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9kmw

OPERATING MANUAL

600 WATT ELECTRONIC LOAD MODULE
HP MODEL 60504B

HP Part No. 60504-90009

OTS LIBRARY

FOR MODULES WITH SERIAL NUMBERS:
3121A-00101 AND ABOVE

Microfiche Part No. 60504-90010

Printed: June, 1991

600-Watt Module

About This Manual

This manual provides information for the HP 60504B 600-Watt Electronic Load Module. It is designed as a supplement to the the HP 6050A/6051A Multiple Input Mainframe Electronic Load Operating Manual (part number 06050-90001). Four tables provide the following module-specific information:

Table 60504-1 lists both the specifications and supplemental characteristics of the module. Specifications indicate warranted performance in the 25°C ± 5°C region of the total temperature range (0 to 55°C). Supplemental characteristics indicate nonwarranted, typical performance and are intended to provide additional information by describing performance that has been determined by design or type testing.

Table 60504-2 lists the ranges that can be programmed in constant current, constant resistance, and constant voltage modes. It shows the maximum and minimum programming values for each range. Refer to this table when programming the module locally as described in chapter 4, or remotely as described in chapter 5 of the operating manual.

Table 60504-3 gives the factory default values of the module. Unless you have saved your own wake-up settings, the module will be set to the factory default values whenever power is applied. See chapter 4 in the operating manual.

Table 60504-4 provides calibration information for the module. This information is needed to perform the annual calibration procedure described in chapter 6 of the operating manual.

Module Installation and Operation

Except for the module-specific information in this manual, all installation, operation, and calibration instructions are given in the Mainframe Operating Manual. The HP Electronic Load Family Programming Reference Manual (part number 06060-90005) contains complete programming details that apply to all Electronic Load models.

Note The following information in chapter 2 of the Mainframe Operating Manual does not apply to electronic load modules with the serial numbers listed on the title page of this manual: The section titled "Extended Power Operation", and the section titled "Extended Power Limit". Also for these modules, change the 3-second delay referred to under "Nominal Power Limit" to 50 milliseconds.

Items Supplied

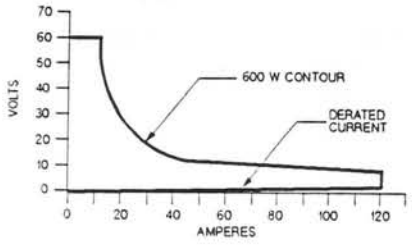
In addition to this manual, a 10-pin connector plug is also shipped with your Electronic Load module. Refer to chapter 3 in the operating manual for more information.

Table 60504-1. Specification and Supplemental Characteristics

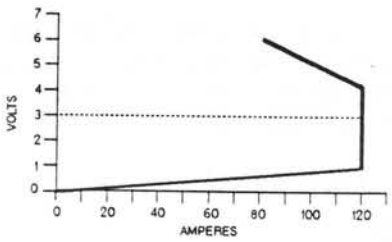
SPECIFICATIONS

DC Input Rating:

Current: 0 to 120 A
Voltage:3 V to 60 V (minimum dc operation from 0 to 2 V for 0 to 120 A
Power:600 W at 40°C (derated to 450 W at 55°C)



A. OPERATING CHARACTERISTICS



B. DERATED CURRENT DETAIL

Constant Current Mode:

Ranges: 0 to 12 A; and 0 to 120 A
Accuracy: (after 30 second wait): ±0.12% ±130 mA (both ranges)
Resolution: 3.2 mA (12 A range); 32 mA (120 A range)
Regulation: 10 mA (both ranges)
Temperature Coefficient: 120 ppm/°C ±8 mA/°C (both ranges)

Constant Resistance Mode:

Ranges: 0.017 to 0.5 Ω; 0.5 Ω to 500 Ω; and 5 Ω to 5 kΩ
Accuracy: ±0.8% ±5 mΩ with ≥12 A at input (0.5 Ω range);
±0.3% ±18 mS with ≥6 V at input (500 Ω and 5 kΩ ranges)
Resolution: 0.14 mΩ (0.5 Ω range); 0.54 mS (500 kΩ range); 0.054 mS (50 kΩ range)
Regulation: 20 mV with remote sensing (0.5 Ω range); 10 mA (500 Ω and 5 kΩ ranges)
Temperature Coefficient: 800 ppm/°C ±0.2 mΩ/°C (0.5 Ω range);
300ppm/°C ±1.2 mS/°C (500 Ω and 5 kΩ ranges)

Constant Voltage Mode:

Range: 0 to 60 V
Accuracy: ±0.1% ±50 mV
Resolution: 16 mV
Regulation: 20 mV (remote sense); 100 mV (local sense)
Temperature Coefficient: 100 ppm/°C ±5 mV/°C

Transient Operation:

Continuous Mode

Frequency Range: 0.25 Hz to 10 kHz
Frequency Resolution: 4%
Frequency Accuracy: 3%
Duty Cycle Range: 3% to 97% (0.25 Hz to 1 kHz); 6% to 94% (1 kHz to 10 kHz)
Duty Cycle Resolution: 4%
Duty Cycle Accuracy: 6% of setting ±2%

Pulsed Mode

Pulse Width: 50 μs ±3% minimum; 4 s ±3% maximum

Table 60504-1 Specifications and Supplemental Characteristics (continued)

Transient Current Level (0 to 12 A and 0 to 120 A ranges):

Resolution: 52 mA (12 A range); 520 mA (120 A range)
Accuracy: ±0.15% ±160 mA (12 A range); ±0.15% ±700 mA (120 A range)
Temperature Coefficient: 150 ppm/°C ±10 mA/°C

Transient Resistance Level (0.017 to 0.5 Ω, 0.5 Ω to 500 Ω, and 5 Ω to 5 kΩ ranges):

Resolution: 2.2 mΩ (0.5 Ω range); 8.7 mS (500 Ω range); 0.87 mS (5 kΩ range)
Accuracy: ±0.8% + 7 mΩ with ≥12 A at input (0.5 Ω range)
±0.3% + 26 mS with ≥6 V at input (500 Ω range)
±0.3% + 18 mS with ≥6 V at input (5 kΩ range)

Transient Voltage Level (0 to 60 V):

Resolution: 260 V
Accuracy: ±0.15% ±300 V
Temperature Coefficient: 150 ppm/°C ±5 mV/°C

Current Readback:

Resolution: 34 mA (via HP-IB); 100 mA (front panel)
Accuracy (after 30 minute wait): ±0.1% ±110 mA
Temperature Coefficient: 100 ppm/°C ±8 mA/°C

Voltage Readback:

Resolution: 17 mV (via HP-IB); 20 mV (front panel)
Accuracy: ±0.1% ±45 mV
Temperature Coefficient: 100 ppm/°C ±2 mV/°C
Maximum Readback Capability: 65 to 70 V (typical)

Power Readback:

Accuracy: ±0.2% ±8 W

External Analog Programming 0 to 10 V (dc or ac):

Bandwidth: 10 kHz (3 db frequency)
Accuracy: ±4% ±200 mA (0 to 12 A range)
±4% ±400 mA (0 to 120 A range)
±0.8% ±200 mV (0 to 60 V range)
Temperature Coefficient: 100 ppm/°C ±12 mA/°C (current ranges)
100 ppm/°C ± 1 mV/°C (voltage range)

External Current Monitor (0 to 10 V):

Accuracy: ±0.4% ±170 mA (referenced to analog common)
Temperature Coefficient: 100 ppm/°C ±10 mA/°C

External Voltage Monitor (0 to 10 V):

Accuracy: ±0.4% ±60 mV (referenced to analog common)
Temperature Coefficient: 100 ppm/°C ±2 mV/°C

Remote Sensing: 5 Vdc maximum between sense and input binding posts

Table 60504-1 Specifications and Supplemental Characteristics (continued)

Maximum Input Levels:
Current: 122.4 A (programmable to lower limits)
Voltage: 75 V

Minimum Operating Voltage: 2 V (derated to 0 V at 0 A)

PARD (20 Hz to 10 MHz noise):
Current: 6 mA rms/60 mA p-p
Voltage: 8 mV rms

DC Isolation Voltage: ±240 Vdc between + or − input binding post and chassis ground

Digital Inputs:
Vlo: 0.9 V maximum at Ilo = −1 mA
Vhi: 3.15 V minimum (pull-up resistor on input)

Digital Outputs:
Vlo: 0.72 V maximum at Ilo = 1 mA
Vhi: 4.4 V minimum at Ilo = −20 μA

SUPPLEMENTAL CHARACTERISTICS

Programmable Slew Rate (For any given input transition, the time required will be either the total slew time or a minimum transition time, whichever is longer. The minimum transition time increases when operating with input currents under 2 A. The following are typical values; ±25% tolerance):

Current Slew Rate:*

Rate #	120 A Range Step	12 A Range Step	Transition Time
1	2 A/ms	0.2 A/ms	8.0 ms
2	5 A/ms	0.5 A/ms	3.2 ms
3	10 A/ms	1 A/ms	1.6 ms
4	20 A/ms	2 A/ms	800 μs
5	50 A/ms	5 A/ms	320 μs
6	100 A/ms	10 A/ms	160 μs
7	0.2 A/μs	20 A/ms	80 μs
8	0.5 A/μs	50 A/ms	32 μs
9	1 A/μs	100 A/ms	16 μs
10	2 A/μs	0.2 A/μs	12 μs
11	5 A/μs	0.5 A/μs	12 μs
12	10 A/μs	1 A/μs	12 μs

*AC performance specified from 3 to 60 V.

Voltage Slew Rate:

Rate #	Voltage Range Step	Transition Time*
1	1 V/ms	8.0 ms
2	2.5 V/ms	3.2 ms
3	5 V/ms	1.6 ms
4	10 V/ms	800 μs
5	25 V/ms	320 μs
6	50 V/ms	160 μs
7	0.1 V/μs	85 μs
8	0.25 V/μs	85 μs
9	0.5 V/μs	85 μs

*Transition time based on low capacitance current source.

Resistance Slew Rate (0.5 Ω range): Uses the value programmed for voltage slew rate.

Resistance Slew Rate (500 Ω and 5 kΩ ranges): Uses the value programmed for current slew rate.

Table 60504-1. Specifications and Supplemental Characteristics (continued)

Transient Current Overshoot (When programmed from 0 A):

Range	Transient Current Level	Current Slew Rate	Overshoot*
120 A	24-120 A	All slew rates	0
	6 A	5 A/μs and 10 A/μs	6%
	6 A	2 A/μs	3%
	6 A	1 A/μs	1%
	6 A	2 A/ms to 0.5 A/μs	0
	12 A	2 A/ms to 2 A/μs	0
	12 A	5 A/μs and 10 A/μs	2%
12 A	6 A	0.5 A/μs, 1 A/μs	5%
	6 A	0.2 A/μs to 0.2 A/μs	0
	12 A	1 A/μs	2%
	12 A	0.2 A/ms to 0.5 A/μs	0

* Overshoot may be higher during first five seconds of programming if unit has been operating at full current. Overshoot values assume a total inductance of 1μH, or less, in the load leads connected to the D.U.T.

Source Turn-On Current Overshoot: Less than 10% of final value (in CC and CR modes when connected to power supplies with voltage rise times of greater than 500μs).

Programmable Short Circuit: 0.17 Ω (0.012 Ω typical)

Programmable Open Circuit: 20 kΩ (typical)

Drift Stability (over an 8 hour interval):
Current: ±0.03% ±20 mA
Voltage: ±0.01% ±10 mV

Reverse Current Capacity: 120 A when unit is on; 60 A when unit is off

Weight: 5.4 kg (12 lbs.)

Table 60504-2. Programming Ranges

Function	Front Panel Key	Front Panel Display	HP-SL Command (Short Form)	Range of Values
Constant Current				
Set Range	Range	C:RNG value	"CURR:RANG value"	
Low Range				≥0 and ≤12 A
High Range				> 12 A and ≤120 A
Set Main Level	CURR	CURR value	"CURR value"	
Low Range				0 to 12 A
High Range				0 to 120 A
Set Slew Rate	(shift) Slew	C:SLW value	"CURR:SLEW value"	
Low Range				0.0002 to 1 (A/μs)
High Range				0.002 to 10 (A/μs)
Set Transient Level	Tran Level	C:TLV value	"CURR:TLEV value"	same as main level
*Set Triggered Level			"CURR:TRIG value"	same as main level
Constant Resistance				
Set Range	Range	R:RNG value	"RES:RANG value"	
Low Range				≥0 and ≤0.5 Ω
Middle Range				>0.5 Ω and ≤500 kΩ
High Range				>500 Ω and ≤5 kΩ
Set Main Level	RES	RES value	"RES value"	
Low Range				0 to 0.5 Ω
Middle Range				0.5 Ω to 500 Ω
High Range				5 Ω to 5 kΩ
Set Slew Rate	(shift) Slew			
Low Range		V:SLW value	"VOLT:SLEW value"	same as voltage slew
Middle/High Range		C:SLW value	"CURR:SLEW value"	same as current slew
Set Transient Level	Tran Level	R:TLV value	"RES:TLEV value"	same as main level
*Set Triggered Level			"RES:TRIG value"	same as main level
Constant Voltage				
Set Main Level	VOLT	VOLT value	"VOLT value"	0 to 60 V
Set Slew Rate	(shift) Slew	V:SLW value	"VOLT:SLEW value"	0.001 to 0.5 (V/μs)
Set Transient Level	Tran Level	V:TLV value	"VOLT:TLEV value"	same as main level
*Set Triggered Level			"VOLT:TRIG value"	same as main level
Transient Operation				
Set Frequency	Freq	FREQ value	"TRAN:FREQ value"	0.25 Hz to 10 kHz
Set Duty Cycle	(shift) Dcycle	DCYCLE value	"TRAN:DCYC value"	3-97% (0.25 Hz-1 kHz)
				6-94% (1 kHz-10 kHz)
*Set Pulse Width			"TRAN:TWID value"	0.00005 to 4 s
Trigger Operation				
*Set Trigger Period			"TRIG:TIM vaLue"	0.000008 to 4 s
Current Protection				
*Set Current Level			"CURR:PROT value"	0 to 122.4 A
*Set Delay Time			"CURR:PROT:DEL value"	0 to 60 s

*Can only be programmed remotely via the HP-IB.

Table 60504-3. Factory Default Settings

Function	Settings	Function	Setting
CURR level	0 A	Mode (CC, CR, CV)	CC
CURR transient level	0 A	Input (on/off)	on
*CURR slew rate	2 A/μs	Short (on/off)	off
CURR range	120 A		
		Transient operation (on/off)	off
*CURR protection (on/off)	off	***TRAN mode	continuous
**CURR protection level	122.4 A	(continuous, pulse, toggle)	
**CURR protection delay	15 s	TRAN frequency	1 kHz
		TRAN duty cycle	50%
RES level	500 Ω	**TRAN pulse width	0.5 ms
RES transient level	500 Ω		
RES range	500 Ω	**TRIG source	hold
		(bus, external, hold, timer, line)	
VOLT level	60 V	**TRIG period	0.001 s
VOLT transient level	60 V	**PORT0 output (on/off)	off (logic 0)
VOLT slew rate	5 V/μs	**CAL mode (on/off)	off

The *RST command resets the CURR slew rate to 0.83 A/μ, not to the factory default.

** Can only be programmed remotely via the HP-IB.

*** Continuous transient mode is the only mode available at the front panel. Pulsed, toggled, and continuous modes can all be programmed remotely via the HP-IB.

Table 60504-4. Calibration Information

Ranges and Calibration Points	Variables	Variables Values	Power Supply Settings	Current Shunt
High Current Range	Hi_curr_rng	120	5 V/121 A	300 A
High Current Offset	Hi_curr_offset	0.0594		
Low Current Range	Lo_curr_rng	12	5 V/15 A	300 A
Low Current Offset	Lo_curr_offset	0.0497		
Voltage Range	N/A	N/A	61 V/10 A	N/A
Voltage Hi point	Volt_hipt	60		
Voltage Lo point	Volt_lopt	2.7		
Low Resistance Range	Lo_res_rng	.5	15 V/21.8 A	100 A
Low Resistance Hi point	Lo_res_hipt	.499		
Low Resistance Lo point	Lo_res_lopt	.02		
Middle Resistance Range	Mid_res_rng	5	10.9 V/30 A	100 A
Middle Resistance Hi point	Mid_res_hipt	15		
Middle Resistance Lo point	Mid_res_lopt	.5		
High Resistance Range	Hi_res_rng	501	60 V/12 A	100 A
High Resistance Hi point	Hi_res_hipt	50		
High Resistance Lo point	Hi_res_lopt	6		

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