

VF-90

VOLTAGE FOLLOWER / LINEAR AMPLIFIER FOR PIEZOELECTRIC (CAPACITIVE) LOADS



USER MANUAL

VF-90 LINEAR PIEZOELECTRIC AMPLIFIER

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Please review the following points for both personal and equipment safety while operating the linear piezoelectric amplifier.

HIGH ENERGY/VOLTAGE WARNINGS

Exercise caution when using amplifiers. High energy level can be stored at the output voltage terminals on all amplifiers in normal operations. In addition, potentially lethal voltages exist in the power circuit and the output screw terminals. Filter capacitors store potentially dangerous energy for some time after power is removed.



AC SOURCE GROUNDING WARNING

Ensure that the amplifier's power supply is connected to a grounded AC outlet with the recommended AC input connector configured for the available line voltage.

OPERATING AND SERVICES PRECAUTIONS


Operate the amplifier in an environment free of flammable gases or fumes. Do not use substitute parts or make any unauthorized modifications to the amplifier to ensure that its safety features are not degraded. Contact DSM for service and repair assistance.

VF-90 SPECIFICATIONS

- Output Voltage: -30/+150V, -30/+200V, or $\pm 100V$
- Input Voltage Signal (gain = 40): -0.75V to +3.75V (for -30/+150V unit)
-0.75V to +5.0V (for -30/+200V unit)
- Maximum Continuous Current: 90mA (RMS current into a capacitive load)
- Maximum Peak Current: 90mA
- Dimensions (NI cRIO 9952 chassis): Approx. 3.5" x 4" x 0.9"
- Operating Voltage: 5.5VDC input @ 3A
- Amplifier bandwidth: > 5kHz (-3dB)
- Electrical Noise on Output: ~1mVrms
- Short circuit, over-current, and over-temperature protection
- Connectors: screw terminal

NOTE: The output voltage is configured at the factory and is not re-configurable in the field.

WARNING!

 This device is marked with the international caution symbol. It is important to read the Recommended Operation section of this manual before using this device as it contains important information related to product safety.

General Precautions

- ◆ The output voltage range of the VF-90 can exceed the rated voltage limits. Do not allow the input signal to exceed the prescribed input voltage range, or damage to the piezo load can occur.
- ◆ All insulation of leads connected to output terminals should have at least a 300V rating.
- ◆ Do not use clip leads in the connections used in arrangements employing the VF-90 linear amplifier. They are very dangerous for high-voltage work.
- ◆ Do not place objects on top of or close beside the amplifier during operation. Adequate airflow around the unit is encouraged to allow heat to dissipate. If the amplifier module is used outside of a National Instruments (NI) CompactRIO or CompactDAQ chassis, apply the rubber feet included with the product to the side of the amplifier opposite the product label. This will allow air to circulate on the back side of the amplifier to help keep the internal circuitry cooler.
- ◆ Under certain operating conditions, the VF-90's power capabilities can exceed the maximum heat dissipation allowable by NI's CompactRIO and CompactDAQ specifications.

Acceptable Load Types

- ◆ This amplifier is designed to drive capacitive loads only. Do not use this amplifier to drive resistive loads. The amplifier will only work properly when a capacitive load is connected to the output.
- ◆ Never connect an inductive or a resistive load to the unit. This would cause a short-lived high-current pulse at the output and would damage the amplifier unit.

Short Circuit Damage

- ◆ Although the VF-90 is protected against a short-circuit on the output, it is recommended that a short circuit condition be avoided.
- ◆ Never connect an "earth ground" lead (e.g., an oscilloscope ground lead) to the output terminal. This causes a short-lived high-current pulse and subsequent damage to the unit.
- ◆ If the user desires to observe or audit the output signal of the amplifier using a voltage meter or an oscilloscope, the user must ensure that the meter or oscilloscope has an input impedance of at least 1 MOhm. A smaller input impedance could damage the amplifier.

RECOMMENDED OPERATION

Intended Use

DSM's VF-90 linear amplifier is intended to drive piezoelectric (capacitive) loads of the following types:

1. Low voltage piezoelectric materials rated for a maximum operating range of -30 to $+150V$ (piezo devices which have two lead wires: output voltage and ground)
2. Low voltage piezoelectric materials rated for a maximum operating range of -30 to $+200V$ (piezo devices which have two lead wires: output voltage and ground)
3. Low voltage piezoelectric "bender" actuators rated for a maximum operating range of $\pm 100V$ (piezo devices which have three lead wires: $-100VDC$, $+100VDC$, and output voltage)

The VF-90 applies a gain of 40 to analog input signals and generates an output voltage suitable for driving or actuating piezoelectric materials of the types described previously.

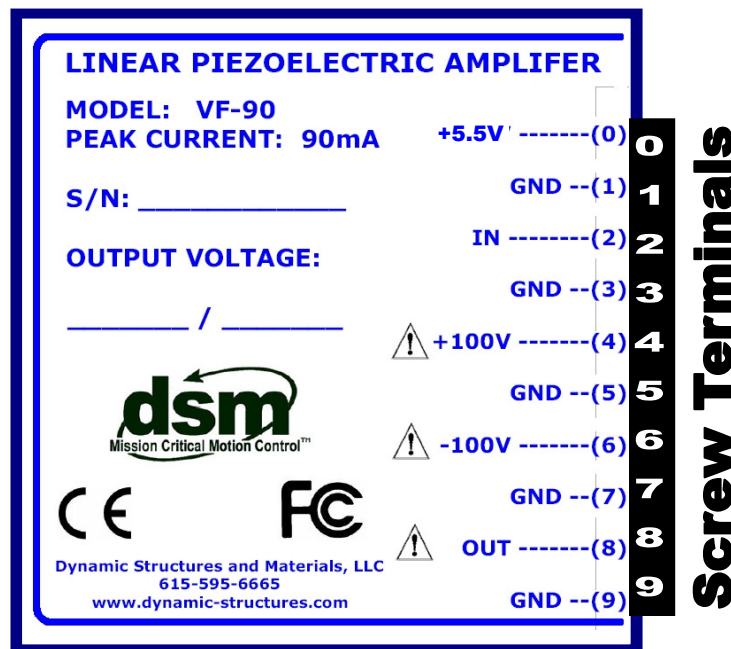


Figure 1. Electrical Connection Description for VF-90 Linear Amplifier
(corresponds to the screw terminals located on the side of the amplifier enclosure)

Instructions for Use

Start-Up / Shut-Down Procedure


The VF-90 amplifier can be powered-up and powered-down with or without being connected to an input signal. However, DSM recommends that the amplifier be connected to a load (capacitive, such as a piezoelectric device of the appropriate rating) during start-up and while the amplifier is running; operating without a load can be damaging to the amplifier's circuitry.

Connecting the Load to the Amplifier's Output

The VF-90 will have been configured at the factory for an output voltage range corresponding to the specifications of the customer's load (one of the three types discussed in the "Intended Use" section).

Attach a standard load (i.e., a piezoelectric actuator with two lead wires for signal and ground) to the VF-90 via the screw terminals 8 (OUT) and 9 (GND), respectively, on the amplifier's side. Typically, the piezoelectric material manufacturer will designate the "live" or "hot" electrode with red lead wire and/or a visible mark on the piezo material to distinguish this electrode from the ground electrode.

If the load is a three-lead wire piezoelectric "bender," two of the leads are attached to the +100V and -100V screw terminals (4 and 6, respectively), and the third lead is attached to the output screw terminal 8 (OUT) according to the piezo bender manufacturer's hook-up instructions. No GND connection is used for controlling the output signal to a three-connection bender element.

 **CAUTION:** When the VF-90 is powered, the output screw terminals of the amplifier (terminals 8 or 4/6/8, depending upon the type of load) carry voltages ranging up to 200V.

Power

Power for the VF-90 is provided through the +5.5V and 0V screw terminals (locations 0 and 1, respectively, in Figure 1) from the regulated AC/DC transformer that is provided with the VF-90. Use of a transformer other than the one provided by DSM could lead to compromised product performance.

Connect the ends of the lead wires from the transformer to the +5.5V and 0V screw terminal connections according to the labels on the transformer lead wires and on the VF-90.

Input

Input signals provided to the VF-90 amplifier (i.e., from a function generator) are made through connections to screw terminals 2 (IN) and 3 (GND). This is a low-voltage only input corresponding to the amplifier's gain of 40, and the input range for each of the amplifier's three factory-configurable output voltage ranges is tabulated below.

Output Voltage Range	Input Voltage Range
-30 to +150V	-0.75 to +3.75V
-30 to +200V	-0.75 to 5.0V
+/- 100V	-2.5 to +2.5V

AC, DC, or superposed AC and DC signals (for example, from a computer D/A board) can be used as input signals.

Operation

Prior to completing the electrical connections outlined below, ensure that the work place is free of conductive objects that could pose electrical hazards to the user should the objects make contact with the high voltage output screw terminals of the VF-90 amplifier.

- Connect the load to the VF-90 to the VF-90 screw terminals
- Connect the lead wires of the AC/DC transformer to the VF-90 screw terminals
- Plug the AC/DC transformer into line power appropriate for the transformer's ratings (see label on transformer)
- Connect the input signal to the VF-90 screw terminals
- Adjust the input signal as needed to achieve the desired output from the piezoelectric load

Circuitry Protection

The VF-90 circuitry incorporates over-current, over-temperature, short-circuit, and over/under voltage (input power) protection.

When the protection circuitry is enabled as a result of excessive operating conditions or temperature, the amplifier will disconnect the output temporarily and will attempt to restart. During restart, the amplifier will recheck the operating conditions and will go into protection mode again if conditions are not yet favorable. This protection thus protects both the amplifier and the load.

However, if the equipment is used in a manner not specified by DSM, the protection provided by the equipment may be impaired.

Recommended Environmental Conditions for Operation

The VF-90 is designed to operate in non-hazardous environments. Any deviation from the specified environment must be approved by DSM and may result in the voiding of any warranty. Any deviation not approved by DSM will be grounds for voiding of any warranty.

- Environmental Temperature: 0-50C
- Percent Relative Humidity: 0-80% non condensing
- Operating Supply Voltage: Refer to label of AC/DC transformer

Cleaning

Prior to any cleaning, unplug the electrical power to the VF-90. Dust can be readily removed by wiping or by blowing with compressed dry air. Wiping the unit with a damp cloth is acceptable, but care must be taken not to leave any residual liquid at the electrical connections.



CAUTION: As with any electrical device, do not spill or immerse the VF-90 amplifier in liquids in order to avoid electrical shock.

Warranty Information

The DSM Warranty Period is a period of sixty (60) days beginning on the date that DSM ships the new, customer-purchased equipment or software. DSM warrants that its new equipment will be free from defects in materials and workmanship during the DSM Warranty Period.

DSM warrants that its software shall be fit for the particular uses described in DSM product literature and user's manuals available at the time of initial equipment shipment, and shall operate properly during the DSM Warranty Period.

In the event that DSM receives written notice of a claim under this Warranty within the DSM Warranty Period, DSM will repair or replace equipment or software, at its option, at no charge. These services shall be performed at DSM's factory or its designated repair facility.

Freight charges to return equipment or software to DSM are the customer's responsibility. DSM will pay freight charges to return the equipment to the customer.

Warranty Shipments Outside of North America:

Warranty-repaired product is generally re-imported into the customer's country without duty, however the customer can most efficiently complete the administration of this duty exemption. Return freight to convey repaired or replaced parts or equipment from DSM to customer shall be "E.X.W." as such term is described by Incoterms 2000, with such expenses charged to customer's freight account for direct payment by customer to their freight service provider. All brokerage, freight, shipping, forwarding and handling charges, duties, customs and taxes applicable to warranty-repaired product shipments, if any, will be paid directly by the customer. DSM agrees to promptly reimburse customer for its actual freight cost incurred, *excluding* brokerage and handling charges, duties, customs and taxes, for warranty shipment from DSM to customer, using the same class of freight service selected to initially return the warranty claim equipment to DSM.

Reinstallation and recalibration of DSM equipment and software into a customer-specific application are not covered by this Warranty.

Equipment or software repaired or replaced under this Warranty are covered under the remaining DSM Warranty Period, if any, associated with the original new equipment or software.

Exclusions

This Warranty does not cover:

1. Damage related to modification of DSM equipment or software after initial shipment by DSM.
2. Consequential or incidental damages such as property damage and incidental expenses.
3. Conditions caused by external factors such as abuse, misuse, inadequate power supply, or acts of God.

Owing to the wide range of experimental uses attempted by our customers, DSM does not warrant that its products are fit for a particular use.

Piezoelectric "stacks" (the elements within DSM's mechanical piezo devices) can bear high compressive load forces, but they are very sensitive to bending-, torsion-, shear- and especially to tensile forces. The design of any attached mechanics must apply only pure axial loading to the actuators. DSM's flexure-guided mechanical amplification frames are designed to provide a compressive preload force and to help prevent other bending or tensile forces that can damage the piezoelectric stacks. The user is advised to pay attention not only to the static force balances, but also to dynamic influences that can produce damaging acceleration forces resulting in bending motion or torque. Off-axis loading and/or dynamic operating conditions that induce resonant or near-resonant mechanical motion or undesirable dynamic modes resulting from physical impact of the actuator with its surroundings will void the terms of DSM's Warranty.

Opening of devices, machines, or electronics enclosures by anyone other than DSM voids this Warranty.