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DLP-50-150-3000A

OPERATOR'S MANUAL

MARCH , 1980

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INSTRUCTION MANUAL--MODEL DLP 50-150-3000A DYNALOAD

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ILLUSTRATIONS

Schematic

Drawing Number
D106744

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1. 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/volt) 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 a 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.

2. SPECIFICATIONS

The following ratings apply:

Load voltage: 0-50V

Load current: 0-150A

Power dissipation: 1-3000W

Overload rating: 10%

Self-protection: Overvoltage--less than 60V

Overcurrent--less than 160A

Over-power--less than 3500W

Mode Selector Switch Positions, from left to right:

Position 1: Constant resistance 0-5 A/V as determined by the front panel DC load adjust.

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- Position 2: Constant resistance 0-30 A/V as determined by the front panel DC Load adjust.
- Position 3: Constant current 0-30A as determined by the front panel DC load adjust.
- Position 4: Constant current 0-150A 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; i.e., 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 0-150A with 0-6V applied to the external modulation terminals (TBI). 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 0-150A and 500-5000 Hz as desired by the front panel pulse control.
- 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 voltage range as selected by the voltmeter range selector switch, 0-6V, 0-18V, 0-60V.
- M2: Load current range as selected by front panel current range selector switch, 0-18A, 0-60A, or 0-180A.

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CAUTION: The meter range selector switch should always be maintained in the highest voltage or highest current position except when readings are being taken; i.e., although the meters have high overload capability, they may be damaged by overloads in the lower range positions.

CBI: Load on-off circuit breaker. For absolute no load tests, this circuit breaker should be opened and the circuit breaker will automatically open in the event of an overvoltage, overcurrent condition; i.e., the circuit breaker is rated at 180A and will open up if more than 180A 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 180A 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.

Current Sample: This is provided for measuring the pulse current amplitude when operating in the pulse mode. There will be .005 volts for each amp of current

Pulse: Sinc. Out--This is a pulse output, which is the same frequency as the pulse load, and may be used to trigger an oscilloscope.

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.

TBI-1: 0 to +6V programming voltage input.

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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.

3. OPERATING INSTRUCTIONS

The following procedure is recommended for hooking up the dynaload: The AC and DC dynaload switches should be turned off so that the load is inherently disconnected. The meter range switches should be set in their maximum voltage and current positions, and the load adjustment controls should be set in the counterclockwise position. The mode selector switch should be set to the appropriate mode to be used. The dynaload should be plugged into standard 115V, 50-60 Hz power (optional input voltage ranges are available) and connections should be made from the source to be tested to the appropriate load terminals of the dynaload, E+ and E- on the rear of the unit. If external modulation is to be used, the external programming voltage should also be connected.

With the AC power switch on, the AC-ON indicator lamp should light. The DC-ON circuit breaker should now be closed, and the front panel dynaload voltmeter should indicate the source voltage. If the circuit breaker

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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. The load may now be increased by turning the load adjust controls slowly clockwise until the appropriate load is obtained. 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 effect of leakage currents in the dynaload or line voltage drops at high currents.

3.1 Constant Resistance Mode (Amps/Volt)

Two scales are provided: i.e., 0-5 A/V and 0-30 A/V. Minimum resistance on the 0-5 A/V is .2 ohm and minimum resistance on the 0-30 A/V is .033 ohm. Let us assume that we wish to test a 12V battery with a one ohm resistive load. We would accordingly set the mode selector switch to the 0-5 A/V position and connect the source as previously described.

After checking the initial readings of the meters, we would then adjust the voltmeter to the 0-18V scale and the ammeter to the 0-18A scale. We would then slowly turn the coarse and fine DC load adjusts to obtain the 12A load, while monitoring the battery voltage on the front panel voltmeter. 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 drop 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 mA 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 approximately 1 to 2V input; i.e., 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.

3.2 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; i.e., 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:

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, 0-30A. Turn on the power source and the dynaload, and set the power source to the desired output voltage (let us assume 30V). 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 one or two volts, or

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until the A/V exceeds 30; i.e., it will maintain 150A constant current down to less than 5V, or 90A down to less than 3V, 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.

3.3 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 0-150A 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; i.e., 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.

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3.4 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 0-150A peak current by the pulse amplitude control on the front panel. The frequency may be varied from approximately 500-5000 Hz by the pulse frequency control on the front panel. This pulse load may be superimposed on the 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 to around 160A by the internal current limit protection.

3.5 Short Circuit

This 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 30 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 180A of current is drawn.

3.6 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

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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.

3.7 Power Rating

The model DLP 50-150-3000A will dissipate 3000W continuously. In order to assure that overheating does not occur, the rear stop of the dynaload should be clear for the air intake and the air exhaust; i.e., the cooling air enters from the top and leaves from the rear. The dynaload should periodically be checked for dust accumulation.

3.8 Protective Circuits

The dynaload has internal current limiting at approximately 160A maximum and also has a circuit breaker which disconnects at somewhat over 180A. The dynaload also incorporates reverse voltage protection by reverse diode; i.e., 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 over-voltage circuit will trigger an SCR across the input, thereby protecting all internal circuits. If the source current is large enough, the front panel circuit breaker will trip. If the source should be damaged by a 150A 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 over-power condition from happening. Accordingly, the current limit characteristics are

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set at approximately 155A, which are maintained to approximately 20V, 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 illustrated in Sections 3.2 and 3.6.

4. CALIBRATION PROCEDURES

4.1 Voltmeter Calibrate

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 5, 15, and 50V respectively. With the voltmeter range selector switch in the 6V position and 5V applied, adjust R32 so that the front panel voltmeter reads 5V. With the meter selector switch in the 18V position and 15V applied, adjust R34 until the front panel voltmeter reads 15V. With the

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meter range selector switch in the 60V position and 50V applied, adjust R36 until the front panel meter reads 50V.

4.2 Ammeter Calibrate

Use an external 15V source and an external ammeter for calibration.

Turn the dynaload adjust to the minimum counterclockwise position and set the mode selector switch to the constant current 0-150A position. With the ammeter range selector switch at 18A, increase the load until the external ammeter reads 15A. Adjust R38 so that the front panel ammeter also reads 15A. Switch the ammeter selector switch to 60A, and adjust the load current until the external ammeter reads 40A. Adjust R40 until the front panel ammeter also reads 40A. With the ammeter range selector switch set at 180A, increase the load current to 120A as indicated on the external ammeter, and adjust R42 until the front panel ammeter also reads 120A.

4.3 Amperes Per Volt Calibrate

With the dynaload in the 0-5 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 and adjust the A/V calibrate potentiometer R54 so that between 25 and 30A of load current is obtained.

With the dynaload in the 0-30 A/V position, and the load adjust in the maximum clockwise position, apply a voltage of 5V to the input terminals of the dynaload, and adjust the 30 A/V calibrate potentiometer R30 so that between 150 and 155A of load current is obtained. Make sure that the current limit setting is not interacting in any way.

4.4 Current Calibrate

Set the mode selector switch to the 0-30A constant current position. Using a 5V source, turn the DC load potentiometer in the maximum clockwise position and adjust R56 to obtain between 30 and 35A.

Set the mode selector switch to the 0-150A constant current position. Using a 5V source, turn the DC load potentiometer in the maximum clockwise position, and adjust R19 to obtain between 150 and 155A. Make sure that the current limit setting is not interacting in any way.

4.5 Current Limit Calibrate

Place the dynaload in the 0-30 A/V position. Using a 10V source, increase the load current to approximately 155A, or until current limiting is achieved. Readjust R50 as appropriate.

4.6 Over-power Protection

Apply a 50V source to the dynaload, and increase the load current either to its maximum counterclockwise position or 65A, whichever occurs first. Adjust R7, the bendback resistor, to limit the current at 50V to between 62 and 65A.

4.7 Linearity

With the dynaload connected to a 5V, 150A, source, place the dynaload in the EXT MOD position and apply an external modulation voltage to TB1-1 of plus 6 volts. Set the front panel load adjust controls for 150A of current.

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Decrease the external modulation voltage to 1V. Adjust the linearity control, R68, for 25A of load current. Repeat the above procedure until the linearity is within 1%.

4.8 Current Sample

With the dynaload connected to a 100 amp source, the 0-150A mode, adjust the front panel load adjust control for 100A. Using a DVM, adjust the current sample control R72 for 500mV at the current sample terminals on the front panel.

4.9 Square

With the dynaload connected to a 10A source in the pulse mode, adjust the front panel pulse amplitude control for a $5A \pm 20\%$ pulse at minimum frequency. Using an oscilloscope to monitor the current sample terminals, adjust the square control to give an equal time-on and time-off period for the square wave load.

5. THEORY OF OPERATION

5.1 Input Circuits

A schematic diagram is shown in Drawing No. D106744. AC power is applied through the line cord, through fuse F101, and AC on-off switch S115 to the AC indicator lamp, blower B101, and the primary of T1 through CB101 when in 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

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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 +16 and +8V.

5.2 0-5 A/V Mode

The input voltage is divided through 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 R171 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 V OUT (pin 10), which in turn drives Q101 through Q104 and consequently, the pass transistors Q105 through Q170.

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 at pin 5, causing U1 to regulate the drive to 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.

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

5.3 0-30 A/V Mode

In this position, the circuit operates the same as in the 0-5 A/V mode, with the exception that the input voltage is now divided by R23, R30, and R171. 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 30A of current can be drawn for each volt of input.

5.4 0-30A 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 30 amps provides a sufficient voltage drop across the shunt to cause U1 to regulate the current in the pass structure.

5.5 0-150A Mode

This range operates the same way as the 0-30A 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 approximately 150A 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 through Q104, which turns on Q105 through Q170, causing the dynaload to draw additional current, attempting to maintain constant voltage.

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 adjusts 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 150A 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.

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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 load pulse and may be used to trigger additional test equipment.

5.9 Short Circuit

This 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 SH101 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.

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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; i.e., the dynaload is rated at 150A up to 20V, and the bend-back is normally set so that at 50V input, it is impossible to draw more than 60A.

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 applied 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 CB101 if the source current is sufficient.

Reverse voltage protection is provided by CR101.