



THURLBY THANDAR INSTRUMENTS

QL Series



Precision laboratory dc linear power supplies

unrivalled accuracy, resolution, stability & noise

advanced user interface gives superior control

multiple output ranges provide greater flexibility

full bus programmability via GPIB, RS232 or USB

QL series precision dc power supplies

the ultimate in laboratory power !

The QL represents the 'next generation' of high performance laboratory power supplies, maintaining the tradition started with the PL series in 1980 and continued throughout more than two decades.

Unmatched precision

The QL series offers an unparalleled level of precision. Voltage and current are controlled using instrumentation quality 16 bit DACs enabling voltages to be set to 1mV resolution even at full output.

Indeed, the accuracy is sufficient for the QL to be used as a calibration source for some hand-held DMMs.

Multiple ranges for greater flexibility

The QL series provides multiple ranges for increased current capability at lower voltages. The QL355, for example, is a 100W PSU with three ranges.

The main range offers 0 to 35 volts at up to 3 amps. The higher current range provides up to 5 amps for voltages up to 15V.

A further low current range provides an enhanced current setting and measurement resolution of 0.1mA.

Unrivalled performance

The QL series uses pure linear technology and offers unrivalled performance in terms of regulation, output noise and dynamics.

Line and load regulation are close to the limit of measurement.

Recovery time from transient current pulses is better than 50µs.

Output noise is less than 350µV rms in CV mode and down to 20µA rms in CI mode - dramatically better than other PSUs.

The model range

QL355	Single output with ranges of 35V/3A, 15V/5A, 35V/500mA
QL564	Single output with ranges of 56V/2A, 25V/4A, 56V/500mA
QL355T	Two outputs with ranges of 35V/3A, 15V/5A, 35V/500mA plus one auxiliary output of 2.7V, 3.3V or 5.0V at 1A
QL355P	As QL355 with GPIB, RS-232 and USB interfaces
QL564P	As QL564 with GPIB, RS-232 and USB interfaces
QL355TP	As QL355T with GPIB, RS-232 and USB interfaces

Note: Further models may have been added since this brochure was printed. Please check our web site (www.tti-test.com) or contact our sales desk.

Fast, simple and safe to use

The user interface of the QL series has been painstakingly designed to provide rapid control whilst guarding against any possibility of error.

Unlike other digitally controlled units, the QL series provides both numeric and rotary control.

Illuminated keys and display legends provide instant confirmation of settings and status.

Voltage and current setting can be performed in either of two ways:

Direct numeric entry

Settings can be made by direct numeric entry using the 0 to 9 keypad.

Each new setting is previewed on the display and must be confirmed with the OK key.

Settings recalled from memory are similarly previewed and confirmed.

Numeric setting is very fast requiring only three key presses to set to 5 volts, for example, (V, 5, OK).

To set a more precise level such as 12.725 volts requires more key presses, but can still be done in seconds.

One third or two third rack width, 4U height

16-bit precision, 1mV setting resolution.

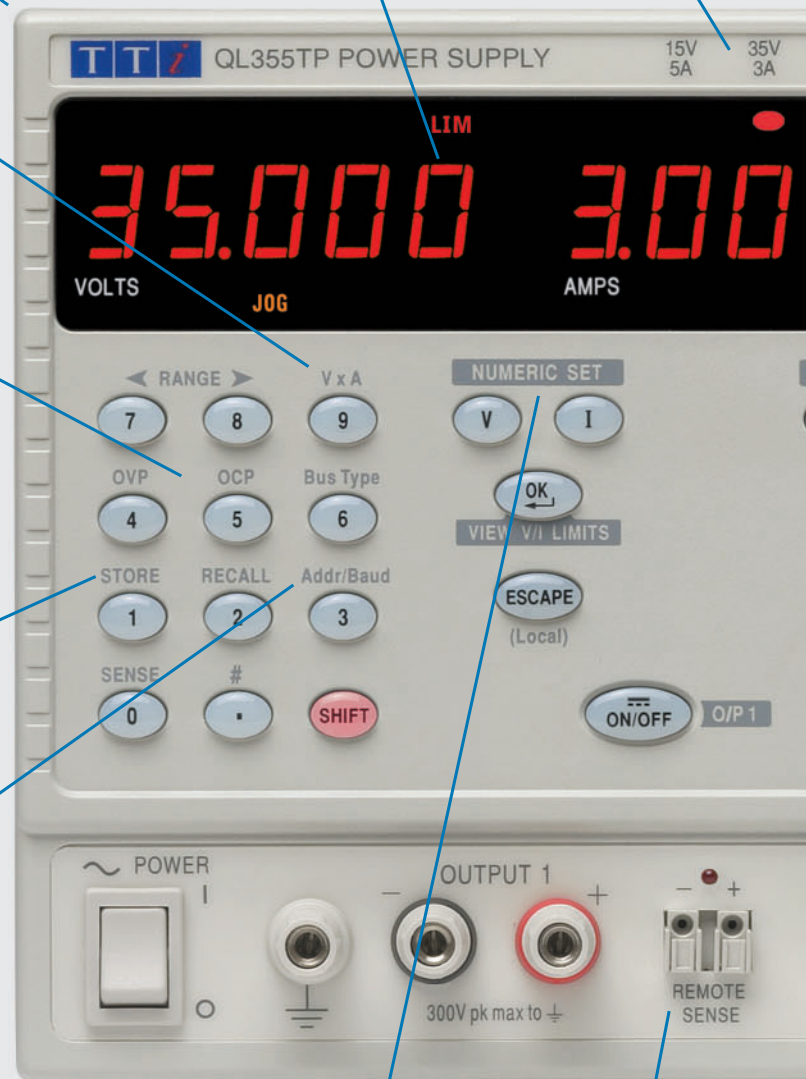
Multiple ranges for increased flexibility.

Watts display (V x A)

Variable over-voltage and over-current protection trips.

Up to 30 memory stores for voltage and current settings.

Fully bus programmable via GPIB, RS232 or USB (P versions).



Direct numeric setting of voltage or current.

Remote or local sense with keypad selection.

Linear regulation with more than 100 watts per output

multiple ranges for increased flexibility

Incremental rotary control

For those preferring quasi-analogue control, or for applications where the voltage or current must be gradually changed, the Jog wheel is available.

The wheel has a positive stepped action but can be spun rapidly when required.

Output voltage can be incremented or decremented in steps of 0.1V, 10mV or 1mV. Current steps can be selected from 0.1A down to 0.1mA.

The Jog function can be left permanently engaged or can be disabled at the touch of a button.

Instant Limits view

To enable the current limit to be set before connecting the load, the limit setting is displayed when the output is set to Off.

With the output set to On, the current meter shows the load current rather than the limit setting.

Pressing the Limits key at any time provides a temporary display of the limit values allowing precise adjustment to be made.

(When operating in CI mode it will be the load voltage which is displayed with the output on, and the voltage limit which is shown using the Limits function).

Setting memories for added convenience

The QL series provided storage of up to 10 power supply sets-up in non-volatile memory (30 set-ups for a triple).

Upon mains switch-off, the set-up of the PSU is saved and is automatically restored at switch-on.

On the QL355T and TP models, independent memories are provided for each output, plus an additional set for 'linked' mode where the user may wish to recall settings for both outputs simultaneously.

OVP and OCP trips with "alarm" output

The QL series provides fully adjustable over-voltage and over-current trips.

These trips can be used both as a fail-safe against accidental mis-setting and as a protection against inappropriate load conditions.

In addition to turning the output off, a trip condition switches the rear panel alarm signal enabling other equipment to be controlled.

For complete protection of the power supply, the trip will also be operated by over-temperature, or excess voltage on the sense terminals.

Remote or local sense

The QL series provides full remote sense capability via dedicated sense terminals.

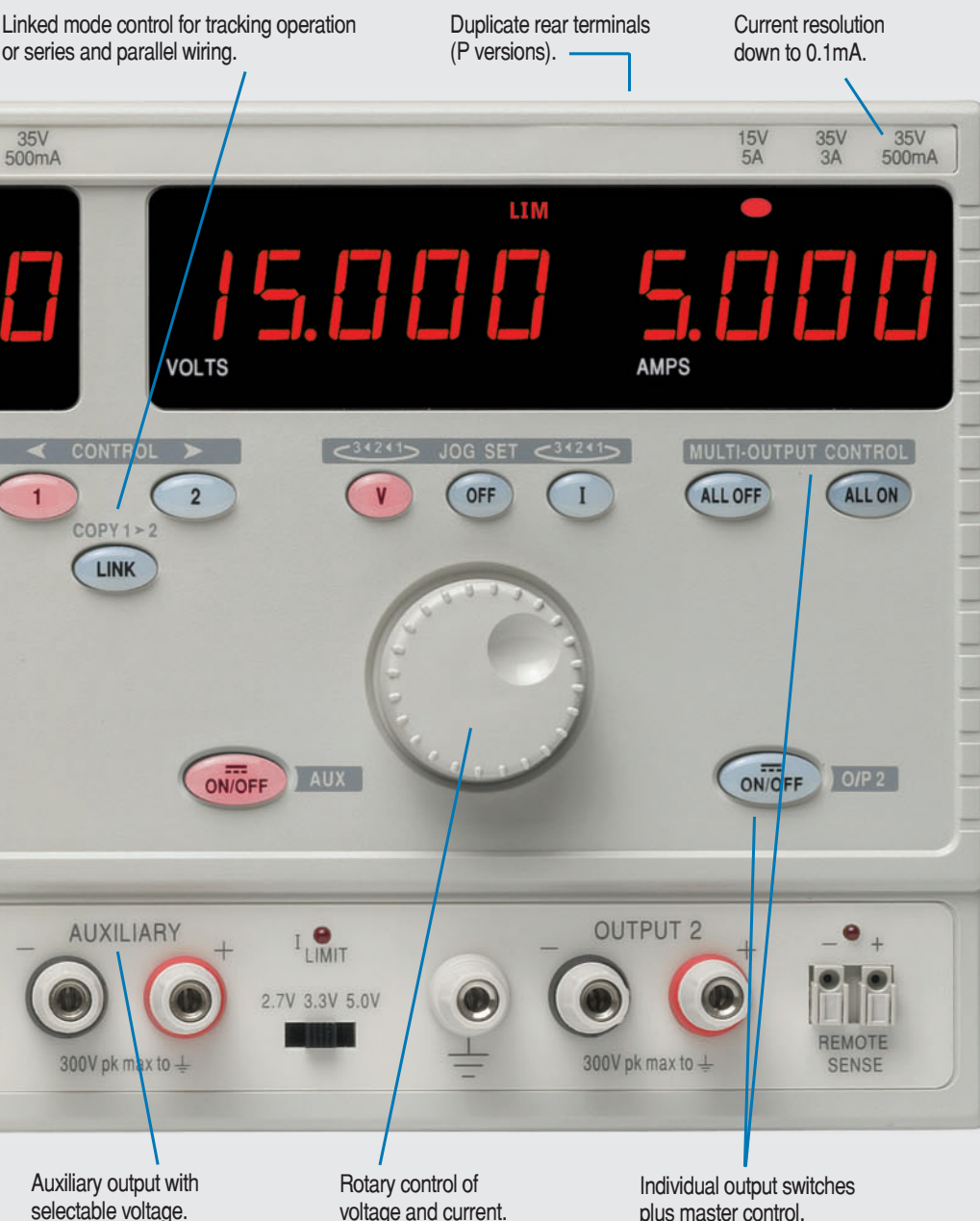
Remote sense is essential to maintain regulation at the load (two 0.01 connection leads will drop 100mV at 5 amps).

When remote sense is not required, internal local sensing can be selected at the touch of a button.

Instant watts display

The product of voltage and current can be displayed at any time by pressing the V x A button.

The power is displayed with a resolution down to 1 milliwatt.



Auxiliary output with selectable voltage.

Rotary control of voltage and current.

Individual output switches plus master control.

Fully programmable for bench or system use

GPIB, RS-232 and USB interfaces

Further facilities - QL355T and QL355TP

These triple output models have two main outputs plus one auxiliary output.

The casing is twice the width of a single output model (two-thirds rack).

Linked mode convenience

The QL355T and TP have two identical outputs which are both independent and isolated.

Illuminated keys selects which output is to be adjusted and provide unambiguous indication.

In situations where the user wishes to set similar voltages or currents on both outputs, "linked" mode is available. When linked, all adjustments are applied to both outputs simultaneously.

Linked mode can provide tracking outputs and is particularly useful when the user wishes to wire the outputs in series or parallel to obtain higher voltages or currents. A "copy" function allows all of the settings of one output to be duplicated on the other prior to linking.

For even greater flexibility, the outputs can be linked when set to different voltages or currents allowing separate settings to be loaded into the linked-mode memories for simultaneous recall.

Auxiliary output for low voltage circuits

The QL355T and TP incorporate a third output intended for powering logic and other low voltage circuitry.

This output is fully isolated from the main outputs and provides a switchable voltage of 2.7, 3.3 or 5.0 volts at a current of up to one amp.

An independent output on/off switch is provided which is bus controllable on the QL355TP.

Comprehensive output control

Each output has its own illuminated dc on/off key providing completely independent control.

For situations where power needs to be connected or disconnected from all three outputs together, master on/off keys are also provided.

Fully programmable via GPIB, RS-232 or USB

Models with a P suffix incorporate a full bus interface enabling remote control and readback via either GPIB (IEEE-488), RS-232 or USB.

On T models, the single interface address controls all three outputs.

The GPIB interface conforms fully with IEEE-488.2 as well as IEEE-488.1.

The serial interface can be used as a conventional single instrument RS-232 interface or as part of a multi-instrument ARC system (Addressable RS-232 Chain).

USB support

The QL bus interface incorporates a USB connection in addition to RS232 and GPIB.

USB represents the future for medium speed PC connectivity and enables multiple devices to be connected.

A Windows device driver is supplied which creates a virtual COM port, enabling USB to be used with applications that do not directly support it.

Rear terminals

P versions incorporate output power and sense terminals on the rear panel in addition to the front panel.

Fully isolated outputs for maximum flexibility

Each output is fully floating and is opto-isolated from the bus interface.

On triple output models the two main outputs can be linked in series or parallel to produce higher voltages or higher currents as required.

Simple and consistent bus control

QL series supplies use simple and consistent command structures which make programming particularly easy regardless of which interface is used.

Drivers for LabWindows* CVI and Labview* IVI are available enabling these PSUs to easily be included within systems that incorporate instruments from a variety of manufacturers.

High resolution control and readback

All power supply settings can be controlled via the bus. Voltage and current can be set to a resolution of 1mV or 0.1mA for each main output. Actual voltage and current can be read back along with the power supply status.

N.B. Control of the auxiliary output on T models is limited to output on-off and monitoring of overload status.

Compact design for bench or rack

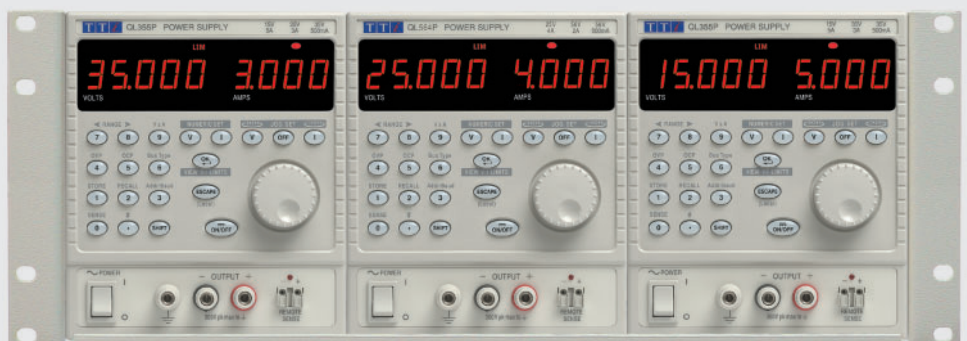
The QL series are highly compact with a small footprint for bench use.

Fold-away feet are incorporated which can be used to angle the front panel upwards.

Single output models are one-third rack width, whilst triple output models are two thirds rack width.

A universal rack mount tray is available which will mount one, two or three singles, one triple, or one triple plus one single.

On P versions, rear output terminals are provided for system use.



* LabWindows and LabView are trademarks of National Instruments Inc.

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Questions & Answers

► Why do I need a **precision** PSU ?

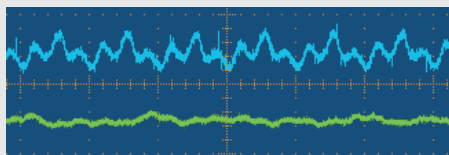
Every engineer needs to have confidence in their equipment. A power supply is one of the most fundamental of bench instruments.

You need certainty that the voltage you apply to a circuit is precisely what you want it to be.



1mV resolution right up to maximum output

You need certainty that the output of your power supply is clean and stable.



QL output noise versus typical bench PSU

You need the ability to define a precise voltage at the load and maintain regulation independent of load resistances.



Selectable local or remote sensing

► What about complexity ?

The QL series can be as simple or as sophisticated as you want it to be.

Setting voltage and current is as easy as using a calculator. Or select Jog wheel control and make all of your adjustments using just the rotary knob.

When you don't need the advanced features you don't have to use them.

However, we believe that you'll soon find many of the capabilities much too useful to ignore.

► How much extra am I paying ?

Surprisingly little.

Despite its wealth of features, a QL series PSU costs little more than a conventional bench power supply of good quality.

Unlike offerings from some other manufacturers, you can choose to buy it without the bus interface, thus saving money in the many situations where remote control is not required.

QL series - digitally controlled precision

The QL series represents the ultimate in laboratory power.

No other power supply offers its combination of performance and convenience.

Digital control gives greatly increased stability, resolution and accuracy.

The advanced user interface provides fast, simple and foolproof operation.

Optimised all-linear regulation gives very low noise and excellent dynamics.

Multiple ranges provide greater flexibility in the choice of voltage and current.

A wealth of convenience features are available at the touch of a button.

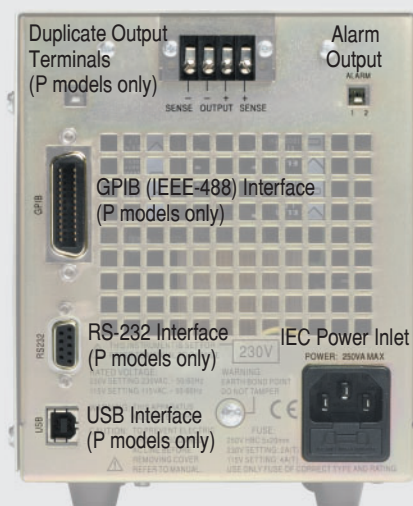
Optional bus interfaces offer high performance remote control operation.

- *Advanced dc power supply range, single or triple output*
- *Very high precision, very low noise, excellent dynamics*
- *Advanced user interface with numeric and rotary control*
- *Multiple voltage/current ranges for increased flexibility*
- *Multiple non-volatile memories for power supply set-ups*
- *Switchable remote sense provides perfect load regulation*
- *Comprehensive protection including OVP and OCP trips*
- *Compact bench footprint; modular width for rack mounting*
- *Auxiliary output of 5.0V, 3.3V or 2.7V (QL355T and TP)*
- *Bus programmable via GPIB, RS-232 or USB (P models)*
- *Duplicate power and sense terminals at rear (P models)*

Side Views



Rear Panel Connections



MODEL	O/Ps	Max V / Max A (see specs.)	Max. O/P Power	Bus Interfaces	Rear Terminals	Size (mm) * W x H x D	Weight (kg)	Input VA max.
QL355	1	35V / 5A	105W	No	No	140 x 160 x 290	5.4	250
QL355P	1	35V / 5A	105W	Yes	Yes	140 x 160 x 290	5.5	250
QL564	1	56V / 4A	112W	No	No	140 x 160 x 290	5.4	250
QL564P	1	56V / 4A	112W	Yes	Yes	140 x 160 x 290	5.5	250
QL355T	3	35V / 5A (x 2) plus auxiliary	215W	No	No	280 x 160 x 290	10.5	500
QL355TP	3	35V / 5A (x 2) plus auxiliary	215W	Yes	Yes	280 x 160 x 290	10.6	500

* Dimensions exclude feet and terminals

Technical Specifications

MAIN OUTPUT(S)

QL355, QL355P, QL355T, QL355TP

Max. Output Power: 105 watts
Output Ranges: Range 1 - 0 to 35V, 0 to 3A
Range 2 - 0 to 15V, 0 to 5A
Range 3 - 0 to 35V, 0 to 500.0mA

QL564, QL564P

Max. Output Power: 112 watts
Output Ranges: Range 1 - 0 to 56V, 0 to 2A
Range 2 - 0 to 25V, 0 to 4A
Range 3 - 0 to 56V, 0 to 500.0mA

All Models

Voltage Setting: By floating point numeric entry or rotary jog wheel; resolution 1mV.
Current Setting: By floating point numeric entry or rotary jog wheel; resolution 1mA or 0.1mA depending on range.
Setting Accuracy: Voltage - 0.03% \pm 5mV. Current 0.2% \pm 5mA/0.5mA
Output Mode: Operation in constant voltage or constant current modes with automatic cross-over and mode indication by LEDs.
DC Output Switch: Sets output voltage and current levels to zero when Off.
Output Terminals: 4mm terminals on 19mm (0.75") spacing.
Duplicated on rear terminal block (P versions only)
Load Regulation: <0.01% of maximum output for 50% load change
Line Regulation: <0.01% of maximum output for 10% line voltage change
Ripple and Noise: Typically <0.35mV rms CV mode, and <0.2mA rms CI mode (<20 μ A rms on 500mA range)
Transient Response: <20 μ s to within 15mV of setting for 90% load change
Temperature Coeff.: \pm (50ppm+0.5mV)/ $^{\circ}$ C (voltage)
Remote Sense: Eliminates up to 0.5V drop per lead. Remote sense operation selected from front panel and indicated by LED
Sense Terminals: Recessed sprung sockets for direct insertion of wires
Duplicated on rear terminal block (P versions only)

OUTPUT PROTECTION

Output Protection: Output will withstand forward voltages of up to 20V above rated output voltage. Reverse protection by diode clamp for currents up to 3A.
Fault Condition Trip: The output will be shut down if any of the four trip conditions listed below occur. In addition to the output being set to Off, an isolated rear panel signal is also activated.
Over Voltage (OVP): Settable 1V to 40V (QL355) or 62V (QL564) in 0.1V steps
Over Current (OCP): Settable 0.1A to 5.5A (QL355) or 4.4A (QL564) in 0.01A steps
Over Temperature: Monitors internal temperature rise to protect against excess ambient temperature or blocked ventilation slots.
Sense Error: Monitors the voltage between the remote sense terminals and output terminals to protect against mis-wiring.
Trip Output Signal: Isolated open-collector output signal on rear panel.

METERING

Display Type: Dual digital displays per output using 14mm (0.56") high brightness LEDs. 5 digits for voltage, 4 digits for current. Update rate 4 per second.
Meter Function: Voltage meter shows set voltage when in CV mode and measured voltage when in CI mode.
Current meter shows measured current when in CV mode and set current when in CI mode.
Limits Display: With the dc output switch set to Off, both meters show the set values (i.e. the limits). With the output On, either the voltage meter or current meter will show a measured value (depending on the CV/CI mode). Pressing the Limits button will provide a temporary display of the set values.
Watts (VxA) Display: The voltage meter can be made to show the instantaneous calculated product of voltage and current. The value displayed is equal to the equivalent power at the moment when the button is pressed and remains whilst the button is held.
Meter Resolution: Voltage: 1mV (CV mode) or 10mV (CI mode)
Current: 1mA or 0.1mA depending on range
Power: 0.01W or 0.001W depending on range
Meter Accuracy: Voltage: 0.1% of reading \pm 10 mV (CI mode)
Current: 0.2% of reading \pm 0.005A or 0.5mA (CV mode)
Power: 0.3% of reading \pm 0.05W or 0.005W

SETTINGS MEMORIES

Number of Stores: 10 (30 total on QL355T and TP) plus power-down store.
Memory Type: Non-volatile using EEPROM.
Parameters Stored: Range, Set volts, Set current, OVP, OCP.
Recall system: Settings are previewed onto the displays before being actioned.

LINK & COPY - QL355T & TP

Each output can be controlled independently or can be linked. When linked, keyboard and jog wheel control operates on both outputs simultaneously. Linked mode can be used to create tracking outputs, or for convenient series or parallel operation of the two outputs.
A Copy function is available which copies all of the settings for output 1 to output 2 (Range, Set volts, Set current, OVP, OCP).
Linked mode can also be used to store the settings for both outputs to a group of common memory stores when simultaneous recall is required.
(Note: Linked mode can be selected with differing voltage and current settings on the two outputs. However both outputs must be set to the same range.)

AUXILIARY OUTPUT - QL355T & TP

Output Voltage: Switchable 2.7V, 3.3V or 5.0V. Accuracy better than \pm 5%.
Output Current: >1.0A maximum. LED indication of over-current.
DC Output Switch: Sets output voltage level to zero when Off.
Output Terminals: 4mm terminals on 19mm (0.75") spacing.
Duplicate terminals at rear (P versions only)
Output Protection: Output will withstand up to 16 V forward voltage. Diode clamped for reverse voltages and 3 Amps reverse current.
Load Regulation: < 1% for 90% load change.
Line Regulation: < 0.1% for 10% line change.

BUS INTERFACES (P Suffix versions)

USB: Standard USB hardware connection. Supplied with device driver for Win98 or above. Operates as a virtual COM port.
RS-232: Variable baud rate 19,200 max. Single instrument or Addressable RS232 Chain (ARC) system.
 GPIB: Conforming with IEEE-488.1 and IEEE-488.2
N.B. All three interfaces incorporate full control, readback and status reporting.
Bus Type Selection: From front panel (GPIB/RS232/USB).
Address Selection: From front panel (1 to 31).
Baud Selection: RS-232 only. From front panel (600 to 19200 baud).
Setting Resolution: Voltage - 1mV, Current 0.1mA (0.01mA on 500mA range).
Readback Resolution: Voltage - 10mV, Current 1mA (0.1mA on 500mA range).
Accuracy: See specifications under Outputs and Metering.

Remote Command Response Time:

Interface: <80 ms (command processing time).
Output Voltage: Response time varies with range and load conditions. Typical time to settle to within 1% of the total excursion on a 35V/3A range with full load is <25ms. With no load it is <7 ms for an upward change and <600ms for downward.

GENERAL

Power Requirements: 230V or 115V \pm 10% (internally adjustable).
Installation category II. See table for VA rating.
Environmental: Operating Range: 5 $^{\circ}$ C to 40 $^{\circ}$ C, 20% to 80% RH
Storage Range: -40 $^{\circ}$ C to +70 $^{\circ}$ C
Size and Weight: See Table
Electrical Safety: Designed and manufactured to comply with IEC1010-1.
EMC: Designed and manufactured to comply with EN61326.
Benchtop Operation: Folding legs are incorporated that can be used to angle the front panel upwards when required.
Rack Mount Option: 19 inch 4U mount for up to three single output units or one triple plus one single. Blanking plates are available for unused sections.

Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice. Accuracy specifications apply for the temperature range 18 $^{\circ}$ C to 28 $^{\circ}$ C after 1 hour warm-up.

Designed and built in Europe by:



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