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Thurlby PL~GP Series

GPIB Controlled Power Supplies

◄ IEEE-488 ►

INSTRUCTION MANUAL

V 1.0

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1 INTRODUCTION

The PL-GP series is a series of GPIB (IEEE-488) controlled linear variable power supplies in single or twin version. As standard the units are bench mounted but a rack mounting kit is available as an option.

The units are based around the well known Thurlby PL series of power supplies. The GPIB control is provided by a controller module incorporated alongside the PL power supply module. The controller module incorporates a remote/local switch for each power supply module. In 'remote' mode the voltage and current settings for the power supply are set via the GPIB, while in 'local' mode the voltage and current settings are controlled from the front panel and the module behaves as a conventional PL series PSU.

2 AC ~ LINE CONNECTION Read this first

(1) The transformer primary taps must be set within ± 10% of the nominal AC line voltage used. The voltage is indicated on a label near the power lead entry point. If alteration of the voltage setting is necessary, the cover must be removed and the taps changed as per section 2.1

(2) The AC fuse is located on the back panel. Fuse ratings are given in the specifications section.

(3) The AC input lead should be connected to a suitable 3 pin plug as follows: brown to live, blue to neutral, green/yellow to earth (ground).

(4) Incorrect connection of the AC input lead, or failure to connect to a supply earth can be dangerous.

(5) The unit is switched on by operating the switch marked ~. Illumination of the LED displays indicates that the unit is on. **For twin units the left-hand AC line switch acts as a master switch, but both AC line switches must be switched on in order to switch on the GPIB control module.**

2.1 Adjusting the AC Line Voltage Setting

If it is necessary to alter the AC line voltage setting this must be done by disconnecting the unit from the AC supply, removing the cover, and changing the primary taps on the transformers.

The transformer for each power supply module has taps of 0, 110V, 120V, and 0, 110V, 120V. For 220V or 240V operation these should be linked in series, whilst for 110V or 120V operation they should be linked in parallel.

The transformer for the GPIB control module has taps at 0, 115V, and 0, 115V. For 220/240V operation these should be linked in series whilst for 110V/120V operation they should be wired in parallel.

Important Note: if the line voltage is changed it is imperative that the voltage marked on the label close to the power lead entry point is erased and the new setting voltage marked clearly in its place.

3 OPTIONAL ACCESSORIES

A 19" rack mount kit (4U height) is available for both single and twin supplies.

The rack mount kit includes an 'anti-tamper' cover which encloses the switches and terminals to prevent accidental or unauthorised switch operation or terminal disconnection.

The anti-tamper cover is available separately for use on free standing units.

4 OPERATING INSTRUCTIONS - LOCAL MODE

With the mode switch in the 'local' position the GPIB control module has no effect on the operation of the power supply.

4.1 Setting up the Output

The DC supply is connected to the output terminals by the right hand switch marked ⎓. With this in the 'off' position, the voltage and current levels may be accurately set prior to connection to the load. The left hand meter indicates voltage, whilst the right hand meter indicates current.

With the output switch in the 'off' (set) position, the current meter shows the value of the current limit setting (indicated by all the decimal points coming on), with the output switch 'on' it shows the value of load current flowing.

Unless remote sensing is required (see Section 4.7), the shorting bars should be placed from + sense to + output and from − sense to − output. **Ensure that the terminals are properly tightened before use.**

4.2 Constant Voltage

The voltage output is set using the coarse and fine voltage controls, the current control sets the maximum current that can be supplied.

4.3 Constant Current

If the load resistance is low enough such that, at the set level of output voltage, a current greater than the current limit setting would flow, the supply will automatically move into the constant current operation.

The current output is set using the current limit control, the voltage controls set the maximum voltage that can be generated.

4.4 Constant Current Indication

When the unit is operating in constant current mode, either by intention or because the current limit point has been reached, the decimal points on the current meter will flash to indicate constant current rather than constant voltage operation.

4.5 Connection to the Load

The load should be connected to the positive (red) and negative (black) terminals marked 'output'. Both are fully floating and either can be connected to ground. The negative terminals are permanently connected to the power supply output, whilst the positive ones are connected through the output switch. The green terminal is connected to chassis and to the earth (ground) of the AC input cable. Either output terminal can be raised up to 300V above true ground - see electrical safety section.

4.6 Instantaneous Current Output

The current limit control can be set to limit the continuous output current to levels down to 1mA. However, in common with all precision bench power supplies, a capacitor is connected across the output (isolated by the output switch) to maintain stability and good transient response. This capacitor charges to the output voltage, and short circuiting of the output will produce a short current pulse as the capacitor discharges which is independent of the current limit setting.

4.7 Remote Sensing

The unit has a very low output impedance, but this is inevitably increased by the resistance of the connecting leads. At high currents, this can result in significant differences between the indicated source voltage and the actual load voltage. (Two 50mΩ connecting leads will drop 0.2V at 2 amps, for instance.) This problem can be minimised by using short, thick, connecting leads, but where necessary it can be completely overcome by using the remote sense facility.

This requires the sense terminals to be connected to the output at the load instead of at the source. To avoid instability and transient response problems, care must be taken to ensure good

coupling between each output and sense lead. This can be done either by twisting the leads together, or by using coaxially screened cable (sense through the inner). An electrolytic capacitor directly across the load connection point may also be beneficial.

The voltage drop in each output lead must not exceed 0.5 volts.

4.8 Current Meter Damping

The digital meters have a reading rate of about four readings per second (as fast as the eye can follow) and a damping time constant of 20msecs, thus providing virtually instantaneous response to reading changes.

If the unit is used to supply a load varying at a rate faster than about 0.5Hz, difficulty may be experienced in interpreting the current meter readings. This problem can be alleviated by turning on the switch marked 'damping'. This increases the current meter damping time constant to 2 seconds with the result that the meter will tend to read the average current flowing rather than following the variations. This facility should only be used when necessary since it greatly increases settling time and reduces absolute accuracy.

4.9 Series or Parallel connection with other units

The unit can be connected in series or parallel with others to produce higher voltages (maximum 300 volts) or higher current outputs.

It should be noted that the unit can only source current and cannot sink it, thus units cannot be series connected in anti-phase. Where several units are connected in parallel, the output voltage will be equal to that of the unit with the highest output voltage setting until the current drawn exceeds its current limit setting, upon which the output will fall to that of the next highest setting, and so on.

In constant current mode, units can be connected in parallel to provide a current equal to the sum of the current limit settings.

4.10 Application of an external voltage source to the output

In common with all series regulated single ended power supplies, the unit is not capable of sinking current provided from an external source. If a voltage greater than the set output voltage of the unit is applied from an external source, the internal regulator will turn off, no current will flow, and the voltage meter will read the applied voltage. No damage will result providing the applied voltage does not exceed 50 volts. Application of voltage greater than this is prohibited.

If a reverse voltage is applied, this will be clamped by an internal reverse protection diode. The reverse current should not exceed 1 amp.

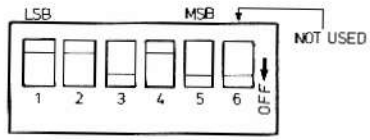
5 OPERATING INSTRUCTIONS - REMOTE MODE

With the mode switch in the 'Remote' position, the voltage and current levels are set by the GPIB control module and the voltage and current setting knobs have no effect. An 'anti-tamper' cover is available to prevent unauthorised switch operation. See section 3.

5.1 Connecting to the GPIB

The unit conforms to the IEEE-488 (1978) standard. Connection to the bus is made using the 24 way IEEE-488 standard socket on the rear of the unit. For IEC-625 systems a converter cable must be used.

The user must choose a unique address for the unit and set it using the switches on the rear panel.
The example address shown is 01011, ie, decimal 11. Thirty one addresses are possible, address 11111 is not allowable.



Should it be required to connect the unit to an operating GPIB system without disrupting operation then the unit should be powered up before the GPIB cable is plugged in. Operating the AC line power switch with the unit connected to the GPIB will cause the Bus to be disabled for a period of up to one second. On twin units the power for the GPIB control module is controlled by both AC line switches.

In a twin power supply the GPIB control module controls both supplies via its single device address.

5.2 Controlling the power supply from the GPIB

The power supply can be combined with other instruments (one of which must be a Bus Controller) to form a GPIB system. Once its address has been defined the power supply can be Addressed to Talk or Addressed to Listen by the Bus Controller.

When Addressed to Listen the unit enters the Listener Active (LA) state and the Listen Lamp illuminates. Any data bytes placed on the Bus by an active talker are accepted. If they form a valid command string they will be acted upon. If not they will be ignored. The LA state may be cancelled by the Unlisten command.

When Addressed to Talk the unit enters the Talker Active (TA) state and the Talk Lamp illuminates. The unit will then place a string of characters on to the Bus, representing the present status of the power supply (or supplies). The TA state may be cancelled by the Untalk command.

The unit will respond to the following GPIB interface commands:

MLA	—	My Listen Address. On receipt goes to LA state.
DCL	—	Device Clear. Resets unit to initialised state.
SDC	—	Selected Device Clear. Only when Addressed. Function as DCL.
SCG	—	Secondary Command Group. See Section 5.8.
UNL	—	Unlisten. Cancels LA state.
MTA	—	My Talk Address. On receipt goes to TA state.
UNT	—	Untalk. Cancels TA state.
IFC	—	Interface Clear. Cancels both LA and TA states.
SPE	—	Serial Poll Enable. Used in conjunction with MTA to place a status byte onto the Bus.
SPD	—	Serial Poll Disable. Cancels effect of SPE command.
PPE	—	Parallel Poll Enable. Used to identify device requesting service.

The unit will output the following messages onto the GPIB:

DAB	—	Data Byte. ASCII character forming part of a string representing status information.
SRQ	—	Service Request. In response to conditions defined in section 5.10.
RQS	—	Requested Service. Single data byte giving status of interface.
PPRn	—	Parallel Poll Response n. Pulls DIO line n true in response to PPE, see section 5.11

5.3 Initialisation and Reset

When the GPIB control module is switched on, it is initialised to the following states:

Power supply X voltage setting - 0V
Power supply X current setting - 0mA
Power supply Y voltage setting - 0V
Power supply Y current setting - 0mA
Terminator set to - LF (Line Feed)
SRQ conditions - No SRQ

Once the unit is connected to the GPIB it can be reset to these initialised states in any of three ways:

1) By switching the unit off and on again. NB this will disable the Bus for a short period.
2) By sending the DCL command over the Bus.
3) By sending the SDC command over the Bus when the unit is in the TA state or LA state.

Since the unit is software controlled it is theoretically possible to get it in to a state from which it will not recover by illegal bus operations. Should this happen it must be reset by turning the unit off and on again.

Important Note: on twin supplies, if the AC line power switch on the Y power supply unit is switched off the power to the GPIB control module will be removed but power to the X power supply unit will remain. The X PSU will stay set to its previously set voltage and current levels until the AC line switch on the Y PSU is switched on again, upon which it will reset to its initialised state.

5.4 Setting the Voltage and Current Levels

When the unit is in the LA state the voltage and current levels can be changed by sending it an ASCII character string of the correct syntax.

The normal syntax is as follows:

Power supply identifier (X or Y); Numerical value; Electrical unit identifier (V or mA); Terminator (normally LF).

For single units the 'power supply identifier' can be omitted. If it is included it must be X. Case is ignored.

For twin units the 'power supply identifier' is X for the left-hand supply and Y for the right-hand supply. Case is ignored. If the identifier is omitted, it is assumed to be the same as the last identifier sent. If the identifier is omitted in the first string sent after the interface has been cleared, it is assumed to be X.

The numeric value is a floating point decimal number. Digits below the minimum setting resolution (.01 for volts, 10 for mA) are ignored. Values, above the maximum allowable setting will cause the whole string to be ignored.

The electrical unit identifier must be V (for volts) or mV (for millivolts) when setting voltage, and mA (for milliamperes) or A (for amps) when setting current. Case is ignored.

The string is terminated by an LF (line feed) character. This can be changed to CR (carriage return), see section 5.7. The Terminator can be omitted altogether if EOI is sent with the last character of the string, see section 5.7.

Examples of valid strings are as follows:

X12VLF
Y23.45VLF
X110mALF
Y1820mALF

When it is required to change several settings simultaneously the strings can be linked together with a single terminator at the end. Where two successive settings apply to the same power supply the power supply identifier can be omitted for the second setting.

Thus the four strings above could be sent as a single string as follows:

X12V110mAY23.45V1820mALF

After the terminator has been received, the unit is enabled to accept one further bus command (eg. Unlisten). This command is not acted upon until the unit has checked the syntax of the string and carried out the appropriate actions, a delay of typically 1½ msecs.

5.5 Maximum Voltage and Current Settings

With a 30V/2A supply the maximum voltage that can be set when the full output current capability of 2.2A is required, is limited to 31V. Providing the current limit is set to 1.1A or below, however, voltages up to 36V may be set. If an attempt is made either to set a voltage above 31V when the current setting is above 1.1A, or to set a current above 1.1A when the voltage setting is above 31V, the control string will be ignored.

With 15V/4A supplies a similar facility is available. The equivalent figures are 15.5V with 3.98A and 18V with 1.99A.

5.6 Voltage and Current Setting Response Speeds

Although the GPIB control module responds to a control string in just over a millisecond, it can take considerably longer for the power supply itself to settle to a new value. This is caused by the internal time constants of the power supply.

When setting a current, the time constant is typically 2msecs. This means that for a 1A change the current limit will settle to within 10mA of its final value within 10 msecs.

When setting a voltage, the time constant is typically 50 msecs. This means that the voltage will settle to within 10mV of its final value in around 115 msecs for a 100mV change, or 230 msecs for a 1V change, or 400 msecs for a 30V change. If the load current falls below 10mA or so, the setting time will be increased when the voltage is being reduced because of the extra time taken to discharge the output capacitor of the power supply (33uf). Consequently if rapid response times are required at very low currents, a dummy load should be added to maintain some output current.

NB: Setting times can be calculated using the following formula:
Setting time to 10% of the step value = 2.3T, to 1% = 4.6T, to 0.1% = 6.9T. Where T is the time constant.

5.7 Power Supply Status Readback

When the unit is put into the TA state it will immediately place a string of ASCII characters onto the Bus describing the operating status of the power supply or power supplies.

For a single supply the string is:

X V LF when the PSU is in constant voltage (CV) mode, or
X I LF when the PSU is in constant current (CI) mode.

For a twin supply the string is:

X V Y V LF for example (both PSUs in CV mode).

The exception to this is when the unit is put into the TA state following a 'current measurement' command (see section 5.12).

5.8 Programmable Terminator (LF or CR)

As initialised the unit requires an LF character as a terminator when in the LA state, and sends an LF character as a terminator when in the TA state.

Some bus controllers send and require a CR character as a terminator. The unit can be made to comply with this by sending it an SCG command with secondary address 6, see section 5.9.

The unit also accepts EOI as a terminator. Thus if the controller sets EOI true on the final character of the control string, no further terminating character is required. Any character sent after the final character (identified as the final character by EOI) will be accepted as the first character of a new string. A CR or LF character at the start of a new string will be ignored and will not cause a syntax error.

When in the TA state the unit automatically sets EOI true when it sends the terminator character (LF or CR).

NB: Throughout this manual example strings are shown using LF as a terminator. This could be replaced by any valid terminator as described above.

5.9 Setting the mode of operation via a secondary address

The unit can be set into a particular mode of operation by placing it in the LA or TA state and sending it one of the following secondary addresses.

Decimal value of Secondary Address	Resultant mode of operation
0	SRQ mode 0
1	SRQ mode 1
2	Unused facility
3	SRQ mode 3
4	SRQ mode 4
5	No SRQ
6	Set terminator to CR
7	Set terminator to LF

NB: If the unit is switched off and on again, the SRQ mode will be reset to No SRQ and the terminator reset to LF (see section 5.3).

5.10 Service Request Modes

As initialised at switch on, the unit will not perform a Service Request (SRQ mode 5). The unit can be instructed to perform a Service Request under one of four conditions by sending it a secondary address (see section 5.9).

The SRQ can be used to tell the bus controller that a power supply has changed mode (either from CV to CI or CI to CV) as might occur when an overload situation arises, for example.

SRQ Mode No.	Conditions under which an SRQ is sent
0	PSU X changed from CV to CI mode
1	PSU Y changed from CV to CI mode
2	Unused facility
3	PSU X changed from CI to CV mode
4	PSU Y changed from CI to CV mode
5	No SRQ sent

5.11 Serial Poll Response

The unit responds to a Serial Poll Enable (SPE) command combined with MTA by placing a serial poll response byte onto the Bus. The order in which MTA and SPE are sent does not matter provided that ATN remains true. If ATN goes false between the two commands the SPE must be sent first.

The response byte is made up as follows:

Bit 0 - 1 if SRQ mode 0 is enabled and condition is satisfied. Otherwise 0.
Bit 1 - 1 if SRQ mode 1 is enabled and condition is satisfied. Otherwise 0.
Bit 2 - 0 (unused facility).
Bit 3 - 1 if SRQ mode 3 is enabled and condition is satisfied. Otherwise 0.
Bit 4 - 1 if SRQ mode 4 is enabled and condition is satisfied. Otherwise 0.
Bit 5 - 1 if a syntax error occured in the last command string. Otherwise 0.
Bit 6 - 1 if the unit has requested service (SRQ sent). Otherwise 0.
Bit 7 - 1 if the last command string contained an overrange value. Otherwise 0.

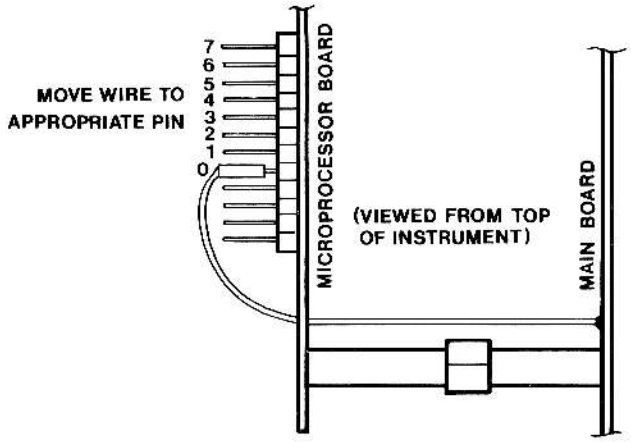
Note that bit 6 is used to identify whether or not the unit was responsible for the SRQ to which the bus controller is responding.

NB: The act of reading the response byte clears it to all zeros, so if it is read again before another SRQ is generated a null byte will be read.

5.12 Parallel Poll Response

The unit can be set to respond to a Parallel Poll Enable (PPE) command.

The user must choose which, if any, of the D10 lines is to be used, by plugging a link onto a connector inside the unit (see diagram). As supplied the link is fitted to line 0.



NB: The unit must not be in the TA state when the PPE command is sent.

5.13 Speed of Response on the GPIB

The unit is microprocessor based and makes extensive use of software. Consequently it is a medium speed interface in terms of its response times on the GPIB.

The unit responds to Attention going true by pulling NDAC true and releasing DAV and DIO lines 0 to 7 within 200nsec as defined by the GPIB standard. All other responses, however, will take several tens of microseconds and a typical time to complete a handshake will be between 200 and 300usecs. This should be borne in mind when estimating maximum data rates on a GPIB system of which the unit is a part.

5.14 Current Measurement Facility

When in CV mode, the unit can be instructed to measure the actual output current flowing by putting it into the LA state and sending it a command string of the correct syntax.

The syntax is: X I ? LF or Y I ? LF or X I ? Y I ? LF

The unit responds by stepping down the current setting in 10mA steps until the CV/CI crossover point is reached, storing that value and rapidly returning the current setting to its original value. The length of time taken to do this depends upon the difference between the original current setting and the actual current flowing. For a 1000mA difference the time is about 300msec.

When the unit is next put into the TA state it will output a string, representing the current value stored, with the following syntax:

X 4 5 0 m A LF for a current of 450mA.

Note that after the current measurement command has been received, the unit is enabled to accept one further bus command (eg. Unlisten). This command is not acted upon until the current measurement command has been completed. This delay could be anything up to 1 second.

6 GENERAL SAFETY CONSIDERATION

The unit generates considerable heat and requires a full air cooling flow for correct operation. Do not obstruct any of the cooling slots in the cover, or block the inflow of air at the bottom.

Avoid allowing the unit to get damp, and keep away from corrosive fluids.

Do not remove the cover or any other part of the unit unless the plug has been removed from the AC supply.

Test, repair, or set-up should only be conducted by skilled engineers conversant with the hazards of working the AC line powered equipment.

Read the electrical safety section at the rear.

7 CALIBRATION

The equipment is so designed and constructed that re-calibration should be required only infrequently. The Manufacturers will provide a re-calibration service, as will their agents overseas. Where owners wish to carry out re-calibration themselves, this should only be done by skilled personnel with access to precision equipment working in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

8. MAINTENANCE AND REPAIR

The Manufacturers or their agents overseas will provide repair for any unit developing a fault. Where owners wish to undertake their own maintenance work, this should only be done by skilled personnel in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

In the UK defective instruments should be returned, carriage paid, to the Manufacturers' Service Department. Careful and substantial packing is essential - no responsibility can be accepted for damage caused in transit - if possible, retain the original packing material. If the guarantee has expired or if the fault is the result of misuse, the repair will be carried out and charged unless other instructions are received.

Customers outside the UK should contact the dealer from whom the unit was purchased to ascertain service arrangements for that country.

9. GUARANTEE

The period and terms of the guarantee vary depending upon the country in which the unit was sold. Details of the product guarantee will either be included in a separate card, or available on request from the dealer from whom the unit was purchased.

10. TECHNICAL SPECIFICATIONS

10.1 Local Mode

Line Voltage:	110, 120, 220, 240V AC ± 10% at 48-63Hz.
Output:	0 to 31 volts nominal, 0 to 2.2A (PL320) 0 to 15.5 volts nominal, 0 to 3.98A (PL154)
Output Termination:	4mm terminals on 19mm (¾") spacing DC output switch.
Sensing:	Remote via 4mm terminals or Direct via shorting links (provided).
Line Stability:	<0.01% of maximum output for 10% line change.
Load Regulation:	<0.01% of maximum output for 99% load change.
Protection:	Full short circuit and overload protection.
Ripple and Noise:	<1mV typically.
Output Impedance:	<5m Ω at 1kHz.
Temperature Coefficient:	<0.01% °C typically.
Transient Response:	<20usecs to 50mV of setting for 100% load change.
Constant Current Output Impedance:	50k Ω typically with voltage limit at maximum.
Voltage Controls:	Continuously variable by coarse and fine controls.
Current Limit:	Continuously variable from 0 to 110% of maximum current rating. (0 to 99% 15V/4A units). Automatic indication of constant current operation.
Meters:	Dual 3¾ digit (4000 count) with 12.5mm (½") LEDS. Reading rate 4 per second.
Meter Resolution:	Voltage 0.01 volts over entire range. Current 0.001 amps over entire range.
Meter Accuracy: 20°C to 25°C	Voltage 0.1% reading ± 0.05% full scale. Current 0.3% reading ± 0.2% full scale (0.5% reading on 15V/4A units).
Current Meter Damping:	Normally 20msec switchable to 2 secs for averaging of rapidly varying loads.
Operating Temperature Range:	0°C to 40°C.
Electrical Safety:	Designed and manufactured to comply with IEC 348.

10.2 Remote Mode

Voltage Programming

Range:	0 to 31V for current up to 2.2A 0 to 36V for current up to 1.1A	(30V/2A PSUs)
	0 to 15.5V for current up to 4A 0 to 18V for current up to 2A	(15V/4A PSUs)
Accuracy:	0.35% setting ± 0.1% range	
Resolution:	0.01 volt steps	

Current Programming

Range:	0 to 2.2 amps (30V/2A PSUs) 0 to 3.98 amps (15V/4A PSUs)
Accuracy:	1% setting ± 0.5% range
Resolution:	10mA steps

Current Readback

Accuracy:	2% setting ± 1% full scale
Resolution:	10mA

Note: The manufacturers maintain a policy of continuous improvement and development and reserve the right to alter specifications without prior notice.

Fuse Ratings:	(anti surge type)	220/240V	110/120V
	Single Supplies	1A	2A
	Dual Supplies	2A	3A

11. SAFETY REGULATIONS IN ACCORDANCE WITH IEC348

(1) This apparatus is safety class 1 by IEC classification.

The apparatus has been designed in accordance with IEC Publication 348 Safety Requirements for Electronic Test and Measuring Apparatus. This manual contains information and warnings which shall be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

(2) Before connecting the apparatus, make sure that it is set to the voltage of the AC ~ line supply. Use only the correctly rated fuses as specified. On no account use mended fuses or short-circuited fuseholders.

(3) If the unit is to be connected to the main supply by fixed wiring, rather than via an AC line plug, then the protective earth (ground) wire in the 3 core mains lead shall be connected to a protective conductor before any other connection is made.

(4) Ensure that an appropriate AC line plug is correctly connected to the captive 3 core cable provided with the unit.

Connections are: brown = live, green/yellow = earth and blue = neutral. Ensure that the AC line socket to be used has a correctly connected protective earth (ground) contact. Do not use extension cords without protective earth conductors.

If the unit is to be used with live measuring or load circuits which have protective earth terminals, ensure that all protective earth terminals are connected to a protective conductor prior to switching on (the green front panel terminal may be used for this purpose).

If the unit is to be used with live measuring or load circuits which do not have protective earth terminals, ensure that the unit AC line plug is inserted before making connections between the unit output terminals and such circuits.

(5) Disconnection of the protective earth (ground) connection, or interruption of protective conductors is liable to render the apparatus dangerous. Intentional interruption is prohibited.

(6) The output of the power supply unit is fully floating and it may be in series with other power supply units to generate high DC voltages up to 300V DC. Such voltages are exceedingly hazardous and great care should be taken to shield the output terminals for such use. On no account should the output terminals be touched when the unit is switched on under such use. All connections to the terminals must be made with the power switched off on all units.

(7) The apparatus must be disconnected from the AC line supply before the cover is removed for any purpose - otherwise dangerous voltages are accessible. Switching off by the front panel ~ on/off switch is not sufficient.

The apparatus should not be re-connected to the AC line supply until the cover is replaced unless essential for the purposes of repair or set-up. Therefore, such work should only be carried out by skilled persons aware of the hazards involved and working in conjunction with manufacturer's service information.

(8) If the apparatus is clearly defective, has been subject to mechanical damage, excess moisture, or chemical corrosion, the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.