PiezoDrive

PD32 - 32 Channel Piezo Driver

Hardware Version 4

Manual and Specifications

Revision History

Date	Rev	By	Changes
16/02/22	2	KB	Updated adaptor table
15/03/24	3	KB	Updated voltage ranges. Added test procedure. Added rack mounting options

Contents

1 Introduction

The PD32 is a high-bandwidth, low-noise linear amplifier for driving up to 32 piezoelectric actuators. The voltage range is configurable from +45V to +/-130V and includes asymmetric voltage ranges such as 0V to +130V. The PD32 works seamlessly with common multi-channel DAC cards and is easy to use with LabView and Simulink. The compact size and 19-inch rack compatibility provides a comprehensive off-the-shelf solution for driving hundreds or thousands of piezoelectric actuators.

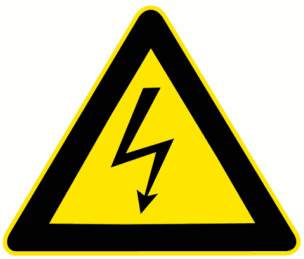
The PD32 is designed for demanding applications such as Adaptive Optics, Acoustic Beam Forming, Materials Testing, Astronomy, Ultrasonics, and Vibration Control. With an output current of 150mA per channel, a large array of piezoelectric actuators can be driven simultaneously at high frequencies. Positive and negative high-voltage bias outputs are also included for compatibility with piezoelectric bender actuators.

Compatible Actuators	
Stack Actuators	60V, 100V, 120V, 150V
Plates and Tubes	up to +/-130V
Two Wire Benders	up to +/-130V
Three Wire Benders	Up to 130V, or +/-65V

Each channel is individually protected against short circuit and thermal overload. Status indicators on the front panel provide individual monitoring of all channels. A digital status signal and external shutdown command is also accessible from the input connector to allow remote monitoring and control. The input and output connectors are industry standard 37 Pin D-Sub connectors which are straight-forward to assemble. Adaptors are available for industry standard 32 Channel DAC cards.

2 Warnings / Notes

This device produces hazardous potentials and should be used by suitably qualified personnel under the supervision of an observer with appropriate first-aid training. Do not operate the device when there are exposed conductors.



3 Specifications

	Grounded Load	Floating Load
Output Voltage	+45V to +130V	+/-90V or +/-130V
Peak Current	150 mA per channel	75 mA per channel
RMS Current	106 mA per channel	53 mA per channel
Power Bandwidth	50 kHz (120 Vpp)	50 kHz (240 Vpp)
Signal Bandwidth	120 kHz	120 kHz
Slew Rate	19 V/us	38 V/us
Gain	15 V/V	20 V/V
Input Impedance	53 kOhm	6.25 kOhm
Input Offset	±5 mV	±5 mV
Load	Unlimited	Unlimited
Output Noise	200 uV RMS (1uF Load)	300 uV RMS (1uF Load)
Protection	Short-circuit and thermal overload	
Inputs	32 Analog inputs, shutdown command	
Outputs	32 HV Analog outputs, overload monitor	
Connectors	Industry standard DB-37 (input) and DD-78 (output)	
Power	85-260Vac, 50/60 Hz, IEC C14 connector, 200W	

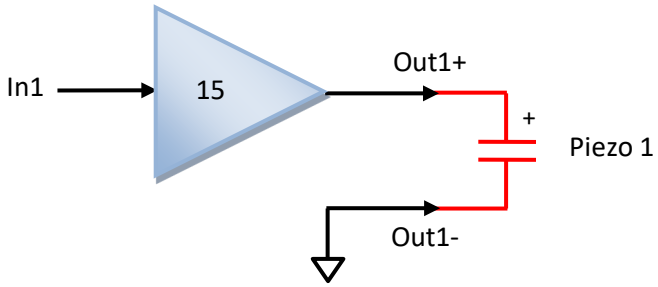
Mechanical Specifications	
Environment	0 - 40°C (-32 to 104°F) Non-condensing humidity
Dimensions	212 x 304.8 x 88 mm (8.35 x 12 x 3.46 in)
Weight	2 kg (4.4 lb)

4 Output Voltage Range

The output voltage range is configurable between +45V and +/-130V and the load can be either grounded or floating. For peak-to-peak voltages less than 135V, the grounded load configuration is recommended since this provides greater current. The floating load configuration is required for the +/-90V and +/-130V ranges. The desired configuration should be specified at the time of ordering.

4.1 Grounded Load

In the grounded load configurations, the actuator connections are illustrated below. The negative output is internally grounded.

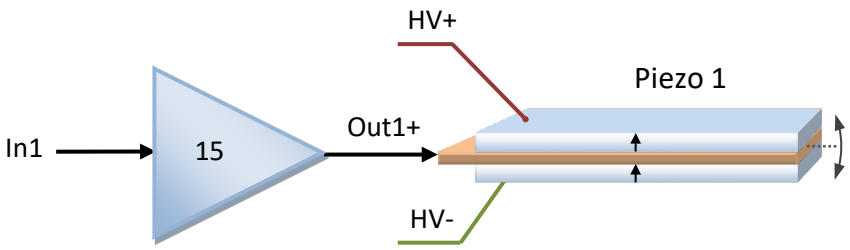


The desired output voltage range can be selected from the following table.

Min Voltage	Max Voltage	Order Code
0	+130	PD32-0,130
0	+120	PD32-0,120
0	+95	PD32-0,95
0	+70	PD32-0,70
0	+45	PD32-0,45
-15	+115	PD32-15,115
-20	+95	PD32-20,95
-45	+45	PD32-45,45
-65	+65	PD32-65,65

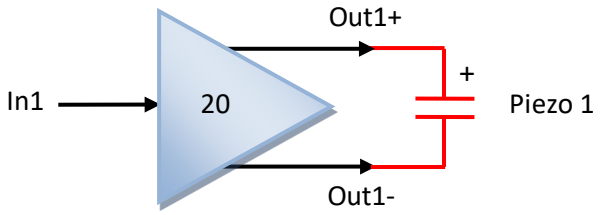
Grounded Load Voltage Ranges

Three wire bender actuators can be driven using the following connection diagram. The HV+ and HV- bias voltages are the minimum and maximum voltages listed in the table above and are accessible on the output connector.



4.2 Floating Load

The floating load configuration is useful for achieving higher peak-to-peak voltage swings. The connection diagram is illustrated below. Do not connect either of these signals to ground, for example, an oscilloscope probe.



The desired output voltage range can be selected from the following table.

Min Voltage	Max Voltage	Order Code
-130	+130	PD32-130,130
-95	+95	PD32-95,95

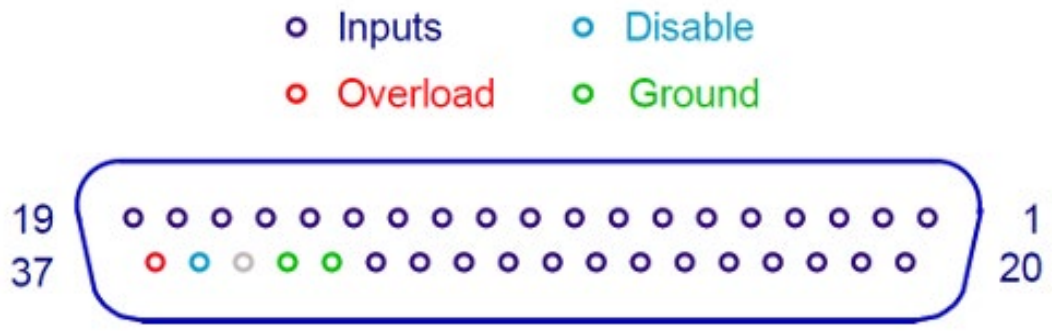
Floating Load Voltage Ranges

5 Input Connection Diagram

The front panel input connector is an industry standard DB37 Female Connector (TE 1658612-1). Any Male DB-37 cable plug is compatible. The connection diagram is illustrated below.

Signals	Input Connector	Notes
Analog Inputs 1 to 32	Pins 1 to 32	+/- 10V max
Ground	33, 34	
Non Connected	35	
Digital disable command	Pin 36	3.3V or 5V logic
Overload indicator	Pin 37	5V logic

Input Connector Signals



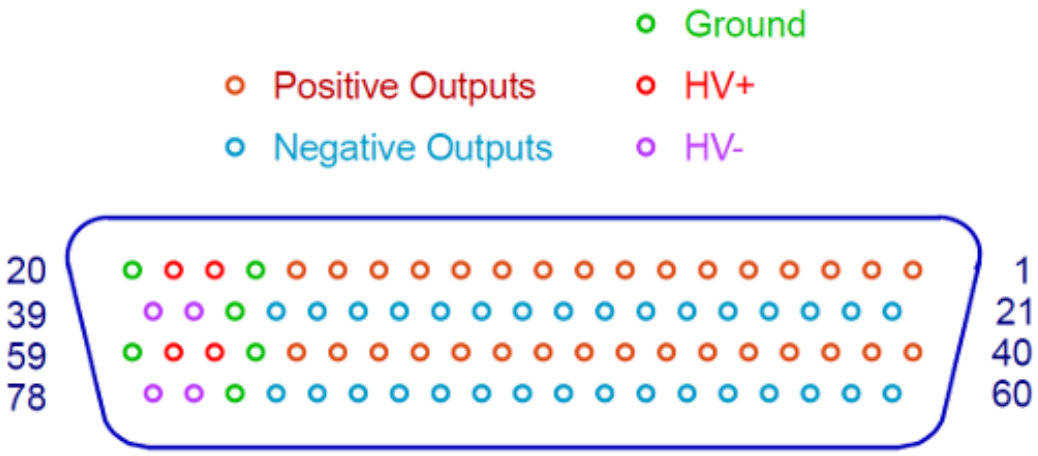
Input Connector Pinout

6 Output Connection Diagram

The front panel output connector is an industry standard DB37 Female Connector (TE 5748483-5). Any Male DD-78 cable plug is compatible. The connection diagram is illustrated below.

Signals	Connector 1	Notes
Outputs 1 to 16 (positive)	1 - 16	
Ground	17, 20	
HV+	18, 19	For driving benders
Outputs 1 to 16 (negative)	21 - 36	
Ground	37	
HV-	38, 39	For driving benders
Outputs 17 to 32 (positive)	40 - 55	
Ground	56, 59	
HV+	57, 58	For driving benders
Outputs 17 to 32 (negative)	60 - 75	
Ground	76	
HV-	77, 78	For driving benders

Output Connector Signals



Output Connector Pinout

7 Output Current

The peak output current is 150 mA per channel in the grounded load configuration or 75 mA per channel in the floating load configuration. The maximum RMS current is 106 mA in the grounded configuration and 53 mA in the floating load configuration.

The maximum simultaneous output current from all channels is 3 Amps RMS.

8 Power Bandwidth

The nominal slew-rate of the PD32 in the grounded load configuration is 19 V/us. Therefore, the unloaded maximum frequency sine-wave is

$$f_{max} = \frac{19 \times 10^6}{\pi V_{L(p-p)}}.$$

That is, the power bandwidth for a 120 Vp-p sine-wave is 50 kHz. In the floating load configuration, the slew-rate is doubled to 38 V/us, therefore, the power bandwidth for a 240 Vp-p sine-wave is 50 kHz

With a capacitive load, the power bandwidth is limited by the output current. The maximum frequency sine wave is

$$f_{pwr} = \frac{I_{pk}}{\pi V_{L(p-p)} C_L}$$

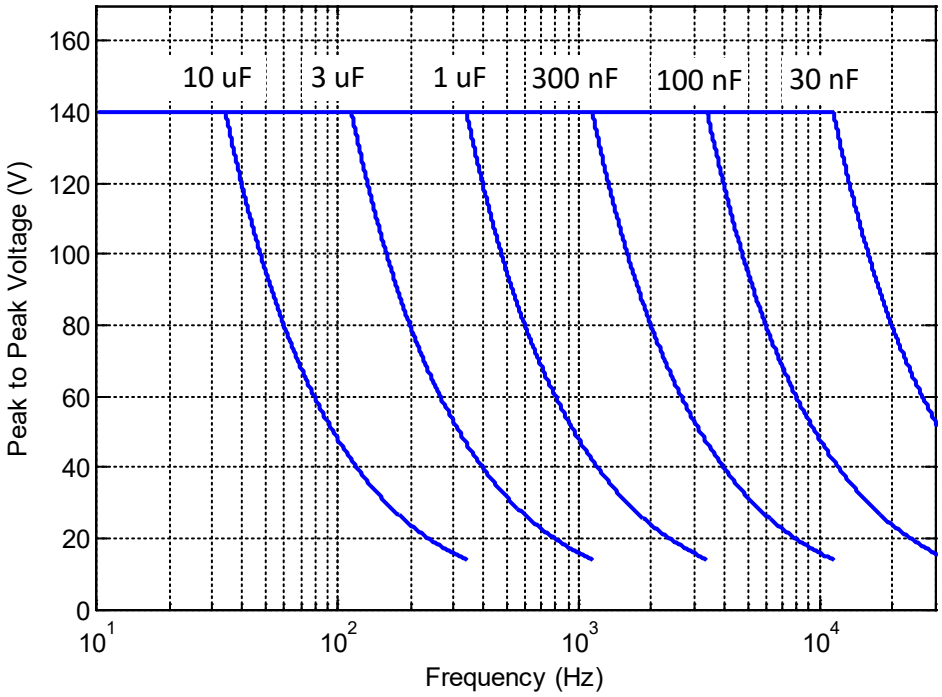
where I_{pk} is the peak current limit, $V_{L(p-p)}$ is the peak-to-peak output voltage, and C_L is the effective load capacitance. The power bandwidth versus load capacitance is listed below.

Load	Grounded Load Voltage (pk-pk)		
Cap.	50	100	130
10 nF	95 kHz	47 kHz	34 kHz
30 nF	31 kHz	15 kHz	11 kHz
100 nF	9.5 kHz	4.7 kHz	3.4 kHz
300 nF	3.1 kHz	1.5 kHz	1.1 kHz
1 uF	950 Hz	470 Hz	340 Hz
3 uF	310 Hz	150 Hz	114 Hz
10 uF	96 Hz	48 Hz	34 Hz
30 uF	32 Hz	16 Hz	11 Hz

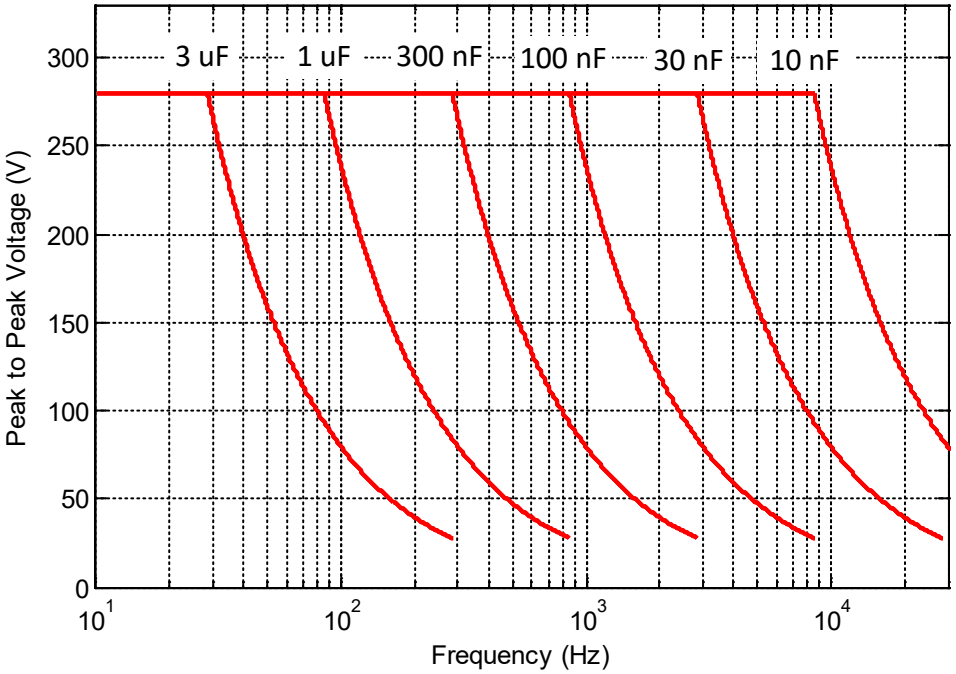
Load	Floating Load Voltage (pk-pk)		
Cap.	100	200	260
10 nF	23 kHz	11 kHz	8.5 kHz
30 nF	7.9 kHz	3.9 kHz	2.8 kHz
100 nF	2.3 kHz	1.1 kHz	850 Hz
300 nF	790 Hz	390 Hz	284 Hz
1 uF	230 Hz	119 Hz	85 Hz
3 uF	80 Hz	40 Hz	28 Hz
10 uF	24 Hz	12 Hz	9 Hz
30 uF	8 Hz	4 Hz	3 Hz

Power Bandwidth versus Load Capacitance (Grounded and Floating Load Configuration)

In the following figures, the maximum frequency periodic signal is plotted against the peak-to-peak voltage.



Maximum frequency versus voltage and capacitance (Grounded Load)



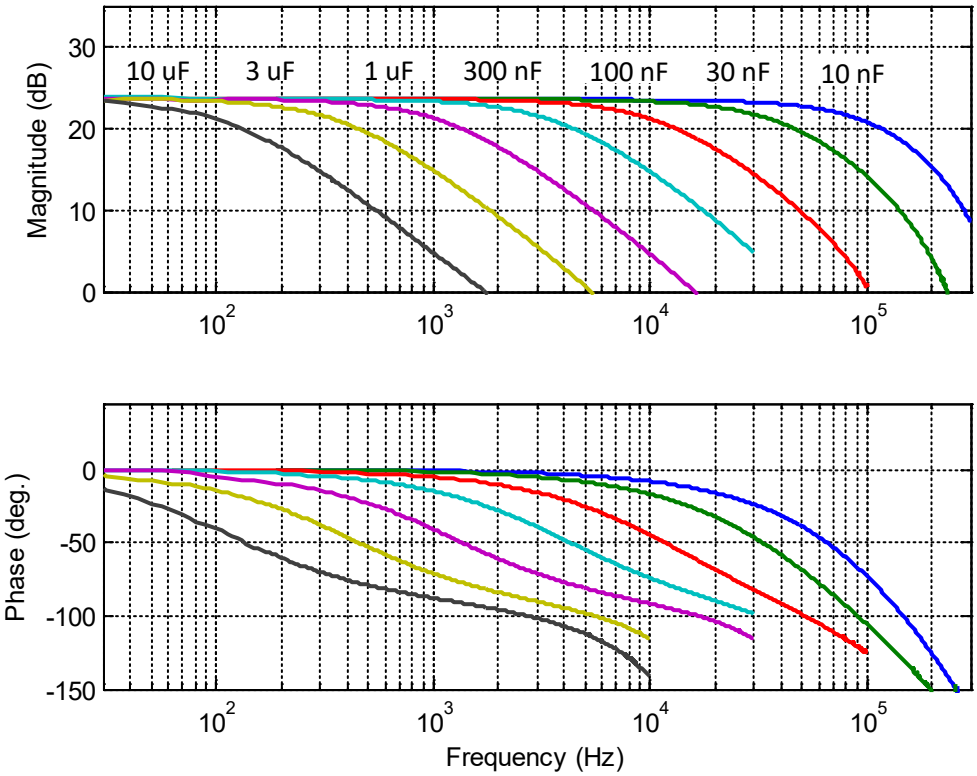
Maximum frequency versus voltage and capacitance (Floating Load)

9 Small Signal Bandwidth

The small-signal bandwidth for a range of capacitive loads is listed below. The small-signal frequency responses are also plotted.

Load Capacitance	Signal Bandwidth
No Load	120 kHz
10 nF	90 kHz
30 nF	40 kHz
100 nF	11 kHz
300 nF	3.8 kHz
1 uF	1.0 kHz
3 uF	320 Hz
10 uF	62 Hz
30 uF	24 Hz

Small signal bandwidth (-3 dB)



Small signal frequency response versus load capacitance

10 Overload Protection

Each channel is protected against short-circuit and thermal overload. If the thermal overload on any channel engages, the front panel indicator for that channel will illuminate. In addition, an overload on any channel will cause the overload signal (pin 37) on the input connector to go high (+5V).

The amplifier can also be disabled by applying a logic high (3.3V to 5V) to the disable pin (pin 36).

The PD32 has a side air intake and rear exhaust. These vents should not be obstructed. If sufficient air-flow is not available, the amplifier will enter a thermal overload state as discussed above.

11 Rack Mounting

The PD32 can be installed in a 19-inch x 2U rack space using the single unit rack kit (order code: SingleRackKit-2U).

Two amplifiers can also be installed in a side-by-side configuration using the double unit rack kit (order code: DoubleRackKit-2U). The double rack kit is assembled in the factory and includes coupling screws for the enclosure, and the same handles as the single rack kit.

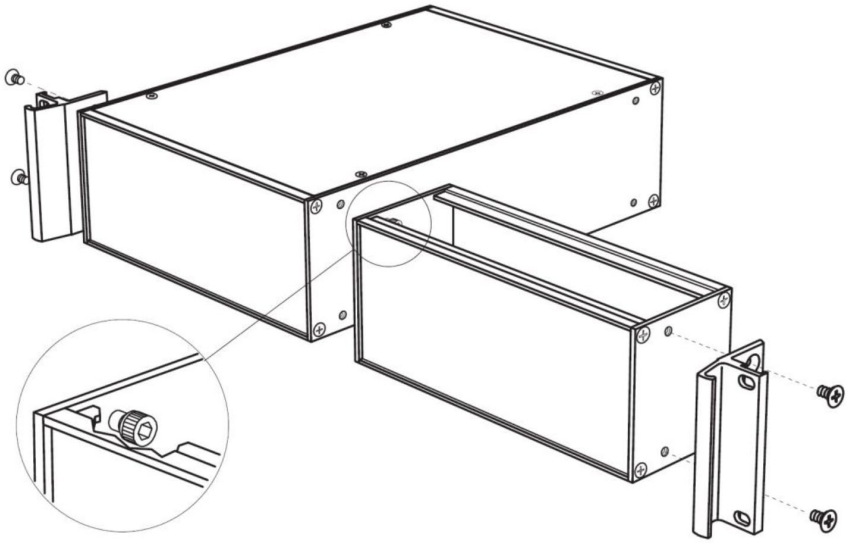


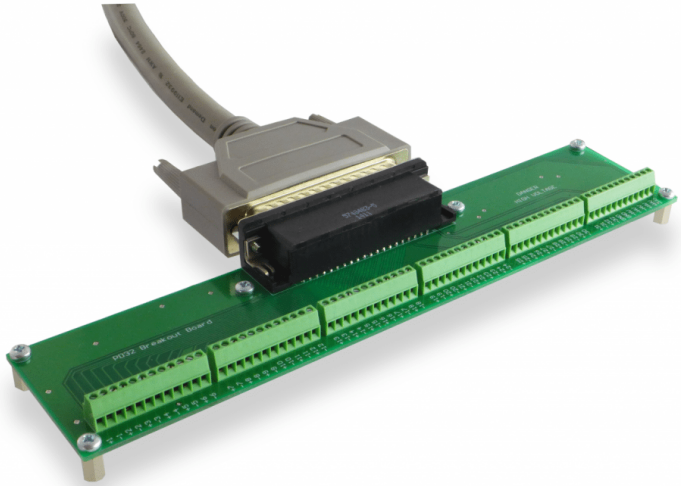
Figure 1. Single rack kit, showing the amplifier on left, and the rack adaptor on right.

12 Input Test Connector and Cable

An adaptor PCB is supplied which connects all input channels to a single BNC connector. A 2.5ft DB37 (Male-Male) input cable is also supplied.

13 Breakout Board and Cable (PD32-Breakout)

A screw-terminal breakout board is included which connects to the amplifier via a Female DD78 connector (TE 5748483-5) and HD78 Male-Male cable (2.5 ft). If required, the board can be mounted onto a base structure using the installed M3 hex spacers.



Breakout Board

14 Signal Adaptors

The signal adaptors allow a direct connection to common multi-channel DAC cards. Standard adaptors are listed below; however, custom adaptors can also be created.

Manufacturer	DAC Card	Adaptor	Notes
National Instruments	NI-5742 for FlexRIO	PD-5742	Requires NI SHC68-C68-D4 VHDCI Cable
National Instruments	PCIe-6738, PXIe-6738	PD-6738	Requires NI SH68-C68-S Cable
National Instruments	PCIe-6739, PXIe-6739	PD-6738	Requires NI SH68-C68-S Cable
National Instruments	PCI-6723 and PXI-6723	PD-6723	Requires NI SH68-C68-S Cable

Standard Signal Adaptors

The adaptors are mounted in-line with the cables from the DAC output card and PD32 input.

15 Test Procedure for Grounded Load Versions

1. Turn the power off and disconnect all the inputs and outputs to the PD32.
2. Use a signal generator with a BNC output to create a 0V to +2V (2 Vpk-pk with 1 Vdc offset) 100Hz sinewave. Check this with an oscilloscope.
3. Use the BNC to DSUB test connector supplied with the PD32 to apply the sine wave to all input channels. Connect the input test connector to the PD32 with the supplied 32-Way DSUB cable.
4. Connect the PD32 to the output terminal block using the supplied 72-Way DSUB cable. Check that nothing is connected to the terminal block outputs.
5. Turn the PD32 on and measure the output voltage on "1+" with an oscilloscope. The voltage should be approximately 30 Vpk-pk with 15V DC offset. It may not be exactly 30 Vpk-pk as the input impedance of all inputs in parallel is 1.65 kOhm and will reduce the signal generator voltage when connected. You can measure the signal generator output and increase the amplitude and offset until it is exactly 2 Vpk-pk with a 1V DC offset, the output should then be 30 Vpk-pk with a 15V DC offset.
6. Increase the amplitude and/or offset of the input to verify that the output voltage range is correct.
7. Check the other channels successively by measuring the voltage at "+2" to “+32”.

16 Test Procedure for Floating Load Versions

1. Turn the power off and disconnect all the inputs and outputs to the PD32.
2. Use a signal generator with a BNC output to create a +/-1V 100Hz sinewave (with zero DC offset). Check this with an oscilloscope.
3. Use the BNC to DSUB test connector supplied with the PD32 to apply the sine wave to all input channels. Connect the input test connector to the PD32 with the supplied 32-Way DSUB cable.
4. Connect the PD32 to the output terminal block using the supplied 72-Way DSUB cable. Check that nothing is connected to the terminal block outputs.
5. Turn the PD32 on and measure the output voltage on "1+" with an oscilloscope. The voltage should be approximately +/-10 V with zero DC offset. It may not be exactly +/-10 Vpk-pk as the input impedance of all inputs in parallel is 195 Ohm and will significantly reduce the signal generator voltage when connected. You can measure the signal generator output and increase the amplitude until it is exactly +/-1V, the output should then be +/-10V.
6. Measure the inverting output “1-“, which should be +/-10V but opposite polarity, i.e. 180 degrees phase shift.
7. Since the load is floating and driven differentially by the “1+” and “1-“ outputs, the total voltage experience by the load is equal to twice that measured on either the “1+” or “1-“ channels.
8. Increase the amplitude of the input and monitor the “1+” and “1-“ output to check the voltage range. The maximum output voltage on either the “1+” or “1-“ outputs should be approximately half the specified voltage range.
9. Check the other channels successively by measuring the voltage at "2+" and “2-“ to “32+” and “32-”.

17 Warranty

The PD32 is guaranteed against manufacturer defects for a period of 12 months.