



# AIM & THURLBY THANDAR INSTRUMENTS

## LD400 & LD400P



### Electronic DC Loads - 80A, 80V, 400W

*constant current, resistance, voltage and power*

*transient generator, variable slew rate, soft start*

*current monitor output, analogue remote control*

*short term high power mode of up to 600 watts*

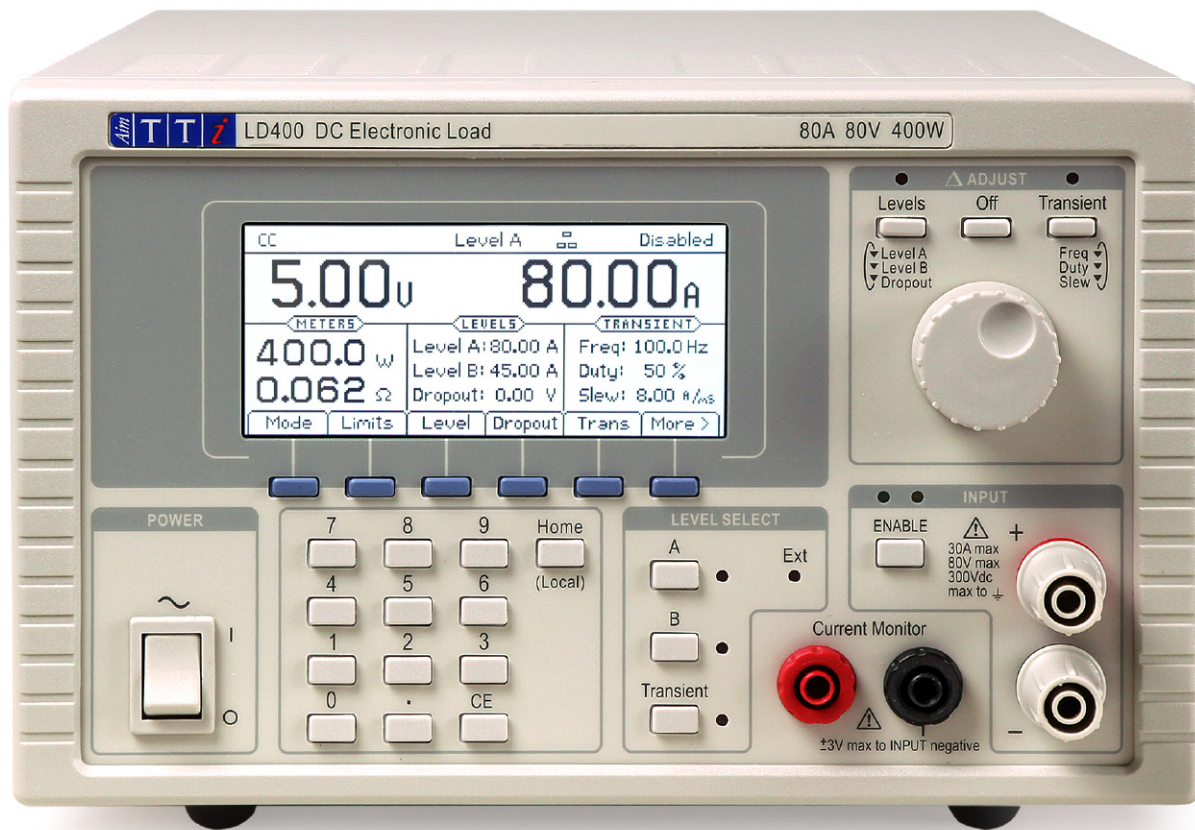
*thirty non-volatile memories for complete settings*

*USB, RS-232, GPIB and LAN interfaces (LD400P)*

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**Aim-TTi**



- ▶ Versatile solution for testing dc power sources
- ▶ Constant current, resistance, conductance, voltage and power modes
- ▶ Wide voltage and current range, 0 to 80V and 0 to 80A
- ▶ 400 watts continuous dissipation at 28°C (360W at 40°C)
- ▶ 600 watts short-term dissipation (up to 60 seconds)
- ▶ Low minimum operating voltage of <math><1V</math> at 40A
- ▶ High resolution and accuracy for level setting
- ▶ Built-in transient generator with variable slew
- ▶ Current monitor output for waveform viewing
- ▶ Variable drop-out voltage for battery testing
- ▶ High resolution backlit graphic LCD with soft key control
- ▶ Analog remote control of levels and TTL control of on/off and transient switching
- ▶ Front and rear input terminals (front terminals 30A max.)
- ▶ Full bus control via USB, RS232, GPIB and LXI compliant LAN interfaces (LD400P)

## Compact electronic DC load

The LD400 is an inexpensive electronic load which is suitable for testing and characterising a wide variety of dc power sources.

It can be used to investigate the behaviour of many different types of power source such as batteries and solar cells, as well as electronic power supply units.

Its wide voltage/current range, multiple operating modes and built-in transient generator give it the versatility to offer test solutions from the design laboratory through to the component test area.

The LD400P adds full bus remote control via USB, RS-232, GPIB and LAN (Ethernet) interfaces.

## Low minimum operating voltage

The LD400 can operate at voltages below 500mV for currents up to 10 amps. At higher currents the fixed minimum resistance (typically better than 25m $\Omega$ ) gradually raises the minimum operating voltage, but it remains below 1 volt up to 40 amps and below 2 volts up to 80 amps.

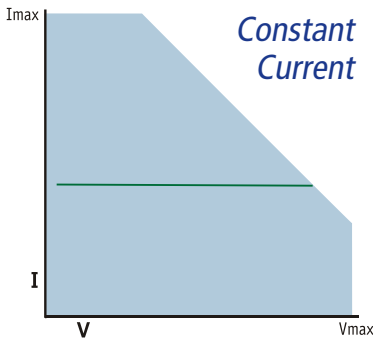
This low operating voltage allows it to be used for many low voltage applications for which other electronic loads are unsuitable.

## 600 watts intermittent power

The LD400 can operate at power levels up to 600 watts for periods of up to 1 minute.

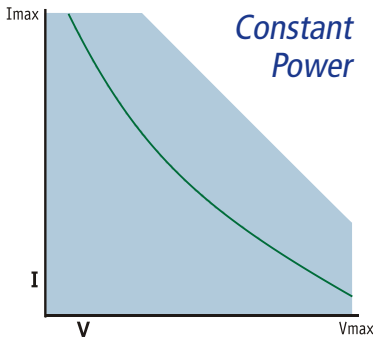
Short term loading can be sufficient for many testing applications and significantly extends the usefulness of the LD400.

## Multiple modes of operation

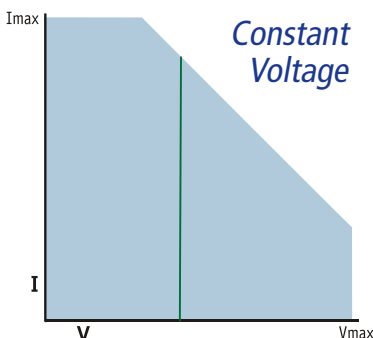


Constant current mode is used for load testing of normal voltage-source power supplies and for constant current discharge testing of batteries.

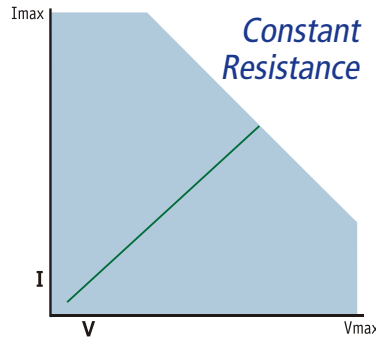
This mode provides rapid measurement of power source regulation (V/I characteristics).



Constant power mode simulates a load whose power consumption is independent of the applied voltage. This is true of many types of equipment that incorporate switch-mode regulators. This mode may be particularly suitable for testing power sources of portable devices such as Lithium-ion batteries.



Constant voltage mode is used for load testing of constant current power supplies. The unit operates as a high power shunt regulator.



Constant resistance mode simulates a standard resistive load by providing a current drain proportional to voltage. Settings are displayed in Ohms or milli-Ohms.

Unlike fixed resistors or rheostats, the load provides a precisely controllable resistance with high power dissipation and high temperature stability over a wide value range.

### Constant Conductance

Constant conductance (CG) mode is also incorporated.

As well as showing settings in amps per volt, this mode provides better resolution when setting very low equivalent resistance values.

### Adjustable voltage drop-out

Some power sources, such as rechargeable batteries, can be damaged if their output voltage falls below a certain level.

The LD400 provides automatic protection by incorporating fully variable voltage dropout (CI, CR, CG and CP modes).

*Resistive discharge (conductance mode) with voltage dropout.* Note that in CR mode the load performs the equation  $I = (V - V_d)/R$  where  $V_d$  is the dropout voltage.



If the voltage applied to the load falls below a preset level, the load current is rapidly reduced to zero.

## Transient generator and variable slew

The LD400 incorporates a full variable frequency, variable duty cycle transient generator.

Switching between the two preset levels can be done at any frequency between 0.01Hz and 10kHz. The transient generator can be used in all operating modes.

The rate of change between levels (slew rate) is controllable over a wide range.

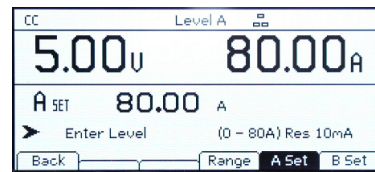
Slew rate control applies to all changes of level including remote control and manual changes between level A and level B.

A slow-start function can be selected for situations where latching would otherwise occur at switch-on.

## High resolution setting/measurement

The two operating levels for each operating mode are settable to high precision.

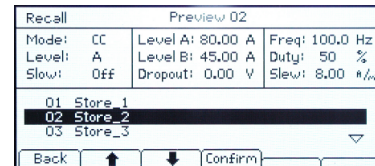
Levels are displayed using four digit meters which provide resolution down to 1mA, 1mV and 1mΩ.



The meters have an accuracy of 0.1% for voltage and 0.2% for current.

## Setting Memories

Thirty non-volatile memories are provided which store all of the parameters of the load.



This makes the LD400 highly suitable for repetitive test use.

## Remote control

The LD400 incorporates analogue remote control for all modes of operation. When "external voltage" is selected the level becomes linearly proportional to the voltage applied to the remote control inputs on the rear panel.

Any waveform can be used as the control voltage allowing complex load conditions to be simulated using, for example, an arbitrary waveform generator.

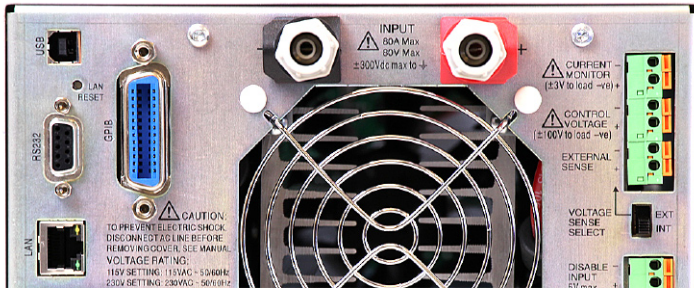
Alternatively, a logic signal can be used to switch between levels. When "external TTL" is selected, the level is switched between the two defined levels in response to an external logic signal.

The remote control inputs have a wide common mode range allowing the control voltage to be referenced independently of the load terminal voltages.

## Current waveform monitor

It is often important to be able to observe the load current waveform on an oscilloscope. The LD400 provides a calibrated monitor output for this purpose as well as a sync output from the transient generator.

The monitor output has several volts of compliance with respect to the load input, thus allowing it to be connected to a grounded oscilloscope without current diversion.



## LD400P - comprehensive bus remote control

To meet a wide variety of needs, the LX400P adds a comprehensive array of digital bus interfaces. RS-232, USB, GPIB and LAN (Ethernet) with LXI support are all provided as standard.

Each of the digital bus interfaces provides full control of and read-back of settings and status. The interfaces are at ground potential and are opto-isolated from the terminals.



The GPIB interface is compliant with IEEE-488.1 and IEEE-488.2. Currently GPIB remains the most widely used interface for system applications.



An RS-232/RS-423 interface is provided for use with legacy systems. This type of serial interface remains in common usage and is perfectly satisfactory for the control of load devices because data speed is not an issue.



USB provides a simple and convenient means of connection to a PC and is particularly appropriate for small system use. A USB driver is provided which supports Windows operating systems.



The LAN interface uses a standard 10/100 base-T Ethernet hardware connection with ICMP and TCP/IP Protocol for connection to a Local Area Network or direct connection to a single PC. This interface supports LXI and is highly appropriate for system use because of its scalable nature and low cost interconnection.



The LAN interface is LXI compliant. LXI (LAN eXtensions for Instrumentation) is the next-generation, LAN-based modular architecture standard for automated test systems managed by the LXI Consortium, and is expected to become the successor

to GPIB in many systems.

For more information on LXI and how it replaces GPIB, or operates along side it, go to: [www.aimtti.com/go/lxi](http://www.aimtti.com/go/lxi)

## IVI Driver

An IVI driver for Windows is included. This provides support for common high-level applications such as LabView\*, LabWindows\*, and HP/Agilent VEE\*.

\* LabView and LabWindows are trademarks of National Instruments.

HPVEE (now Agilent VEE) is a trademark of Agilent Technologies.

\* Windows is a trademark of Microsoft.

## INPUT SPECIFICATIONS

### Maximum Input Ratings

Current:	80 Amps max. through the rear panel terminals. 30 Amps max. through the front panel terminals
Voltage:	80 Volts max. while conducting current. Surge suppressors start to conduct at 120V (nominal), Max. non-repetitive surge energy: 80 Joules.
Power Continuous:	400 Watts max. up to 28°C, derating to 360 watts at 40°C.
<sup>(1)</sup> Power Short Term:	600 Watts max. up to 28°C, for up to 60 seconds on-time, with off time at least double the on time.
Min. Operating Volts:	<2V at 80A; typically equivalent to 25mΩ above 100mV (at 4A).
Off State Leakage:	<10 mA (including voltage sense circuit input resistance).
Reverse Polarity:	Diode will conduct; 80 Amps max.
Isolation Voltage:	± 300Vdc max, either load input to chassis ground.

### Input Terminals

Rear Panel Input:	Safety terminals accepting 5mm diameter wire, or 8mm spades up to 80 Amps max., or 4mm plugs at 30 Amps max.
Front Panel Input:	Safety terminals accepting 4mm diameter wire, 4mm plugs or 6.5mm spades up to 30 Amps max.

### External Voltage Sense

Connection:	Terminal block on rear panel. Sense selection by slide switch.
Input Impedance:	680kΩ each input to load negative.
Max. Sense Offset:	6V (allowance for backing-off supply for zero volt operation)

## OPERATING MODES

### Constant Current Mode (CC)

Current Ranges:	0 to 8 A (1 mA resolution) and 0 to 80 A (10 mA resolution).
Setting Accuracy:	± 0.2% ± 30 mA.
Regulation:	< 30 mA for 90% load power change (V > 2 Volts).
Temp. Coefficient:	< (±0.02% ± 5 mA) per °C.
<sup>(2)</sup> Slew Rate Ranges:	8 A range: <2.5 Amp per s to >250 Amp per ms. 80 A range: <25 Amp per s to >2500 Amp per ms.
<sup>(3)</sup> Min. transition time:	50 μs.

### Constant Power Mode (CP)

Power Range:	0 to 400 (or 600) Watts.
Setting Accuracy:	± 0.5% ± 2 W ± 30mA).
Regulation:	< 2% over 5 V to 75 V source voltage change (using remote sense).
Temp. Coefficient:	< (± 0.1% ± 5 mA) per °C.
<sup>(2)</sup> Slew Rate Ranges:	<40 W per s to >6000 W per ms.
<sup>(3)</sup> Min. transition time:	150 μs.

### Constant Resistance Mode (CR)

Resistance Ranges:	0.04 to 10Ω (0.01Ω resolution); 2 to 400Ω (0.1Ω resolution).
Setting Accuracy:	±0.5% ± 2 digits ± 30 mA.
Regulation:	< 2% for 90% load power change (V > 2 Volts, using remote sense).
Tem. Coefficient:	< (±0.04% ± 5 mA) per °C.
<sup>(2)</sup> Slew Rate Ranges:	10Ω range: <1Ω per s to 100Ω per ms. 400Ω range: <40Ω per s to 4000Ω per ms.
<sup>(3)</sup> Min. transition time:	150 μs.

### Constant Conductance Mode (CG)

Conductance Ranges:	<0.01 to 1 A/V (1 mA/V resolution); <0.2 to 40 A/V (0.01 A/V resolution).
Setting Accuracy:	± 0.5% ± 2 digits ± 30 mA.
Regulation:	< 2% for 90% load power change (V > 2 Volts, using remote sense).
Temp. Coefficient:	< (±0.04% ± 5 mA) per °C.
<sup>(2)</sup> Slew Rate Ranges:	1 A/V range: <0.1 A/V per s to >10 A/V per ms. 40 A/V range: <4 A/V per s to >400 A/V per ms.
<sup>(3)</sup> Min. transition time:	150 μs.

### Constant Voltage Mode (CV)

Voltage Ranges:	Vmin to 8 V (1 mV resolution) and Vmin to 80 V (10 mV resolution). Vmin depends on current: typically <2V at 80A
Setting Accuracy:	± 0.2% ± 2 digits.
Regulation:	< 30 mV for 90% load power change (using remote sense).
Temp. Coefficient:	< (0.02% + 1 mV) per °C.
<sup>(2)</sup> Slew Rate Ranges:	8 V range: <0.8 V per s to >80 V per ms. 80 V range: <8 V per s to >800 V per ms.
<sup>(3)</sup> Min. transition time:	150 μs.

## TRANSIENT CONTROL

### Transient Generator

Pulse Repetition Rate:	Adjustable from 0.01Hz (100 seconds) to 10kHz.
Pulse Duty Cycle:	1% to 99% (percentage of period at Level A).
Setting Accuracy:	± 1 %

### Slew Rate Control

The slew rate control applies to all changes of level whether caused by manual selection, remote control or the transient generator. The level change is a linear slew between the two level settings. The range available in each mode is shown above.

Setting Accuracy:	± 10% (on linear part of slope, excluding high frequency aberrations).
Variation in Level Settings:	± 5 digits of specified setting resolution for present mode and range.

### Oscillator Sync Output

Connection:	Terminal block on rear panel. Opto-isolated open collector output conducts during Level B phase of internal transient generator.
Ratings:	Max Off State Voltage: 30V. Collector Current: 2mA (typical).

# LD400 & LD400P - Technical Specifications (continued)

## DROPOUT VOLTAGE

The load will cease to conduct if the applied voltage falls below the Dropout Voltage setting; active in all modes except Constant Voltage. The Dropout Voltage setting is also the threshold for the Slow Start facility and acts as an offset voltage in Constant Resistance mode.

Setting Accuracy:  $\pm 2\% \pm 20\text{mV}$ .

### Slow Start

If Slow Start is enabled, the load will not conduct any current until the source voltage reaches the Dropout Voltage setting; it will then ramp the controlled variable up (in CC, CP and CG modes) or down (in CR and CV modes) to the Level setting at a rate determined by the Slew Rate setting..

## METER SPECIFICATIONS

Display Type: 256 x 112 pixel backlit graphic LCD.

### Measured Values

Volts & Amps: Measured values of current through and voltage across the load.  
Watt & Ohms: Power and equivalent load resistance, calculated from Volts and Amps.  
Voltage Accuracy:  $\pm 0.1\% \pm 2$  digits.  
Current Accuracy:  $\pm 0.2\% \pm 3$  digits.

## CURRENT MONITOR OUTPUT

Output Terminals: 4mm safety sockets on front panel or terminal block on rear panel.  
Output Impedance: 600 $\Omega$  nominal, for  $>1\text{M}\Omega$  load (e.g. oscilloscope)  
Scaling: 50mV per Amp (4 Volts full scale).  
Accuracy:  $\pm 0.5\% \pm 5\text{mV}$ .

## REMOTE CONTROL (All Models)

### External Control Input Characteristics

Connection: Terminal block on rear panel.  
Input Impedance: 400k $\Omega$  each input to load negative.  
Common Mode Range:  $\pm 100\text{V}$  to load negative.

### External Analogue Voltage Control

Operating Mode: The applied voltage sets the operating level within the selected range.  
Scaling: 4 Volts full scale.  
Accuracy:  $\pm 2\% \pm$  accuracy of selected range.  
Common Mode Rejection: Better than -66dB.

### External Logic Level (TTL) Control

Operating Mode: The applied signal selects between Level A and Level B settings.  
Threshold: + 1.5V nominal. A logic high selects Level B.

### Remote Disable Input

Connection: Terminal block on rear panel.  
Input to the LED of an opto-isolator through 1k $\Omega$  resistor.  
Threshold: Apply +3 to +5 V to disable load input.

## REMOTE CONTROL (LD400P only)

### Digital Remote Interfaces

The LD400P model provides LAN, USB, GPIB and RS232 interfaces for full remote control.  
LAN: Ethernet 100/10base-T connection with auto cross-over detection.  
LXI v1.4 Core 2011 compliant.  
USB: Standard USB 2.0 connection. Operates as virtual COM port.  
GPIB: Conforming to IEEE488.1 and IEEE488.2.  
Capabilities: SH1, AH1, T6, L4, SR1, RL2, PP1, DC1, DT0, C0, E2.  
RS232: Standard 9-pin D connection. Baud rate: 9600.

## PROTECTION

Excess Power: The unit will attempt to limit the power to approx 430 Watts; if this fails the unit will trip into the fault state at about 460 Watts. If intermittent mode operation is enabled, these levels are 610W and 630W.  
Protection Current: The input is disabled if the measured current exceeds a user set limit.  
Excess Current: The unit will trip into the fault state at nominally 92 Amps.  
Protection Voltage: The input is disabled if the measured voltage exceeds a user set limit.  
Excess Voltage: The unit will conduct a current pulse (to absorb inductively generated spikes) for 1ms at about 90V.  
The unit will trip into the fault state at nominally 106V  
Surge suppressors will start to conduct above 120V.  
Temperature: The unit will trip into the fault state if the heatsink temperature exceeds safe levels.  
Sense Error: The unit will trip into the fault state if the external voltage sense is more than 6V below the internal sense.

## GENERAL

AC Input: 110V-120V or 220V-240V AC  $\pm 10\%$ , 50/60Hz. Installation Category II.  
Power Consumption: 30VA max. Mains lead rating 6A.  
Operating Range: + 5°C to + 40°C, 20% to 80% RH.  
Storage Range: - 40°C to + 70°C.  
Environmental: Indoor use at altitudes up to 2000m, Pollution Degree 2.  
Cooling: Variable speed fan. Air exit at rear.  
Safety: Complies with EN61010-1 and EN61010-2-030.  
EMC: Complies with EN61326.  
Size: 130mm H (3U) x 212mm W (1/2 rack) x 435mm D.  
Weight: 5.7 kg.  
Option: 19-inch rack mount kit.

### Specification Notes

- (1) In 600 Watt short-term operation mode the dynamic response is not specified, and both the slew rate and the transient oscillator frequency range are restricted. The slew rate limitation applies also to external voltage control. This mode is primarily intended for limited duration operation at a fixed level setting.
- (2) Slew Rate Ranges refer to the theoretical slope of the transition between two levels, regardless of whether that transition can be achieved when taking into account the level difference, the set transition duration, the minimum transition time, and the characteristics of the source.
- (3) Minimum Transition Time specification is an indication of the fastest available transition using a benign battery source and low inductance connections, with a minimum terminal voltage of 5V and a minimum current of 1A. The actual performance attainable with electronically regulated power supplies depends on the combination of source and load loop bandwidths and interconnection inductance.

*Accuracy specifications apply for 18°C – 28°C, at 50W load power (in normal 400W mode), after 30 minutes operation at the set conditions; regulation specifies variation at other powers. Setting accuracies apply with slew rate at the 'Default' setting.*

*Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice.*

Designed and built in Europe by:



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