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*THURLBY THANDAR INSTRUMENTS*

**PL SERIES**

*PRECISION LINEAR POWER SUPPLIES*

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**INSTRUCTION MANUAL**

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## EC Declaration of Conformity

We Thurlby Thandar Instruments Ltd  
Glebe Road  
Huntingdon  
Cambridgeshire PE29 7DR  
England

declare that the following power supplies:

**PL154, PL320, PL320QMD, PL320QMT  
PL330, PL330QMD, PL330QMT**

meet the intent of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. Compliance was demonstrated by conformance to the following specifications which have been listed in the Official Journal of the European Communities.

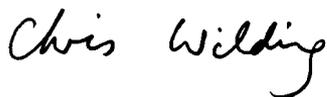
### **EMC**

Emissions:                   a) EN61326 (1998) Radiated, Class B  
                                      b) EN61326 (1998) Conducted, Class B  
                                      c) EN61326 (1998) Harmonics, referring to EN61000-3-2 (2000)

Immunity:                   EN61326 (1998) Immunity Table 1, Performance B, referring to:  
                                      a) EN61000-4-2 (1995) Electrostatic Discharge  
                                      b) EN61000-4-3 (1997) Electromagnetic Field  
                                      c) EN61000-4-11 (1994) Voltage Interrupt  
                                      d) EN61000-4-4 (1995) Fast Transient  
                                      e) EN61000-4-5 (1995) Surge  
                                      f) EN61000-4-6 (1996) Conducted RF

### **Safety**

EN61010-1 Installation Category II, Pollution Degree 2.



CHRIS WILDING  
TECHNICAL DIRECTOR

2 July 2004

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# Specification

## MAIN OUTPUT(S)

Output Range:	Nominally 0-32V, (PL320/330); 0-15.5V (PL154). Nominally 0-2·1A (PL320); 0-3·1A (PL330); 0-4A (PL154).
Output Voltage Setting:	By coarse and fine controls; resolution <5mV across the range.
Output Current Setting:	By single logarithmic control.
Output Mode:	Constant voltage or constant current modes with automatic cross-over. Decimal points flash to indicate constant current mode.
Configuration Selection: (QMD and QMT only)	Isolated, True parallel, Series, or Series Tracking via front panel switches.
Output Switch:	Isolates the output and permits voltage and current limits to be set up before connecting the load.
Output Terminals:	4mm terminals on 19mm (0·75") spacing.
Sensing:	Remote via 4mm terminals or direct via shorting links (provided).
Output Impedance:	
Constant Voltage:	<5 mΩ at 1kHz.
Constant Current:	Typically 50 kΩ with voltage limit at maximum.
Output Protection:	Up to maximum output voltage +20 Volts forward; diode clamped for reverse voltages and up to 3A reverse current.
Load & Line Regulation:	< 0·01% of maximum output for 90% load change or 10% line change.
Ripple and Noise:	Typically <1 mV rms.
Transient Response:	< 20 μsec to within 50 mV of setting for 90% load change.
Temperature Coefficient:	Typically < 100 ppm/°C.
Meter Type:	Dual 3·75 digit (4095 count) with 12·5mm (0·5") LEDs. Reading rate 4Hz.
Meter Resolution:	10 mV and 1mA over the entire range.
Meter Accuracy:	Voltage 0·1% of reading + 1 digit, current 0·3% of reading + 1 digit.
Current Meter Damping:	~20 ms, switchable to 2 sec for averaging of rapidly varying loads.

## LOGIC OUTPUT (PL320QMT & PL330QMT)

Output Voltage Range:	4 to 6 Volts.
Output Current:	0·1 to 4 Amps (PL320QMT); 0·1 to 7 Amps (PL330QMT).
Output Switch:	Electronic.
Output Terminals:	4mm terminals on 19mm (0·75") spacing.
Over-Voltage Protection:	Above 7 Volts.
Output Protection:	Clamped by the over-voltage protection circuit for forward voltages over 7 Volts and up to 1 Amp forward current. Diode clamped for reverse voltages and up to 3 Amps reverse current.
Load & Line Regulation:	< 0·01% of maximum output for 90% load change or 10% line change.
Ripple and Noise:	Typically <1 mV rms.

Transient Response: < 20 µsec to within 50 mV of setting for 90% load change.  
 Temperature Coefficient: Typically < 100 ppm/°C.  
 Metering (*PL330QMT only*): 3.75 digit (4095 count) with 12.5mm (0.5") LEDs. Reading rate 4Hz.  
 Meter Type:  
 Meter Resolution: 10 mV and 10 mA  
 Meter Accuracy: 0.5% of reading + 1 digit.

## GENERAL

AC Input Voltage: Internally set for 110, 120, 220, 230 or 240VAC 50/60 Hz; operating range ±10% of setting. Installation Category II.

Power Consumption:	Single	Dual	Triple
15V / 4A or 30V / 2A:	160VA	320VA	400VA
30V / 3A:	250VA	500VA	600VA

Operating Range: 5° C to 40 °C, 20% to 80% RH.  
 Storage Range: -20 °C to +60 °C.  
 Environmental: Indoor use at altitudes up to 2000m, Pollution Degree 2.

Weight:	Single	Dual	Triple
15V / 4A or 30V / 2A:	5.0kg	9.5kg	12.5kg
30V / 3A:	6.0kg	12.0kg	15.0kg

Size: Single                      Dual                      Triple.  
 155 mm wide                      350 mm wide                      425 mm wide  
 All units 170mm high and 265mm deep, except PL330 versions 300mm deep.

Safety: Complies with EN61010-1.

EMC: Complies with EN61326.

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# Safety

This instrument is Safety Class I according to IEC classification and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single phase supply.

This instrument has been tested in accordance with EN61010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

This instrument has been designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20% - 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and -10°C without degradation of its safety. Do not operate while condensation is present.

Use of this instrument in a manner not specified by these instructions may impair the safety protection provided. Do not operate the instrument outside its rated supply voltages or environmental range.

## **WARNING! THIS INSTRUMENT MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

When the instrument is connected to its supply, terminals may be live and opening the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair. Capacitors inside the power supply may still be charged even if the power supply has been disconnected from all voltage sources but will be safely discharged about 1 minute after switching off power.

Any adjustment, maintenance and repair of the opened instrument under voltage shall be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.

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

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

Do not wet the instrument when cleaning it.

The following symbols are used on the instrument and in this manual:-

	Earth (ground) terminal.
	alternating current (ac)
	direct current (dc)

This instrument has been designed to meet the requirements of the EMC Directive 89/336/EEC.

Compliance was demonstrated by meeting the test limits of the following standards:

### **Emissions**

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use. Test limits used were:

- a) Radiated : Class B
- b) Conducted : Class B
- c) Harmonics: EN61000-3-2 (2000) Class A; the instrument is Class A by product category.

### **Immunity**

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use.

Test methods, limits and performance achieved were:

- a) EN61000-4-2 (1995) Electrostatic Discharge : 4kV air, 4kV contact, Performance A.
- b) EN61000-4-3 (1997) Electromagnetic Field, 3V/m, 80% AM at 1kHz, Performance B.
- c) EN61000-4-11 (1994) Voltage Interrupt, 1 cycle, 100%, Performance B.
- d) EN61000-4-4 (1995) Fast Transient, 1kV peak (AC line), 0.5kV peak (DC Outputs), Performance B.
- e) EN61000-4-5 (1995) Surge, 0.5kV (line to line), 1kV (line to ground), Performance A.
- f) EN61000-4-6 (1996) Conducted RF, 3V, 80% AM at 1kHz (AC line only; DC Output connections <3m not tested), Performance A.

According to EN61326 the definitions of performance criteria are:

**Performance criterion A:** 'During test normal performance within the specification limits.'

**Performance criterion B:** 'During test, temporary degradation, or loss of function or performance which is self-recovering'.

**Performance criterion C:** 'During test, temporary degradation, or loss of function or performance which requires operator intervention or system reset occurs.'

Where Performance B is stated it is because DC Output regulation may deviate beyond Specification limits under the test conditions. However, the possible deviations are still small and unlikely to be a problem in practice.

Note that if operation in a high RF field is unavoidable it is good practice to connect the PSU to the target system using screened leads which have been passed (together) through an absorbing ferrite sleeve fitted close to the PSU terminals.

### **Cautions**

To ensure continued compliance with the EMC directive observe the following precautions:

- a) after opening the case for any reason ensure that all signal and ground connections are remade correctly and that case screws are correctly refitted and tightened.
- b) In the event of part replacement becoming necessary, only use components of an identical type, see the Service Manual.

# Installation

## Mains Operating Voltage

Check that the operating voltage of the instrument shown on the rear panel is suitable for the local supply. Should it be necessary to change the operating voltage range proceed as follows:

1. Ensure that the instrument is disconnected from the AC supply.
2. Remove the screws holding the case upper and handle.
3. Lift off the case upper.
4. If the transformer primary taps are marked: A 0-110-120 B 0-110-120, rewire as follows:
  - 240V operation: Neutral (blue) wire to A0; Link (red) wire from A120 to B0; Live (brown) wire to B120.
  - 230V operation: Neutral (blue) wire to A0; Link (red) wire from A110 to B0; Live (brown) wire to B120.
  - 220V operation: Neutral (blue) wire to A0; Link (red) wire from A110 to B0; Live (brown) wire to B110.
  - 120V operation: Neutral (blue) wire to A0; Link (blue) wire from A0 to B0; Link (brown) wire from A120 to B120; Live (brown) wire to B120.
  - 110V operation: Neutral (blue) wire to A0; Link (blue) wire from A0 to B0; Link (brown) wire from A110 to B110; Live (brown) wire to B110.

Alternatively, if the transformer primary taps are numbered 1 to 6, rewire as follows:

- 230V operation: Neutral (blue) wire to 6; Link (red) wire from 3 to 4; Live (brown) wire to 1.
- 115V operation: Neutral (blue) wire to 6; Link (blue) wire from 3 to 5; Link (red) wire from 2 to 4; Live (brown) wire to 1.

Note: Units factory set to 220, 230 or 240V will have no blue link wire - this must be provided when converting to 110/115/120V operation. When converting a 110/115/120V unit to 220/230V/240V the blue link wire should be discarded.

5. Reassemble in the reverse order.
6. Change the fuse type if necessary.

**Important Note:** Safety regulations state that the AC line voltage to which the apparatus is set must be clearly marked on the outside. If the line voltage setting is changed, it is imperative that the voltage marked on the label close to the power lead entry point is also changed.

## Fuse

The AC fuse is located on the back panel; note that the PL320QMT and PL330QMT have an additional AC fuse for their logic output sections. The correct fuse type is 20mm x 5mm 250V HBC time-lag with the following rating:

Model	220/230/240V	110/115/120V
PL320 / PL154 (single)	1.6A (T)	3.15A (T)
PL330 (single)	2A (T)	4A (T)
PL320QMD / PL320QMT	3.15A (T)	6.3A (T)
PL330QMD	4A (T)	8A (T)
PL330QMT	5A (T)	10A (T)
PL320QMT & PL330QMT	Logic Output: 1.6A (T)	3.15A (T)

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Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

## Mains Lead

When a three core mains lead with bare ends is provided this should be connected as follows:

BROWN	-	MAINS LIVE	
BLUE	-	MAINS NEUTRAL	
GREEN/YELLOW	-	EARTH	

Safety Earth Symbol

As the colours of the wires in the mains lead of this apparatus may not correspond with the coloured markings identifying the terminals in your plug proceed as follows:

The wire which is coloured green-and-yellow must be connected to the terminal in the plug which is marked by the letter E or by the safety earth symbol or coloured green or green-and-yellow.

The wire which is coloured blue must be connected to the terminal which is marked with the letter N or coloured blue or black.

The wire which is coloured brown must be connected to the terminal which is marked with the letter L or coloured brown or red.

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.

### **WARNING! THIS APPARATUS MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

## Mounting

This instrument is suitable both for bench use and rack mounting. It is delivered with feet for bench mounting.

Rack kits for mounting supplies in a 19" rack are available from the Manufacturers or their overseas agents.

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# Connections

All connections are made from the front panel.

The load(s) should be connected to the positive (red) and negative (black) terminals marked OUTPUT.

Remote sense connections to the load, if required, are made from the positive (red) and negative (black) SENSE terminals. The shorting links between OUTPUT and SENSE terminals should be removed when remote sensing is required. Replace the shorting links (red SENSE to red OUTPUT, black SENSE to black OUTPUT) when remote sensing is not in use.

The green terminal marked  is connected to the chassis and safety earth ground.

## Main Outputs

### Setting Up the Output

With the power switch ON and the output switch OFF the output voltage and current limit may be accurately set using the three output controls prior to connection to the load. The left hand meter indicates voltage and 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 the shorting bars should be placed from + sense to + output and from - sense to - output. Ensure that the terminals are properly tightened before use.

### 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.

### 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 constant current operation.

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

### 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.

### Instantaneous Current Output

The current limit control can be set to limit the continuous output current to levels down to 1 mA. 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.

### Current Meter Damping

The digital meters have a reading rate of about four readings per second and a damping time constant of 20 ms, 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 pressing the button 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.

### Series or Parallel connection with other units

The output of the power supply unit is fully floating and may be used in series with other power supply units to generate high DC voltages up to 300V DC.

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**WARNING!** 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.

It should be noted that the unit can only source current and cannot sink it, thus units cannot be series connected in anti-phase.

The unit can be connected in parallel with others to produce higher currents. 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.

### **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 the maximum output voltage of the power supply by more than 20 Volts. Application of a 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 3 Amp.

### **Additional Instructions for Quad Mode Dual Versions**

Quad-Mode Dual versions of the power supplies incorporate a bank of four interlocked push-button switches which enable any one of four different modes of operation to be selected. These are as follows:

#### **1. Isolated**

Each power supply operates as a completely separate and independent unit, electrically isolated from the other.

#### **2. Parallel**

The output from both units is channelled into the Master unit (right hand side), increasing its current output capability accordingly. The Master unit then behaves exactly as a single power supply of increased current capability. The Slave unit (left hand side) becomes inoperative. The resolution of the current meter is 2mA on the PL330QMD in parallel mode.

#### **3. Series**

Operation is as in Isolated mode, except that the Slave positive output terminal is internally connected to the Master negative output terminal.

#### **4. Tracking**

Operation is as for Series mode, except that the Master voltage controls operate on the Master and Slave units simultaneously. The current limit controls on each unit continue to operate individually. Tracking accuracy is better than  $\pm 0.3\%$  of setting  $\pm 0.1\%$  of full range.

The Slave output switch should always be on. Both outputs are then switched from the Master output switch.

Remote sensing cannot be used in either Series or Tracking modes, therefore the shorting bars should be left in place.

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## Additional Instructions for Quad Mode Triple Versions

The Quad-Mode Triple consists of a Quad-Mode Dual as described in the previous section, plus a logic supply.

### P310QMT Logic Supply

This has a fixed 5V 1.5A output which is isolated from the other supplies.

The logic supply is protected against short circuits. It is protected against external forward voltages up to 16 Volts and reverse voltages by a diode: the reverse current must not exceed 3 Amps.

### PL320QMT & PL330QMT Logic Supply

#### Setting the Output

Set the output with the calibrated control. With the output switch OFF the meter (PL330 only) displays voltage; with the switch ON it displays load current. Unless remote sensing is required the shorting bars should be placed from + sense to + output and from - sense to - output.

#### Current Limit (PL320QMT)

Current limit is indicated by lighting the CURRENT LIMIT LED and is set by a calibrated control with a range of 0.1A to 4A. The power supply is not designed to operate in constant current mode as a current source.

#### Current Limit (PL330QMT)

Current limit is indicated by all the decimal points flashing and is set by a calibrated control with a range of 0.1A to 7A. The power supply is not designed to operate in constant current mode as a current source.

#### Protection

Over-voltage protection is fitted to this supply and will be triggered if the voltage across the output terminals exceeds 7 Volts. If this occurs the power supply output is crowbarred by a thyristor; the power supply will then shut down and TRIP will be shown in the display. The power supply can be reset by turning off the DC output switch or by turning the supply off.

The power supply is protected from reverse voltages by a diode; the reverse current must not exceed 3 Amps.

## General

### 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 switched electromechanically (main outputs) or electronically (logic outputs). The green terminal is connected to chassis and to the earth (ground) of the AC input cable.

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.

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## 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; remove the two shorting bars and connect the sense terminals directly to the load. 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.

The shorting bars must be re-fitted if the remote sensing facility is not being used. Remote sensing cannot be used in the tracking or series modes on either output.

## Other Considerations

The power supplies generate considerable heat and require 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 supply to get damp, and keep away from corrosive fluids.

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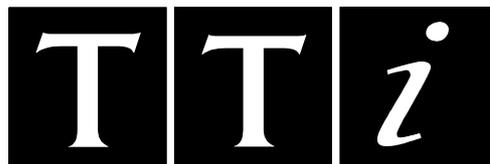
# Maintenance

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.

## Cleaning

If the PSU requires cleaning use a cloth that is only lightly dampened with water or a mild detergent. Polish the display window with a soft dry cloth.

**WARNING! TO AVOID ELECTRIC SHOCK, OR DAMAGE TO THE PSU, NEVER ALLOW WATER TO GET INSIDE THE CASE. TO AVOID DAMAGE TO THE CASE OR DISPLAY WINDOW NEVER CLEAN WITH SOLVENTS.**



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