Manatronics

4kW Electronic Load

For Telecom Rectifier
and Power Supply testing

10th March 2016 | Model No. PT04-48 | Product Datasheet

- **Quality Product**
- **Rugged and Reliable Design**
- **Current control from 0 to 70A on 64V Range**
- **Current control from 0 to 135A on 32V Range**
- **4kW plus rating (at 40℃ ambient)**
- **Cost effective; simple robust design**
- **CC, CP, CR and CV modes as standard**
- **Current control from either ATE with 0 - 5V demand input or from a Remote Control Box (both standard)**
- **Ultra Low electrical noise**
- **Selectable Range 64V or 32V**
- **Temperature controlled quiet fans**
- **19 Inch Rack case 4U**

Description

This model has been developed to accommodate testing of both 48V and 24V telecommunications power systems or Power Supplies. It is also useful as a general-purpose variable Load. Its founding principle is simplicity – ease of use, enhanced reliability, greater value for money and wider applicability.

This Load is continuously rated to operate fully over the specified Current and Voltage ranges.

The standard model gives constant current control, with a differential 0 - 5V input for simple control systems, or can be paralleled for use in large systems.

Constant Power, Resistance and Voltage modes are standard, as well as full ATE/remote control. The D9 connector on the rear panel provides access to the analogue demand input, and all logic controllable functions and status lines.

4kW Electronic Load

64V Range

Absolute Maximum Ratings

DC Input Voltage ……..…. -0.5 to +72V
DC input current ……. 71A
Max Voltage between the chassis and the DC connector (SB350) ……. 50V ac or 120Vdc

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the unit. This is a stress only rating and operation of the unit at or above these limits is not implied.

Electrical Specifications (for 64V range; assumes TA= -10°C to +40°C unless otherwise stated)

Parameter	Min	Typ	Max	Units	Comments
DC Input Voltage	0		70	V	
DC Input Current	0		70	A	
Common to all Modes (e.g. CC, CP, CR and CV).					
Min Voltage required to achieve max current		45.5		V	(see next line)
Minimum series resistance		0.65		Ohm	
Constant current Mode					
Current range	0		70	A	
Demand sensitivity		14		A/V	I.e. 5V demand input gives 70A.
Demand sensitivity tolerance		+/-0.1		%	
Constant power mode					
Power range	1		4,900	W	At 70V input
Demand sensitivity		1140		W/ V	1V demand input sets 1140W load.
Constant resistance mode					
Resistance range	0.66		1,000	Ohm	
Demand sensitivity					See constant resistance mode text.
Constant voltage mode					
Voltage range	6		70	V	
Demand sensitivity					See constant Voltage mode text.

N.B. Modes are CC CP CR or CV. Ranges are 64V or 32V.

32V Range

Absolute Maximum Ratings

DC Input Voltage …… -0.5 to +39V
DC input current …… 136A

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the unit. This is a stress only rating and operation of the unit at or above these limits is not implied.

Electrical Specifications (for 32V range) (assumes TA= -10°C to +40°C unless otherwise stated)

Parameter	Min	Typ	Max	Units	Comments
DC Input Voltage	0		35	V	
DC Input Current	0		135	A	
Common to all Modes (e.g. CC, CP, CR and CV).					
Voltage needed to achieve maximum current	22.3			V	
Minimum series resistance		.165		Ohms	
Constant current mode					
Current range	0		135	A	
Demand sensitivity	-.05%	28	+.05%	A/V	i.e. 5V demand input gives 140A
Constant power mode					
Power range	0.6		4,725	W	At 35V input
Demand sensitivity		1140		W/ V	1V demand input sets 1140W load.
Constant resistance range					
Resistance range	0.17		1,000	E	
Demand sensitivity					See constant resistance mode text.
Constant voltage range					
Voltage range	6		35	V	
Demand sensitivity					See constant Voltage mode text.

Common Specification to both 64V and 32V Ranges

Absolute Maximum Ratings

Logic input signals on rear D9 connector
Range Input Voltage …… -2.0 to +14V wrt to Load DC –ve.
Enable Input Voltage ……... -2.0 to +14V wrt to Load DC –ve.
Mode select (LSB) Input Voltage …… -2.0 to +14V wrt to Load DC –ve.
Mode select (MSB) Input Voltage …… -2.0 to +14V wrt to Load DC –ve.

Fault output Voltage ……. -2.0 to +16V wrt to Load DC –ve.

Demand inputs (+/-) ……..…….. -10 to +10V wrt to Load DC –ve.

0V reference on D9 connector …… 50mA

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the unit. This is a stress only rating and operation of the unit at or above these limits is not implied.

Electrical Specifications (assumes TA= -10°C to 40°C unless otherwise stated)

Demand input	**Min**	**Typ**	**Max**	**Units**	**Comments**
CMRR of differential demand input stage		50		dB	For DC
Common mode range of differential demand input stage	-10		+10	V	wrt load -ve DC input
Demand current; temperature drift.		0.5		%	Over the temperature range
Demand current offset		15		mA	
Demand current linearity		0.2		%	
Demand Voltage, 3dB cutoff frequency, for CC, CP and CR Modes.		800		Hz	can be increased at factory up to 20kHz.
Demand Voltage, step response, for CC, CP and CR Modes.		1		mS	10% to 90% rise or fall
Demand Voltage, 3dB cutoff frequency, for CV Mode only.		1.59		Hz	
Logic inputs					
Range Input Voltage (High Level)	7			V	Internal pull up resistor 3k3 to +12V
Range Input Voltage (Low Level)			4	V	
Enable Input Voltage (High Level)	10			V	Internal pull up resistor 2k2 to +12V
Enable Input Voltage (Low Level)			7	V	
Mode select (LSB or MSB) Input Voltage (High Level)	7			V	Internal pull up resistor 22k to +12V
Mode select (LSB or MSB) Input Voltage (Low Level)			3.5	V	

Warning: Observe correct polarity on the rear SB connector.

If the Load is enabled, a very high current will be drawn if the DC connections are reversed. This may damage the SB connector.

Note: Always ensure that the ENABLE / OFF switch is in the OFF position before connecting or disconnecting to the rear SB connector. Also set the Coarse and Fine knobs to fully anti-clockwise.

	Min	Typ	Max	Units	Comment
Logic outputs					
Fault output high (Iout = 10uA)		11		V	
Fault output low (active) (sink 30mA)		1.2		V	
Dynamic Characteristics					
Noise and ripple, psophometric		0.7		mA	RMS
Noise and ripple, psophometric		0.1		mV	RMS see note 1.
Noise and ripple, wideband		3		mA	RMS
Noise and ripple, wideband		0.2		mV	RMS see note 1.
Settling time, 0 – 100A step		300		uS	
DC Input Resistance of load		1		Meg Ohm	

Note 1. Measured at the DC input terminals with a 24V battery connected in CC mode.

PHYSICAL AND OTHER SPECIFICATIONS

	Min	Typ	Max	Units	Comment
Dimensions	482.6 wide x 177.8 high x 345 deep			mm	
Weight	16			kg	
Dimensions	19 wide x 7 high x 13.6 deep			inches	
Weight	35			lb.	
Rated AC line power supply Voltage (if factory set for nom 240V ac) see rear panel label.		240		V ac	RMS
Rated AC line power supply Voltage (if factory set for nom 120V ac) see rear panel label.		120		V ac	RMS
Mains Freq.	50		60	Hz	

Specifications herein, are subject to change without notice. This publication supersedes and replaces all information previously supplied.

Physical description and user controls

The standard model Load is housed in a 4U 19 inch rack case. The weight has been minimised for ease of relocation. Two fans are situated at the front panel of the rack unit to provide forced air cooling.

The following parts are located on the rear panel:

- The exhaust vents for the forced air cooling – KEEP FREE FROM OBSTRUCTIONS.
- D9 male and female connectors for control from either the remote control box or from ATE control. These are connected in parallel for ease of daisy chaining external 9 way cables if using several Loads in parallel.
- Two off DC power connectors (Anderson 350 Amp power lock) for DC connection to the Load. These are connected in parallel for ease of daisy chaining external heavy-duty cables if using several Loads in parallel. Either connector may be used alone, for single Load operation.
- IEC power connector. A label states the rated AC mains Voltage 110V or 230V options.
- A fuse holder for the mains fuse.

On the front panel:

- Twin vents for the cooling air intake – KEEP FREE FROM OBSTRUCTIONS.
- Three LED's, that indicate (1) that the AC mains power is applied and that, the internal power supply is on. (2) That the Load is enable by the remote control box or from ATE control. (3) That the 32V Range has been selected.

Internally:

- An alarm beeper which is audible outside the unit. This is to indicate either one of three conditions, i.e. reversed DC input polarity, an over Voltage on the DC input, e.g. 54V input on the 32V range, or for an over temperature condition on the FET heatsink or on the internal power resistors.

The Remote Control Box has the following controls:

- COARSE adjust knob.
- FINE adjust knob.
- Load ENABLE/OFF Switch.
- 32/64 Range Switch.
- Four position Mode switch, i.e. CC, CP, CR, and CV.
- 1.8 m long D9 extension cable 9 way.

Using the Load

Operation is very simple and intuitive. When operating the Load within the maximum rated Voltage for the range and with adequate ventilation with the ambient temperature within the operating temperature range, the Load cannot be over stressed.

A basic set up would consist of an external DC Power Source to be tested, (e.g. a power supply, a Telecomm rectifier, individual battery or battery strings), connected to the Loads DC power connectors (Anderson 350 Amp power lock). With the Remote Control Box connected to the Load for the control.

The following sequence is a preferred method of connecting the Load and controlling the Load. The unit is however fully protected against any accidental combination of control.

Sequence:
Connect the AC mains to the IEC connector set the range and mode as required set both the COARSE and FINE demand knobs fully anti-clockwise (i.e. to zero current), set the Load ENABLE/OFF Switch to OFF. Connect the DC Power Source under test to the 350A Power Connector, then Switch on the DC power source. Switch the ENABLE/OFF Switch to ENABLE and turn up the demand knobs on the Remote Control Box for the desired current level.

CAUTION: It is NOT recommended to disconnect the DC power input 350 Amp connector whilst current is flowing. This will result in a large arc being drawn on the connector. To guard against this, always ensure that the ENABLE/OFF Switch is OFF before disconnecting the DC Power input.

DANGER*: If the DC Power source under test can supply more than 60V then this is above the level allowed for SELV (safe extra low voltage). When this Voltage is connected to the Load, it is possible to touch this voltage on the other power lock connector – with a risk of electric shock.*
Do not operate the Load with any part of the case removed.

Description of Operation

The demand input Voltage is fed into a fully differential amplifier. Typically, this demand voltage comes from the coarse and fine demand knobs on the Remote Control Box, which are supplied from a stable reference voltage. Alternatively, the Voltage demand can be generated externally and fed into the Load demand input pins. The common mode range of this differential input is limited as given in the specification table.

When using more than one Load in parallel, the 0V pins on the D9 connector may be commoned together. If one of the Loads DC Power connector should become accidentally disconnected, protection is provided.

The standard CP, CR and CV modes are realised by the use of an analogue processor circuit between the differential amplifier and Load control circuit. This processor measures the DC input Voltage to the Load, then generates a current demand which gives the required level for the power, resistance or Voltage that has been demanded. The Mode control may be changed whilst the Load is sinking current. The Load has in-built protection for this. However, to protect the external DC power source under test from any short lived current surges, either turn down the demand knobs on the Remote Control Box or decrease the input demand Voltage to 0V, else switch the Load enable to OFF, then change modes and then switch the Load back to enable.

Changing the Voltage range is also protected against with Load current being drawn. The clamp circuit holds the Load current to zero whilst the Power resistors change over. If the Load is switched from the 64V to the 32V range and the Overvolt is exceeded for the 32V range, then no current will flow and the alarm beeper will sound and the fault output will be activated. A time of 100mS should be allowed, (for Range change over and release of protection clamps), before the current will settle to its new value after any of the following conditions occur:

- first enabling the Load
- powering up the Load
- applying DC input Voltage
- changing the Voltage Range (64V/32V)
- following an Over Voltage on the DC input
- following an Over Temperature shut down
- after a low mains dip (brown out), or momentary mains off.

ATE control of the logic inputs is available on the D9 connector on the rear of the case. This gives full control over the Load and includes Load enable, 64V or 32V range control, CC, CP, CR or CV mode control, Analogue demand input 0 – 5V and access to the fault output. Large Voltage signals are used for excellent noise immunity on the logic inputs. Control inputs to the Load are pulled high internally from 12V. These can be operated by open collector relay drivers – large logic levels are used for enhanced noise immunity.

Pin out for the D9 connector:

D9 pin	**Function**
1	Demand input +ve
2	Demand input -ve
3	0V
4	64V / 32V Range (low for 64V)
5	Fault output (active low)
6	Load +ve output monitor
7	Enable (active low)
8	Mode MSB
9	Mode LSB

The fault output is active low when any of the following conditions occur:

- over temperature
- over Voltage on the DC input
- negative DC input Voltage (i.e. reverse polarity)
- saturation of the power MOSFETs (i.e. the Load can no longer regulate the current or power or resistance that is being demanded.

Any of the above conditions can be disabled at the factory if requested. By default, they are all active.

Truth table for the Mode control.

	MSB	LSB
CC	1	1
CP	0	1
CR	1	0
CV	0	0

The fans speed is controlled and is based on the current demand and/or the heatsink temperatures. After a period of the Load not drawing any current e.g. the DC input Voltage is zero or the enable is off, the fans will completely switch off. This provides a silent Load during non-use. It also extends the life even further of the already long life, high quality fans.

An over temperature alarm monitors the heatsink temperatures, if it exceeds a pre-set limit then the alarm beeper is sounded, the fault output is activated and the Load current is clamped to zero Amperes until the temperature has reduced sufficiently. This alarm has been included to protect against misuse; e.g. an external blockage to the inlet or exhaust vents. This alarm will NOT occur during normal operation. The selection of the FET types together with the design of the heatsinks are such as to ensure that the FET junction temperatures are held to a level to assure long life and high reliability. The heatsink temperatures are tested on every unit whilst soaked at maximum FET dissipation as one of the Quality Assurance checks.

Operating power is drawn from the AC mains. All Load circuitry is isolated from mains earth (Chassis). The chassis is connected to mains earth for Safety.

Constant Current Mode

The constant current mode is the basic operating mode of the Load. All other modes make use of the same current-control method described here.

In this mode the Load acts as a programmable current sink:

for the 64V range

$$I_{Load} = V_{demand} * 14$$

for the 32V range

$$I_{Load} = V_{demand} * 28$$

On either Voltage range, the maximum current is achievable with the Remote Control Box demand knobs turned fully up (i.e. clockwise).

Variations from the "I Load = I demand" will occur under the following conditions:

- The current limit of the Load has been reached.
- The FET's have become fully saturated. It is impossible to get more current than the internal Power resistors will limit to – in other words trying to operate below the diagonal line (into the "Unavailable Area"), in the Range Operating Graphs at the end of this datasheet. This is regardless of whether the demand knobs are turned up further or if being used, the DC demand Voltage is increased above 5V. This condition is indicated by activation of the Fault output.
- If the Current Limit on the DC source being applied is reached. It is not possible to draw more current than the source can supply. This condition is indicated by activating the Fault output.
- If the DC power source input has reverse polarity – this is protected against, virtually no current will flow, IF the load is not enabled. This condition is indicated by activating the Fault output.
- If the DC power source input Voltage exceeds the absolute maximum rating, the Load current will be clamped to zero Amps. The Load is protected against this condition. This condition is indicated by activating the Fault output.
- Excessively low mains, severe brown outs, or temporary loss of mains.
- Over temperature on the FET heatsinks. The Load is protected against this condition. This condition is indicated by activating the Fault output.
- If the DC power source under test is disconnected or is powered down.

Applications:

- Production testing of Rectifier / Power supplies for Quality Assurance.
- Burn-in room testing of Rectifier / Power supplies.
- Development of new Power Supplies at various output currents.
- Efficiency measurements over the full load range.
- Measurements of Power Factor Correction over the full load range.
- Measurements of DC to DC converter loop transfer characteristics.
- Checking current fold-back characteristics.
- Measurements of Load regulation over the full load range.
- Measurements of Power supply output noise, both wideband and psophermetric (audible band), output power limiting characteristic.
- Measurements of DC to DC converter loop stability, over the full load range.
- Power supplies component stress testing over the full load range.
- Measurements of hold up time testing at full load.
- Capacity testing of Batteries or Battery Strings.
- Research and development of "Fuel Cells".
- Simulation where current draw is the specified parameter.
- Loading of a Unit under test with a known current, without the need to log the current continuously because it remains constant.
- Battery charging and discharge tests where constant current is specified (e.g. Ni-Cad fast charging).

Constant Power mode

$$I_{Load} = P_{demand} / V_{dc\ in}$$

The constant power circuit has an accurate constant power characteristic over the specified Voltage range. CP is also subject to the same conditions, as in CC mode above, that will cause variation from the demand being set by Vdemand input to the Load. Selection of CP mode is by the rotary switch on the Remote Control Box or form ATE control via the rear D9 connector.

The input is calibrated to approx 1,139.53 Watts = 1V on the demand input, so

$$P_{demand} = V_{demand} * 1139.53W$$

and

$$I_{Load} = V_{demand} * 1139.5W / V_{dc\ in}$$

These apply for either 64V or 32V ranges.

Applications:

- Simulating constant power Loads e.g. DC to DC converters.
- Checking power supply load lines.
- Simulating downstream switching regulators.
- Battery discharge tests where a constant power Loads is specified.

Constant Resistance mode

$$I_{Load} = V_{dc\ in} / R_{demand}$$

The constant resistance circuit has an accurate constant resistance characteristic over the specified Voltage range. CR is also subject to the same conditions, as in CC mode above, that will cause variation from the demand being set by Vdemand input to the Load. Selection of CR mode is by the rotary switch on the Remote Control Box or form ATE control via the rear D9 connector.

Note: This function is actually the inverse of resistance control (i.e. "constant conductance"). This keeps the sense of the control from the Remote Control Box correct; (i.e. both knobs turned fully up gives maximum current).

The input is calibrated as given below. As this is really a constant conductance mode, then the resistance is inversely proportional to the demand Voltage; i.e. at a demand input of 1V gives 2.885 Ohms and 2V gives 1.442 Ohms etc.

$$R_{demand} = 2.885V / V_{demand},$$

and

$$I_{Load} = V_{dc\ in} * V_{demand} / 2.855V$$

This applies for either 64V or 32V ranges.

Applications:

- Characterising a power supplies current / Voltage curves from normal constant voltage operation into current limit without having to switch modes.
- Battery discharge tests where a Resistive Load is specified.

Constant Voltage mode

In constant voltage mode the Load acts as a shunt regulator, sinking whatever current is required to maintain its terminals at the demand Voltage.

On the 64V range where 5V input on the demand input corresponds to 82.1V, so

$$V_{regulation} = V_{demand} / 5V * 82.1V$$

(82.1V is just the scaling factor; it is not achievable as it is above the maximum DC input Voltage allowed).

On the 32V range where 5V input on the demand input corresponds to 41.1V, so

$$V_{regulation} = V_{demand} / 5V * 41.1V$$

(41.1V is just the scaling factor; it is not achievable as it is above the maximum DC input Voltage allowed).

This control is not as harsh as it may seem, due to the *"active"* output impedance of most rectifiers, (to aid passive current sharing), it is possible to adjust the control to a particular current level.

The constant voltage circuit has accurate constant voltage operation over the specified range. CV is also subject to the same conditions, as in CC mode above, that will cause variation from the demand being set by Vdemand input to the Load. Selection of CV move is by the rotary switch on the Remote Control Box or form ATE control via the rear D9 connector.

The response to fast transients is slowed in this mode by increased filtering on the demand input to this function.

Applications:

- Use as a Voltage shunt regulator when used in conjunction with an external constant current source.
- checking power supplies current limiting circuit stability when shorted into various Voltages, e.g. when a LVD reconnects to battery strings at different Voltages (i.e. different states of charge). In addition to the Load, this test requires a contactor, a bank of capacitors and a small current source. Please contact us for details.
- battery discharge tests where the need exists to stop the test at a certain Voltage – to limit the current in this case you may use a second Manatronics Load in series as a high powered current limit. Alternatively, it may be possible to reduce the current limit in the Load to the current required for the discharge test. Please contact us for details.

Stability

In almost all practical cases, the Load operation is stable. However, as with other Loads if there is excessive series external lead inductance from the DC power source, this may cause instability. Large filter chokes may also have the same affect. Operation of the

Load in the unlikely case of instability should be avoided.

Operating several Loads in parallel

Multiple Loads can be paralleled. These can all be controlled by a common 0-5V demand input signal. Stability is assured in constant current mode. Sharing occurs intrinsically (each Load just draws as much current as the demand input requests. The CP and CR mode performs in a similar way.

It is always difficult to get CV modes to share evenly. Controlled wiring resistance can assist with even sharing. This does not present a problem, if one of the Loads does go into current limit, it is continuously rated for this condition, and the overall Voltage control will be maintained.

Ordering Information

Model number: PT04-48 / 230 (for 230V mains version)

Model number: PT04-48 / 110 (for 110V mains version)

EMC and Safety Approvals

This model conforms with the EU conformity marking requirements, (CE mark). This model conforms with the following standards:

EN 61010-1 (Safety)
EN 61326 (Immunity and Emissions)

and provisions of the low Voltage directive and the EMC directive plus applicable amendments.

Type of EMC test	Test Spec	
Radiated emissions	CISPR 22:1997	CLASS B
Conducted emissions	CISPR 22:1997	CLASS B (but intended for industrial use only Class A).
ESD	IEC 1000-4-2	4kV / 4kV contact/ air
Radiated immunity	IEC 1000-4-3	3V/m criteria B
Conducted immunity		
EFT	IEC 1000-4-4	1kV

For Australia and New Zealand "Communication Friendly Certification" (C-tick) our Supplier Code Number is Z094.

Environment

Pollution Degree 2
Transient overvoltage according to Installation Category II
Class 1 Equipment
Intended for Indoor use only
Altitude 2000m maximum.
Ambient temperature range 5C to 40C
Maximum relative humidity 80% for temperature up to 31C, de-rate linearly to 50% at 40C.
Mains Voltage supply fluctuations not to exceed +/- 10% of the nominal Voltage.
A Protective Earth must be connected to this unit by way of an IEC mains cable and a suitable building mains outlet.
Adequate ventilation must be allowed both at the front and rear of the unit to allow for air flow, for example an unimpeded area equivalent to 400 x 150 mm from the rear vent, into an open room.

DANGER*: Be aware that the voltages above 60V are above the level allowed for SELV (safe extra low voltage) equipment. This Voltage level may be present from the DC source under test and connected to the Load. It is possible to touch this voltage on the other power lock connector – risking electric shock.*
Do not operate the Load with any part of the case removed. This equipment is not intended to be operated by untrained personnel for these reasons.

WARNING: The rear panel vent can reach high temperatures when the load is operated at high power for extended periods.

WARNING NOTE TO USER: If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

PT04-48 Available Operating Areas for 64V and 32V Ranges.