OPERATING MANUAL

300 WATT ELECTRONIC LOAD MODULE
Agilent Model 60502B

FOR MODULES WITH SERIAL NUMBERS:
3118A-00101 AND ABOVE

Agilent Technologies

Agilent Part No. 60502-90008
Microfiche No. 60502-90009

Printed in U.S.A.
June, 1991

DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name:	Agilent Technologies
Manufacturer's Address:	New Jersey Division 140 Green Pond Road Rockaway, NJ 07866 U.S.A.

declares that the product

Product Name:	Load mainframe and modules
Model Number(s):	Agilent 6050A, 6051A mainframes with modules Agilent 60501A/B, 60502A/B, 60503A/B, 60504A/B, 60507A/B

conform(s) to the following Product Specifications:

Safety:	IEC 348:1978 / HD401 S1:1981[1]
EMC:	CISPR 11:1990 / EN 55011:1991 - Group 1, Class B IEC 801-2:1991 / EN 50082-1:1992 - 4kV CD, 8 kV AD IEC 801-3:1984 / EN 50082-1:1992 - 3 V/m IEC 801-4:1988 / EN 50082-1:1992 - 0.5 kV Sig. Lines, 1 kV Power Lines

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Note 1: The product family was introduced prior to 12/93

New Jersey	January 1997	
Location	Date	Bruce Krueger / Quality Manager

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300-Watt Module

About This Manual

This manual provides information for the Agilent 60502B 300-Watt Electronic Load Module. It is designed as a supplement to the Agilent 6050A/6051A Multiple Input Mainframe Electronic Load Operating Manual (part number 06050-90001). Four tables provide the following module-specific information:

Table 60502-1 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 non-warranted, typical performance and are intended to provide additional information by describing performance that has been determined by design or type testing.

Table 60502-2 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 60502-3 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 60502-4 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 Agilent 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

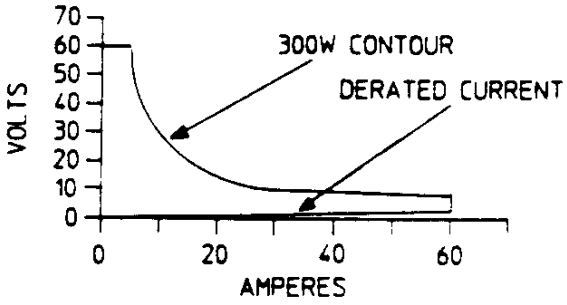
In addition to this manual, a 10-pin connector plug is also shipped with your Electronic Load module. Refer to Chapter 3 in the operating manual for more information.

Table 60502-1. Specification and Supplemental Characteristics

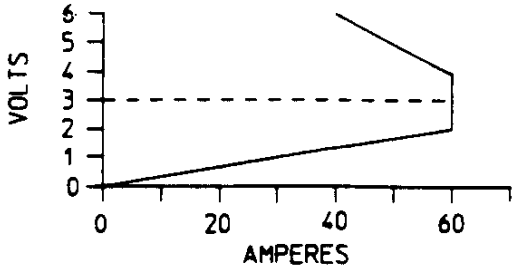
SPECIFICATIONS

DC Input Rating:

Current: 0 to 60 A
Voltage: 3 V to 60 V (minimum dc operation from 0 to 2 V for 0 to 60 A)
Power: 300 W at 40 °C (derated to 225 W at 55 °C)



A. OPERATING CHARACTERISTICS



B. DERATED CURRENT DETAIL

Constant Current Mode:

Ranges:	0 to 6 A; and 0 to 60 A
Accuracy:	(after 30 second wait): ± 0.1% ± 75 mA (both ranges)
Resolution:	1.6 mA (6 A range); 16 mA (60 A range)
Regulation:	10 mA (both ranges)
Temperature Coefficient:	100 ppm/°C ± 5 mA/°C (both ranges)

Constant Resistance Mode:

Ranges:	0.033 to 1 Ω; 1 Ω to 1 kΩ; and 10 Ω to 10 kΩ
Accuracy:	± 0.8% ± 8 mΩ with ≥ 6 A at input (1 Ω range); ± 0.3% ± 8 mS with ≥ 6 V at input (1 kΩ and 10 kΩ ranges)
Resolution:	0.27 mΩ (1 Ω range); 0.27 mS (1 kΩ range); 0.027 mS (10 kΩ range)
Regulation:	10 mV with remote sensing (1 Ω range); 10 mA (1 k and 10 kΩ ranges)
Temperature Coefficient:	800 ppm/°C ± 0.4 mΩ/°C (1 Ω range); 300ppm/°C ± 0.6 mS/°C (1 k and 10 kΩ ranges)

Constant Voltage Mode:

Range:	0 to 60 V
Accuracy:	± 0.1% ± 50 mV
Resolution:	16 mV
Regulation:	10 mV (remote sense); 40 mV (local sense)
Temperature Coefficient:	100 ppm/°C ± 5 mV/°C

Table 60502-1 Specifications and Supplemental Characteristics (continued)

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

Transient Current Level (0 to 6 A and 0 to 60 A ranges):

Resolution:	26 mA (6 A range); 260 mA (60 A range)
Accuracy:	± 0.1% ± 80 mA (6 A range); ± 0.1% ± 350 mA (60 A range)
Temperature Coefficient:	100 ppm/°C ± 7 mA/°C

Transient Resistance Level (0.033 to 1 Ω, 1 Ω to 1 kΩ, and 10 Ω to 10 kΩ ranges):

Resolution:	4.3 mΩ (1 Ω range); 4.3 mS (1 kΩ range); 0.4 mS (10 kΩ range)
Accuracy:	± 0.8% + 8 mΩ with ≥ 6 A at input (1 Ω range) ± 0. 3% + 10 mS with ≥ 6 V at input (1 kΩ range) ± 0.3% + 7 mS with ≥ 6 V at input (10 kΩ range)

Transient Voltage Level (0 to 60 V):

Resolution:	260 mV
Accuracy:	± 0.1% ± 300 mV
Temperature Coefficient:	150 ppm/°C ± 5 mV/°C

Current Readback:

Resolution:	17 mA (via GPIB); 20 mA (front panel)
Accuracy:	(after 30 minute wait): ± 0.05% ± 65 mA
Temperature Coefficient:	50 ppm/ °C ± 5 mA/ °C

Voltage Readback:

Resolution:	17 mV (via GPIB); 20 mV (front panel)
Accuracy:	± 0.05% ± 45 mV
Temperature Coefficient:	50 ppm/°C ± 1.2 mV/°C
Maximum Readback Capability:	65 to 70 V (typical)

Power Readback:

Accuracy:	± 0.2% ± 4 W

Table 60502-1 Specifications and Supplemental Characteristics (continued)

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

Bandwidth:	10 kHz (3 db frequency)
Accuracy:	± 4.5% ± 75 mA (0 to 6 A range)
	± 4.5% ± 250 mA (0 to 60 A range)
	± 0.8% ± 200 mV (0 to 60 V range)
Temperature Coefficient:	100 ppm/°C ± 6 mA/°C (current ranges)
	100 ppm/°C ± 1 mV/°C (voltage range)

External Current Monitor (0 to 10 V):

Accuracy:	± 0.4% ± 85 mA (referenced to analog common)
Temperature Coefficient:	50 ppm/°C ± 6 mA/°C

External Voltage Monitor (0 to 10 V):

Accuracy:	± 0.25% ± 40 mV (referenced to analog common)
Temperature Coefficient:	50 ppm/ °C ± 0.2 mV/ °C

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

Maximum Input Levels:

Current:	61.2 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:	4 mA rms/40 mA p-p
Voltage:	6 mV rms

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

Digital Inputs:

Vlo**:**	0.9 V maximum at **I**lo = -1 mA
Vhi	3.15 V minimum (pull-up resistor on input)

Digital Outputs:

Vlo:	0.72 V maximum at **I**lo = 1 mA
Vhi:	4.4 V minimum at **I**lo - 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 1 A. The following are typical values; ± 25% tolerance):

Table 60502-1 Specifications and Supplemental Characteristics (continued)

Current Slew Rate:*

Rate #	60 A Range Step	6 A Range Step	Transition Time
1	1 A/ms	0.1 A/s	8.0 ms
2	2.5 A/ms	0.25 A/s	3.2 ms
3	5 A/ms	0.5 A/s	1.6 ms
4	10 A/ms	1 A/ms	800 µs
5	25 A/ms	2.5 A/ms	320 µs
6	50 A/ms	5 A/ms	160 µs
7	0.1 A/µs	10 A/ms	80 µs
8	0.25 A/µs	25 A/ms	32 µs
9	0.5 A/µs	50 A/ms	16 µs
10	1 A/µs	0.1 A/µs	12 µs
11	2.5 A/µs	0.25 A/µs	12 µs
12	5 A/µs	0.5 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 (1 Ω range): Uses the value programmed for voltage slew rate.

Resistance Slew Rate (1 k and 10 kΩ ranges): Uses the value programmed for current slew rate.

Transient Current Overshoot (When programmed from 0A):

Range	Transient Current Level	Current Slew Rate	Overshoot*
60 A	6-60 A	All slew rates	0
	3 A	1 A/µs to 5 A/µs	1%
	3 A	1 A/µs to 0.5 A/µs	0
6 A	6 A	All slew rates	0
	3 A	0.25 A/µs to 0.5 A/µs	1%
	3 A	0.1 A/ms to 0.1 A/µs	0

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

Table 60502-1 Specifications and Supplemental Characteristics (continued)

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: 0.033 Ω (0.002 Ω typical)

Programmable Open Circuit: 20 kΩ (typical)

Drift Stability (over an 8 hour interval):

Current:	± 0.03% ± 10 mA
Voltage:	± 0.01% ± 10 mV

Reverse Current Capacity: 100 A when unit is on; 40 A when unit is off

Weight: 3.2 kg (7 lbs.)

Table 60502-2. Programming Ranges

Function	Front Panel Key	Front Panel Display	HPSL Command (Short Form)	Range of Values
Constant Current				
Set Range	Range	C:RNG value	"CURR:RANG value"	
Low Range				≥ 0 and ≤ 6 A
High Range				> 6 A and ≤ 60 A
Set Main Level	CURR	CURR value	"CURR value"	
Low Range				0 to 6 A
High Range				0 to 60 A
Set Slew Rate	(shift) Slew	C:SLW value	"CURR:SLEW value"	
Low Range				0.00001 to 0.5 (A/µs)
High Range				0.001 to 5 (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 ≤ 1 Ω
Middle Range				> 1 Ω and ≤ 1 kΩ
High Range				>1 kΩ and ≤ 10 kΩ
Set Main Level	RES	RES value	"RES value"	
Low Range				0 to 1 Ω
Middle Range				1 Ω to 1 kΩ
High Range				10 Ω to 10 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

Table 60502-2. Programming Ranges (continued)

Function	Front Panel Key	Front Panel Display	HPSL Command (Short Form)	Range of Values
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 61.2 A
*Set Delay Time			"CURR:PROT:DEL value"	0 to 60 s
*Can only be programmed remotely via the GPIB.				

Table 60502-3. 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	1 A/µs	Short (on/off)	off
CURR range	60 A		
		Transient operation (on/off)	off
*CURR protection (on/off)	off	***TRAN mode	continuous
**CURR protection level	61.2 A	(continuous, pulse, toggle)	
**CURR protection delay	15 s	TRAN frequency	1 kHz
		TRAN duty cycle	50%
RES level	1 kΩ	**TRAN pulse width	0.5 ms
RES transient level	1 kΩ		
RES range	1 kΩ	**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 5 A/µs, not to the factory default.

**Can only be programmed remotely via the GPIB.

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

Table 60502-4. Calibration Information

Ranges and Calibration Points	Variables	Variables Value	Power Supply Settings	Current Shunt
High Current Range	Hi_curr_rng	60	5 V/61 A	100 A
High Current Offset	Hi_curr_offset	0.0282		
Low Current Range	Lo_curr_rng	6	5 V/10 A	15 A
Low Current Offset	Lo_curr_offset	0.0197		
Voltage Range	N/A	N/A	61 V/5 A	N/A
Voltage Hi point	Volt_hipt	60		
Voltage Lo point	Volt_lopt	2.7		
Low Resistance Range	Lo_res_rng	1	15 V/10.9 A	15 A
Low Resistance Hi point	Lo_res_hipt	1		
Low Resistance Lo point	Lo_res_lopt	0.04		
Middle Resistance Range	Mid_res_rng	10	10.9 V/15 A	15 A
Middle Resistance Hi point	Mid_res_hipt	30		
Middle Resistance Lo point	Mid_res_lopt	1		
High Resistance Range	Hi_res_rng	1001	60 V/6 A	15 A
High Resistance Hi point	Hi_res_hipt	120		
High Resistance Lo point	Hi_res_lopt	12		

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