HEWLETT PACKARD

600 WATT ELECTRONIC LOAD MODULE
HP MODEL 60504A

FOR MODULES WITH SERIAL NUMBERS:
2917A-00101 AND ABOVE

HP Part No. 60504-90001
Microfiche Part No. 60504-90002

Printed: May, 1989

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600-Watt Module

About This Manual

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

Table 60504–1 provides detailed specifications.

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 Electronic Load 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 that 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.

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MANUAL CHANGES
Model 60504A 600W Electronic Load Module
Operating Manual HP P/N 60504-90001
7/25/90

Make all the corrections according to ERRATA below, then check the following table for your module's serial number and make any listed changes.

SERIAL NUMBER		MAKE CHANGES
prefix	numbers	
ALL		ERRATA
2947A	00551-00570	1
3011A	00571-00690	1
3036A	00691-up	1,2

ERRATA:

Change the following specifications in Table 60504-1 as indicated:

Current Readback Accuracy (after 30 second wait): +/-0.1% +/-110 mA

Current Readback Temperature Coefficient: 100 ppm/C +/-8 mA/C

Voltage Readback Accuracy: +/-0.1% +/-45 mV

Voltage Readback Temperature Coefficient: 100 ppm/C +/-2 mV/C

External Analog Programming Accuracy:
+/-4% +/-200 mA (0 to 12 A range)
+/-4% +/-400 mA (0 to 120 A range)

External Current Monitor Temperature Coefficient: 100 ppm/C +/-10 mA/C

CHANGE 1:

In Table 60504-3, change the CURR slew rate factory default setting from 10 A/us to 2 A/us.

Also, add the following note to Table 60504-3: "Note: The *RST command resets the CURR slew rate to 10 A/us and not to the factory default setting."

CHANGE 2:

On page 60504-1, delete the 800W contour shown in Figure A. Also delete the figure showing the extended power availability.

Make the following changes in Chapter 2 of the HP 6050A/6051A Mainframe Operating manual (P/N 06050-90001), as they apply to the operation of the HP 60504A:

1) Delete the section titled "Extended Power Operaton". Extended power operation is not applicable to newer electronic load modules.

2) Under the section titled "Protection Features", delete the information under "Extended Power Limit". Also change the 3-second delay referred to under "Nominal Power Limit" to 50 milliseconds.

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ACOUSTIC NOISE INFORMATION

This document lists the HP Power Products which, as of April 4, 1991, have been measured in accordance with German acoustic noise Specification 3. GSGV. The results of these measurements are listed below.

The following power supply products have no fan:

LpA < 70 dB
operator position
normal operation
per ISO 7779
No fan installed

LpA < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19
Kein Ventilator eingebaut

6114A	6212C	6253A	6289A	59501B	60504A	69721A	69754A	69790B
6115A	6214C	6255A	6291A	59510A	60504B	69730A	69755A	69791A
6177C	6216C	6263B	6294A	59511A	69700A	69731B	69759A	69792A
6181C	6218C	6264B	6296A		69701A	69734A	69761A	69793A
6186C	6227B	6266B	6299A	60501A	69702A	69735A	69770A	69793A/J32
	6228B	6267B		60501B	69704A	69736A	69771A	
6200B	6234A	6281A	6825A	60502A	69705A	69750A	69774A	
6205C	6235A	6282A	6826A	60502B	69706A	69751A	69775A	
6206B	6236B	6284A	6827A	60503A	69709A	69752A	69776A	
6209B	6237B	6286A		60503B	69720A	69753A	69776A/J32	

The following products have fans:

Lpa < 70 dB
operator position
normal operation
per ISO 7779

LpA < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19

6002A	6024A	6038A	6063B	6621A	6627A	6641A	6652A	6673A	6954A
6010A	6030A	6050A		6622A	6628A	6642A	6653A	6674A	
6011A	6031A	6051A	6274B	6623A	6629A	6643A	6654A	6675A	
6012B	6032A	6060A		6624A	6632A	6644A	6655A	6942A	
6015A	6033A	6060B	6434B	6625A	6633A	6645A	6671A	6943A	
6023A	6035A	6063A	6448B	6626A	6634A	6651A	6672A	6944A	

The following products exceed 70 dB(A):

ACOUSTIC NOISE EMISSION

normal operation
operator position
LpA = 78.1 dB

bystander position
LpA = 72.4 dB
per ISO 7779

All data are the results from type tests.

GERAeUSCHEMISSION

normaler Betrieb
am Arbeitsplatz
LpA = 78.1 dB

fiktiver Arbeitsplatz
LpA = 72.4 dB
nach DIN 45635 T. 19

Die Angaben beruhen auf Ergebnissen von Typpruefungen.

6259B	6261B	6269B	6456B	6464C	6469C	6475C	6479C
6260B	6268B	6453A	6459A	6466C	6472C	6477C	6483C

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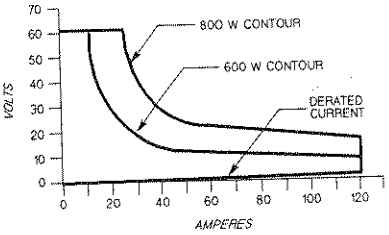
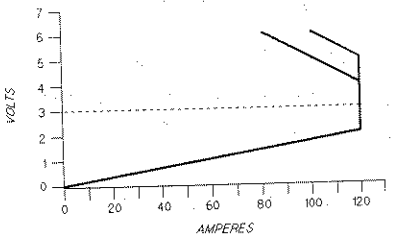
Table 60504-1. Specifications
(Specifications apply for 25°C ±5°C, except as noted)

DC Input Rating:

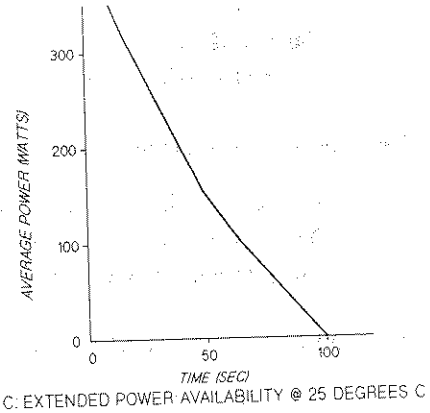
Current: 0 to 120 A
Voltage: 3 V to 60 V (minimum dc operation from 0 to 2 V for 0 to 120 A)
Power: 600 W at 40°C (derated to 450 W at 55°C)



A. OPERATING CHARACTERISTICS



B. DERATED CURRENT DETAIL



C. EXTENDED POWER AVAILABILITY @ 25 DEGREES C

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 and 5 kΩ ranges)
Resolution: 0.14 mΩ (0.5 Ω range); 0.54 mS (500 Ω range); 0.054 mS (5 kΩ range)
Regulation: 20 mV with remote sensing (0.5 Ω range); 10 mA (500 and 5 kΩ ranges)
Temperature Coefficient: 800 ppm/°C ±0.2 mΩ/°C (0.5 Ω range);
300 ppm/°C ±1.2 mS/°C (500 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 ±5mV/°C

Transient Operation:

Continuous Mode
Frequency Range: 0.25 Hz to 10 kHz
Frequency Resolution: 4%
Frequency Accuracy: 3%

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Table 60504-1. Specifications (continued)

Continuous Mode (continued)

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

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); .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 mV
Accuracy: ±0.15% ±300 mV
Temperature Coefficient: 150 ppm/°C ±5 mV/°C

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 nominal 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.

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Table 60504-1. Specifications (continued)

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 and 5 kΩ ranges): Uses the value programmed for current slew rate.

Current Readback:

Resolution: 34 mA (via HP-IB); 100 mA (front panel)
Accuracy (after 30 second wait): ±0.05% ±130 mA
Temperature Coefficient: 50 ppm/°C ±10 mA/°C

Voltage Readback:

Resolution: 17 mV (via HP-IB); 20 mV (front panel)
Accuracy: ±0.05% ±45 mV
Temperature Coefficient: 50 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: ±4.5% ±150 mA (0 to 12 A range)
±4.5% ±500 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: ±4% ±170 mA (referenced to analog common)
Temperature Coefficient: 50 ppm/°C ±12 mA/°C

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Table 60504-1. Specifications (continued)

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

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)

Programmable Short Circuit: 0.017 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

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

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

Weight: 5.4 kg (12 lbs.)

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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 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 Ω
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.

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Table 60504-3. Factory Default Settings

Function	Setting	Function	Setting
CURR level	0 A	Mode (CC, CR, CV)	CC
CURR transient level	0 A	Input (on/off)	on
CURR slew rate	10 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

* 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	Variable Values	Power Supply Settings	Current Shunt
High Current Range	Hi_curr_rng	120	5 V/121 A	200 A
High Current Hi point	Hi_curr_hipt	105		
High Current Lo point	Hi_curr_lopt	3		
Low Current Range	Lo_curr_rng	12	5 V/15 A	20 A
Low Current Hi point	Lo_curr_hipt	11		
Low Current Lo point	Lo_curr_lopt	1		
Voltage Range	N/A	N/A	61 V/10 A	N/A
Voltage Hi point	Volt_hipt	55		
Voltage Lo point	Volt_lopt	3		
Low Resistance Range	Lo_res_rng	.5	15 V/21.8 A	20 A
Low Resistance Hi point	Lo_res_hipt	.5		
Low Resistance Lo point	Lo_res_lopt	.017		
Middle Resistance Range	Mid_res_rng	5	10.9 V/30 A	20 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	20 A
High Resistance Hi point	Hi_res_hipt	50		
High Resistance Lo point	Hi_res_lopt	6		

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