



DLP-50-60-1000A
OPERATOR'S MANUAL

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INTRODUCTION

The Dynaload is a precision instrument which simulates electrical loads to test power supplies, generators, servo systems, batteries, and similar electrical power sources. It simulates, at the option of the user, resistive loads (amps/ volts) or may be switched to a constant current load characteristic (current regulated at a pre-selected value) or a constant voltage type of load (similar to a battery or zener diode). Provisions are also made for external programming in automated test set-ups. The external programming voltage is from 0-6V with an input impedance of 10K minimum. Load current is directly proportional to programming voltage, and the sensitivity is adjustable with the front panel current adjustments.

SPECIFICATIONS

The following ratings apply:

Load Voltage:	3 to 50V	
Load Current:	0 to 60A	
Power Dissipation:	0 to 1000W	
Overload Rating:	10%	
Self-Protection:	Overvoltage:	<60V
	Overcurrent:	<65A
	Overpower:	<1300W

MODE SELECTOR SWITCH POSITION

(From left to right)

Position 1: Constant resistance 0-1 A/V as determined by the front panel DC load adjust.

Position 2: Constant resistance 0-10 A/V as determined by the front panel DC load adjust.

Position 3: Constant current 0-10A as determined by the front panel DC load adjust.

Position 4: Constant current 0-69A as determined by the front panel load adjust.

Position 5: Constant voltage load. In this position, the load is similar to a battery being charged or a constant voltage zener diode; no current is drawn until the source voltage reaches the regulating voltage. The voltage at which the Dynaload regulates is adjustable by the front panel volts control.

Position 6: External modulation—will program from 0-60A with – 6V applied to the external modulation terminal (TB1). Modulation sensitivity is directly adjustable by the front panel DC load adjust control.

Position 7: A square wave pulse load which may be varied from 0-50A and 500-5000Hz as desired by the front panel pulse controls.

Position 8: A short circuit which is applied in series with the ammeter across the input allowing short circuit current tests.

FRONT PANEL CONTROLS

S115: AC On/Off switch and indicator lamp

M1: Load current range as selected by front panel current range select switch, 0-6A, 0-18A, or 0-60A

CAUTION: THE METER RANGE SELECTOR SWITCH SHOULD ALWAYS BE MAINTAINED IN THE HIGHEST VOLTAGE OR HIGHEST CURRENT POSITION EXCEPT WHEN READINGS ARE BEING TAKEN. ALTHOUGH THE METERS HAVE HIGH OVERLOAD CAPABILITY, THEY MAY BE DAMAGED BY OVERLOADS IN THE LOWER RANGE POSITIONS.

CB1: Load On/Off circuit breaker. For absolute no-load test, this circuit breaker should be opened; the circuit breaker will automatically open in the event of an overvoltage, overcurrent condition. The circuit breaker is rated at 60A and will open up if more than 60A is sustained through the Dynaload. In the event that an overvoltage condition is applied, an overvoltage SCR will fire, protecting the Dynaload, and if the source has more than a 60A capability, the circuit breaker will open.

NOTE: When testing low current sources, it may be advisable to use an external fuse or circuit breaker to protect the source.

Provision is made to connect the load by front panel binding posts for load currents of less than 15A. In the event of load currents greater than 15A, the studs on the rear of the unit should be used.

Current Sample: This is provided for measuring the pulse current amplitude when operating in the pulse mode. There will be .01 volts for each amp of current.

Pulse: Sync out. This is a pulse output which is the same frequency as the pulse load, and may be used to trigger external test equipment.

REAR PANEL CONNECTIONS

- E+: Plus load-connect to positive terminal of source to be tested
- E-: Minus load- connect to minus terminal of source to be tested
- TB1-1: 0 to +6V programming voltage input
- TB1-2: Programming voltage return internally connected to the minus terminal of the Dynaload
- TB1-3: +6V which may be used as a source for programming
- F101: AC line fuse 1A, SB

OPERATING INSTRUCTIONS

The following procedure is recommended for hooking up the Dynaload:

- A. Set the AC and DC ON/OFF switches to OFF.
- B. Set the meter range switches in their maximum voltage and current positions.
- C. Set the load adjustments controls full counter clockwise.
- D. Set the mode selector switch to the desired mode.
- E. Connect the Dynaload to a standard 115VAC, 50-60 Hertz power source (optional input voltage ranges are available).
- F. Connect the source to the load terminals of the Dynaload (E+ and E- on the rear of the unit). Two terminals are provided in parallel for each polarity for simplified connections. Parallel + and - terminals are provided on the front panel for convenience but should only be used where the load currents are 15A or less.
- G. If external modulation is to be used; the external programming voltage should also be connected.
- H. Set the AC power switch to ON. The AC ON indicator lamp should light.

- I. The DC ON switch should now be closed.
- J. Observe that the front panel Dynaload voltmeter indicates the source voltage.
- K. If the circuit breaker trips, or if there is no indication of source voltage, check the external hook-up wiring to see that all connections are tight and secure.
- L. To increase the load, slowly turn the load adjust controls slowly clockwise until the appropriate load is obtained.
- M. The meter range switches may be switched to the lower scale positions if greater accuracy is required, and external instrumentation may be used to obtain further accuracy and eliminate the effects of leakage currents in the Dynaload or line voltage drops at high currents.

CONSTANT RESISTANCE MODE (AMPS/VOLT)

Two scales are provided: 0-1 A/V and 0-10 A/V. Minimum resistance on the 0-1 A/V is 1 ohm, and minimum resistance on the 0-10 A/V is .1 ohm. For example; to test a 12V battery with a two ohm resistive load:

- A. Set the mode selector switch to the 0-1 A/V position.
- B. Connect the source as previously described.
- C. Check the initial readings of the meters.
- D. Adjust the voltmeter to the 0-18 V scale.
- E. Adjust the ammeter to the 0-6A scale.
- F. Slowly turn the coarse and fine DC load adjusts to obtain the 6A load, while monitoring the source voltage on the front panel voltmeter.
- G. For precision settings at high load currents, it is desirable to use an external voltmeter connected at the source terminals to eliminate the effects of lead drops.

Lead drops at 50A may well be .25 to .5V if substantial lead lengths are used, and there is a slight voltage drop internal to the Dynaload, due to the circuit breaker and internal power wiring. Similarly, it may be desirable to use external ammeters for particular tests to supplement the scales of the Dynaload or for use at very low currents. There are minor leakage currents of a few milliamperes in the Dynaload instrumentation, which do not pass through the Dynaload ammeter (voltmeter current, voltage sensing network).

The resistive load characteristics of the Dynaload simulate a pure resistance down to 1 to 2 V input; for a given resistance setting, the current is directly proportional to the voltage over wide dynamic ranges. In the very low voltages, the power transistors will saturate.

CONSTANT CURRENT MODE

Some power sources, such as variable power supplies are rated at a fixed maximum load current and adjustable over a predetermined voltage range (for example, 5-30V @ 20A), If the resistive load characteristic were used for this type of test, it would be necessary to reset the load each time the power supply voltage was changed in order to maintain the full load current. Accordingly, the following procedure should be used:

- A. With the load adjustments turned counterclockwise, and the DC load switch off, and the Dynaload meters in their maximum voltage and current positions, switch the mode selector switch to the constant amperes position, 0-60A.
- B. Turn on the power source and the Dynaload.
- C. Set the power source to the desired output voltage (assume 30V).
- D. Turn the coarse and fine DC load adjusts until 20A of load current is achieved.

The power supply may now be programmed from 5-30V, and the load current will be maintained constant at 20A, This constant current characteristic is maintained down to approximately one or two volts, or until the A/V exceeds ten. Therefore it will maintain 50A constant current down to less than 5V, or 20A down to less than 2V, etc.

It should be noted that many solid state power supplies are designed for short circuit protection by internal current limiting and bendback, and therefore, may not start up into a constant current type of load. Accordingly, the constant resistance characteristic should be used as a load when simulating short circuit protection and recovery of most solid state power supplies unless otherwise specified by the manufacturer.

EXTERNAL MODULATION

In the external modulation mode, the Dynaload acts as a constant current load with the constant current proportional to the external voltage applied to TB1-1 and TB1-2. (TB1-2 is the return of the external modulating voltage and is internally connected to the negative lead of the Dynaload.)

The Dynaload will program from 0-60A as the external modulation voltage is programmed from 0-6V if the DC load adjustments are set in the maximum clockwise position. The programming sensitivity may be reduced proportionately by the front panel DC load adjust controls. Turning the load adjust counterclockwise reduces the programming sensitivity, The input impedance of the external modulation terminals is approximately 10K ohms. The transient response of the Dynaload is determined by the feedback loop characteristics of the constant current regulator to achieve precision programming.

PULSE MODE

In the pulse mode the Dynaload places a pulsating square wave load on the input voltage source. This pulse load may be varied from 0-50A peak current by the pulse amplitude control on the front panel. The frequency may be varied from approximately 500-5000Hz by the pulse frequency control on the front panel. This pulse load may be superimposed on top of a constant DC load, which may be selected by the DC load control on the front panel.

If the pulse is to be used down to a no-load state, the DC load controls should be turned fully counterclockwise, The maximum total of the pulse and DC load will be limited around 65A by the internal current limit protection.

SHORT CIRCUIT

The short circuit mode is for checking short circuit and recovery from a short. It places a short in series with the ammeter across the input. It should not be used directly on a large capacitive voltage source, as the relay contacts may be welded shut.

For testing short circuit of a large capacitive source, the Dynaload should be placed in the 10 A/V position and the DC load adjust turned fully clockwise; then the short circuit button may be pressed. The short circuit relay will cause the circuit breaker to trip if more than 60A of current are drawn.

CONSTANT VOLTS MODE

In the constant volts mode, the Dynaload acts as an adjustable power zener diode. The regulating voltage is programmable from approximately 2-50V by the front panel volts Adjust control. The constant volts position is used to simulate a battery to a battery charger, or the Dynaload may also be used as a shunt regulator for special applications.

POWER RATING

The Model DLP 50-60-1000A will dissipate 1000W continuously. In order to assure that overheating does not occur, the rear of the Dynaload should be clear for the air intake and the air exhaust. The cooling air enters and leaves from the rear. The Dynaload should periodically be checked for dust accumulation.

PROTECTIVE CIRCUITS

The Dynaload has internal current limiting at approximately 65A maximum and also has a circuit breaker which disconnects at somewhat over 60A. The Dynaload also incorporates reverse voltage protection by reverse diode. If the input is hooked up backwards, the source will be shorted, and the circuit breaker will trip if the source current capability is sufficient. In the event that an overvoltage is applied to the Dynaload, an internal overvoltage circuit will trigger an SCR across the input, thereby protecting all internal circuits. If the source current is large enough, the circuit breaker will trip. If the source should be damaged by a 60A load or is not short proof, it may be desirable to incorporate an external fuse or circuit breaker to protect the source.

The voltage current product is also monitored to prevent an overpower condition from happening. Accordingly, the current limit characteristics are set at approximately 65A, which are maintained to approximately 16V, at which time the current limit characteristic is reduced as the input voltage is increased, thereby limiting the maximum power which may be programmed into the Dynaload.

3.9 SPECIAL APPLICATIONS

The Dynaload may be used for AC load testing, within its ratings, by the use of an external bridge rectifier so that the Dynaload sees pulsating DC, but the AC source sees an AC load. The effect of the rectifier is to slightly distort the Dynaload characteristics at low voltages and currents. The Dynaload is not normally recommended for testing AC sources above 60 cycles due to its limited speed of response, unless the user specifically recognizes the load characteristics at higher frequencies.

The Dynaload may also be used as a current or voltage regulator rather than a load for special applications as described in Sections 3.2 and 3.6.

4.0 CALIBRATION PROCEDURES

4.1 LINEARITY SETTING

Before any of the calibration is performed it is very important that the main regulator be tuned for absolute zero relative to itself.

For the DLR and DLP series the procedure is as follows:

- A. The load should be plugged into the appropriate AC power, all front panel adjustments full counter-clockwise, and connected to a 5VDC test source.
- B. Monitor the current through an external shunt (we recommend a 100 amp/100mv) using a digital voltmeter.
- C. Set the mode select for the low constant current function. Leaving all of the load adjust pots fully counterclockwise adjust R68 (lin) on the main P.C. Board until the load draws current.
- D. Slowly turn R68 (lin) in the opposite direction until the load current is between 0 (zero) and 5 (five) milliamps. Be careful not to pass thru the zero threshold.

NOTE

IT IS POSSIBLE TO OVER ADJUST IN THE NEGATIVE DIRECTION AND THIS WILL UPSET EVERY FUNCTION IN THE LOAD. THIS SETTING IS CRITICAL TO THE PROPER OPERATION OF THE LOAD.

4.2 VOLTMETER CALIBRATE

- A. With the Dynaload set for no load, place an external calibrated voltmeter across the input terminals of the Dynaload and program the input voltage to obtain 5V, 15V, and 50V, respectively.
- B. With the voltmeter range selector switch in the 6V position and 5V applied, adjust R32 so that the front panel voltmeter reads 5V.
- C. With the meter selector switch in the 18V position and 15V applied, adjust R34 until the front panel voltmeter reads 15V.
- D. With the meter range selector switch in the 60V position and 50V applied, adjust R36 until the front panel meter reads 50V.

4.3 AMMETER CALIBRATE

- A. Use an external 5V source and an external ammeter for calibration.
- B. Turn the Dynaload adjust to the minimum counterclockwise position.
- C. Set the mode selector switch to the constant current 0-60A position.
- D. With the ammeter range selector switch at 6A, increase the load until the external ammeter reads 5A.
- E. Adjust R38 so that the front panel ammeter also reads 5A.
- F. Switch the ammeter selector switch to 18A, and adjust the load current until the external ammeter reads 15A.
- G. Adjust R40 until the front panel ammeter also reads 15A.
- H. With the ammeter range selector switch set at 60A, increase the load current to 50A as indicated on the external ammeter.
- I. Adjust R42 until the front panel ammeter also reads 50A.

4.4 AMPERES PER VOLT CALIBRATE

- A. With the Dynaload in the 0-1 A/V position, and the DC load adjust in the maximum clockwise position, apply a voltage of 5V to the input terminals of the Dynaload.
- B. Adjust the A/V calibrate potentiometer R54 so that between 5 and 5.5A of load current is obtained.
- C. With the Dynaload in the 0-10 A/V position, and the load adjust in the maximum clockwise position, apply a voltage of 5V to the input terminals of the Dynaload.
- D. Adjust the 10 A/V calibrate potentiometer R30 so between 50 and 55A of load current is obtained.
- E. Make sure that the current limit setting is not interacting in any way.

4.5 CURRENT CALIBRATE

- A. Set the mode selector switch to the 0-10A constant current position.
- B. Using a 5V source, turn the DC load potentiometer in the maximum clockwise position and adjust R56 to obtain between 10 and 11A.
- C. Set the mode selector switch to the 0-60A constant current position.
- D. Using a 6V source, turn the DC load potentiometer in the maximum clockwise position, and adjust R19 to obtain between 60 and 65A.
- E. Make sure that the current limit setting is not interacting in any way.

4.6 CURRENT LIMIT CALIBRATE

- A. Place the Dynaload in the 0-10 A/V position.
- B. Using a 10V source, increase the load current to approximately 65A or until current limiting is achieved.
- C. Readjust R50 as appropriate.

4.7 OVERPOWER PROTECTION

- A. Apply a 50V source to the Dynaload.
- B. Increase the load current either to its maximum counterclockwise position or 25A, whichever occurs first.
- C. Adjust R7, the bendback resistor, to limit the current at 50V to between 21 and 25A.

4.8 LINEARITY

- A. With the Dynaload connected to a 5V, 60A source, place the Dynaload in the EXT MOD position.
- B. Apply an external modulation voltage to TB1-1 of plus 6 volts.
- C. Set the front panel load adjust for 60 amps of current.
- D. Decrease the external modulation voltage to 1V.
- E. Adjust the linearity control, R68, for 10A of load current.
- F. Repeat the above procedure until the linearity is within 1%.

4.9 CURRENT SAMPLE

- A. The Dynaload is connected to a 40-amp source, in the 0-60A mode.
- B. Adjust the front panel load adjust control for 40A.
- C. Using a DVM, adjust the current sample control R72 for 400mV at the current sample terminals on the front panel.

4.10 SQUARE ADJUST

- A. Connect the Dynaload to a 10A source in the pulse mode.
- B. Adjust the front panel pulse amplitude control for a $5A \pm 20\%$ pulse at minimum frequency.
- C. Use an oscilloscope to monitor the current sample terminals.
- D. Adjust the square control to-give an equal time-on and time-off period for the square wave load.

5.0 THEORY OF OPERATION

5.1 INPUT CIRCUITS

A schematic diagram is shown in Drawing No.D106746, AC power is applied through the line cord, through fuse F101, and AC ON/OFF switch S115 to the AC indicator lamp, blowers B101 and B102, and the primary of T1 through CB101 when in the ON position. The secondary of T1 is rectified and filtered in both the positive and negative directions compared to the center tap, generating approximately +25V and -25V on capacitors C1 and C2, respectively. The negative voltage is regulated to 5.6V by constant current source Q5 and associated components R12, VR7, R13, and zener diode VR6. The +25V is regulated to +16V by constant current source Q1, and its associated components R1, VR5, and R2, and zener diodes VR2 and VR3, which generate +16V and +8V.

5.2 0-1 A/V MODE

The input voltage is divided by a divider consisting of R24, R54, and the DC load adjust controls R125A and R125B. A portion of the input voltage is fed through R49 to the non-inverting input of U1 (Pin 5).

The inverting input of U1 (Pin 4) is connected through R27 to the top of SH101 (+).

As R125 is turned clockwise, the non-inverting input (Pin 5) becomes more positive than inverting input (Pin 4) causing U1 to turn on, allowing current to flow from Vc (Pin 11) to Vout (Pin 10), which in turn drives Q101 and consequently, the pass transistors Q102 through Q122.

As current flows through the pass transistors, the top of SH101 (+) becomes more and more positive, until the voltage at Pin 4 becomes equal to that of Pin 5, causing U1 to regulate the current through the pass-transistors. As the input voltage rises, the voltage at Pin 5 rises proportionally, causing more current to flow, until the voltage drop across SH101 is high enough to create an equilibrium between the inverting and non-inverting inputs of U1, giving the effect of a resistive load.

The maximum voltage that can be applied to the non-inverting input is limited by R24 and R54, so that approximately only 1 amps of current can be drawn for each volt at the input.

5.3 0-10 A/V MODE

In this position, the circuit operates the same as in the 0-1 A/V mode, with the exception that the input voltage is now divided by R23, R30, and R125. This new divider allows more voltage to be applied to the non-inverting input of U1 (Pin 5), requiring a much higher current to flow through SH101 before the voltage at the inverting input is sufficient to cause U1 to regulate the pass structure.

R23 and R30 are set so that about 10A of current can be drawn for each volt at the input.

5.4 0-10A MODE

An internal voltage reference (6V) is generated by series-dropping R14 and zener diode VR8, which in turn is reduced by the voltage divider network of R56, R21, R125A, and R125B. A portion of this voltage determined by the DC load adjust control is fed into the non-inverting input of U1 (Pin 5).

The inverting input (Pin 4) is connected to the top of shunt SH101. The pass structure is turned on by U1 until the voltage drop across the shunt is sufficient to equalize the voltage on the inverting and non-inverting inputs of U1. These two points are controlled only by the voltage reference supplied to Pin 5 and the current through the shunt, which means a constant amount of current will flow through the Dynaload regardless of the input voltage change.

The maximum voltage that can be applied to the non-inverting input, determined by divider R56 and R21, is limited so that a current of approximately 1 amp provides a sufficient voltage drop across the shunt to cause U1 to regulate the current in the pass structure.

5.5 0-60A MODE

This range operates the same way as the 0-10A mode, except that the reference is divided by R19 and R20, allowing more voltage to be applied to the non-inverting input of U1. This increased voltage requires 60A of current to flow through the shunt, SH101, before there is a sufficient voltage drop to cause U1 to regulate the current through the pass structure.

5.6 VOLTS

In the volts mode, the Dynaload is converted into a constant voltage regulator at the input terminals similar to a shunt regulator or a zener diode. The input voltage is applied through R23 and R30 and the load adjust to the non-inverting input of U1, and a constant voltage reference is applied from resistive divider R17 and R18 to the inverting input of U1, replacing the current feedback loop. Accordingly, if the input voltage tends to exceed the voltage selected by the volts control on the front panel U1 conducts more, thereby turning on Q101 which turns on Q102 through 122, causing the Dynaload to draw additional current, attempting to maintain constant voltage at the outputs.

5.7 EXTERNAL MODULATION MODE

The external modulation mode provides for the use of an external reference applied to the external modulation input in place of zener diode VR8. The coarse and fine DC load adjust on the front panel can then be used to define the programming sensitivity of the external modulation signal. If a pulse load is desired, a pulsing signal may also be applied to the external modulation input.

5.8 PULSE

This mode converts the Dynaload into a pulse load, which may be varied in amplitude and frequency as well as superimposed upon a fixed DC load. The pulse is generated by a CA3140E operational amplifier. The frequency is controlled by R126B, which controls the charging rate of C5. The amplitude of the pulse is controlled by R126A.

The output of the square wave generator is fed to the non-inverting input of U1 along with the 60A constant current circuit. The inverting input is connected to the top (+) of SH101. As the non-inverting input is driven positive by the square wave generator, the output of U1 rises, driving the power circuit. The current then rises until the voltage across the shunt is sufficient to raise the voltage at the inverting input, turning U1 off.

If a portion of the voltage on the non-inverting input of U1 is constant, as selected by the DC load adjust controls, the input current will be maintained at the fixed level selected, and rise as the square wave generator drives the non-inverting input more positive, thus giving a pulse load superimposed upon a fixed DC load.

If the pulse load is desired to return to no-load, the DC load adjust pots should be turned fully counterclockwise.

A sync output pulse is taken from an amplifier driven directly from the output of the square wave generator, creating a pulse which coincides with the leading edge of the load pulse and may be used to trigger additional test equipment.

5.9 SHORT CIRCUIT

The short circuit mode is a contactor that places the ammeter directly across the Dynaload input for short circuit current tests; all three ammeter ranges may be used in this mode.

If the contactor is energized when a very large capacitive source is connected to the input, it may cause the contacts to weld together. To prevent this from occurring, the DC load should be increased to maximum current, and the relay then energized by the short circuit button.

5.10 CURRENT LIMIT/POWER LIMIT PROTECTION

The voltage proportional to load current generated across SH1 is applied through R7 to the base of Q3, The voltage reference generated by zener diode VR8 is reduced by divider network R15 and R50 (current limit adjust) and applied to the base of Q4. Accordingly, Q4 will normally conduct, thereby turning on Q2 and permitting it to drive the Dynaload. When the load current reaches the current limit point, Q3 conducts, thereby turning off Q4, which turns off Q2, restricting the drive to the Dynaload in a constant current regulating characteristic.

It should be noted that zener diode VR1 begins to conduct when the input voltage is approximately 16V, and accordingly, R5, R6, and R7 divider network comes into play as the voltage is increased by adding a voltage to the current signal so that the current limit point is reduced as the input voltage rises. To make a more accurate constant power curve, VR4 is introduced when the voltage across R6 and R7 reaches approximately 8.2V. This draws some of the introduced signal away from Q3, preventing excessive reduction in the current limit point at high voltages. This results in an almost constant power limitation, The Dynaload is rated at 60A up to 17V, and the bendback is normally set so that at 50V input, it is impossible to draw more than 25A.

5.11 INSTRUMENTATION CIRCUITS

Range selector switches and calibrating resistors are provided for the front panel ammeter and voltmeter.

5.12 OVERVOLTAGE PROTECTION

If the input voltage exceeds approximately 55V, divider R44, R45, and R46 (overvoltage adjust) causes Q6 to conduct, thereby firing SCR101 which crowbars the output and trips circuit breaker CB1 if the source current is sufficient. Reverse voltage protection is provided by CR101.