INDEX

INDEX

INTRODUCTION

The Lambda LLS-6000-GPIB, LLS-8000-GPIB and LLS-9000-GPIB Series of programmable power supplies can be configured into a programmable power system to provide up to 31 DC outputs. This system can be controlled from an IEEE-488 Bus and/or an RS-232 Port. This manual describes the installation, operation, programming, and specifications of these systems. Throughout this manual, these power supplies are generally refered to as LLS-GPIB series power supplies. Model specific information is given by refering to a particular model, i.e. LLS-8120-GPIB.

GENERAL INFORMATION

Physical Features

The first, or only LLS-GPIB in each system contains the IEEE interface. Only one IEEE-488 cable and address controls the entire system; control of multiple units (from one to thirty slave units) is handled by interconnecting cables, supplied with the slave units.

Electrical Features

The power supply DC output is electrically isolated from the primary source and may be connected positive ground, negative ground, or floating ground. The LLS-GPIB continuously monitors its output(s), making digital readings of the actual output voltage(s) and current(s).

Digital Control Features

Digital control of the power supply output is achievable in two ways; over the IEEE-488 Bus, and from the RS-232 terminal port. Both interfaces feature two-way communication, so power supply commands may be given and output measurement data received at either interface.

Both the IEEE-488 and RS-232 Interfaces accept alphanumeric commands, introduced in the *Initial Checkout* section of this manual (see Page 22), and further explained in the *Programming Format and Syntax* section of this manual (see Page 32). The format of all commands comply with the CIIL (Computer Interface Intermediate Language) Standard.

Output measurements requested over the IEEE bus are provided as ASCII alphanumeric strings easily readable by the host system computer. Similar information is available from the RS-232 port. In addition, this port can drive a Digital Equipment VT100$_{TM}$* or compatible terminal to provide a continuously updated output measurement screen for up to 16 power supplies at a time.

* VT100 is a product of Digital Equipment Corporation.

INSTALLATION

The instructions in this section cover unpacking and inspecting the LLS-GPIB, mounting it into your host system, and connecting power and load leads.

Safety Notice: *All LLS-GPIB units have a chassis ground screw. Ground these to your system AC ground for electrical safety.*

Unpacking

Your Lambda LLS-GPIB was factory inspected and tested. Carefully unpack the unit upon receipt and inspect for damage. Save the packaging material. If the unit arrived damaged, make a claim with the carrier and arrange for their agent to inspect the damaged equipment and the packaging.

Mounting and Cooling

LLS-GPIB power supplies are fan cooled, and are rated for full output at 40°C ambient. When mounted in rack adapters, these power supplies need unrestricted airflow through the rack adapter. This can be achieved by placing blank panels above and below the rack, and by making sure that all air intakes and exhausts have adequate clearance.

Rear Panel Connections Layout

The AC input connector is located left-most when viewed from the rear, followed by the DC output and control barrier strips. The INTERFACE panel is at the far right, where all digital ports are located. Slave units have only the two 9-pin D-type connectors on their rear INTERFACE panels. These are used for daisy-chaining the interconnects of all slaved units.

Wiring DC Outputs

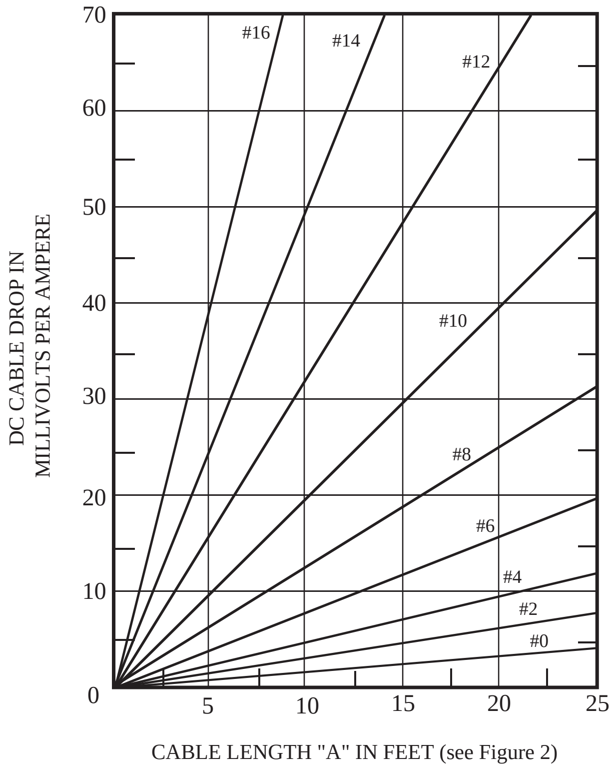
The LLS-GPIB DC output is available at the rear panel. Wire this output from +V, -V to your load(s) with cables made from insulated, stranded wire. For best results, twist or ty-wrap the positive and negative wires together to minimize magnetic pickup.

Warning - *Because of the risk of fire, select a wire size that will safely handle the full rated current available at that output.*

For each of the outputs, select a suitable wire size and voltage sensing method (local or remote sense). Figures 1 and 2 can help you pick a wire size (see Page 5). For one way distances of two feet or less (or under four feet round trip), wires may be sized by temperature consideration only. For one way lengths exceeding two feet, voltage drops may become excessive even though the wire is used safely within its temperature rating.

The power supply senses its own output voltage from the sense terminals (+S, -S) at the output barrier strips, using this information to correct its output. The LLS-GPIB outputs come factory wired for local voltage sensing. Factory installed jumper wires connect +V to +S and -V to -S at the rear panel, so programmed voltages are accurate to specification at this point. To simplify initial setup and testing, we suggest starting with local sense, as shown in Figure 3 (see Page 16).

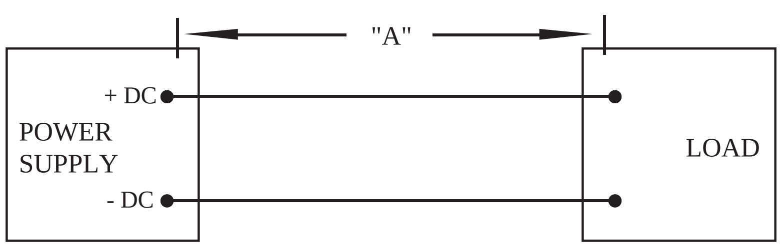
Figure 1: Cable Length "A" in Feet



Local sense does not give optimal voltage accuracy at the load. A local sense hookup will produce a voltage loss between the LLS-GPIB output and the load. A remote sense hookup will sense the actual load voltage to effectively eliminate the effect of lead loss. To convert an output to remote sense, simply remove the factory-provided jumpers and run an extra pair of wires to the desired sense point at the load, as shown in Figure 4 (see Page 17). These sense wires may be #18 - #24, preferably a twisted pair.

Caution: *Carefully check remote sense wiring before energizing the LLS-GPIB. Missing sense wires may cause the affected output to increase beyond its maximum voltage rating, tripping the power supply overvoltage protection. Reversed sense wires may damage the LLS-GPIB circuitry.*

Figure 2: Cable Connection Chart



Interconnecting Slave Units

If your desired system configuration consists of more than one DC output voltage, interconnect cables (supplied with the slave units) allow the master unit to control the other slave units. Interconnect the units by starting at the master (the one with the IEEE-488 Connector on the rear interface panel). Plug an interconnect cable from J2 on the master unit to J1 on the slave. For additional slaves, continue by plugging J2 of the second to J1 on the next slave, in any order, until all units are interconnected.

GPIB Connector and Address

Connect a shielded GPIB (IEEE-488) cable to the mating connector J1 located on the Interface Panel, right rear of the LLS-GPIB. Connect the other end to another GPIB Bus instrument or directly to the GPIB connector at your system computer or controller. GPIB cables may be stacked up to 3 high at any one instrument. Each cable may be up to 4 meters (13 feet) long. The total length of all GPIB cables is limited to 2 meters per device on the bus (including the computer), with an ultimate restriction of 20 meters. No more than 15 devices are allowed on one bus (again including the computer).

Assign a GPIB primary address to your LLS-GPIB from 0 to 30, making sure that no other device on this bus is set to that address. Set the PRIMARY ADDRESS switch located on the rear of the LLS-GPIB so that the sum of numerical values of all sliders set to ON (16, 8, 4, 2, 1) add up to your chosen GPIB address.

RS-232 Connector

The RS-232 port may be used for “local” control of the LLS-GPIB (contrasted to “remote” control via the IEEE-488 Bus), or may be used as the primary control port where no GPIB is available in the host system. To use this port, connect an RS-232 cable equipped with at least pins #1 (GND.), 2 (LLS-GPIB receives data), 3 (LLS-GPIB transmits data) and 7 (Return) to RS-232 connector J4, located on the INTERFACE panel. Connect the other end to a terminal or computer RS-232 port. This port operates at 9600 Baud, no parity, 8 bits + one stop bit.

Re-configuring AC Voltage

All LLS-GPIB series programmable power supplies are switchable for nominal 115 or 230 VAC operation. This may be accomplished by first unplugging the AC line cord, then selecting the desired position of the voltage selector slide switch on the rear panel, and reconnecting the AC line cord.

SPECIFICATIONS AND FEATURES (Specifications apply for all models)

DC Output - Voltage and Current regulated for line and load.

TABLE I: Voltage and Current Ratings

MODEL	VOLTAGE RANGE (volts)	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE		
		40°C	50°C	60°C
LLS-9008-GPIB	0 to 8	100A	90A	78A
LLS-9018-GPIB	0 to 18	45A	40A	33A
LLS-9040-GPIB	0 to 40	20A	18A	15A
LLS-9060-GPIB	0 to 60	14A	12A	10A
LLS-9120-GPIB	0 to 120	7.0A	6.0A	5.0A

MODEL	VOLTAGE RANGE (volts)	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE		
		40°C	50°C	60°C
LLS-8008-GPIB	0 to 8	50.0A	47.0A	41.0A
LLS-8018-GPIB	0 to 18	24.0A	22.0A	20.5A
LLS-8040-GPIB	0 to 40	10.0A	9.80A	9.20A
LLS-8060-GPIB	0 to 60	7.00A	6.60A	6.10A
LLS-8120-GPIB	0 to 120	3.50A	3.40A	3.20A

MODEL	VOLTAGE RANGE (volts)	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE		
		40°C	50°C	60°C
LLS-6008-GPIB	0 to 8	20.0A	20.0A	16.5A
LLS-6018-GPIB	0 to 18	9.0A	9.0A	8.2A
LLS-6040-GPIB	0 to 40	4.0A	4.0A	3.8A
LLS-6060-GPIB	0 to 60	2.8A	2.8A	2.6A
LLS-6120-GPIB	0 to 120	1.4A	1.4A	1.3A

Current range must be chosen to suit appropriate ambient temperature.
Current ratings apply for entire voltage range.

Regulated Voltage Output

Regulation (line).. 0.05% of Vo (max) for input changes from 85-132 or 170-265 volts AC.

Regulation (load)... 0.05% of Vo (max) from 0 to full load.

Ripple and noise .... 5 millivolts rms, 35 millivolts peak-to-peak on Models LLS-X008-GPIB and LLS-X018-GPIB.

10 millivolts rms, 75 millivolts peak-to-peak on Models LLS-X040-GPIB and LLS-X060-GPIB.

20 millivolts rms, 150 millivolts peak-to-peak on Model LLS-X120-GPIB.

Overshoot.. No overshoot at turn on, turn off or power failure.

Temperature Coefficient................................ 0.03% per °C.

Stability (drift)... 0.1% per 8 hour period after 30 minute warm up.

Remote Sensing... Provisions are made for remote sensing to eliminate the effect of power output lead resistance on DC regulation. Up to 0.5 volts drop per power lead is permissible provided the output voltage of the power supply is no greater than the rated maximum voltage.

Regulated Current Output (Automatic Crossover)

Regulation (line)... 0.3% Io (max) or 2.5mA, whichever is greater, for input changes from 85-132 volts AC or 170-265 volts AC.

Regulation (load).. 0.3% Io (max) or 2.5mA, whichever is greater, for output voltage changes from Vo (max) to short circuit.

Current range... Specifications apply for 5% to full load current.

Voltage range.. As shown in Table I, see Page 7.

Ripple... 1% Io (max) - rms.

AC Input

Line voltage.. 85-132 volts AC (47-440Hz) or 170-265 volts AC (47- 440Hz) via rear panel selector switch.

Input power..	LLS-9000-GPIB	1100 Watts Max.
	LLS-8000-GPIB	620 Watts Max.
	LLS-6000-GPIB	245 Watts Max

Input RMS current..	LLS-9000-GPIB	17.5	Amperes Max.
	LLS-8000-GPIB	10.0	Amperes Max.
	LLS-6000-GPIB	4.0	Amperes Max.

Inrush limiting.. Power-up inrush current will not exceed 20 Amps peak for 85-132 VAC input, 40 amps peak for 170-265 VAC input (for a cold start).

Overload Protection

Thermal.. Internal airflow sensing circuit shuts down unit's operation if air inlet blockage or fan rotor lockup occurs. When a thermal shutdown occurs, the main oscillator's operation will be terminated and all internal bias supplies, and the fan, will shut down. In addition, a front panel fault indicator light will turn on. AC power must be removed for approximately 30 seconds to reset the shutdown circuit.

Electrical Input............LLS-9000-GPIB...... 20A/250V Normal Blo fuse F101 and F102 protect AC input circuitry. 10A/250V Normal Blo fuse F103 protects printed circuit board from damage in the case of internal component failures.

Electrical Input............LLS-8000-GPIB.......15A/250V Normal Blo fuses F101 and F102 protect AC input circuitry. 8A/250 Normal Blo fuse F103 protects printed circuit board from damage in the case of internal component failures.

Electrical Input............LLS-6000-GPIB......10A/250V Normal Blo fuses F101 and F102 protect AC input circuitry. 3A miniature fuse F103 protectrs printed circuit board from damage in the case of internal component failures.

Output.. Automatic constant-current-limiting circuit limits the output current to a customer adjustable value (0% to 102% full load), providing protection for the load as well as the power supply. There is also an internal inverter peak-current-limit circuit which protects the power supply during load transients.

Overvoltage Protection

All LLS-GPIB models include a built-in adjustable overvoltage protection circuit which prevents damage to the load caused by excessive power supply output voltage. Exceeding the overvoltage set point will shut down the unit's operation and cause the front panel FAULT indicator to light up. AC power must be removed from the unit for approximately 30 seconds to reset the OV shutdown circuit.

Overvoltage Adjustability Range.................. Model LLS-X008-GPIB: 4 to 11 VDC.
Model LLS-X018-GPIB: 4 to 24 VDC.
Model LLS-X040-GPIB: 8 to 50VDC.
Model LLS-X060-GPIB: 8 to 70VDC.
Model LLS-X120-GPIB: 20 to 130 VDC.

Cooling - The LLS-GPIB Series is fan cooled. Leave adequate clearance at all air intake and exhaust openings.

Operating Ambient Temperature Range and Duty Cycle - Continuous duty from 0 to 60°C ambient with corresponding load current ratings for all modes of operation, with appropriate derating for ambient temperatures above 40°C.

Storage Temperature (Non-operating) -55°C to +85°C.

Input / Output Connections

AC input .....LLS-9000-GPIB........................Heavy duty barrier strip
.....LLS-8000-GPIB,.......................IEC power line connector (recessed 3-pin male).
LLS-6000-GPIB

DC output...... LLS-9000-GPIB,....................X008 and X018 model: bus bars; X040,
LLS-8000-GPIB X060 and X120 models: heavy duty terminal block at the rear of the chassis.

DC output....... LLS-6000-GPIB...................Heavy duty, printed-circuit board-mounted block at the rear of the chassis.

Controls

DC output..Numerical keypad on the front panel allows adjustability of either constant voltage or constant current limit points.

Resolution of programmed voltage: 10mV on Models LLS-X008-GPIB and LLS-X018-GPIB.

100mV on Models LLS-X040-GPIB, LLS-X060-GPIB and LLS-X120-GPIB.

Resolution of programmed current: 1 Amp on LLS-9008-GPIB.
100 MA on Models LLS-9018-GPIB, LLS-9040-GPIB, LLS-9060-GPIB, LLS-8008-GPIB, LLS-8018-GPIB, LLS-8040-GPIB and LLS-6120-GPIB.
10mA on Models LLS-9120-GPIB, LLS-8060-GPIB, LLS-8120-GPIB, LLS-6018-GPIB, LLS-6040-GPIB, LLS-6060-GPIB and LLS-6120-GPIB.

Accuracy of programmed value versus delivered output: ± 2% or 3 counts, whichever is greater.

Standby Control... Allows for zero output without losing the last programmed values for voltage and current.

On/Off Switch... Rocker switch located on the front panel.

Overvoltage control (manual) .... Multi-turn, screwdriver-adjust potentiometer located on the front panel.

Meters - Front panel 3 1/2 digit voltmeter and 3 digit ammeter simultaneously monitors output voltage and current. Accuracy of metered value versus delivered output: ± 2% or 3 counts, whichever is greater.

Constant Voltage/Constant Current Indicators - Located on the front panel. These displays indicate whether the power supply is operating as a constant voltage source or is in current limit.

Mounting - One mounting surface, one mounting position.

Physical Data

Size (approximate
LLS-9000-GPIB..12 9/32" x 4 9/32" x 12 13/16"
LLS-8000-GPIB..12 9/32" x 4 9/32" x 12 11/16"
LLS-6000-GPIB.. 8" x 4 9/32" x 13 5/16"

Weight (net)
LLS-9000-GPIB..19 lb. 5 oz.
LLS-8000-GPIB..17 lb. 2 oz.
LLS-6000-GPIB..11 lb. 3 oz.

Finish..Off white, FED STD 595, No. 26622

Isolation Ratings

Input to output.. 1500 Volts rms

Output to ground.. 500 Volts rms

Input to ground .... 1500 Volts rms

MANUAL MODE OF OPERATION

Indicators, Fuses and Operating Controls

Auto/Manual switch/Led - Front panel push button switch which selects either the manual or auto mode of operation. The manual mode of operation is defined as operation from the front panel, while the auto mode of operation is defined as operation from either the IEEE-488 Bus or the RS-232 Port. The Led illuminates to indicate the manual mode of operation.

Front Panel On/Off switch - Located on the front panel is an On/Off switch which controls the application of input power to the supply.

Front panel programmer (manual mode of operation only) - The front panel numerical keypad serves to program both the constant voltage and constant current limit points. Starting with the most significant digit, keying in the desired value followed by an "ENTER" keystroke will institute a new operating limit for either output voltage or current limit, as determined by the programming mode indicators. The programming mode can be switched from voltage to current via the "VOLTAGE/CURRENT" key which functions as a pushbutton toggle.

During a new programming key-in sequence, the front panel digital meter will present the keyed-in value of voltage or current until the "ENTER" key is depressed. Once this occurs, the meter will revert back to measurement mode and present the output voltage or current delivered by the supply. In the event of a programming instruction not being followed by an "ENTER" command, the meter will automatically revert back to the measurement mode after approximately ten seconds. The value of the non-entered programming instruction is then lost and any new programming instructions must be started from the most significant digit onwards. At any point during a programming instruction key-in, the meter can be reset back to the measurement mode, and the programming instruction discarded by depressing the "C/E" key.

If an entered programming instruction is not compatible with the rated output voltage or current of the power supply, the appropriate meter will display an "Err" message and the program instruction will not be carried out. Depressing the "C/E" key, or waiting approximately ten seconds, will reset the meter back to the measurement mode.

At any time during operation of the power supply the programmed value of voltage or current can be displayed by momentarily depressing the "ENTER" key. This will change the appropriate front panel meter, as denoted by the programming mode indicator, to display the last programmed value for voltage or current for a period of approximately two seconds. After this time the meter will automatically revert back to the measurement mode. Care should be exercised when performing this check so as not to depress the "ENTER" key for more than one second. This will institute the "Slew

Down” function, as described below.

The output voltage or current limit points can be ramped up or down by using the “Slew Up” or “Slew Down” arrow controls. Depressing the “Up” arrow will cause the output voltage or current (as denoted by the programming mode indicator) to ramp up at a rate which will increase with the length of time that the key is depressed. Similarly, depressing the “Down” arrow (which also serves as the “ENTER” key) will cause the programmed value for either voltage or current to decrease at a rate which will increase with the length of time that the key is depressed.

The output voltage of the supply can be brought to zero, without losing the last programmed values of voltage or current (which is the case when power is switched off), by using the “STANDBY” key. Depressing the “STANDBY” key once will bring the output voltage to zero. Depressing the “STANDBY” key a second time will reinstate the last programmed values of voltage and current. Programmed values of either voltage or current can be changed while the unit is in standby.

Output mode indicators - Included on the front panel are a pair of Output Mode indicators which report on whether the power supply is operating as a constant voltage source, or is in current limit. If the output current of the supply is below the programmed value for constant current, the Operating Mode indicator under the voltmeter will illuminate to indicate that the unit is not in current limit. If the load connected to the supply is of low enough impedance to draw a current which reaches the programmed current limit point, the unit will crossover into constant current, and the Operating Mode indicator under the ammeter will illuminate.

Fault Indicator - Also included on the front panel is a FAULT indicator which will illuminate if either an overvoltage or overtemperature shutdown occurs.

Overvoltage Control - This is a multi-turn, screwdriver-adjust potentiometer located on the front panel. Rotation of this control will vary the overvoltage limit-point from the minimum specified value (fully CCW) to the maximum specified value (fully CW).

Fuse F101, F102 - these are Normal-Blo fuses located in series with the AC line. These fuses protect the power supply from excessive overcurrents in the event of an internal component failure. For North American operation from nominal 220 VAC inputs which are derived from two 110 VAC phases (neither line is neutral), it is recommended that the power supply be fused externally in both lines, in accordance with the appropriate safety agency requirements. NOTE: POWER SHOULD BE REMOVED FROM THE UNIT BEFORE CHECKING OR REPLACING THIS FUSE.

Fuse F103 - This is a Normal-Blo fuse located in series with the main inverter current path. This fuse protects printed circuit board traces in this circuit in the event of an internal component failure. NOTE: POWER SHOULD BE REMOVED FROM THE UNIT BEFORE CHECKING OR REPLACING THESE FUSES.

Line Select Switch S101 - This is a screwdriver-activated switch which is accessible through a hole in the rear of the unit. Selection of input voltage range (85-132 or 170-265VAC) should only be performed with AC power removed from the unit.

Connections

AC input- LLS-9000-GPIB series - heavy duty terminal block.

AC Input -LLS-8000-GPIB and LLS-6000-GPIB, the AC input connection should be made using an IEC type, three-prong female connector. An IEC line cord is supplied with the unit.

DC Output - Load connections must be made to output bus bars (LLS-90108-GPIB, LLS-9018-GPIB, LLS-800-GPIB and LLS-8018-GPIB), the two-position terminal block TB201 on all other models. This block is designed to handle the maximum current and voltage attainable from the supply and will accept a No. 8 Ring or Spade-type lug.

Sensing - Terminals for sensing output voltage are located on TB202, terminals 10 and 12. Local sensing can be achieved by strapping terminal 10 to terminal 11 (connects to +V) and terminal 12 to terminal 13 (connects to -V). See Figure 3 on Page 16.

Load Ground Connection - This power supply can be operated with either the positive or negative output terminal grounded, or with neither terminal grounded. A tapped hole in the chassis at the rear of the unit is provided for grounding one of the output terminals, if desired.

NOTE: *When operating the supply with neither output terminal grounded, high impedance leakage resistance and capacitance paths can exist between the power supply circuitry and chassis ground.*

Basic Modes of Operation and Operating Procedures

This power supply is designed to operate as a constant-voltage source or as a constant-current source. Automatic crossover to either mode of operation occurs when load conditions change as follows:

Constant Voltage - The power supply will function as a constant-voltage source while the load current is less than the current value I_{LIM} as set by the front panel current-limit programming generator. When the load current I_L (=Vo/R_L) reaches I_{LIM}, the supply will crossover automatically and will operate as a constant current source. Further decrease in the value of the load resistor will result in a decrease of voltage across the load while the current remains regulated to I_{LIM}.

Constant Current - The power supply will function as a constant-current source while the load voltage V_L does not exceed the voltage value set by the front panel constant voltage programming generator. When the load resistance is high enough so that the load voltage Vo (=I_LxR_L) reaches the value set by the programming controls, the supply will automatically crossover and operate as a constant voltage source.

Power Up and Front Panel Initial Settings - Upon initiation of AC power, the front panel constant voltage and constant current generators will be preset to deliver zero output voltage along with a current limit point corresponding to the 40°C rating of the supply, plus 2%. Immediately following power on, the front panel meters will display these programmed values for approximately two seconds before reverting to the measurement mode.

* For positive ground, disconnect the jumper from -V to GND, and reconnect from +V to GND.

To deliver voltage after power up, the desired operating voltage must be entered through the numeric keypad, or the "Slew Up" arrow can be used. It should be noted that when the power supply is switched off via the front panel switch, the last entered programming values of voltage and current will be lost. When the power supply is switched back on again, it will power up as described above. If an application requires that power be interrupted to a load, and a quick return to the pre-existing programmed values of voltage and current is desired, the front panel “STANDBY” control can be used.

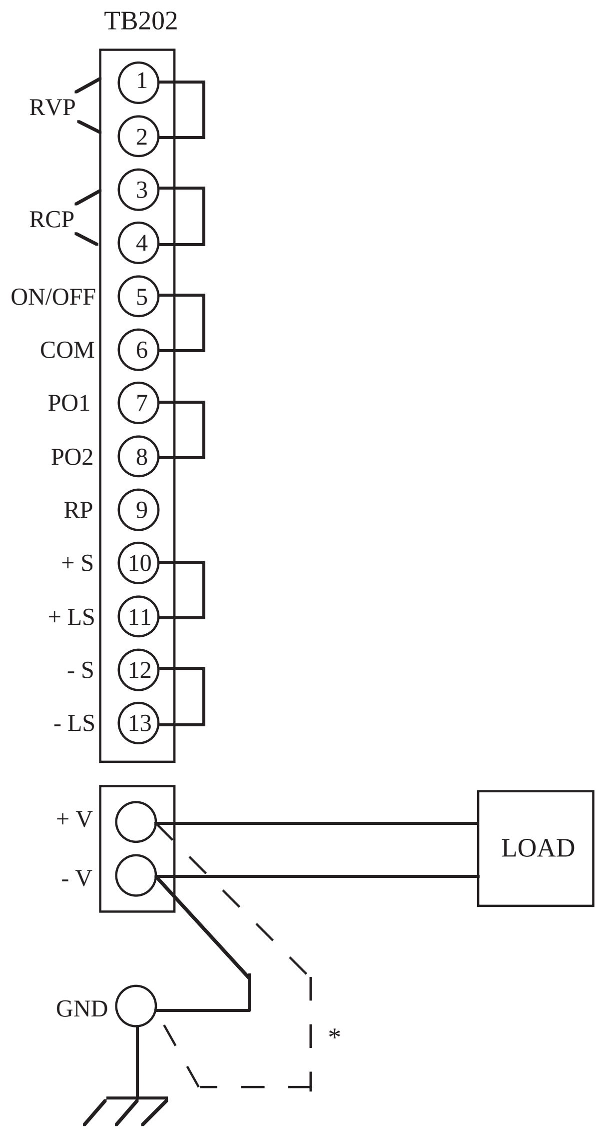
Operation as a Constant Voltage Source

The output impedance and regulation of the power supply at the load may change when using the supply as a constant-voltage source, and when connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing can be used. Recommended types of supply-load connections, with local or remote sensing are described on the following pages.

Local Sensing Connection - Local sensing is the connection suitable for applications with relatively constant load where extremely close load regulation over the full rated current excursion is not required at the load. See Figure 3 below.

Constant Voltage Operation, Internal Programming, Adjustable Current Limit

Figure 3: Local Sensing Connection

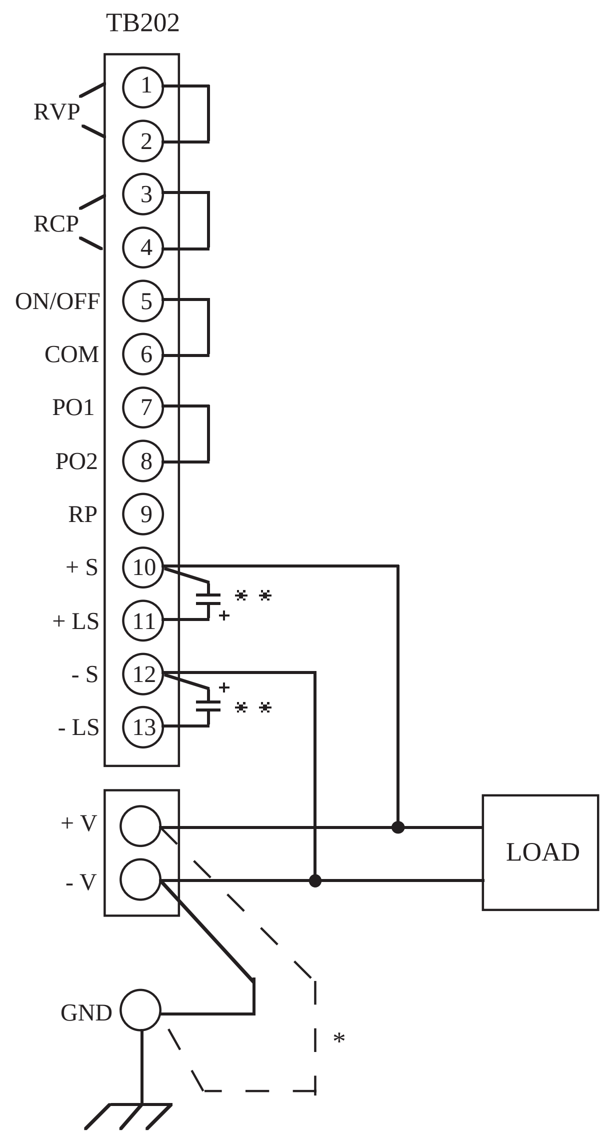


* For positive ground, disconnect the jumper from -V to GND, and reconnect from +V to GND.

SAFETY NOTICE:DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

Remote Sensing Connection - Remote sensing provides complete compensation for the DC voltage drop in the connecting cables. Sensing leads should be a twisted pair to minimize AC pickup. A 2.5uF capacitor may be required between the output terminals and sense terminals to reduce noise pickup. See Figure 4 below.

Figure 4: Remote Sensing Connection



* For positive ground, disconnect the jumper from -V to GND and reconnect from +V to GND.
** A 2.5uF, electrolytic capacitor may be required.

SAFETY NOTICE: DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

When shipped from the factory, the supply is ready for use as a constant-voltage/constant-current source with automatic crossover. Initial programmed points for constant voltage and constant current are as described in the previous text. Jumpers are in place for local voltage sensing, as shown in Figure 3 (see Page 16). If remote sensing connection is desired, the load should be wired as shown in Figure 4 (see Page 17). It should be noted that the front panel voltmeter measures the voltage at the rear panel power terminals and may not accurately reflect voltage at the load in remote sense applications.

Determine load requirements and select wire size from Figures 1 and 2, on Page 5.

After applying input power, the output voltage can be adjusted to any desired value via the front panel numerical keypad programmer. The current limit point can be adjusted by setting the “PROGRAM MODE” indicator to “AMPS” via the “VOLTAGE/CURRENT” key and then keying in the desired current limit value, followed by an “ENTER” keystroke.

It should be noted that this programmed value must be re-entered every time AC power is applied to the power supply.

Operation as a Constant Current Source

In this mode of operation, when the load voltage increases due to changing load resistance to the limit of the front panel constant voltage setting, the power supply crossover circuit will cause the unit to operate as a constant-voltage supply.

Constant-Current Operation, Internal Programming, Adjustable Voltage Limit - When shipped from the factory, the supply is ready for use as a constant-voltage/constant-current source with automatic crossover. Initial programmed points at power up for constant voltage and constant current are as described in the previous text.

Determine load requirements and select wire size from Figures 1 and 2, on Page 5. After applying power, the output current and maximum voltage limit point can be adjusted to any desired value via the front panel numerical keypad.

Adjustment of Front Panel Overvoltage Control

The overvoltage protection circuit provides an adjustable means of shutting down the power supply if the output voltage exceeds a pre-determined safe value. In the event of an overvoltage shutdown, the main power inverter is disabled. A front panel indicator light will turn on to indicate a fault condition. Once the cause of the overvoltage has been determined and removed, the shutdown circuit can be reset by turning off AC power to the unit via the front panel ON/OFF switch for approximately 30 seconds.

The procedure for setting the overvoltage control is as follows:

NOTE: *The power supply should be removed from associated equipment, be at an ambient temperature of 25-30°C and be operated at nominal line voltage.*

1. The recommended voltage protection point is 115% of the selected power supply operating voltage,

1. The recommended voltage protection point is 115% of the selected power supply operating voltage, or 1.5 volts above the selected operating voltage, whichever is greater. (If set too low, load-off transients may cause the overvoltage detection circuit to trip.)

2. Turn the OV adjust control fully clockwise.

3. Apply AC power to the unit and adjust the output voltage to the desired protection point. If the power supply does not have adequate output range to reach this point, omit steps 4 and 5, and proceed to step 6.

4. Slowly rotate the OV adjust control CCW while monitoring the front panel display. When the front panel FAULT indicator comes on, the OV shutdown point has been reached.

5. The voltage protection point is now set. Turn the unit off for approximately 3 seconds to reset the shutdown circuit. When power is switched back on, the initial programmed points for voltage and current will be as described under the *Power Up* and *Front Panel Initial Settings* sections. (See Page13)

6. If the power supply adjustment range is not adequate to reach the desired OV protection point, proceed as follows:
a) Adjust the power supply output to the normal operating voltage.

b) Slowly turn the OV adjust control R501 CCW until the front panel FAULT indicator comes on.

c) Refer to the chart below. Select the appropriate volts/turn ratio and turn the OV adjust control clockwise by the number of turns equivalent to 15% of the operating voltage (or 1.5 volts, whichever is greater) to bring the OV set-point to the proper value.

TABLE II

MODEL	NOMINAL VOLTS PER TURN (OV ADJ)
LLS-X008-GPIB	0.7
LLS-X018-GPIB	2.1
LLS-X040-GPIB	4.3
LLS-X060-GPIB	6.2
LLS-X120-GPIB	11

Operation After Protective Device Shutdown

Thermal Shutdown - The thermal shutdown circuit will activate if any interruption to normal cooling occurs (such as a blocked air inlet). When a thermal shutdown occurs, the main inverter will be inhibited, bringing the supply output to zero and causing the FAULT indicator to light. In order to reset the unit after a thermal shutdown, first determine and remove the cause(s) of over-heating, and then remove power from the unit for at least 30 seconds, if the unit has already cooled down. (If the unit has not cooled down, remove power for up to 2 minutes immediately after a thermal-shutdown occurrence).

Fuse Shutdown - Fuses will blow when the maximum rated current value for the fuses are exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition and replacing the blown fuse will make the fuse-protected circuit operative.

NOTE: *Power should be removed from the unit before checking or replacing any fuse.*

Overvoltage Shutdown - When the power supply output increases above the overvoltage limit, the overvoltage protection circuit will shut down the main inverter operation, causing the output voltage to go to zero. During overvoltage shutdown, the front panel FAULT indicator will be lit. After eliminating the cause(s) for overvoltage, resume operation of the power supply by turning off the unit for a period of at least 30 seconds.

FRONT PANEL CONFIGURATION - S601 SWITCH SETTINGS

Table III below shows the correct setting of the front panel configuration switches S601. These switches were configured at the factory and require no further setting, except for bits 9 and 10, as indicated during the calibration procedure.

TABLE III

MODEL	S601 BIT									
	1	2	3	4	5	6	7	8	9	10
LLS-9008-GPIB	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	*	*
LLS-9018-GPIB	ON	OFF	OFF	OFF	OFF	OFF	ON	ON	*	*
LLS-9040-GPIB	OFF	ON	OFF	ON	ON	OFF	ON	OFF	*	*
LLS-9060-GPIB	ON	ON	OFF	OFF	ON	ON	OFF	OFF	*	*
LLS-9120-GPIB	OFF	OFF	ON	OFF	OFF	ON	ON	ON	*	*

MODEL	S601 BIT									
	1	2	3	4	5	6	7	8	9	10
LLS-8008-GPIB	OFF	OFF	OFF	ON	ON	OFF	ON	ON	*	*
LLS-8018-GPIB	ON	OFF	OFF	ON	OFF	ON	ON	OFF	*	*
LLS-8040-GPIB	OFF	ON	OFF	ON	OFF	ON	OFF	OFF	*	*
LLS-8060-GPIB	ON	ON	OFF	OFF	OFF	ON	ON	ON	*	*
LLS-8120-GPIB	OFF	OFF	ON	ON	ON	OFF	OFF	ON	*	*

*Bits 9 and 10 should be on for all models except during calibration of the front panel, when they should both be off.

S601 Switch Settings cont'd.

MODEL	S601 BIT 1	2	3	4	5	6	7	8	9	10
LLS-6008-GPIB	OFF	OFF	OFF	ON	ON	OFF	ON	OFF	*	*
LLS-6018-GPIB	ON	OFF	OFF	ON	ON	ON	ON	ON	*	*
LLS-6040-GPIB	OFF	ON	OFF	OFF	ON	ON	OFF	ON	*	*
LLS-6060-GPIB	ON	ON	OFF	OFF	OFF	OFF	OFF	ON	*	*
LLS-6120-GPIB	OFF	OFF	ON	ON	ON	OFF	OFF	OFF	*	*

*Bits 9 and 10 should be on for all models except during calibration of the front panel, when they should be off.

AUTO MODE OF OPERATION

The auto mode of operation is defined as operation either from the IEEE-488 Bus or from the local RS-232 Port. This mode is activated by selecting the "AUTO" position on the rear panel auto/manual toggle switch.

System Specifications

Regulated Voltage

Output Voltage Range............ 0 to Vout maximum

Temperature Coefficient......... Power Supply specification +0.01%/C

Programming Accuracy.......... 0.1% of full scale.

Programming Resolution......... 0.025% of full scale.

Overshoot........... 0.25 volts max. at turn-on, turn-off or recovery from short circuit.

Programming Range.......... 00.00% to 99.99% of Vout max.

Remote Sensing........... Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

Constant Current Mode (For zero-up supplies capable of constant current mode operation only)

Programming Accuracy....... 2% full scale.

Programming Resolution..... 1% of rated current.

INITIAL CHECKOUT

This section describes how to set up an LLS-GPIB programmable power supply for a bench test, and gets you started with controlling this unit. To exercise the unit you need either a computer equipped with an IEEE-488 interface card (and software to control the card), a VT-100 terminal, or a computer equipped with an RS-232 serial port (and software to emulate a VT-100 terminal). First prepare the LLS-GPIB as outlined below, then read the instructions for the control method you plan to use.

Preparation

Arrange the LLS-GPIB on your bench and make the connections described in the previous *Installation* section of this Manual (see Page 4). Use the list below as a checklist of connections to make, referring to the *Installation* section where necessary.

1. Set the front panel power switch of each LLS-GPIB to OFF. Set the front panel auto/manual switch to auto.

2. Check to see that at each DC output, the factory-installed local voltage sensing jumpers (from +V to +S and from -V to -S) are intact. For initial checkout, it is not necessary to connect any loads. To verify output operation, connect any suitable voltmeter to the output.

3. For multiple output systems, interconnect all LLS-GPIB slave units using the supplied cables (refer to the *Installation* section).

4. Plug in AC line cord(s) (refer to the *Installation* section).

5. Connect either an IEEE-488 controller or an RS-232 controller as described below.

Connecting a GPIB (IEEE-488) Controller

With both the LLS-GPIB and your control computer OFF, connect a shielded GPIB interface cable from you control computer to mating connector J1 located on the INTERFACE PANEL on the rear of the unit. Set the adjacent PRIMARY ADDRESS Switch located near the GPIB connector, so that the sum of numerical values of all sliders set to ON (16, 8, 4, 2, 1) add up to your desired GPIB address. Program examples below assume an address of 4, set by moving the “4” slider up and all others down.

The LLS-GPIB is now ready for operation. To apply AC input, set the front panel switch to the ON position. All outputs will reset to zero at power-on.

Addressing the LLS-GPIB via IEEE-488 Bus

Let’s command the LLS-GPIB output to be 5.0 volts at a maximum current of 0.5 amps. This can be done by sending the following message over the IEEE-488 Bus:

fnc dcs :ch1 set volt 5.0 set curl 0.5 <return> <linefeed>

In GPIB terms, this is a "device dependent message" ; the IEEE-488 Standard does not dictate its content, so the command format is established by the LLS-GPIB command interpreter. LLS-GPIB device-dependent messages are in CIIL (Computer Interface Intermediate Language).

How to get your controller to find the LLS-GPIB at its set GPIB address and send it the above message depends on the particular computer you are using. For example, in BASIC on a HP 200 computer, one program line will do it (example assumes a bus select code of 7 and a GPIB address of 4):

```
output 704; “fnc dcs :ch1 set volt 5.0 set curl 0.5”
```

Using an IBM-PC or compatible with a National Instruments NI-488 card, the same is accomplished using calls to their GPIB Handler Package. First call the IBFIND routine to identify the device and address to the N.I. software:

```
lpps$ = “dev4”
call ibfind (lpps$, dev4%)
```

Then assemble the message, adding a carriage return (ASCII code 13 decimal) and line feed (ASCII code 10) to the end, and send it with the National Instruments IBWRT call:

```
msg$ = “fnc dcs :ch1 set volt 5.0 set curl 0.5” + chr$(13) + chr$(10)
call ibwrt (dev4%, msg$)
```

The program listed below sends device-dependent messages you type into your controller transparently to the LLS-GPIB. Like the examples above it works with a National instruments card and handler software. Don't panic if you own another brand of GPIB card. By consulting its manual you can substitute the other manufacturer's equivalent function calls to get the controller to talk to the LLS-GPIB.

```
100  A$ = space$(100)
110  lpps$ = “dev4”
120  call ibfind (lpps$, dev4%)
130  rem Bus ready.
140  print “Type command string (<blank> to end)”
150  input A$
160  if A$ = “”then call ibloc(dev4%) : end
170  A$ = A$ + chr$(13) + chr$(10)
180  call ibwrt (dev4%, A$)
300  goto 140
```

To enter this program in your IBM-PC, start BASIC and load the file DECL.BAS (from the National Instruments disk). This places several lines in the beginning of your program, needed to initialize the GPIB Card. Then type the program in as shown above. Have the file "bib.m", also from the National Instruments disc, on the same drive as BASIC, because the running program will load and use it. The program prompts you for the command string (message), then sends it to the LLS-GPIB when you press <return>. It comes back for more until you send a blank command line (just <return>). In that case it calls the N.I. routine IBLOC, which sends the Go To Local GPIB command to the

LLS-GPIB, and terminates. The Go To Local command returns the LLS-GPIB to control via its RS-232 (Local) port.

To see how the LLS-GPIB can read an output’s condition and send this data back over the bus, add these following lines to the program:

```
200  for J = 1 to 1000 : next J
210  A$ = “fnc dcs :ch1 fth” + chr$(13) + chr$(10)
220  call ibwrt (dev4%, A$)
230  A$ = space$(100)
240  call ibrd (dev4%, A$)
250  print “fth result >>  “; A$
```

Line 200 allows the power supply output to settle and the present voltage and current readings to update before they are transferred to the computer. Line 210 requests the voltage and current readings for output 1 (set by the command string fnc dcs :ch1). The CIIL command “fth” at the end of this line instructs the LLS-GPIB to “fetch” the readings. Then, the N.I. call IBRD reads the LLS-GPIB answer. With this program you can experiment with the CIIL commands that request output changes, and see their results on output channel 1. Here’s some command lines to try and their typical output (Bold face portions are typed into the computer, and <return> means press the “return” key):

run <return>

type command string (<blank> to end)
? **rst dcs :ch1 <return>**
fth result>>
f07 dcs01 dev : Vout = 0.000 Volts Iout = 0.000 Amps

The “rst” command resets the affected output channel. This sets V and I to zero.

type command string (<blank> to end)
? **fnc dcs :ch1 set volt 5.0 set curl 0.5<return>**
fth result>>
f07 dcs01 dev : Vout = 5.000 Volts Iout = 0.000 Amps

This command string sets the voltage (“set volt”) and current limit (“set curl”) of the output channel specified by “:ch<x>“.

Note: You may set any value of voltage and current from zero to the maximum rating. Setting zero current may inhibit the output of the supply (it won’t be able to come up to the set voltage). Setting V or I outside of rating via GPIB will be ignored, and the last valid setting remains in effect.

LOCAL RS-232 PORT

The LLS-GPIB programmable power system can be operated in local mode via an optional VT-100 (or equivalent) terminal connected to the local RS232 port. The system will respond to commands from local terminal at power up, upon system reset or upon a GTL (Go to Local) command received over the IEEE-488 Bus. The local terminal can be disabled (locked out) by transmitting an REN (remote enable) command over the IEEE-488 Bus. The VT-100 terminal must be supplied by the user. If you do not have a VT-100 or compatible terminal available, there are several software packages on the market that permit various computers to emulate a VT-100.

Output Status Display

Continuous display of output status of all power supplies initialized is available on the VT-100 terminal by keying “CTRL R” at any time. Displayed information for each channel includes:

Channel #: from 1 to 31 channels if installed.
Power Supply Ratings - minimum and maximum output voltage and maximum current .
Programmed values of voltage and current
Measured output voltage and load current
Status i.e. operation, busy pending initialization or faulted.

The Figure below shows the VT-100 display for a system with 4 outputs installed; one master and three slave units.

Figure 5: VT-100 Display

POWER SUPPLY OPERATION SUMMARY (COMMERCIAL)

Ch	Ratings			Program		Output		Status
#	Vmin	Vmax	Amps	Volts	Curl	Volts	Amps	
1	0.000	8.000	10.00	5.250	7.500	5.250	0.000	Operational
2	0.000	18.00	4.500	10.00	1.000	10.00	0.000	Operational
3	0.000	18.00	4.500	18.00	4.500	18.00	0.000	Operational
4	0.000	120.0	0.700	25.00	0.500	25.00	0.000	Operational

RS-232 Setup

When programming the LLS-GPIB programmable power supply via the RS-232 port, the following information may be required to set up the VT-100 or equivalent terminal:

Emulate - VT-100
Mode - Call
Speed - 9600 Baud Rate
Parity - None
Data Bits - 8 Bits
Stop Bits - 1 Bit

SYSTEM MONITORING

The programmable power system is capable of monitoring the voltage and load current of every channel present within the system. If you are controlling the system via the IEEE-488 bus, this information is obtained by using a FTH Command. This will display the actual output voltage and load current of the desired channel for the instant in time that the system is accessed. This same information is available via the RS-232 port on a VT-100 terminal display. The response to the FTH Command will be as follows:

```
Fø7 DCSXX :DEV Vout=XX.XX volts Iout=XX.XX amps
1 2    3    4     5            6                          7
```

1 - The ASCII “F” indicates an abnormal response.
2 - The two digit code “ø7” indicates a non-catastrophic hardware failure.
3 - “DCS” is the mnemonics for the CIIL noun “DC SIGNAL”
4 - The two digit code “XX” indicates the channel #.
5 - The “DEV” indicates device. In this case an individual channel is considered a device.
6 - The output voltage expressed in volts.
7 - The load current expressed in amps.

Output Voltage..................................... Measured across the +/- sense terminals at the rear of the assembly.
Accuracy= +/- 0.7% of full scale voltage.
Resolution= .133% of full scale voltage.

Load Current....................................... Measured across the internal shunt.
Accuracy= +/- 1.7% of full scale current.
Resolution= 1.12% of full scale current

SYSTEM STATUS REPORTING

Operational status of the programmable power system is transmitted to the controller upon request using the STA Command. When this command is sent to the system, the system will respond with the following messages. If there is a soft fault <WINDOW LIMIT EXCEEDED> message or hard fault <FAULTED> message on any of the channels within the system, status must be requested twice to obtain the complete error message. An example of the system's response to the first STA Command is as follows:

Fø7 DCS ø1 DEV :DEVICE OVER VOLTAGE LIMIT
1 2 3 4 5 6

1 - The ASCII "F" indicates an abnormal response.
2 - The two digit code "ø7" indicates a non-catastrophic hardware failure.
3 - "DCS" is the mnemonics for the CIIL noun "DC SIGNAL".
4 - The two digit code "ø1" indicates that channel #1 is the channel responding with an error. This two digit code will vary from 1 to 31 depending on how many channels are initialized in the system.
5 - The "DEV" indicates device. In this case an individual channel is considered a device.
6 - The abnormal condition is described. In this case the output voltage exceeded the VLTL value.

If multiple channels are present in the system you must repeatedly request status until the last response repeats itself to insure that you obtained all the available information. The response after the second STA Command would be as follows:

Fø7 DCSøø MOD :FAULTED CHANNELS :1
1 2 3 4 5 6

1 - Same as previous description.
2 - Same as previous description.
3 - Same as previous description.
4 - The two digit code "øø" represents the global system as compared to a particular channel.
5 - "MOD" represents a system level fault.
6 - The channels that faulted are listed. In this case, channel 1.

When status of the system is requested via an STA Command, the system will respond by displaying a message describing the system status. All the possible system responses are listed below. Note that every system response to an STA Command is followed by a Carriage Return, then a Line Feed.

SYSTEM RESPONSE	SYSTEM CONDITION
' '	Channel is operational
'Fø7 DCSøø MOD :INPUT BUFFER FULL'	Input buffer full
'Fø7 DCSøø MOD :COMMAND SYNTAX ERROR'	Programming syntax error
'Fø7 DCSøø MOD :DEVICE INTERNAL TESTING IN PROCESS'	Channel is in process of internal self test

SYSTEM RESPONSE	SYSTEM CONDITION
‘Fø7 DCSøø MOD :DEVICE INTERNAL RESETTING IN PROCESS’	Channel in process of resetting
‘Fø7 DCSøø MOD :FAULTED CHANNELS XX’	Lists channels that have faulted
‘Fø7 DCSøø MOD :WNDO LIMIT CHANNELS XX’	Lists channels that have window limit values exceeded
‘Fø7 DCSXX DEV :ILLEGAL CHANNEL #’	Channel number is greater than 31
‘Fø7 DCSXX DEV :DEVICE NOT INITIALIZED’	Channel is not initialized
‘Fø7 DCSXX DEV :DEVICE COMMUNICATION ERROR’	Disrupted communication to programmer card
‘Fø7 DCSXX DEV :ILLEGAL SET CURL VALUE’	Programmed current limit value exceeds rating of power supply
‘Fø7 DCSXX DEV :ILLEGAL SRN CURR VALUE’	Programmed lower window limit value exceeds current rating of power supply
‘Fø7 DCSXX DEV :ILLEGAL SRX CURR VALUE’	Programmed upper window limit value exceeds current rating of power supply
‘Fø7 DCSXX DEV :DEVICE OVER CURRENT LIMIT’	Load current exceeded programmed current limit value
‘Fø7 DCSXX DEV :DEVICE UNDER SRN CURR’	Load current is below programmed current lower window limit value
‘Fø7 DCSXX DEV :DEVICE OVER SRX CURR’	Load current exceeded programmed current window limit value
‘Fø7 DCSXX DEV :ILLEGAL SET VOLT VALUE’	Programmed voltage is below or exceeds rating of power supply
‘Fø7 DCSXX DEV :ILLEGAL SRN VOLT VALUE’	Programmed lower window limit value exceeds voltage rating of power supply
‘Fø7 DCSXX DEV :ILLEGAL SRX VOLT VALUE’	Programmed upper window limit value exceeds voltage rating of power supply
SYSTEM RESPONSE	SYSTEM CONDITION

‘Fø7 DCSXX DEV :DEVICE OVER VOLTAGE LIMIT’	Output exceeded VLTL value
‘Fø7 DCSXX DEV :DEVICE UNDER SRN VOLT’	Output is below programmed voltage lower window limit value
‘Fø7 DCSXX DEV :DEVICE OVER SRX VOLT’	Output exceeded programmed voltage upper window limit value
‘Fø7 DCSXX DEV :DEVICE UNDER SRN VOLT, OVER CURRENT LIMIT’	Output is under programmed voltage lower window limit value and load current exceeded programmed current limit value
‘Fø7 DCSXX DEV :DEVICE UNDER SRN VOLT, OVER SRX CURR’	Output is below programmed voltage lower window limit value and exceeded voltage upper window limit value
'Fø7 DCSXX DEV :DEVICE UNDER SRN VOLT, UNDER SRN CURR’	Output is under programmed voltage lower window limit value and below current lower window limit value
‘Fø7 DCSXX DEV :DEVICE OVER SRX VOLT, OVER CURRENT LIMIT’	Output exceeded programmed voltage upper window limit value and programmed current limit value
‘Fø7 DCSXX DEV :DEVICE OVER SRX VOLT, OVER SRX CURR’	Output exceeded programmed voltage upper window limit value and current upper window limit value
‘Fø7 DCSXX DEV :DEVICE OVER SRX VOLT, UNDER SRN CURR’	Output exceeded programmed voltage upper window limit value and is below current lower window limit value

SYSTEM FAULT MONITORING

An LLS-GPIB programmable power system is designed to protect the customer's load in the event of an internal or external fault. Upon detecting a faulted condition, the system advises the controller of the faulted condition by activating SRQ (service request) line. In addition, for a hard fault (VLTL value or CURL value exceeded) condition the system will reset faulted outputs. If a system is initialized for LOCAL RESET, only the faulted channel will be reset and all other channels within the system will remain operational. If initialized as AUTO RESET, when one channel in the system faults every channel within the system resets. System response to detected faulted conditions are listed below:

FAULT	SYSTEM RESPONSE
Specified SRN or SRX values of voltage or current are exceeded.	System advises controller.
Overvoltage (VLTL) value is exceeded. Overvoltage trip point value defaults to (1.15XVprogrammed)+ 1 volt or user programmed VLTL value.	Faulted channel is reset.* System controller is advised.
Current Limit (CURL) is exceeded.	Faulted channel is reset.* System controller is advised.

* If preprogrammed during initialization for AUTO RESET, system will reset all power supplies in the system.

INITIALIZATION

System Initialization

All programmable power systems are provided with signature identification (location and ratings of all power supplies in the system) and is coded for operating mode. This procedure is called the "Initialization" procedure. All Lambda power systems are initialized at the factory. They are initialized as "LOCAL RESET". If there is a need to change the initialization of the system it can be accomplished by using the following commands via the IEEE-488 Bus or via the RS-232 port on a VT-100 terminal.

1. LOCAL RESET.

“INIT CH0 COMMERCIAL=YES” <CARRIAGE RETURN><LINE FEED>
Then press reset button on the rear of the main rack.

2. AUTO RESET.

“INIT CH0 COMMERCIAL=YES AUTO RESET=YES” <CARRIAGE RETURN><LINE FEED>
Then press reset button on the rear of the main rack.

Note that all of the above initialization changes do not require internal rewiring or recalibration.

Channel Initialization

In order to change signature identification ratings of a particular channel, (enable/disable current metering) the following commands must be used. Note that if initialization changes are made to the parameters listed above the system may require recalibration.

1. Power supply ratings, and current metering.

"INIT CHXX VMIN=XXXX VMAX=XXXX IMAX=XXXX CURRENT=YES <CARRIAGE RETURN><LINE FEED>
Then press the reset button on the rear of the main rack.

2. Power supply ratings only (current metering not desired):

"INIT CHXX VMIN=XXXX VMAX=XXXX IMAX=XXXX <CARRIAGE RETURN><LINE FEED>
Then press the reset button on the rear of the main rack.

OPERATING MODES

Voltage Mode Operation............................. The LLS-GPIB is capable of being programmed in the Voltage Mode. In this mode the system will fault if the overvoltage value (either user defined VLTL or default) is exceeded or if the programmed power supply current limit programmed (CURL) value is exceeded.

Current Mode Operation............................ The programmable power system is capable of operating in Constant Current Mode. If programmed in the Current Mode the system will fault if the metered current exceeds the current limit (CURL) value plus 5%. The programmable power system must be used in Current Mode Operation when automatic crossover is desired.

PROGRAMMING FORMAT AND SYNTAX

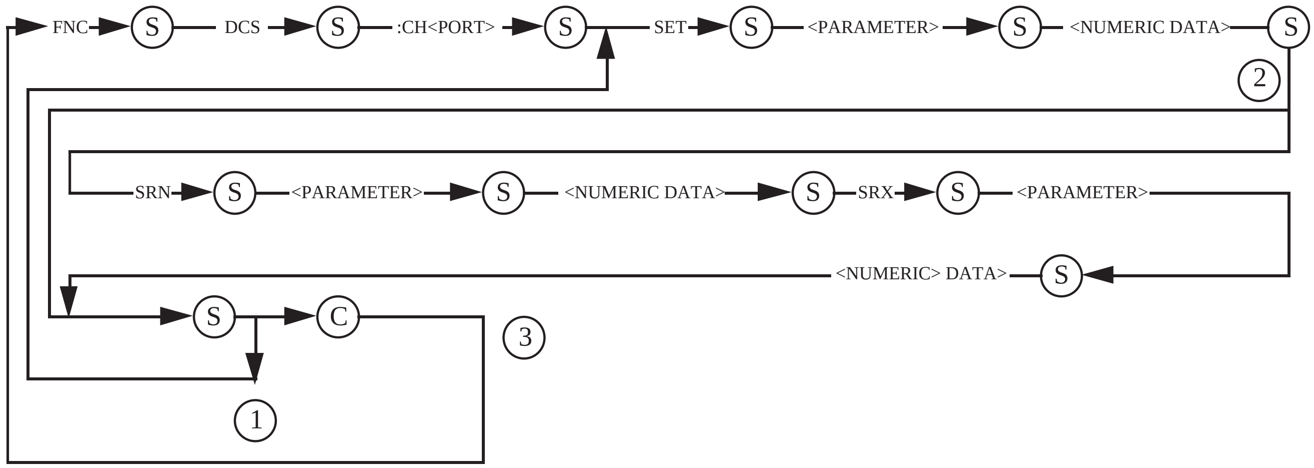
The LLS-GPIB programmable power supply system uses CIIL (Control Interface Intermediate Language) mnemonics as defined in the Mate standard. Command statements and numeric data must be in specific formats and syntax forms. Programming commands may be in either upper case or lower case letters (ASCII characters). Numeric data must be either in explicit form (contains a decimal point such as 10.50) or in scientific notation. In scientific notation, letter E is used for “10 raised”; for example, 1.05E1 is read as 1.05 * 10 or 10.5. Values programmed beyond the system’s resolution specifications will be automatically rounded off. ASCII character space <SP> is used to separate elements in the command string while carriage return <CR> is used to terminate the command string. Power supply commands, operation codes and statement syntax forms are defined below.

COMMAND	OP CODE	SYNTAX FORM
Set output <parameter>	SET<parameter>	Fig 6a,Fig 6b
Set minimum window value of <parameter>	SRN<parameter>	Fig 6a,Fig 6b
Set maximum window value of <parameter> or value of crossover voltage in current mode operation.	SRX<parameter>	Fig 6a,Fig 6b
Reset outputs	RST	Fig 7
Status report	STA	Fig 8
Fetch	FTH	Fig 9
Current Mode	CURR MODE	Fig 6b

The system will recognize and respond to the following CIIL(Control Interface Intermediate Language) operation codes transmitted either via the IEEE Bus or a local VT-100 terminal.

MNEMONIC	FUNCTION
FNC	Function Module
SET	Set Value
STA	Status Report
RST	Reset
SRX	Maximum Window Limit Value
SRN	Minimum Window Limit Value
DCS	DC Source
:CH	Channel #
VOLT	Voltage
CURR	Current
CURL	Current Limit
FTH	Fetch
VLTL	Voltage Limit Trip Level

Figure 6A: Syntax Form for Programming Output Parameters in Voltage Mode

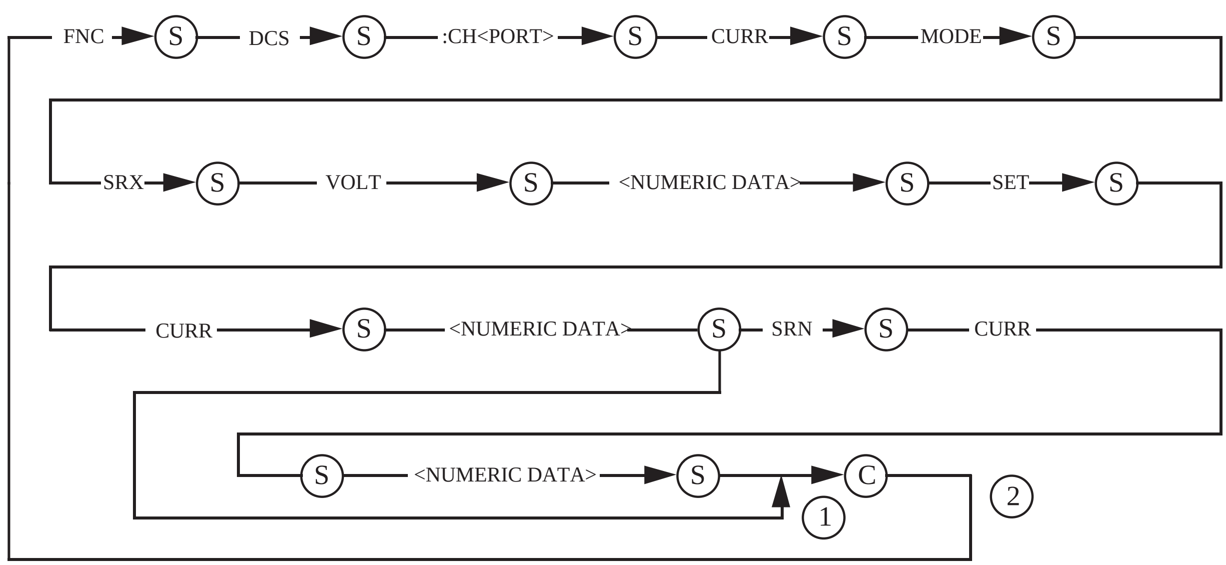


(1) REPEAT FOR OTHER PARAMETER

(2) OPTIONAL SKIPPING IF PROGRAMMING OF WINDOW LIMITS IS NOT DESIRED.

(3) REPEAT FOR OTHER CHANNELS (OUTPUTS)

Figure 6B: Syntax Form for Programming Output Parameters in Current Mode

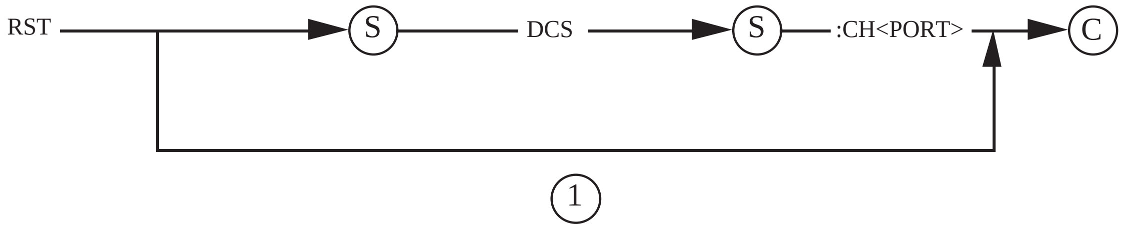


(1) OPTIONAL SKIPPING IF PROGRAMMING OF WINDOW LIMITS IS NOT DESIRED

(2) REPEAT FOR OTHER CHANNELS (OUTPUTS)

NOTE- SRX current window cannot be implemented in constant current mode.

Figure 7: Syntax Form for Resetting Power Supplies



(1) RESETS ALL POWER SUPPLIES IN THE SYSTEM

Figure 8: Syntax Form for Requesting Status Internal Self Test

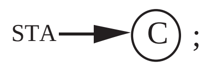
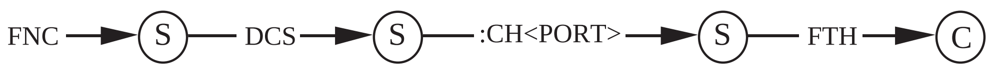


Figure 9: Syntax Form for Obtaining Voltage and Current



Key for Symbols, Definitions and Mnemonics

S - space
C - carriage return, line feed
<Port> - # of channel being programmed
<Parameter> - desired parameter

PARAMETER	MNEMONIC	UNITS
voltage	VOLT	VOLTS
current	CURR	AMPS
current limit	CURL	AMPS
overvoltage trip level	VLTL	VOLTS

<Numeric data> - value of desired parameter.

Examples of Command Strings

COMMAND STRING	SYSTEM RESPONSE
RST	Resets all outputs to zero.
RST DCS :CH1	Resets Channel 1 only.
(First) STA	Reports status of 'faulted' power supplies in system.
(Second) STA	Reports channel # of faulted supplies.
FNC DCS :CH1 SET VOLT 10.0 SRN VOLT 9.0 SRX VOLT 10.5 SET CURL 2.0 SRN CURR 1.5 SRX CURR 1.8	Sets output on channel 1 to 10.0 volts; Sets window limits for fault monitoring to 9.0 and 10.5 volts; Sets current limit point at 2.0 amps; Sets load current window limits to 1.5 and 1.8 amps.
FNC DCS :CH1 SET VOLT 10 SET CURL 2.0	Sets output voltage to 10.0 volts; Sets current limit point at 2.0 amps; Window limits are not programmed.
FNC DCS :CH1 SET VOLT 10.0 SET VLTL	Set output voltage to 10.0 volts; Set overvoltage trip point (VLTL) to 20.0 volts; Set current limit point at 2.0 amps; Window limits are not programmed.
FNC DCS :CH1 FTH	Actual operating condition (voltage and load current values) will be displayed.
FNC DCS :CH1 CURR MODE SRX VOLT 10.0 SET CURL 2.0 SRN CURR 1.0	Current Mode Operation Set crossover voltage value to 10.0 volts; Set current limit value to 2.0 amps; Set current limit window to 1.0 amps.

Remote Operation (via IEEE-488 Bus)

When remote programming, commands must use proper programming format and syntax as shown in the *Programming Format and Syntax* section (see Page 31). They must be transmitted over the IEEE-488 Bus. In order to transmit these command strings over the IEEE-488 Bus, they must be preceded and followed by appropriate interface functions as defined by the IEEE-488 Standard. The format and syntax of these statements are specific to the controller and the programming language. The user should refer to the operators manual for the controller in order to determine the exact syntax and format.

Communication from the controller to the programmable power system is conducted in accordance with the IEEE-488/1978 Standard. The system recognizes and responds to the following Bus commands:

COMMAND	DESCRIPTION
ATN	Attention
DAB	Data Byte
DCL	Device Clear
GTL	Go To Local
IFC	Interface Clear
MLA	My Listen Address
MTA	My Talk Address
REN	Remote Enable
SPE	Serial Poll Enable
UNL	Unlisten
UNT	Untalk

Remote operation- The following IEEE-488 Bus messages are implemented in the programmable power system.

SH1 - Source handshake
AH1 - Acceptor handshake
T6 - Talker
L4 - Listener
RL1 - Remote/Local
DC1 - Device clear
SR1 - Service request

TALKER@, LISTENER, SOURCE HAND-SHAKE AND ACCEPTOR HANDSHAKE......... These functions are performed by the interface circuits of the power supply and the controller. When the system is addressed as a talker (either when a FTH or STA command is used) a maximum of 64 characters will be transmitted over the IEEE-488 Bus.

REMOTE/LOCAL .... The programmable power system can receive information either over the IEEE-488 Bus (Remote) or via user furnished VT-100 or equivalent terminal (Local). The system will respond to commands from both controllers unless an REN (Remote Enable) command is transmitted over the IEEE-488 Bus. To transfer control back to the local terminal a GTL (Go to Local) command is required.

DEVICE CLEAR COMMAND............................. This command will reset all channels to zero voltage and current.

SERVICE REQUEST .... Upon a faulted or window limit value exceeded condition, the service request (SRQ) line is activated on the IEEE-488 Bus to interrupt the controller.

SERIAL POLL.. Upon receiving a service request interrupt, the controller polls each instrument on the bus one at a time. The programmable power system responds by placing all databits on the IEEE-488 Bus to zero. After the serial poll the SRQ line is cleared. For the status of the actual fault, the controller must request system status by programming the STA Command twice over the IEEE-488 Bus.

LOCAL OPERATION.. The programmable power system can be operated via a user furnished VT-100 or equivalent terminal. The system will respond to commands from a local terminal at power up, upon system reset or upon GTL (Go to Local Command transmitted over the IEEE-488 Bus.

CALIBRATION PROCEDURE

In order to ensure compliance with specifications, the programmer card(s) should be calibrated on a 6 month cycle, or after any repairs. The calibration procedure requires that the system is removed from associated equipment, and is stabilized at a 25°C - 30°C ambient. Each output is calibrated separately.

Required Calibration Equipment

To calibrate the LLS-GPIB, you first need either a GPIB equipped computer or an RS-232 serial port equipped computer and terminal emulation software capable of emulating the VT-100/220 terminal. The calibration procedures given here assume you can set output voltages and currents as well as read back the resulting LLS-GPIB measurements. If using an IBM-PC and National Instruments GPIB card to control the LLS-GPIB for calibration purposes, the sample program in Appendix B will provide all control facilities needed for the procedures which follow. The external measurement instruments which will serve as calibration standards are normally found in any calibration facility.

1. 4½ digit or better **DC** Digital Volt Meter equipped with "grabber" test leads to be used wherever **DC** voltages are measured.

2. A shunt for measuring the LLS-GPIB output current.

3. An adjustable load resistance capable of loading the LLS-GPIB output to full rated load current at full rated output voltage.

System Setup

NOTE: R202, R204, R223 and R229 are located on the power supply. The other calibration controls are located on the programmer card.

1. Remove **AC** input power to the system. Remove the cover.

2. Connect the LLS-GPIB output in a local sense configuration (See Figure 3), with no external load.

3. Locate the programmer card in your LLS-GPIB. It can be identified by its adjustment pots in the front left area of the unit.

4. Set potentiometers **R218** and **R222** on programmer card fully counterclockwise.

5. Set potentiometers **R229** and **R254** on programmer card fully clockwise.

6. Set **S202** switch positions according to Table 4. Normally the switches of **S202** will already be in their correct positions.

7. Connect the DVM to measure the **-10.100** volt reference on the programmer card: plus lead to **TP1**, minus lead to **TP2**.

8. Power on the LLS-GPIB, and adjust **R216** until the DVM reads **-10.100** volts +**/-5mV**.

9. Move the plus lead of your DVM to **TP3**. Adjust **R212** until your meter reads **+5.120** volts +**/-5mV**.

10. Set front panel **"Auto/Manual"** switch to **"Auto"** (light is off).

Calibration of Output Voltage

1. Set front panel **"Auto/Manual"** switch to **"Auto"** (light is off).

2. With no load on the output of the power supply, program the front panel (keypad) to zero volts and program the computer to full current.

3. While monitoring the output voltage with an external DVM, adjust **R202** so that the output voltage is between **-**/+**0.01** volts.

4. Program maximum output voltage and current on the front panel (keypad) and also program maximum voltage and current on the computer.

5. Connect DVM to **TB202** in the rear of power supply: plus lead to **Pin 1**, minus lead to **Pin 6**. Switch the front panel **"Auto/Manual"** switch to **"Manual"** (light is on) and record DVM's reading.

6. Switch it back to **"Auto"** (light is off) position and adjust **R254** so that DVM displays the same reading as in step 4 above +/**-1mV**.

7. Adjust **R223** until the output voltage monitored from **+V** to **-V** with an external DVM indicates the rated output voltage of the supply +/**-0.01** volts.

8. Adjust **R218** so that *Voltage meter* on the computer displays the programmed voltage.

9. Seal **R202**, **R223**, **R218** and **R254** with RTV sealant.

Calibration of Output Current

1. With no load on the output of the power supply, program output voltage and current on the front panel (keypad) for zero and also program the computer for zero current.

2. Apply a short circuit through an external shunt connected across the output of the supply. Adjust **R204** until the output current is between **-**/+**0.01** amps.

3. Remove short circuit.

4. Connect the DVM plus lead to **TP4**, minus lead to **TP2**. Adjust **R260** until the DVM reads **0.00 volts** +/**-0.1mV**.

5. Reapply short circuit and program maximum output voltage and the 40°C rated current on the front panel (keypad) and also on the computer.

6. Connect DVM to **TB202** in the rear of power supply: plus lead to **Pin 3**, minus lead to **Pin 6**. Switch the front panel **"Auto/Manual"** switch to **"Manual"** (light is on) and record DVM's reading.

7. Switch it back to **"Auto"** position and adjust **R229** so that DVM displays the same reading as in step 6 above +/**-1mV**.

8. Adjust **R264** until the output current monitored by the external shunt connected across the output of the supply indicates the programmed current value +/**-0.01** amps.

9. Adjust **R222** so that *Current meter* on the computer displays the programmed current.

10. Seal **R204**, **R229**, **R264** and **R222** with RTV sealant.

Calibration of V_o (meas) Adjust on the Front Panel

1, With **AC** power removed from the supply, set bits **9** and **10** of **S601**, located on front panel P.C. board F to the **OFF** position.

2. Apply power to the unit. Switch the front panel **"Auto/Manual"** switch to **"Manual"** (light is on). Program for rated output voltage with no load connected at the output.

3. Adjust **R210** until the reading presented by the front panel voltmeter corresponds with that of the external DVM connected to the output.

4. Remove **AC** input power to the system. Reset bits **9** and **10** of **S601** to the **ON** position. Seal **R210**.

Calibration of I_o (min) Measure and I_o (max) Measure on the Front Panel

1. With **AC** power removed from the supply, set bits **9** and **10** of **S601**, located on front panel P.C. board F to the **OFF** position.

2. Apply power to the unit. Switch the front panel **"Auto/Manual"** switch to **"Manual"** (light is on). With no load connected at the output, monitor the voltage between test points **TP1** and **TP2** located at the top of front panel P.C. board F.

3. Adjust **R632** (potentiometer located closest to the top of the P.C. board F) so that the voltage between **TP1** and **TP2**, as measured with the external DVM, is between **+0.01** and **-0.01** volts. Seal **R632** with RTV sealant.

4. Apply a short circuit across the output terminals of the supply through a current measurement shunt. Program maximum output voltage and current on the front panel (keypad).

5. Adjust **R634** so that the reading presented by the front panel ammeter agrees with that of the external shunt.

6. Remove **AC** input power to the system. Reset bits **9** and **10** of **S601** to the **ON** position. Seal **R634** with RTV sealant.