OPERATOR'S MANUAL

MODEL 50/750

HIGH-VOLTAGE AMPLIFIER

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Thank-you

for buying Trek's Model 50/750 High-Voltage Amplifier. This product has been designed and built to very high standards to give you years of trouble-free service.

If you have any questions, please feel free to contact your Trek Representative at:

WRITE: **TREK, INC.**
11601 Maple Ridge Road
Medina, NY 14103-9710 USA

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International Customers: (585) 798-3140

Again, thank you for buying a Trek Product.

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SECTION I

GENERAL INFORMATION

WARNING: THIS INSTRUMENT IS NOT RATED FOR AN EXPLOSIVE ENVIRONMENT. DO NOT USE IT IN AN EXPLOSIVE ENVIRONMENT OR AN EXPLOSION MAY OCCUR.

INTRODUCTION

This manual provides instructions to install and operate the Model 50/750 High-Voltage Amplifier. The Model 50/750 is a two-channel amplifier. This manual describes the installation and operation of a typical channel and applies to either channel of the instrument.

The Model 50/750 is a high-voltage amplifier with a 1500-volt output range at 50 mA continuous, 100 mA peak (for 10 µs into capacitive or resistive loads). It uses a floating output driver, allowing the instrument to be strapped to produce an output voltage range of 0 V to +1500 V, 0 V to -1500 V or -750 V to +750 V. As such, the user may select bipolar of full unipolar operation.

It features adjustable DC gain in the range of 15 to 300 V/V and AC response controls that permit handling of different capacitive loads. The four-quadrant output stage sources or sinks current into capacitive or resistive loads anywhere within the output voltage range.

SPECIFICATIONS

All specifications are with no load unless otherwise noted.

OUTPUT

Output Voltage Range
0 to +1.5 kV DC or peak AC, or
0 to -1.5 kV DC or peak AC, or
0 to ±750 V DC or peak AC
(jumper pin programmable).

Output Current Range
0 to ±50 mA DC, continuous
(100 mA peak for 10 μs).

AMPLIFIER INPUT

Input Voltage Range
0 to ±10 V DC or peak AC.

Input Impedance (Noninverting)
100 kΩ, nominal.

FEATURES

The Model 50/750 consists of a power supply module with up to two modular amplifier channels which can be mounted together in a half rack enclosure.

Digital Enable (Power Supply Module)
An input providing a connection for a TTL compatible signal to turn on and off the high-voltage output. A TTL low turns on the high-voltage output. A TTL high turns off the high-voltage output.

Gain Control
The DC gain of the Model 50/750 can be adjusted using a potentiometer from 15 to 300 V/V.

Dynamic Adjustment
Two graduated potentiometers are used to optimize the damping and response of the output signal.

Zero Adjustment
A multi-turn potentiometer can adjust for zero volt output when a zero volt input is applied.

PERFORMANCE

DC Voltage Gain
15 to 300 V/V, adjustable.

DC Voltage Gain Accuracy
Better than 0.1% of full scale.

Offset Voltage
Less than ±500 mV.

Output Noise
0 to +1500 V range or
0 to -1500 V range
Less than 50 mV rms to 20 kHz for a 1 nF load (measured with the true rms feature of the Hewlett Packard Model 34401A digital multimeter).
0 to ±750 V range
Less than 60 mV rms to 20 kHz for a 1 nF load (measured with the true rms feature of the Hewlett Packard Model 34401A digital multimeter).

Slew Rate (10% to 90%)
Greater than 125 V/μs.

Large Signal Bandwidth (1% distortion)
DC to greater than 8 kHz.

Small Signal Bandwidth (-3 dB)
DC to greater than 30 kHz.

Settling Time to 1%
Less than 50 μs when critically damped.

Stability
Drift with Temperature
Less than 50 ppm/°C.
Drift with Time
Less than 10 ppm/hr, noncumulative.

SPECIFICATIONS, cont.

All specifications are with no load unless otherwise noted.

GENERAL

Dimensions
148 mm H x 216 mm W x 432 mm D
(5.8” H x 8.5” W x 17” D).

Weight
Model 50/750-1 (one channel)
6 kg (14 lb).
Model 50/750-2 (two channels)
8 kg (18 lb).

High-Voltage Output Connector
MHV coaxial connector.

Amplifier Input
BNC coaxial connector.

Digital Enable Connector
BNC coaxial connector.

Power Requirements
Line Supply
Factory set for one of two ranges:
90 to 127 V AC or 180 to 250 V AC,
at 48 to 63 Hz.

Power Consumption
100 VA, per channel.

AC Line Receptacle
Standard three-prong AC line connector, with an integral fuse holder, that supplies power to all the amplifier channels of the instrument.

Operating Conditions
Temperature
0°C to 40°C.
Relative Humidity
To 85% noncondensing.

ACCESSORIES SUPPLIED

Operator’s manual, MHV mating connector for each amplifier channel, and line cord.

CERTIFICATION

Trek, Inc. certifies that each Model 50/750 is tested and calibrated to specifications using measurement equipment traceable to the National Institute of Standards and Technology or traceable to consensus standards.

INCOMING CONFIDENCE TEST

The 50/750 undergoes extensive checks and adjustments at the factory and should require no initial calibration. However, you may wish to perform an incoming confidence test as part of the incoming inspection on the instrument. This incoming confidence test is intended to confirm that the instrument was not damaged in transit.

Applying a test signal to the INPUT connector and measuring the signal at the OUTPUT connector constitutes a reasonable incoming confidence test.

We recommend that you familiarize yourself with the information in INSTALLATION (page 4) and OPERATION (page 7) before performing this test.

WARNING: Do not plug in the 50/750 or turn it on until instructed to do so. An electrical shock could result if this precaution is not observed.

Incoming Confidence Test Procedure

The following test requires a DC voltage reference and a digital voltmeter capable of withstanding more than 1500 V at its input terminals.

This test procedure is written for the 50/750 unit configured as a 0 to +1500 V amplifier or as a -750 V to +750 V amplifier. To test a 50/750 unit configured as a 0 to -1500 V amplifier, substitute the value indicated in parenthesis. Perform this test for each channel.

1. Insure that the power switch is OFF before beginning this test.

2. Plug the AC line cord into the AC line cord receptacle on the rear panel.

3. Plug the 50/750 into a power source.

   WARNING: Make no attempt to bypass the ground prong in the AC line cord. Any attempt to negate this safety feature could result in an electrical shock.

4. Connect a digital voltmeter to the OUTPUT receptacle on the front panel. Turn on the voltmeter.

5. Connect a +1 V (-1 V) reference supply to the INPUT receptacle on the front panel. Turn on the reference supply.

6. Turn on the 50/750 POWER switch.

7. Note the voltage on the digital voltmeter. It must indicate +100 V (-100 V).

   NOTE: The output voltage of 100 V (-100 V) will be seen, given a gain setting of 100 V/V. Readjustment of this gain can be set using the front panel GAIN adjustment control.

This completes the Incoming Confidence Test. Turn off the POWER switch. Disconnect the reference power supply and the digital voltmeter.

SECTION II

INSTALLATION

MOUNTING

The 50/750 is designed for operation as a tabletop instrument.

CAUTION: The 50/750 is air cooled. Do not impair the airflow through the vent holes in the top and bottom covers, or the rear-panel fan.

AC LINE CORD CONNECTION

1. Insure that the 50/750 POWER switch is off.

2. Plug the AC line cord into the AC line cord receptacle on the rear panel.

3. Plug the 50/750 into a 115 V power source.

   WARNING: Make no attempt to bypass the ground prong in the AC line cord. Any attempt to negate this safety feature could result in an electrical shock.

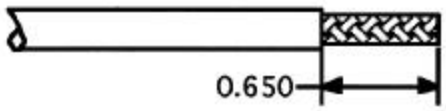
HOW TO ASSEMBLE THE HIGH VOLTAGE CONNECTOR

A load is connected to the 50/750 using the high-voltage plug provided.

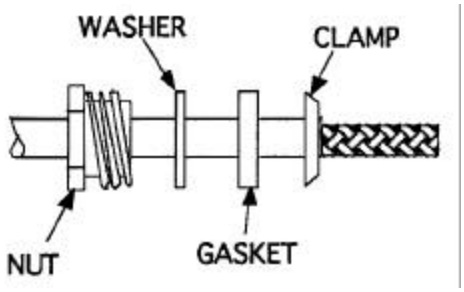
CAUTION: Use only high-voltage coaxial cables and high-voltage connector plugs (MHV type). Do not use BNC plugs (they are typically rated to only 500 V). The MHV connector provided must be used with a coaxial cable having a voltage rating of at least 1200 V rms. The MHV connector will accept a coaxial cable with an outer diameter up to .212 inches or 5.4 mm.

Connect the HV plug to the cable as follows:

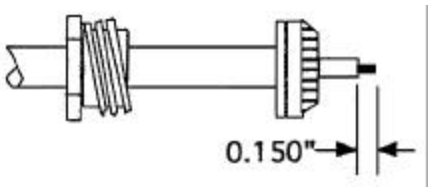
1. Cut the cable and square up the end. Strip the cable jacket back 0.65 in.



2. Slide the connector parts onto the cable jacket. Slide the nut on first, next the washer, then the gasket, and finally the clamp. The clamp's inner shoulder should fit squarely against the end of the cable jacket.

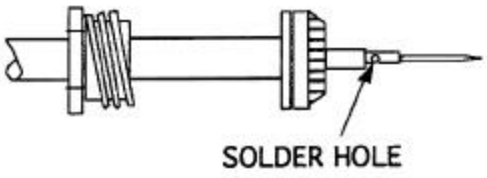


3. With the clamp in place, comb out the braid and fold the fibers back over the clamp. Trim the center conductor to 0.15 in. Tin the center conductor.

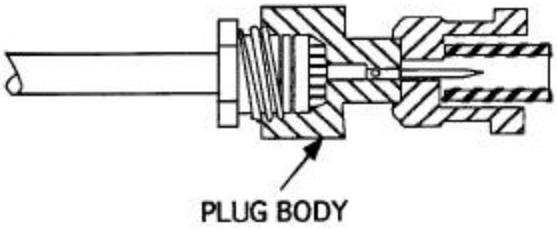


4. Solder the contact onto the conductor through the solder hole. The contact should butt flush against the dielectric. Remove excess solder from outside of the contact.

   CAUTION: Avoid applying excess heat to the contact. This will cause the dielectric to swell and interfere with the connector body.



5. Push the contact assembly into the connector body. Screw the nut into the body with a wrench until tight. Do not rotate the connector body on the cable assembly to tighten.



This completes the high voltage connector/ cable assembly procedure.

LOAD CONNECTIONS

Load connections should be made as short and direct as possible.

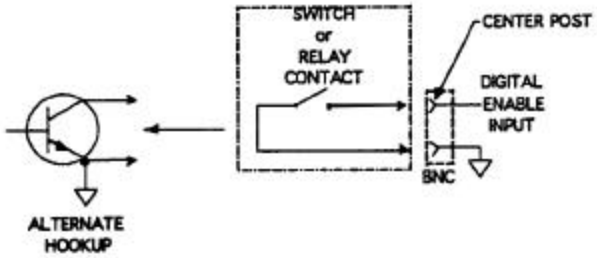
1. Connect the center conductor of the high-voltage cable to the “hot” side of the load.

2. Return the low side of the load to the shield of the coaxial cable or to the green, five-way binding post on the rear panel of the amplifier.

DIGITAL ENABLE CONNECTION

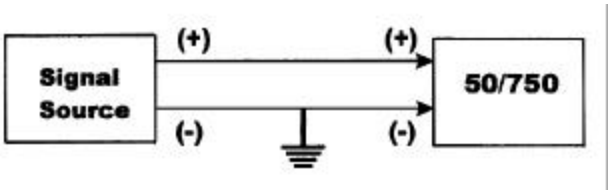
The DIGITAL ENABLE connection is made at the DIGITAL ENABLE BNC connector on the front panel of the POWER SUPPLY module. To control the 50/750 from a remote device, connect this input to ground through a switch or relay contact, or connect it to the output of a controlling device such as an open collector transistor or TTL gate that has a current sinking capability of approximately 2 mA. When contact is made from the center post to ground (or the BNC connector shield), both channels are enabled. When contact is broken, the high-voltage rails to both channels are disabled.

When a remote enable/disable function is not required, connect the cap over the DIGITAL ENABLE receptacle. This shorts the DIGITAL ENABLE input and allows the 50/750 to operate.



INPUT CONNECTIONS

To prevent noise pickup, the ground reference for the input signal must be connected to the input BNC connector shield. See diagram below.



CHANGING THE OUTPUT VOLTAGE RANGE

The 50/750 output voltage can be programmed for any of the three output voltage ranges: 0 to +1500 V, 0 to -1500 V, or -750 V to +750 V. The programming is accomplished by a programming plug located on the power supply module. The programming plugs are supplied with the loose-parts kit that accompanies the instrument. Programming plugs for 0 to +1500 V and for 0 to -1500 V are supplied in the loose-parts kit. The programming plug for -750 V to +750 V is installed on the power supply module.

NOTE: Observe the following safety precautions when changing the output voltage range of the 50/750 unit:

1. Hazardous voltages exist within the instrument enclosure. Always turn off the 50/750 and disconnect it from its power source before attempting to make any output voltage range wiring changes. Failure to observe this precaution could result in electrical shock.

2. Allow a cool-down period to reduce the danger of burns from heated parts such as transistors and heat sinks.

3. Refer all maintenance procedures to qualified personnel.

Locating the Programming Plug

Remove the power supply module. The programming connector is a white Molex connector that is located at the rear of the power supply board near the gold PC fingers.

Programming the Output Voltage Range

Connect the appropriate programming plug for the output voltage range required to the programming connector on the power supply board.

Install the programming plug so that the ridge of the plug faces away from the gold fingers of the power supply board.

SECTION III

OPERATION

FRONT PANEL CONTROLS and INDICATORS

Refer to figure below for the location of the controls and indicators.

1. **POWER Switch:** This switch turns the 50/750 on and off. A red lamp in this switch assembly glows when the 50/750 is on.

2. **DIGITAL ENABLE:** Connect a switch, relay, or TTL control signal to this input to turn the high voltage on and off.

3. **H.V. OUTPUT:** This receptacle, using the MHV connector (provided), is for the connection to the load device.

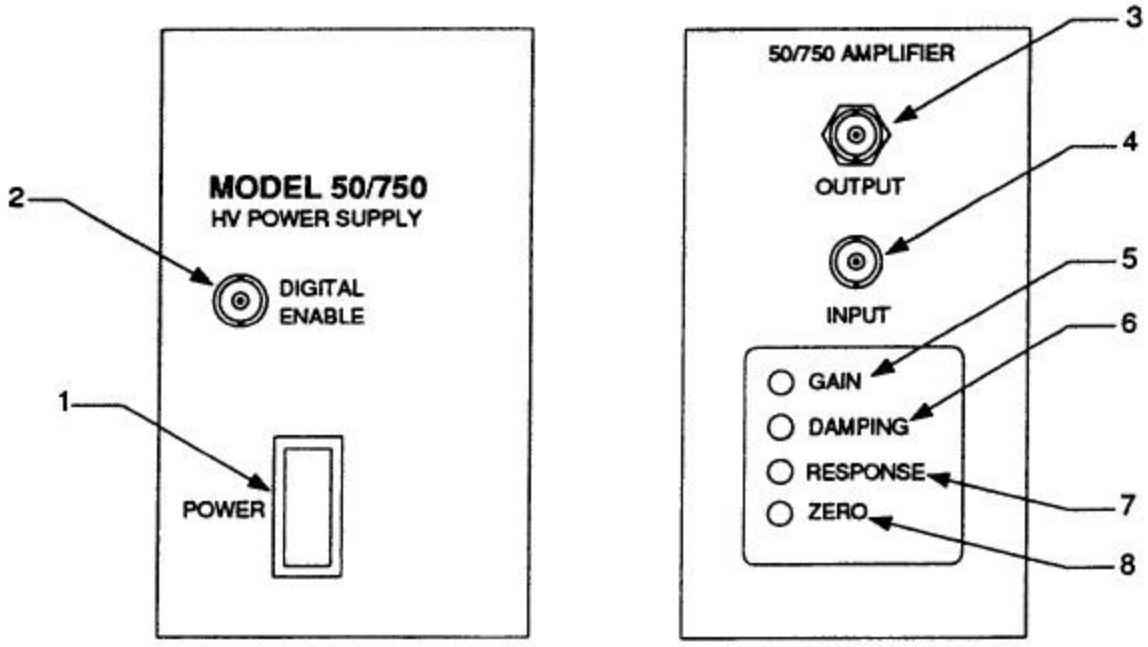
4. **AMPLIFIER INPUT:** This BNC input connector is for the connection to an external, low voltage signal source.

5. **GAIN Control:** The gain control allows the user to adjust the DC gain from 15 to 300 V/V. The gain is factory set at 150 V/V unless otherwise specified when ordered.

6. **DAMPING Control:** Use this control in conjunction with the RESPONSE control to optimize the step response characteristics of the amplifier.

7. **RESPONSE Control:** Use this control in conjunction with the DAMPING control to optimize the step response characteristics of the amplifier.

8. **ZERO Control:** Use this control to produce zero voltage at the OUTPUT when the input signal is zero.



REAR PANEL CONNECTOR

The rear panel includes a green, five-way binding post. This is a return connection for the low side of the load and/or a ground reference point for other equipment.

OPERATING PROCEDURE

The 50/750 may be used as either a high-voltage amplifier or as a high voltage reference supply. The operation is the same for both applications: an external, low voltage signal is applied to the input connector and a proportional high-voltage signal is delivered through the output connector to the load device.

WARNING: The high-voltage OUTPUT connector carries high voltage. DO NOT touch the high voltage OUTPUT connector or the load circuit while the 50/750 is operating. An electrical shock could result. Always turn off the amplifier before making changes to the load connection.

1. Ensure that the POWER switch is off before connecting the input signal and the load.

2. Connect the input signal to the INPUT receptacle. Ensure that the amplitude of the input signal does not exceed the input voltage range specified for the selected channel and that the source current is limited to 100 mA.

3. Connect the output signal to the load circuit using the high-voltage connector/ cable assembly previously constructed.

4. Turn on the POWER switch.

ADJUSTING THE GAIN

NOTE: Unless a different gain was specified at the time of order, the gain was set at 150 V/V when the 50/750 was shipped from the factory.

To set the Gain for a different value:

1. Ensure that the 50/750 POWER switch is off before connecting the input signal and the digital voltmeter.

2. Connect the output of a DC reference supply to the INPUT of the 50/750.

3. Connect the output signal to a digital volt-meter. Ensure that the digital voltmeter has an input voltage rating higher than ±1500 V.

4. Turn on the POWER switch.

5. Adjust the gain potentiometer until the desired gain is obtained. The gain pot is accessed through the GAIN hole in the front panel. Use a small screwdriver, preferably nonconductive.

ADJUSTING THE AC RESPONSE CONTROLS

As shipped from the factory, the AC response controls, RESPONSE and DAMPING, are optimized for a no-load condition. You may desire to readjust these controls for your load.

NOTE: If it is not feasible to apply the test signal stated below to your particular load device, substitute an equivalent RLC load for the purpose of setting the AC response controls.

Optimizing the AC Response with a Load Connected

1. Apply a 100 Hz square wave to the input of the 50/750. The amplitude of the square wave must cause a full scale output excursion: ±5 V in for -750 V to +750 V out, 0 to +10 V in for 0 to +1500 V out, and 0 to -10 V in for 0 to -1500 V out (values for a gain of 150).

2. Monitor the output of the 50/750 with an oscilloscope. Use a compensated high-voltage probe with the oscilloscope if necessary to limit the oscilloscope input to a safe voltage level.

3. Adjust the DAMPING and RESPONSE potentiometers for the best square wave response (no undershoot or overshoot and flat tops).

   Given the fast response and high stability of this amplifier, fine waveshapes are obtainable. When viewing the waveshape under certain loads, a slight overshoot may exist that will not be adjusted out using the DAMPING and RESPONSE potentiometers. This helps maintain the high speed of response of the amplifier.

PROTECTIVE CIRCUITRY

The Model 50/750 includes internal protection for high reliability.

Current Limiting

The Model 50/750 is a voltage-regulated amplifier by controlling output current. The output current is internally limited for protection against short circuits and overloading conditions.

Thermal Limiting

The Model 50/750 is forced-air cooled to remove any internal accumulation of heat. If the internal temperature of the amplifier rises above a safe level, the amplifier will automatically reduce its output current capability until the amplifier returns to a safe area of thermal operation.

Overvoltage Protection

The Model 50/750 is designed for driving active loads (loads capable of returning energy into the output of the amplifier). It incorporates output terminal voltage protection against high voltage from the load. If the voltage at the load exceeds approximately 15% of the rated output voltage of the amplifier, an internal clamp absorbs additional energy from the load.

When the voltage of an active device (load) is within the output voltage range of the 50/750, there is no practical limitation to the amount of energy that the 50/750 must absorb.

However, a limitation for the amount of energy the 50/750 can absorb occurs when the voltage of the active device exceeds the voltage range of the 50/750. The amount of energy that the output can absorb is a complex function of the voltage, of the duration of the current, and their effects upon different components in the protective circuit. A discussion of this limitation is given in Appendix A.

SECTION IV

MAINTENANCE

SAFETY

Observe the following safety precautions when performing maintenance procedures on the 50/750:

1. Hazardous voltages exist within the instrument enclosure. Always turn off the 50/750 and disconnect it from its power source before cleaning or inspecting it. Failure to observe this precaution could result in an electrical shock.

2. Allow a cool-down period to reduce the danger of burns from heated parts such as transistors and heat sinks.

3. Refer all maintenance procedures to qualified personnel.

PREVENTATIVE MAINTENANCE

Preventative maintenance consists of inspecting and cleaning the instrument. Preventative maintenance performed on a regular basis may prevent instrument failure and improve reliability.

ACCESS: Remove the top cover to expose all assemblies for inspection and cleaning.

INSPECTION: Visually inspect the instrument for loose or damaged components or other undesirable conditions such as heat-damaged parts.

CLEANING: Clean the 50/750 as operating conditions require. Dust and dirt on components act as an insulating blanket and prevent efficient heat dissipation. This can cause overheating and component failure.

Dust and direct also provide an electrical conduction path that can result in instrument failure, especially under conditions of high humidity that can cause arcing in the high-voltage sections.

Use dry, low-pressure compressed air to blow the accumulated dust and dirt from the interior of the instrument. Use a brush to dislodge dirt and dust that is not readily dislodged by the compressed air.

Clean the exterior of the instrument with an equal part solution of denatured alcohol and water. The use of stronger solvents may damage the finish or plastic components. A small brush is effective in removing dirt from the front and rear panel controls and connectors.

SERVICING THE FUSES

WARNING: Never attempt to service the fuses when the instrument is plugged into a power source. An electrical shock could result. Refer servicing of the fuses to qualified personnel.

1. Disconnect the 50/750 from its power source before changing the fuses.

2. Remove and replace the fuses with new ones of the same style and value.

If the 50/750 continually blows fuses, a more serious problem may exist within the instrument. In this instance, contact the Customer Service Department at Trek, Inc. and request instructions.

CUSTOMER SERVICE ASSISTANCE

In the event that you require assistance on a maintenance item, direct your request for assistance to the Customer Service Department at Trek, Inc.

Telephone assistance is usually effective for obtaining additional maintenance information that is beyond the scope of this manual. Troubleshooting advice that is given over the telephone may be useful for solving the simpler malfunctions or confirming that the instrument should be returned to the factory or to an authorized service organization for repair.

Factory Repairs:

The terms and conditions of the warranty are given in the warranty statement that is found in this manual.

CAUTION: The warranty is voided if the instrument is serviced within the warranty period by anyone other than Trek, Inc. or one of its authorized service organizations.

In the event of a malfunction, and the instrument must be returned to the factor for repair:

a) Notify the Customer Service Department at Trek, Inc., giving full details about the difficulty, including the model number and serial number of the instrument. Obtain a return authorization number, which will be issued by the Customer Service Department.

b) If a return authorization number is issued, forward the instrument (prepaid) with the return authorization number prominently displayed on the shipping container and the packing list, to Trek, Inc. for repair.

If we determine that the malfunction is not covered by the terms and conditions of the warranty, an estimate will be submitted for customer approval before the commencement of repairs.

FAX: (585) 798-3106

TELEPHONE:

In the United States
1 800 367-8735 (FOR-TREK)

International Customers
(585) 798-3140

APPENDIX A

ACTIVE LOAD LIMITATIONS

The Model 50/750 is designed for driving active loads. Active loads are loads capable of returning energy into the output of the amplifier. An example of an active load is a piezoelectric transducer. A piezoelectric transducer will develop a voltage across itself when forced to expand or contract.

The amount of energy that can be generated by the piezoelectric transducer or any active load is determined by the formula:

$$\text{Energy in joules} = 1/2CV^2,$$

where C is the capacitance value of the active load and V is the voltage created by the stress on the active load.

When the voltage created by an active load is within the output voltage range of the 50/750, there is no practical limitation to the amount of energy that the 50/750 must absorb.

However, a limitation for the amount of energy the 50/750 can absorb occurs when the voltage created by the active device exceeds the voltage range of the 50/750. The amount of energy that the output can absorb is a complex function of the voltage, of the duration of the current, and of their effects upon different components in the protective circuit.

A limitation for the amount of energy that the 50/750 can absorb is based on the maximum energy that certain components in the 50/750 can dissipate. Please refer to Figure 1 for the following discussion. D1 and D2 become forward biased when the voltage created by the active device exceeds the value of V1 or V2. (V1 and V2 represent the high voltage supplies of the 50/750.) When this occurs, V1 or V2 act as capacitors and begins charging until the voltage rating of ZD1 or ZD2 is reached. At this point ZD1 or ZD2 absorbs the energy produced by the active load.

NOTE: ZD1 and ZD2 are idealized representations of different components in the 50/750. The specific components (zener voltage values) are different when the 50/750 is operated in different output voltage ranges.

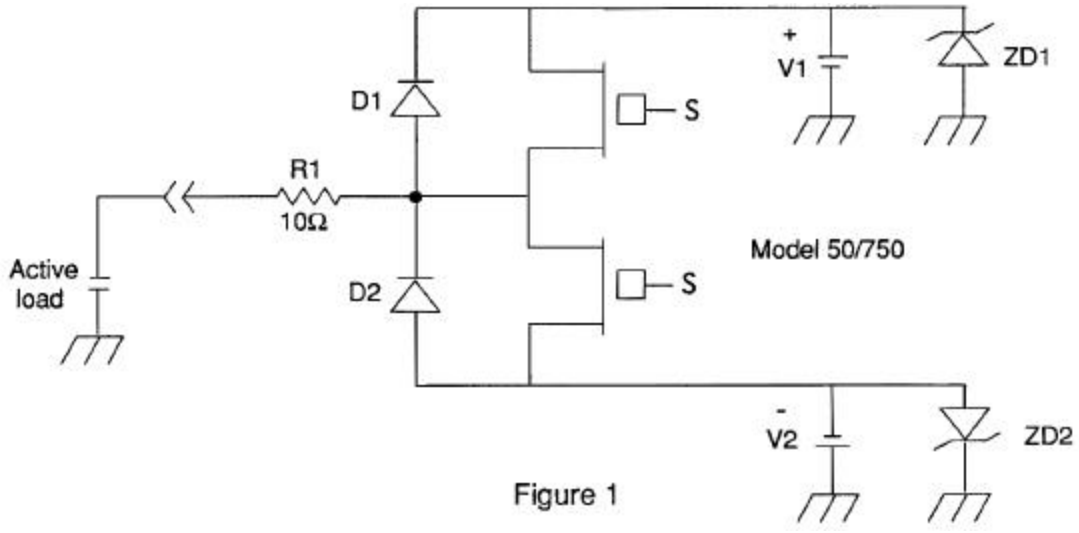


Figure 1

To calculate the maximum energy in joules that the ZD1 and ZD2 can dissipate, use the formula:

Maximum energy in joules = $(V_m)(I_s)(T_s)$,

Where V_m is the voltage rating of ZD1 or ZD2, I_s is the maximum surge current that ZD1 or ZD2 can absorb for a certain duration (T_s), and T_s is the maximum duration of the particular surge current from the load that ZD1 and ZD2 can withstand. The calculations for the different voltage ranges of the 50/750 are shown in Table 1.

Now the energy that can be supplied by an active load can be compared to the maximum energy dissipation of the 50/750 for a certain output voltage range.

If the energy that can be supplied by the active load device is greater than the maximum energy dissipation of the 50/750 for a certain output voltage range, then additional external protection is required. Some examples of external protection are adding series impedance to the output or using a spark gap device.

TABLE 1

VOLTAGE RANGE	DESIGNATION	VOLTAGE RATING	NONRECURRENT SURGE CURRENT (MAX.)	CURRENT DURATION (MAX.)	MAXIMUM ENERGY (in Joules)
0 to ±750 V	ZD1 ZD2	+1000 V, ±5% -1000 V, ±5%	0.005 amps 0.35 amps 0.85 amps 2 amps	continuous 100 ms 10 ms 1 ms	- 35 8.5 2
0 to +1500 V 0 to -1500 V	ZD1 ZD2	+2000 V, ±5% -2000 V, ±5%	0.005 amps 0.35 amps 0.85 amps 2 amps	continuous 100 ms 10 ms 1 ms	- 70 17 4
0 to +1500 V 0 to -1500 V	ZD2 ZD1	-115 V, ±10% +115 V, ±10%	0.01 amps 1.2 amps 2 amps 5 amps	continuous 100 ms 10 ms 1 ms	- 13.8 2.3 0.575