially on high current DC Power Modules and master/slave configurations. Be sure the sense lines are connected properly and to the correct load.

If the Crowbar consistently fires when the DC Power Module is not programmed (programmed to zero), then the problem is probably the adjustment of the module potentiometer R4. Refer to MODULE ADJUSTMENT procedure above.

If the CHANNEL number display does not stop flashing when a key is pressed, the Crowbar is constantly re-occurring. Isolate each slave from its master, since a Crowbar on one DC Power Module of a channel also fires all other DC Power Module Crowbars on that same channel.

TEMP

An overtemperature condition on a DC Power Module's heatsink assembly illuminates the TEMP LED. Its sensor is located on the DC Power Module heatsink.

Excessive temperature on the DC Power Module output transistor heatsink sensor shuts down the channel. Grossly insufficient cooling by the internal fans and inadequate ventilation are usually the cause. Verify proper fan operation to be sure they are all powered and not just free wheeling. Check the fan unregulated 24 volt supply. Also verify adequate chassis ventilation and that the chassis has a supply of fresh (not pre-heated) cooling air. Adequate ventilation applies to not restricting the instrument rear chassis exhaust air.

Should your application not require all six slots to be filled in a chassis, yet an overtemperature is indicated, optional "Dummy Module(s)" may be installed in the unused slots. A dummy module is installed as any other module except the dummy module has no electrical connections. A dummy module re-directs cooling air from the fans across the heatsinks of "real" DC Power Modules instead of through the gaps of empty slots.

The thin plastic insulation sheet on the back of each DC Power Module has no effect on cooling. DO NOT REMOVE THIS INSULATION SHEET. The purpose of this sheet is to prevent adjacent module chafing during shipping and long term instrument use.

The symptoms of overtemperature go away with time if the instrument is allowed to cool. However, the overtemperature will re-occur minutes later in marginal ventilation installations. Be sure to check external air filters (the Model AT8000 has no air filter) for restrictions.

CURL

The CURL LED on the display indicates the DC Power Module (channel) output current reached the maximum programmed current (CURL mode) or exceeded this programmed value (CURR mode). Upon internally sensing this fault, the processor shuts down the channel and illuminates the CURL LED.

The DC Power Module DAC analog circuits continuously sense output current. In constant current mode (CURR), as current increases, the output voltage (called compliance voltage) is varied downward to regulate the output current to a constant level. In constant voltage mode (CURL mode), the current is allowed to increase, depending upon the external load.

If this problem occurs with a new load configuration, verify proper cabling for both output power and the sense lines. Verify DC Power Module ranges are not mixed or two independent channels improperly connected/programmed. Remote programming (ABLE version) should use PAR and GRP carefully.

SECTION VI
PARTS LIST

6.1 GENERAL

This section contains a listing of all parts necessary for factory-authorized repair of the Elgar Programmable DC Power System. Location of parts and assemblies are given on an assembly drawing accompanying each board schematic. Parts are located on the assembly drawing and correlated on the parts lists by reference designators.

6.2 SPARE PARTS

When ordering spare parts, specify part name, part number, manufacturer, component value and rating. Where no specific manufacturer or part number is given, the replacement part should conform to the value, rating, and tolerance as listed. If complete assemblies are desired, order assemblies from Elgar Corporation at 9250 Brown Deer Road, San Diego, CA 92121. Specify instrument model number (Model AT8000), serial number, assembly name and its part number.

Federal Stock Code Manufacturer (FSCM) identification is provided for components used within this instrument per the following table:

Manufacturer	Address	FSCM No.
Airpax	Cambridge, MD	81541
Alco	Lawrence, MA	95146
Allen Bradley	Milwaukee, WI	01121
AMD	Sunnyvale, CA	34335
AMP	Harrisburg, PA	00779
Amphenol	Broadview, IL	02660
Augat	Attlebord, MA	91506
Beckman	Fullerton, CA	73138
Bishop	Pico Rivera, CA	58518
Bourns	Riverside, CA	80294
Burndy	Norwalk, CT	09922
Bussman	St. Louis, MO	71400
Centralab	Milwaukee, WI	71590
Corning	Corning, NY	14674
CTS	Elkhart, IN	71450
Dale	Columbus, NE	91637
Douglas/Randell	Pawcatuk, CT	95073
Electro Switch	Charolette, NC	2V181
Elgar	San Diego, CA	25965
Elmwood	Cranston, RI	14604
Elpac	Fullerton, CA	12406
Erie	Erie, PA	72982
Fairchild	Mtn. View, CA	07263
General Electric	Syracuse, NY	03508
General Instrument	Newark, NJ	72699
Grayhill	La Grange, IL	81073
Hewlett Packard	Palo Alto, CA	28480

Manufacturer	Address	FSCM No.
IMB	Santa Fe Springs, CA	27556
International Rect.	El Segundo, CA	59993
IXYS	San Jose, CA	0A5K5
E. F. Johnson	Waseka, MN	74970
Keystone	New York, NY	91833
Kulka	Mt. Vernon, NY	75382
3M	St. Paul, MN	04963
Magnecraft	Northbrook, IL	94696
Magnum	Erie, MI	52458
Mempco Electra	Morristown, NJ	80031
Molex	Downers Grove, IL	27264
Motorola	Phoenix, AZ	04713
National	Santa Clara, CA	27014
Panasonic	Secaucus, NJ	61058
Panduit	Tinley Pk, IL	06383
Positronic Ind	Springfield, MO	28198
Potter-Brumfield	East Princeton, IN	77342
RCA	Hawthorne, CA	18722
Rotron	Woodstock, NY	82877
Saronix	Palo Alto, CA	94303
Siemens	Iselin, NJ	19500
Signetics	Sunnyvale, CA	18324
Silicon General	Westminster, CA	34333
Southco	Lester, PA	94222
Spectrol	City of Industry, CA	02111
Sprague	North Adams, MA	56289
Sullins	San Marcos, CA	54453
T&B Ansley	Elizabeth, NJ	59730
Tekna	Belmont, CA	57442
Texas Instruments	Dallas, TX	01295
Thermalloy	Dallas, TX	13103
Topaz	San Diego, CA	06049
TRW	Wheeling, IL	80223
TRW Cinch Jones	Chicago, IL	71785
Useco	Van Nuys, CA	88245
Zierick	New Rochelle, NY	79963

6.3 CHASSIS ASSEMBLY - MASTER

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
B1,2,3	ROTRON	MC24A3	FAN, 24VDC	853-24V-DC
CB1	AIRPAX	UPG12-22477-2	CIRCUIT BREAKER,10A	852-247-72
DS1	IND.DEVICES	2112QA5	LAMP, 115VAC	854-115-GN
J7 CABLE	ELGAR	5970071-01	GPIB CONNECTOR	5970071-01
*J9	AMPHENOL	126-218	DFI-CONNECTOR	8551262-18
*J9 MATE	AMPHENOL	126-217	DFI-CONNECTOR	8551262-17
P1	ELGAR	9900026-01	LINE CORD	9900026-01
P2	AMP	640428-3	CONN 3PIN	856-156-03
P5	AMP	640428-5	CONN 5PIN	856-156-05
P6	AMP	640428-4	CONN 4PIN	856-156-04
*P7	AMP	640428-2	CONN 2PIN	856-156-02
P11	AMP	640428-4	CONN 4PIN	856-156-04
T1	ELGAR	5900373-01	TRANSFORMER	5900373-01
A1 BACK-PLANE	ELGAR	5699960-01	PC ASSEMBLY	5699960-01
A2 PROCESSOR	ELGAR	5699952-01	PC ASSEMBLY	5699952-01
*A3 TEST	ELGAR	5699950-01	PC ASSEMBLY	5699950-01
*A4	ELGAR DISPLAY	5699951-01	PC ASSEMBLY	5699951-01
OPTIONAL REAR PANEL CONNECTORS				
*J1-6	AMPHENOL	MS3102-16-9S	CONNECTOR	855-116-9S
*J10	AMPHENOL	MS3102-16-10P	CONNECTOR	855-160-3X
*J1-6 MATE	AMPHENOL	MS3106-16-9P	CONNECTOR	855-316-9P
J10 MATE	AMPHENOL	MS3106-16-10S	CONNECTOR	855-360-3X
*J1-6,10 CLAMP	AMPHENOL	MS3057-8A-1	STRAIN RELIEF	855-09A-X3

*OPTIONAL

6.4 CHASSIS ASSEMBLY - EXTENDER

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
B1,2,3	ROTRON	MC24A3	FAN, 24VDC	853-24V-DC
CB1	AIRPAX	UPG12-22477-2	CIRCUIT BREAKER,10A	852-247-72
P1	ELGAR	9900026-01	LINE CORD	9900026-01
P5	AMP	640428-5	CONN 5PIN	856-156-05
P6	AMP	640428-4	CONN 4PIN	856-156-04
P11	AMP	640428-4	CONN 4PIN	856-156-04
T1	ELGAR	5900373-01	TRANSFORMER	5900373-01
A1 BACK PLANE	ELGAR	5699960-01	PC ASSEMBLY	5699960-01
A2 AUX. POWER SUPPLY	ELGAR	5690013-01	PC ASSEMBLY	5690013-01

OPTIONAL REAR PANEL CONNECTORS

J1-6	AMPHENOL	MS3102-16-9S	CONNECTOR	855-116-9S
J10	AMPHENOL	MS3102-16-10P	CONNECTOR	855-160-3X
J1-6 MATE	AMPHENOL	MS3106-16-9P	CONNECTOR	855-316-9P
J10 MATE	AMPHENOL	MS3106-16-10S	CONNECTOR	855-360-3X
J1-6,10	AMPHENOL	MS3057-8A-1	STRAIN RELIEF	855-08A-X3

6.5 CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - BACKPLANE 5699960-01 A1 ASSEMBLY

	ELGAR	9699960-01	PC BOARD	9699960-01
J1A-J6A	POSITRONIC IND	41M8SS	CONN 8PIN 13A MALE	856-41M-8S
J1B-J6B	PANDUIT	100-348-452	CONN 48PIN FEMALE	856-DIN-48
J8 CABLE	ELGAR	5970074-01	CABLE	5970074-01
J11	MOLEX	09-75-1048	MOLEX 4PIN MALE	856-104-75
S1	CTS	206-5	DIP SWITCH5 206-5	860-206-5X
S2	ALCO SWITCH	MSS-6300G	SWITCH 6P3T PC MT	860-MSS-63
S3	ELECTRO SWITCH	73-7816	SWITCH 5PDT PC MT	860-737-81
TB1-6	MAGNUM	A307204-NL	TERM 4PIN PCB BLK	893-PCB-04
W1	ELGAR	9949948-01	BUS BAR-BACKPLANE	9949948-01

6.6 CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - PROCESSOR 5699952-01 A2 ASSEMBLY

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9699952-01	PC BOARD	9699952-01
C1	PANASONIC	ECE-B1CV472S	CAP 470UF 20% 35V	824-478-01
C2	SPRAGUE	503D108M05000F	CAP 1KUF 50V	824-108-54
C3,18	SPRAGUE	196D106X0020JAI	CAP 10UF,20V	823-106-41
C4,5	SPRAGUE	CM05FD220J03	CAP 22PF 500V 5%	820-220-05
C6-17	ERIE	CK05BX104K	CAP .1 DISC 50V	821-104-CK
C19	ERIE	CK05BX103K	CAP .1 DISC 50V	821-104-CK
CR1-8	GE	1N5624	DIODE	845-562-4X
CR9-11	MOTOROLA	1N914	DIODE	844-914-XX
CR12,13	MOTOROLA	1N4004	DIODE	845-400-4X
HS1	THERMALLOY	6230B-TT	HSNK T0220 VERT	894-623-0T
J1	T&B ANSLEY	609-2437	MALE HEADER 24PIN	856-243-7X
J2	T&B ANSLEY	609-3437	MALE HEADER 34PIN	856-343-7X
J3	T&B ANSLEY	609-4037	CONN 40PIN FLAT	856-403-7X
J4	T&B ANSLEY	609-1437	MALE HEADER 14PIN	856-143-7X
J5	MOLEX	09-65-1051	CONN 5PIN TIN	856-105-12
J6	MOLEX	09-72-1041	CONN 4PIN GOLD	856-104-11
J7	MOLEX	09-75-1028	MALE 2PIN	856-102-75
K1*	P&B	JWD171-17	RELAY REED 1 FORM B	861-DIP-FB
Q1*	(GENERIC)	NPN 3643	XST-30V HF/AM TO92	865-364-3P
R1	DALE	CMF07 103 G	RES 10K OHM 1/4W 2%	801-103-05
R2	DALE	CMF07 106 G	RES 10M OHM 1/4W 5%	801-106-05
R4-6,8,9	DALE	CMF07 222 G	RES 2.2K OHM 1/4W 2%	801-222-05
R3,7	DALE	CMF07 333 G	RES 33K OHM 1/4W 2%	801-333-05
R10	MEMCO ELECTRA	504A3AD 56 K	RES 56K OHM 1/4W 2%	801-563-05
R11	ROHM	R-25 473J	RES 47K CFILM 1/4W	801C473-05
RN1,3,4	SPRAGUE	256CK333X2PD	RES NETWORK 33K	818-333-SP
RN2	ALLEN BRADLEY	110A222	RES NETWORK 2.2K	818-222-SP
U1	NATIONAL	MM74HC373N	CMOS OCT LATCH	849-H37-3X
U2,3	AMD	AM2732A-4DC	EPROM 2732A 4KX	849-273-2A
U4	RCA	CDM6116AE2	RAM 2KX8 SRAM	849-611-62
U5	MOTOROLA	MC146805E2P	CMOS MICROPROC	849-680-5E
U6	TI	SN75161N	MOS GPIB TX/RX	849-751-61
U7	TI	SN75160N	MOS GPIB TX/RX	849-751-60
U8	TI	TMS9914A	MOS GPIA TM29914A	849-991-4A
U9	RCA	CD74HC02E	CMOS 4X2 NOR	849-H02-XX
U10,17	RCA	D74HC04E	CMOS HEX INVERTER	849-H04-XX
U11	RCA	CD74HC00E	CMOS 4X2IN-NAND	849-H00-XX
U12	SIGNETICS	N82S23N	PROM MEM DECODE	849-MEM-DC
U13,18	RCA	CD74HC240E	CMOS 8XINVERTING	849-H24-0X

6.6 CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - PROCESSOR 5699952-01 A2 ASSEMBLY -- Continued

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
U15	RCA	CD74HC138E	CMOS 1 OF 8 DECODER	849-H13-8X
U16,19	RCA	CD74HC541	OCT BUSS/DRIVER	849-H54-1X
U20	NATIONAL	MM74C374N	CMOS OCTAL LATCH	849-7C3-74
U21,22	MOTOROLA	74HC533	HCMOS 8 INP LATCH	849-H53-3X
U23	FAIRCHILD	UA7805UC	REG POS 5V	849-780-5P
XU1,6,7, 13, 16, 18-22	BURNDY	DILB20P-108	DIP SOCKET 20PIN	849-DIP-20
XU2,3,4	BURNDY	DILB24P-108	DIP SOCKET 24PIN	849-DIP-24

* - 02 only (CIIL version)

XU5,8	BURNDY	DILB40-108	DIP SOCKET 40PIN	849-DIP-40
XU9,10,11,17	BURNDY	DILB14P-108	DIP SOCKET 14PIN	849-DIP-14
XU12,14,15	BURNDY	DILB16P-108	DIP SOCKET 16PIN	849-DIP-16
Y1	SARONIX	NYP050-20	CRYSTAL 5MHZ	864-5MH-ZP

6.7 CHASSIS ASSEMBLY
PC BOARD ASSY - AUX POWER SUPPLY - SLAVE 5690013-01 A2 ASSY

	ELGAR	9690013-01	PC BOARD	9690013-01
C1	PANASONIC	ECE-B1CV472S	CAP 4700UF, 16VDC	824-478-01
C2	SPRAGUE	503D108M0500F	CAP 1000UF, 50VDC	824-108-54
C3	SPRAGUE	513D477M025DG4	CAP 470UF, 25VDC	824-477-25
CR1-8	GE	1N5624	DIODE	845-562-4X
HS1	THERMALLOY	6230B-TT	HSNK T0220 VERT	894-623-0T
J3	T&B ANSLEY	609-4037	CONN 40PIN FLAT	856-403-7X
J5	MOLEX	09-65-1051	CONN 5PIN TIN	856-105-12
J6	MOLEX	09-72-1041	CONN 4P GOLD PC	856-104-11
U1	FAIRCHILD	UA7805UC	REG POS 5V	849-780-5P

6.8 CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - TEST 5699950-01 A3 ASSEMBLY

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9699950-01	PC BOARD	9699950-01
C1,2	SPRAGUE	501D477F035P5	CAP 470UF 20% 35V	824-477-61
C3,4,5,6	SPRAGUE	196D106X0020JA1	CAP 10UF,20V	823-106-41
C7	SPRAGUE	192P22292	CAP .0022UF 10%	822-222-05
C8	CDE	CD19FD561J03	CAP 560PF 500V 5%	820-561-05
C9	IMB	BA1B392F	CAP .0039 100V 1%	822-392-11
C10,11	CDE	CD15FD101J03	CAP 100PF 500V 5%	820-101-05
C12-18, 20-23	ERIE	CK05BX104K	CAP .1OUF 50V	821-104-CK
CR1,2,7,8	MOTOROLA	1N914	DIODE	844-914-XX
CR3,4,5,6	FAIRCHILD	1N4004	RECTIFIER	845-400-4X
CR9,10	MOTOROLA	LM329BZ	RECTIFIER, ZENER	848-329-BZ
J1 CABLE	ELGAR	5970073-01	CABLE	5970073-01
J2	MOLEX	09-75-1038	CONN 3PIN	856-666-09
Q1-5	FAIRCHILD	PN3643	TRANSISTOR,30V,NPN	835-364-3P
R1,2	SPECTROL	64S-102	POT 1K	819-102-3X
R3	DALE	RN60C3401F	RES 1/8W 1% 3.4K	813-340-1F
R4,5	DALE	CMF07 432 G	RES 4.3K OHM 1/4W 2%	801-432-05
R6	DALE	RN60C2151F	RES 2.15K 1/8W 1%	813-215-1F
R7	DALE	RN60C2491F	RES 2.49K 1/8W 1%	813-249-1F
R8	DALE	RN60C6491F	RES 6.49K 1/8W 1%	813-649-1F
R9	DALE	RN60C5762F	RES 57.6K 1/8W 1%	813-576-2F
R10	DALE	CMF07 184 G	RES 180K OHM 1/4W 2%	801-184-05
R11	DALE	CMF07 103 G	RES 10K OHM 1/4W 2%	801-103-05
R12,19,20	DALE	CMF07 222 G	RES 2.2K OHM 1/4W 2%	801-222-05
R13,14	DALE	CMF07 102 G	RES 1K OHM 1/4W 2%	801-102-05
R15,16,37	DALE	CMF07 273 G	RES 27K OHM 1/4W 2%	801-273-05
R17,18, 34-36	DALE	CMF07 153 G	RES 15K OHM 1/4W 2%	801-153-05
R21,31,32	DALE	CMF07 331 G	RES 330 OHM 1/4W 2%	801-331-05
R24,28	DALE	CMF07 201 G	RES 200 OHM 1/4W 2%	801-201-05
U1	TI	TL072CP	OP AMP X2	849-TL0-72
U2	ANALOG DEVICES	AD7582KN	CONV 12 BIT A/D	849-758-2K
U3	RCA	CD4021BE	CMOS 8XSHFTREG	849-C40-21
U4	RCA	CD4013BE	CMOS DUAL-D-F	849-C40-13
U5	RCA	CD4098BE	CMOS 4X2IN SCH	849-C40-98
U6	RCA	CD4093BE	CMOS 4X2IN SCH	849-C40-93
U7	RCA	CD4071BE	CMOS 4X2IN OR	849-C40-71
U8	RCA	CD4017BE	CMOS CTR-10LI	839-C40-17
U9,12,13	MOTOROLA	H11L2	OPTO-ISOLATOR	849-H11-L2
U10,11	GE	4N27	OPTO-ISOLATOR	849-4N2-7X

CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - TEST 5699950-01, A3 ASSEMBLY - CONTINUED

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
U14	FAIRCHILD	UA7805UC	REG POS 5V	849-780-5P
U15	FAIRCHILD	UA78L15AWC	REG POS 15V	849-78L-15
U16	NATIONAL	LM79L05ACZ	REG NEG 5V	849-79L-05
XU2	AUGAT	228-AG39D	DIP SOCKET 28PIN	849-DIP-28
XU3,5,8	BURNDY	DILB16P-108	DIP SOCKET 16PIN	849-DIP-16
XU4,6,7	BURNDY	DILB14P-108	DIP SOCKET 14PIN	849-DIP-14

6.9 CHASSIS ASSEMBLY
PC BOARD ASSEMBLY - DISPLAY 5699951-01 A4 ASSEMBLY

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9699951-01	PC BOARD	9699951-01
C1,2	SPRAGUE	196D106X0020JA1	CAP 10UF, 20V	823-106-41
C3	SPRAGUE	196D105X035JA1	CAP 1UF, 35V	823-105-61
C4-12	ERIE	CK05BX104K	CAP .10UF, 50V	821-104-CK
CR1,2,3	MOTOROLA	1N914	DIODE	844-914-XX
DS1-10	GEN.INSTRUMENT	MAN4410A	LED GREEN DISPLAY	848-441-0A
DS11-15, 25	HEWLETT PKRD	HLMP-3507	LED GREEN	848-955-04
DS16-18	HEWLETT PKRD	HLMP-3301	LED RED	848-655-02
J1 CABLE	ELGAR	5970072-01	CABLE	5970072-01
KYBD1	GRAYHILL	88BAZ	KEYBOARD	860-KEY-PD
	ELGAR	860-KEY-02	KEYBOARD OVERLAY	860-KEY-02
Q1	MOTOROLA	PN3643	TRANSISTOR,30V,NPN	835-364-3P
R1	DALE	RC42GF220J	RES 22OHM 2W 5%	804-220-05
R2,4	DALE	CMF07 333 G	RES 33K OHM 1/4W 2%	801-333-05
R3	DALE	CMF07 473 G	RES 47K OHM 1/4W 2%	801-473-05
RN1	ALLEN BRADLEY	110A103	RES NETWORK 10K	818-103-SP
RN2,3	ALLEN BRADLEY	110A331	RES NETWORK 330 OHM	818-331-SP
RN4	ALLEN BRADLEY	316B510	RES NETWORK 51 OHM	818-510-DP
RN5,6	ALLEN BRADLEY	316B471	RES NETWORK 470 OHM	818-471-DP
U1	RCA	CD4071BE	CMOS 4X2IN OR	849-C40-71
U2	MOTOROLA	MC74HC74N	CMOS DUAL "D" HCMOS	849-H74-XX
U3,6	NATIONAL	MM74C374N	CMOS OCTAL-LA	849-7C3-74
U4	RCA	CD40106BE	CMOS HEX-SCHM	849-401-06
U5	MAXIM	1CM7218CIPI	DRIV 8X7SEG DISPLY	849-721-8C
U7,8	TI	SN74LS47N	LS 7SEG DRIVER	849-74S-47
U9,10	SPRAGUE	UCN 5801A	BIMOS 8XLATCH/DRV	849-580-1A
XRN4,5,6, XU7,8	BURNDY	DILB16P-108	DIP SOCKET 16PIN	849-DIP-16
XU1,2,4	BURNDY	DILB14P-108	DIP SOCKET 14PIN	849-DIP-14
XU3,6	BURNDY	DILB20P-108	DIP SOCKET 20PIN	849-DIP-20
XU5	AUGAT	228-AG39D	DIP SOCKET 28PIN	849-DIP-28
XU9,10	BURNDY	DILB22P-108	DIP SOCKET 22PIN	849-DIP-22

6.10 DC POWER MODULE - BASIC PARTS LIST, 5699959-BS

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
C4-7	SPRAGUE	SGA P10	CAP .10UF 500V	821-5GA-P1
C8,9	SPRAGUE	513D477M025DG4	CAP 470UF 25V	824-477-25
C10,11	SPRAGUE	196D106X0020JA1	CAP 10UF, 20V	823-106-41
C12	SPRAGUE	196D105X035JA1	CAP 1UF, 35V	823-105-61
C13	ERIE	DD103	CAP .01UF 100V	821-103-01
CR1	GEN.INSTR.	KBPC25-1-04	BRIDGE 25A	847-KBP-25
CR2-12	MOTOROLA	IN4004	DIODE 1A	845-400-4X
F1,2	BUSSMAN	MDA-02	FUSE SLOW 250V 2A	858-MDA-02
J2,3	MOLEX	22-03-2201	CONN 20 PIN.100" PC	856-445-5M
K1-4	SIEMENS	V23056-A0105-A101	RELAY 16A 24V COIL	861-230-56
K5	DOUGLAS/RAND	6MG3A	RELAY 3FORM A 6VDC	861-6AH-3A
K6,8	POTTER/BRUMFLD	T82S11D114-24	RELAY PC MNT 2FORM	861-T82-24
P1A	POSITRONIC IND	41F8SR	CONN PCB 8 PIN 13A	856-41F-8S
P1B	PANDUIT	100-348-053	CONN 48PIN DIN MALE	856-100-48
Q1,2	FAIRCHILD	PN3643	TRANSISTOR 30V NPN	835-364-3P
R5	CORNING	SMA07 1 K0 02%	RES 1K OHM 1/4 W 2%	801-102-05
R6-8	MEMPÇO ELECTRA	5043AD 10 KOG	RES 10K OHM 1/2 W 2%	802-103-05
R9,10	DALE	RN55C1001F	RES 1K .1W 1%	812-100-1F
R11	DALE	RN60C6341F	RES 6.34K 1/8W 1%	813-634-1F
U1	SILICON GEN	BG7815ACP	REG POS 15V	849-781-5P
U2	SILICON GEN	SG7915CP	REG NEG 15V	849-791-5P
XF1,2	KEYSTONE	3529	FUSECLIP PC MNT	858-PCX-25
	ELGAR	9699953-01	HANDLE	9699953-01
	ELGAR	9699955-01	HANDLE	9699955-01
	ELGAR	9699956-01	BRACKET	9699956-01
	ELGAR	9920036-01	HEATSINK	9920036-01

DC POWER MODULE - 7VDC PARTS LIST 5699959-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LWR HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-01	UPPER HEATSINK ASSY	5809942-01
A2	ELGAR	5699958-01	PC ASSY-DAC	5699958-01
C1,2	SPRAGUE	80D223P025MEZ	CAP 22000/25V	826-223-82
C3	SPRAGUE	39D507G025HE4	CAP 500UF 25V	824-507-52
R1	DALE	RC42GF471J	RES 470,2W	804-471-05
R2,3	DALE	CW520R	RES 20,5W	807-200-05
R4	TRW	4LPW-10.01	OHM 5% RES.01,10W	808-R01-05
R12	DALE	RN60C7150F	RES 750 OHM 1/8W 1%	813-715-0F
T1	ELGAR	5900403-01	TRANSFORMER	5900403-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 10VDC PARTS LIST 5699959-11

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LOWER HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-01	UPPER HEATSINK ASSY	5809942-01
A2	ELGAR	5699958-11	ASSY DAC BD 10V P/I	5699958-11
C1,2	SPRAGUE	82D223M025ME	CAP 22000/25V	826-223-82
C3	SPRAGUE	39D507G025HE4	CAP 500UF 25V	824-507-52
C14	MURATA ERIE	DD109M10Z5U103Z	CAP.01 100V-150V	821-103-00
R1	DALE	RC42GF471J	RES 470,2W	804-471-05
R2,3	DALE	CW5-36R	RES 5W,36R	807-360-05
R4	TRW	4LPW-10-.01 OHM	RES .01,10W	808-R01-05
R12	DALE	RN60C3741F	RES 3.74K 1/8W 1%	813-374-1F
T1	ELGAR	5900370-01	TRANSFORMER	5900370-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 20VDC PARTS LIST 5699959-21

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LOWER HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-01	UPPER HEATSINK ASSY	5809942-01
A2	ELGAR	5699958-21	ASSY DAC BD 20V P/I	5699958-21
C1,2	SPRAGUE	80D822P050ME2	CAP 8200/50V	826-822-82
C3	SPRAGUE	39D507G025HE4	CAP 500UF 25V	824-507-52
C14	CENTRALAB	DDM502	CAP .005UF Z5V 150	821-502-00
R1	CORNING	RL42S102G	RES 2W 5% 1K	804-102-05
R2,3	DALE	CW5-75R	RES 5W W/W 5% 75R	807-750-05
R4	TRW	4LPW-10-.01 OHM	RES .01,10W	808-R01-05
R12	DALE	RN60C1372F	RES 13.7K 1/8W 1%	813-137-2F
T1	ELGAR	5900372-01	TRANSFORMER	5900372-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 32VDC PARTS LIST 5699959-31

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LOWER HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-02	UPPER HEATSINK ASSY	5809942-02
A2	ELGAR	5699958-31	ASSY DAC BD 32V	5699958-31
C1,2	SPRAGUE	82D332M100ME	CAP PC 3300/100V	826-332-82
C3	BISHOP	A11B106J	CAP 10.0UF 100V	822-106-X0
R1	DALE	CW5-2.5K-5%	RES 2.5K 5% CW5	807-252-05
R2,3	DALE	CW5-200R-5%	RES 200 OHM 5% CW5	807-201-05
R4	TRW	4LPW-10-.050OHM	RES 4 10W 5% .05R	808-R05-05
R12	DALE	RN60C2492F	RES 24.9K 1/8W 1%	813-249-2F
T1	ELGAR	5900419-01	TRANSFORMER	5900419-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 40VDC PARTS LIST 5699959-41

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LOWER HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-02	UPPER HEATSINK ASSY	5809942-02
A2	ELGAR	5699958-41	ASSY DAC BD 40V P/I	5699958-41
C1,2	SPRAGUE	82D332M100ME	CAP PC 3300/100V	826-332-82
C3	BISHOP	A11B106J	CAP 10.0UF 100V	822-106-X0
R1	DALE	RC42GF392J	RES 2W 5% 3.9K	804-392-05
R2,3	DALE	CW10-369OHM5%	RES 5W W/W 5% 360	807-361-05
R4	TRW	4LPW-10-.050OHM	RES 4 10W 5% .05R	808-R05-05
R12	DALE	RN60C3482F	RES 34.8K 1/8W 1%	813-348-2F
T1	ELGAR	5900371-01	TRANSFORMER	5900371-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 80VDC PARTS LIST, 5699959-51

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699959-BS	BASIC PARTS LIST	5699959-BS
A1-LOWER	ELGAR	5809941-01	LOWER HEATSINK ASSY	5809941-01
A1-UPPER	ELGAR	5809942-02	UPPER HEATSINK ASSY	5809942-02
A2	ELGAR	5699958-51	ASSY DAC BD 80V P/I	5699958-51
C1,2	SPRAGUE	82D122M200ME	CAP 1200/200V	826-122-82
C3	BISHOP	A11B106J	CAP 10.0UF 100V	822-106-X0
R1	DALE	RC42GF123J	RES 12K 2W 5%	804-123-05
R2,3	DALE	CW5 1.5K 5%	RES 1.5K 5W	807-152-05
R4	TRW	4LPW-10-.050OHM	RES 4 10W 5% .05R	808-R05-05
R12	DALE	RN60C7152F	RES 71.5K 1/8W 1%	813-715-2F
T1	ELGAR	5900371-01	TRANSFORMER	5900371-01
	ELGAR	9699959-01	PC BOARD	9699959-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 160VDC PARTS LIST 5699959-61

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5690033-BS	BASIC PARTS LIST	5690033-BS
A1-LOWER	ELGAR	5691071-01	LOWER HEATSINK ASSY	5691071-01
A1-UPPER	ELGAR	5691070-01	UPPER HEATSINK ASSY	5691070-01
A2	ELGAR	5699958-61	ASSY DAC BD 160V PI	5699958-61
C1,2	SPRAGUE	82D221M400KE2	CAP-220UF 400VDC PC	824-221-40
C3	IMB	ZA1E505K	CAP 5.0UF 400V	822-505-04
R1A,1B	DALE	RC42GF473J	RES 47K 2W 5%	804-473-05
R2,3	DALE	CW5-7.5K	RES 7.5K 5W	807-752-05
R4	TRW	4LPW10-.10 OHM	RES 4 10W 5% 0.1R	808-R10-05
R12	DALE	RN65D1503F	RES 150K 1/2W 1%	816-150-3F
T1	ELGAR	5900420-01	TRANSFORMER	5900420-01
	ELGAR	9690033-01	PC BOARD	9690033-01
	ELGAR	9699969-01	A NOMEX INSULATOR	9699969-01

DC POWER MODULE - 320VDC PARTS LIST 5699959-71

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5690033-BS	BASIC PARTS LIST	5600339-BS
A1-LOWER	ELGAR	5691071-01	LOWER HEATSINK ASSY	5691071-01
A1-UPPER	ELGAR	5691070-02	UPPER HEATSINK ASSY	5691070-02
A2	ELGAR	5699958-71	ASSY DAC BD 320V PI	5699958-71
C1,2	SPRAGUE	82D221M400KE2	CAP 220UF 400VDC PC	824-221-40
C3	IMB	ZA2G105J	CAP 1/600V 5%	822-105-58
R1A,1B	DALE	RC42GF473J	RES 47K 2W 5%	804-473-05
R2,3	DALE	CW5-33K	RES 33K 5W	807-333-05
R4	DALE	CPSL10-.22 OHM	RES 4 10W 5% 0.12R	808-R22-05
R12	DALE	RN60C2743F	RES 274K 1/8W 1%	816-274-3F
R20	DALE	RN603922F	RES 39.2K 1/8W 1%	813-392-2F
T1	ELGAR	5900420-01	TRANSFORMER	5900420-01
	ELGAR	9690033-01	PC BOARD	9690033-01
	ADV ELEC SLS	996001	NOMEX .02 #410	995-311-30

6.11DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - BASIC 5699958-BS

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9699959-01	PC BOARD	9699959-01
C2-5,13-15,19,21,22,24,25,27,30,31	SPRAGUE	196D106X0020JAI	CAP 10/20V	823-106-41
C6	CENTRALAB	DDM103 (Z5U)	CAP .001/150V	821-102-00
C7,8	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
C11	ERIE	CK05BX104K	CAP .1 DISC 50V	821-104-CK
C12	CENTRALAB	DDM103 (Z5V)	CAP .01 100V	821-103-00
C16,18,23,26	SPRAGUE	196D105X035JA1	CAP 1-35V	823-105-61
C20	SPRAGUE	501D477M035PR	CAP 470UF 20% 35V	824-477-61
C28,29	SPRAGUE	CM05ED330J03	CAP 33PF 500V 5%	820-330-05
C32	SPRAGUE	196D475X0034JA1	CAP 4.7 35V	823-475-61
CR1-4,10,13	FAIRCHILD	1N4004	RECTIFIER	845-400-4X
CR7-9,12,15-20	MOTOROLA	1N914	DIODE	844-914-XX
CR11	MOTOROLA	1N5817	RECTIFIER	845-581-7X
CR14	NATIONAL	LM329CZ	DIODE ZENER	848-LM3-29
DS1,2	HP	HLMP-3301	LED RED	848-655-02
P2,3	MOLEX	22-15-2206	CONN 20PIN .100 RT	856-445-5F
Q3,2	FAIRCHILD	PN2907	TRANSISTOR 40V	832-P29-07
Q4,5,6	FAIRCHILD	PN3643	TRANSISTOR 30V NPN	835-364-3P
R1,2	BOURNS	3296W-1-202	POT 2K OHM	819-202-96
R3,6	BOURNS	3296W-1-103	POT 10K OHM	819-103-96
R5,4	BOURNS	3299W-1-104	POT 100K OHM	819-104-99
R7,21,30	DALE	CMF07225G	RES 2.2M OHM 1/4W 2%	801-225-05
R9	DALE	RN60C1372F	RES 13.7K 1/8W 1%	813-137-2F
R10	DALE	RN55C2551F	RES 2.55K .1W 1%	812-255-1F
R11,23	DALE	RN55C2211F	RES 2.21K .1W 1%	812-221-1F
R12,24	DALE	RN55C2212F	RES 22.1K .1W 1%	812-221-2F
R13,25,26,42	DALE	CMF07102G	RES 1K OHM 1/4W 2%	801-102-05
R16	DALE	RN55C1002F	RES 10K .1W 1%	812-100-2F
R17,31,33,37,39,43,53,54	DALE	CMF07 103 G	RES 10K OHM 1/4W 2%	801-103-05
R18	DALE	CMF07 220 G	RES 22 OHM 1/4W 2%	801-220-05
R19	DALE	RN55C1621F	RES 1.62K .1W 1%	812-162-1F
R22,8	DALE	RN55C1001F	RES 1.00K .1W 1%	812-100-1F
R27	DALE	CMF07 224 G	RES 220K OHM 1/4W	801-224-05
R28	DALE	RN55C6492F	RES 64.9K .1W 1%	812-649-2F
R29	DALE	RN55C7501F	RES 7.50K .1W 1%	812-750-1F

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - BASIC 5699958-BS - CONTINUED

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
R32	DALE	CMFO7 105 G	RES 1M OHM 1/4W 2%	801-105-05
R34,50-52	DALE	CMF07223G	RES 22K OHM 1/4W 2%	801-223-05
R35	DALE	CMF07 332 G	RES 3.3K OHM 1/4W	801-332-05
R36	DALE	CMF07 152 G	RES 1.5K OHM 1/4W	801-152-05
R38	DALE	CMF07393G	RES 39K OHM 1/4W 2%	801-393-05
R40	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R41	DALE	RC32GF621J	RES 620 OHM 2W 5%	803-621-05
R45	DALE	CMF07 474 G	RES 47K OHM 1/4W 2%	801-473-05
R46,48,49	DALE	CMF07 474 G	RES 470K OHM 1/4W	801-474-05
R47,44	DALE	CMF07 153 G	RES 15K OHM 1/4W 2%	801-153-05
RN1,2.3	BECKMAN	698-3-R10KF,D.B	RES NETWORK 10K	818-103-DR
RN4,5	ALLEN BRADLEY	110-A331	RES NETWORK 330 OHM	818-331-SP
S1	CTS	206-5	SWITCH 5 POLE DIP	860-206-5X
U1-4,6	TI	TL074	OPAMP X4	849-TL0-74
U5	NATIONAL	LM339N	COMPARATOR X4	849-LM3-39
U7,8	ANALOG DEVICES	AD7543KN	CMOS 12BIT DAC	849-754-3K
U9-12	MOTOROLA	H11L2	OPTO ISOLATOR	849-H11-L2
U13	SPRAGUE	UCN 4401A	BIMOS 4XLATCH/DRIV	849-440-1A
U14	SPRAGUE	UCQ5821A	BIMOS 8BIT SER LTH	849-582-1A
U15,16,17	MONSANTO	MCA230	OPTO ISOLATOR	848-MCA-23
U18	RCA	CD4040BE	CMOS 12ST BINC	849-C40-40
U20	RCA	CD4093BE	CMOS 4X2IN SCH	849-C40-93
U21	MOTOROLA	MC74HC251N	HCMOS 8IN MUX	849-H25-1X
U22,23	FAIRCHILD	UA78L04AWC	REG 78L05 POS 5V	849-78L-05
W1-11	MOLEX	5547-10A	CONN HEADER MICRO	856-554-7X
W2,3,7,11	MOLEX	90059-0007	CONN MICRO PCB	856-900-59
XU1-6,13, 20,J1	BURNDY	DILB14P-108	DIP 14PIN SOCKET	849-DIP-14
XU7,8,14, 18,19,21	WELCON	802-016-1612	DIP 16PIN SOCKET	849-DIP-16

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 7VDC 5699958-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C10	SPRAGUE	CM05FD101J03	CAP 100PF 500V 5%	820-101-05
Q1	RCA	2N3440	TRANSISTOR 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C3922F	RES 39.2K .1W 1%	812-392-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-07V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 10VDC 5699958-11

	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C10	SPRAGUE	CM05FD101J03	CAP 100PF 500V 5%	820-101-05
Q1	RCA	2N3440	TRANSISTOR 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C4992F	RES 49.9K .1W 1%	812-499-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-10V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 20VDC 5699958-21

	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C10	SPRAGUE	CM05FD101J03CAP	100PF 500V 5%	820-101-05
Q1	RCA	2N3440	TRANSISTOR 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN60C6042F	RES 60.4K 1/8W 1%	813-604-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-20V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 32VDC 5699958-31

	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C9	SPRAGUE	CM05FD331J03	CAP 330PF 500V 5%	820-331-05
C10	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
Q1	RCA	2N3440	TRANSISTOR, 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN60C1962F	RES 19.6K 1/8W 1%	813-196-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-32V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 40VDC 5699958-41

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C9	SPRAGUE	CM05FD331J03	CAP 330PF 500V 5%	820-331-05
C10	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
Q1	RCA	2N3440	TRANSISTOR, 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C2492F	RES 24.9K .1W 1%	812-249-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-40V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 80VDC 5699958-51

	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C9	SPRAGUE	CM05FD331J03	CAP 330PF 500V 5%	820-331-05
C10	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
Q1	RCA	2N3440	TRANSISTOR, 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C4992F	RES 49.9K .1W 1%	812-499-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-80V-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 160VDC 5699958-61

	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C9	SPRAGUE	CM05FD331J03	CAP 330PF 500V 5%	820-331-05
C10	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
Q1	RCA	2N3440	TRANSISTOR, 250V	837-344-0X
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C4992F	RES 49.9K .1W 1%	812-499-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-160-ID

DC MODULE ASSEMBLY
DAC PC BOARD ASSEMBLY - 320VDC 5699958-71

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	5699958-BS	BASIC ASSY	5699958-BS
C9	SPRAGUE	CM05FD331J03	CAP 330PF 500V 5%	820-331-05
C10	SPRAGUE	CM06FD471J03	CAP 470PF 500V 5%	820-471-05
Q1A	TOPAZ	SD1500BD	FET N CHAN 600V	842-SD1-50
R14	DALE	CMF07 471 G	RES 470 OHM 1/4W 2%	801-471-05
R15	DALE	CMF07 222 G	RES 2.2K OHM 1/4W	801-222-05
R20	DALE	RN55C3922F	RES 39.2K .1W 1%	812-392-2F
U19	TI	TITBP24S10N	PROM SPECIAL PROG.	849-320-ID

6.12 DC MODULE ASSEMBLY
UPPER HEATSINK ASSY - 7V, 10V, 20V, 32V 5809942-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9920035-01	HEATSINK	9920035-01
Q3,4	RCA	2N6259	TRANSISTOR	841-V62-59
TK1	ELMWOOD	3450G-00210884	THERMOSTAT	861-118-TK
	ELGAR	5809931-01	PC ASSEMBLY	5809931-01

DC MODULE ASSEMBLY
UPPER HEATSINK ASSY - 40V, 80V 5809942-02

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9920035-01	HEATSINK	9920035-01
Q3,4	RCA	2N6259	TRANSISTOR	841-V62-59
TK1	ELMWOOD	3450G-00210884	THERMOSTAT	861-118-TK
	ELGAR	5809931-02	PC ASSEMBLY	5809931-02

DC MODULE ASSEMBLY
UPPER HEATSINK ASSY - 160V, 320V 5691070-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9920035-01	HEATSINK	9920035-01
Q3,4	IXYS	IX4N60	TRANSISTOR	842-4N6-0X
TK1	ELMWOOD	3450G-00210884	THERMOSTAT	861-118-TK
	ELGAR	5690036-01	PC ASSEMBLY	5690036-01

6.13 DC MODULE ASSEMBLY
LOWER HEATSINK ASSY - 7V, 10V, 20V, 32V, 40V, 80V 5809941-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9920035-01	HEATSINK	9920035-01
Q5,6	RCA	2N6259	TRANSISTOR	841-V62-59
	ELGAR	5809932-01	PC ASSEMBLY	5809932-01

DC MODULE ASSEMBLY
LOWER HEATSINK ASSEMBLY - 160V, 320V 5691071-01

	ELGAR	9920035-01	HEATSINK	9920035-01
Q5,6	IXYS	IX4N60	TRANSISTOR	842-4N6-0X
	ELGAR	5690037-01	PC ASSEMBLY	5690037-01

DC MODULE ASSEMBLY
PC ASSEMBLY - UPPER HEATSINK - 7V, 10V, 20V, 32V 5809931-01

	ELGAR	9809931-01	PC BOARD	9809931-01
C1	SPRAGUE	192P10492	CAP .10UF 10% 200V	822-104-05
C2	SPRAGUE	513D476M025AA4	CAP 47UF 25V	823-476-25
CR1,2	FAIRCHILD	1N4004	RECTIFIER	845-400-4X
CR3	GE	1N5625	DIODE 5A 400V	845-562-5X
CR4	MOTOROLA	1N4936	RECTIFIER	845-493-6X
Q1	2N5416	TRANSISTOR 350V	836-541-6X	
Q2	RCA	TIP48	TRANSISTOR 300V	842-TIP-48
R1	DALE	CMF20 220 G	RES 22 OHM 1/2W 2%	802-222-05
R2	DALE	CMF20 472 G	RES 4.7K OHM 1/2W	802-472-05
R3,4	DALE	CW5 .22OHM 5%	RES .22 OHM 5W	807-R22-05
R7	DALE	CMF20 470 G	RES 47 OHM 1/2W 2%	802-470-05

DC MODULE ASSEMBLY
PC ASSEMBLY - UPPER HEATSINK - 40V, 80V 5809931-02

	ELGAR	9809931-01	PC BOARD	9809931-01
C1	SPRAGUE	192P10492	CAP .10UF 10% 200V	822-104-05
C2	SPRAGUE	513D476M025AA4	CAP 47UF 25V	823-476-25
CR1,2	FAIRCHILD	1N4004	RECTIFIER	845-400-4X
CR3	GE	1N5625	DIODE 5A 400V	845-562-5X
CR4	MOTOROLA	1N4936	RECTIFIER	845-493-6X
Q1		2N5416	TRANSISTOR 350V	836-541-6X
Q2	RCA	TIP48	TRANSISTOR 300V	842-TIP-48
R1	DALE	CMF20 680 G	RES 68 OHM 1/2W	802-680-05
R2	DALE	CMF20 473 G	RES 47K OHM 1/2W 2%	802-473-05
R3,4	DALE	CW5-.22 OHM 5%	RESISTOR	807-R22-05
R7	DALE	CMF20 470 G	RES 47 OHM 1/2W 2%	802-470-05

DC MODULE ASSEMBLY
PC ASSEMBLY - UPPER HEATSINK - 160V, 320V 5690036-01

REF DESIG	MFG	MFG P/N	DESCRIPTION	ELGAR P/N
	ELGAR	9690036-01	PC BOARD	9690036-01
C1	SPRAGUE	CM06FD102J03	DIP 1000PF 500V 5%	820-102-05
C2	SPRAGUE	196D105X035JA1	CAP 1-35V	823-105-61
CR1-3	FAIRCHILD	1N4004	RECTIFIER	845-400-4X
CR4,6,7	MOTOROLA	1N4744A	ZENER 1W 15V	843-474-4A
CR10	MOTOROLA	MR826	RECTIFIER 600V	845-826-40
Q1,8,9	TOPAZ	SD1500BD	FET N CHAN 600V	842-SD1-50
Q2	FAIRCHILD	PN3643	TRANSISTOR 30V NPN	835-364-3P
R1	DALE	RC20GF470J	RES 47 OHM 1/2W 5%	802-470-05
R2	DALE	CMF20 122 G	RES 1.2K OHM 1/2W	802-122-05
R3,4	DALE	CW5-10R	RES 20 OHM 5W	807-010-05
R7	DALE	CMF20 105 G	RES 1M OHM 1/2W 2%	802-105-05
R9,11	DALE	CMF20 823 G	RES 82K OHM 1/2W 2%	802-823-05
R10	DALE	CMF20 510 G	RES 51 OHM 1/2W 2%	802-510-05
R12	DALE	RC42GF473	RES 47K 2W	804-473-05
R13,14	DALE	CMF20 820 G	RES 82 OHM 1/2W 2%	802-820-05
R16	DALE	CMF20683G	RES 68K 1/2W 2%	802-683-05

6.14 DC MODULE ASSEMBLY
PC ASSY - LOWER HEATSINK - 7V, 10V, 20V, 32V, 40V, 80V 5809932-01

	ELGAR	9809932-01	PC BOARD	9809932-01
C3	ERIE	CK05BX104K	CAP .1 DISC 50V	821-104-CK
CR5	GENERAL INST	NP16GT	DIODE 400V 16A T0220	845-NP1-6G
Q7	RCA	S2800M	SCR 10A, 600V	846-S28-00
R5,6	DALE	CW5-.22 OHM 5%	RES .22 OHM 5W	807-R22-05
R8	DALE	CMF20 820 G	RES 82 OHM 1/2W 2%	802-820-05

DC MODULE ASSEMBLY
PC ASSEMBLY - LOWER HEATSINK - 160V, 320V 5690037-01

	ELGAR	9690037-01	PC BOARD	9690037-01
C3	ERIE	CK05BX104K	CAP .1 DISC 50V	821-104-CK
CR5	MOTOROLA	MR826	RECTIFIER 600V	845-826-40
CR8,9	MOTOROLA	1N4744A	DIODE ZENER	843-474-4A
Q7	RCA	S2800M	SCR 10A, 600V	846-S28-00
R5,6	DALE	CW5-20R	RES 20 OHM 5W	807-200-05
R8	DALE	CMF20 220 G	RES 82 OHM 1/2W 2%	802-820-05
R15,16	DALE	CW5 47R	RES 47 OHM 5W	807-470-05
R17	DALE	CW5 5R	RES 5 OHM 5W	807-5R0-05

SECTION VII
SCHEMATICS AND ASSEMBLY DRAWINGS

7.1 INTRODUCTION

This section contains the schematic diagrams and the assembly drawings for the Model AT8000. The schematic diagrams should be used to understand the theory of operation and as a aid in troubleshooting the instrument. The assembly drawings are to be used for locating components. Reference designators shown on schematics and assembly drawings correspond to reference designators shown on parts lists where exact component values are given.

7.2 SCHEMATIC AND ASSEMBLY DRAWINGS

The following is a list of drawings included in this section:

Standard System Configuration	5701000
Interconnect Diagram	6699961
PC Board Assembly - Auxiliary Power Supply A2 Assy	5690013
PC Board Schematic - Auxiliary Power Supply	6690013
PC Board Assembly - Test Board A3 Assy	5699950
PC Board Schematic - Test Board	6699950
PC Board Assembly - Display Board A4 Assy	5699951
PC Board Schematic - Display Board	6699951
PC Board Assembly - Processor Board A2 Assy	5699952
PC Board Schematic - Processor Board	6699952
PC Board Assembly - Back Plane A1 Assy	5699960
DC Power Module Assembly	5699959
DC Power Module Schematic	6699959
PC Board Assembly - Digital to Analog Control	5699958
PC Board Schematic - Digital to Analog Control	6699958
PC Board Assembly - Upper Heatsink 7,10,20,32,40,80V	5809931
PC Board Assembly - Lower Heatsink 7,10,20,32,40,80V	5809932
PC Board Schematic - Heatsink 7,10,20,32,40,80V	6809940
Heatsink Assembly - Upper 7,10,20,32,40,80V	5809942
Heatsink Assembly - Lower 7,10,20,32,40,80V	5809941
PC Board Assembly - Upper Heatsink 160,320V	5690036
PC Board Assembly - Lower Heatsink 160,320V	5690037
Heatsink Assembly - Upper 160,320V	5691070
Heatsink Assembly - Lower 160,320V	5691071
PC Board Schematic - Heatsink 160,320V	6691070

APPENDIX A
WIRE GAUGE SELECTION

The following guidelines assist in determining the optimum cable specification for your power applications. These guidelines are equally applicable to both DC and low frequency AC (up to 15 kHz) power cabling. The same engineering rules apply whether going into or out of an electrical device. Thus, this guide applies equally to the input cable and output cable for your ELGAR instrument and application loads.

Power cables must safely carry maximum load current without overheating or causing insulation destruction. Important to everyday performance is to minimize IR (voltage drop) loss within the cable. These losses have a direct effect on the quality (tight specifications) of power delivered to and from instruments and corresponding loads.

As a rule of thumb, specifying a generously larger power cable wire gauge has a negligible fiscal impact when compared to the costly investment in time and effort to evaluate and overcome both the cable deficiencies and the performance tradeoffs associated with a marginal (smaller) wire gauge.

Specifying wire gauge needs to consider operating temperature.

Wire gauge current capability and insulation performance drops with increased temperature developed within a cable bundle and with increased environmental temperature. Thus, short cables with generously overrated gauge and insulation properties come well recommended for power source applications.

Avoid using published commercial utility wiring codes.

These codes are designed for the internal wiring of homes and buildings and do accommodate the safety factors of wiring loss heat, breakdown insulation, aging, etc. However, these codes consider that up to five (5) per cent voltage drop is acceptable.

Such a loss directly detracts from the quality performance specifications of your ELGAR instrument. Frequently, these codes do not consider bundles of wire within a cable arrangement.

Sense lines carry very little current and thus have negligible gauge overrating requirements. Sense lines tend to be particularly sensitive to induced voltages from nearby cables and from electrically noisy devices. ANY disturbance induced onto sense lines is immediately signaled back to the instrument with a direct adverse effect on the output terminals. To minimize undesired sense line pickup, sense line cables should use the canceling effects of twisted pair wires.

Shielded twisted pair is even better, if needed. Sense lines should be physically separated from high current output ideally via a separate cable. Sense resistors, if used, should be connected as close as practical to the load. High frequency disturbances are usually minimized by judicious use of 0.01 mfd to 1.0mfd bypass capacitors.

In high performance applications, as in motor startup and associated inrush/ transient currents, extra consideration is required. The cable wire gauge must consider peak voltages and currents which may be up to ten (10) times the average values. An underrated wire gauge adds losses which alter the inrush characteristics of the application, and thus the expected performance.

The following table identifies popular ratings for DC and AC power source cable wire gauges.

Size AWG	Amperes (max.)	Ohms/ 100 feet (one way)	IR Drop/ 100 feet (col. 2 * col. 3)
18	5 amps	0.473 ohms	2.363 volts
16	7	0.374	2.621
14	15	0.233	3.489
12	20	0.147	2.94
10	30	0.095	2.859
8	40	0.053	2.136
6	55	0.033	1.837
4	70	0.021	1.477
2	95	0.013	1.273

Recommended Wire Gauge Selection Guide Table

The following notes are apply to the table above and to the power cable definition:

1. Above figures based upon insulated copper conductors at 30 deg. C (86 deg. F), two (2) current carrying conductors in cable plus safety ground (chassis) plus shield. Columns 2 and 3 above refer to "one way" ohms and IR drop of current carrying conductors. (A 50 foot long cable contains 100 feet of current carrying conductors).

2. Determine which wire gauge for your application by knowing your expected peak load current (Ipeak), maximum tolerated voltage loss (Vloss) within the cable, and one way cable length. The formula below determines which ohms/ 100 feet entry from column 3 is required. Read the corresponding wire gauge from the first column.

   (Column 3 value) =
   Vloss / [Ipeak x 0.02 x (cable length)]

   Where:

   Column 3 value:
   entry of table above.
   Cable length:
   one way cable length in feet.
   Vloss:
   maximum loss, in volts, permitted within cable.

Special case:
Should your Vloss requirement be very loose, Ipeak may exceed the maximum Amperes (column 2). In this case, the correct wire gauge is selected directly from the first two columns of the table.

Example:
A 20 ampere (Ipeak) circuit which may have a maximum 0.5 volt drop (Vloss) along its 15 foot long cable (one way cable length) requires (by formula) a column 3 resistance value of 0.083. This corresponds to wire gauge size 8 AWG.

If the cable length was 10 feet, column 3 value is 0.125 and the corresponding wire gauge is 10 AWG.

3. Aluminum wire not recommended due to soft metal migration at terminals which may cause long term (years) poor connections and oxidation. If used, increase wire gauge by two sizes (e.g. specify 10 gauge aluminum instead of 14 gauge copper wire).

4. Derate above wire gauge (use heavier gauge) for higher environmental temperature since conductor resistance increases with temperature:

Temperature Degrees C	F	Current Capability
40	104	80%
50	122	50%

5. Derate above wire gauge (go to heavier gauge) for increased number of current carrying conductors. This offsets the thermal rise of bundled conductors.

Number of Conductors	Current Capability
3 to 6	80%
6	70%

6. Preferred insulation material is application dependent. Recommended is any flame retardent, heat resistant, moisture resistant thermoplastic insulation rated to nominal 75 deg. C (167 deg. F). Voltage breakdown must exceed the combined effects of:

   a) Rated output voltage,

   b) Transient voltages induced onto the conductors from any source,

   c) Differential voltage to other nearby conductors,

   d) Floating or series connections of supplies/ loads,

   e) Safety margin to accommodate degradations due to age, mechanical abrasion and insulation migration caused by bending and temperature.

7. Sense lines are generally 24 to 18 (more mechanical strength) gauge wire, twisted pair, shielded, and have the same insulation rating and properties as its related current carrying conductors. Sense lines are physically separated (separate cable) from current carrying conductors to minimize undesirable pickup.

8. As frequency increases, the magnetic field of the current carrying conductors becomes more significant in terms of adverse coupling to adjacent electrical circuits. Use twisted pairs to help cancel these effects. Shielded twisted pair is even better. Avoid close coupling with nearby cables by using separate cable runs for high power and low power cables.

9. The above general values and recommendations should be reviewed, modified and amended, as necessary, for each application. Cables should be marked with appropriate safety WARNING decals if hazardous voltages may be present.

APPENDIX B

CONFIGURATION and FUNCTIONAL VERIFICATION CHECKSHEET
ELGAR MODEL AT8000 PROGRAMMABLE DC POWER SYSTEM

Model No.: ______________________ Chassis S/N: ______________

Equipment Property No.: ______________________

Part of Equipment: ______________________ Location: ______________

Date: ________ Inspector: ______________________ Dept.: ______________

AC Input Voltage (Sw S3) 115 ________ 230 ________

Remote Language ABLE ________ CIIL ________

GPIB Addr (DIP SW S1) 0 to 30: ______________

Group Select (Sw S2) A,B or C: ______________

Display/Keyboard Installed Yes ________ No ________

Built In Test (BIT Board) Installed Yes ________ No ________

Output Connectors Terminal ______ Mil-Spec. ______

Table of Installed DC Power Modules

Channel No.	CNF Test.	Load Relay	Max. Voltage	Prog. Voltage	Meas. Voltage	Pol. Relay	Max. Current	Current Limit	Remote Tests