FP2 Series Piezo driver filters

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Electronics for Research and Science



- Passive RC-filter
- Low pass
- Designed for high voltages
- Non-polarized
- Selection of work impedance and cut-off frequency
- Robust to discharges
- Customized versions available

The FP2 series of filters target specifically the reduction of noise from piezo drivers. The filters are designed to be operated at the high voltages associated with piezo drivers, and are available in versions with different system impedance and ranges of load capacitance to suit your requirements to both current drive capability and filtering.

Numerous laboratory applications call for low-noise piezo drivers that are able to supply high voltages, often above 100 V. Piezo-actuated mirrors, for instance, are devices for which low-noise and high voltages need to go hand in hand. You may find a large variety of piezo drivers on the market, but if your favorite driver has a noise level which is too high, the FP2 series may be the remedy.

Other uses of the FP2 series include filtering of bias voltages for avalanche photodiodes, and other applications where wideband noise must be reduced for a high-voltage feed.

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Specifications and characteristics

Model FP2-	100-3k	200-3k	500-3k	1000-3k	2000-3k
Topology	$3k\Omega$ and 200 nF total	$3k\Omega$ and 440 nF total	$3k\Omega$ and 1 μF total	3k and 2 µF total	$3k\Omega$ and 4.4 μF total
Cap. load	100 nF (0 – 200 nF)	220 nF (0 – 440 nF)	500 nF (0 – 1 µF)	1 μF (0 – 2 μF)	2.2 μF (0 – 4.4 μF)
-3 dB fc vs. load 1)	364 Hz (220 – 780 Hz)	165 Hz (100 – 355 Hz)	73 Hz (44 – 156 Hz)	36 Hz (22 – 78 Hz)	16.5 Hz (10 – 78 Hz)
Group delay 1)	520 μs (220 – 820 μs)	1.14 ms (0.48 – 1.8 ms)	2.6 ms (1.1 – 4.1 ms)	5.2 ms (2.2 – 8.2 ms)	11.4 ms (4.8 – 18 ms)
Max. voltage 2)	200 V	200 V	200 V	200 V	150 V
Max. current	35 mA	35 mA	35 mA	35 mA	35 mA
Max. AC voltage 3)	100 V (LF) / 40 V (HF)	100 V (LF) / 40 V (HF)	100 V (LF) / 40 V (HF)	100 V (LF) / 40 V (HF)	100 V (LF) / 40 V (HF)
Model FP2-	100-600	200-600	500-600	1000-600	2000-600
Topology	600 Ω and 200 nF total	600 Ω and 440 nF total	600 Ω and 1 μF total	600 Ω and 2 μF total	600 Ω and 4.4 μF total
Cap. load	100 nF (0 – 200 nF)	220 nF (0 – 440 nF)	500 nF (0 – 1 µF)	1 μF (0 – 2 μF)	2.2 μF (0 – 4.4 μF)
-3 dB fc vs. load 1)	1.82 kHz (1.1 – 3.9 kHz)	830 Hz (500 – 1800 Hz)	364 Hz (220 – 780 Hz)	182 Hz (110 – 390 Hz)	83 Hz (50 – 180 Hz)
Group delay 1)	104 µs (44 – 164 µs)	228 µs (97 – 360 µs)	520 μs (220 – 820 μs)	1040 µs (440 – 1640 µs)	2.28 ms (0.97 – 3.6 ms)
Max. voltage 2)	200 V	200 V	200 V	200 V	150 V
Max. current	70 mA	70 mA	70 mA	70 mA	70 mA
Max. AC voltage 3)	100 V (LF) / 20 V (HF)	100 V (LF) / 20 V (HF)	100 V (LF) / 20 V (HF)	100 V (LF) / 20 V (HF)	100 V (LF) / 20 V (HF)
Model FP2-	100-150	200-150	500-150	1000-150	2000-150
Topology	150 Ω and 200 nF total	150 Ω and 440 nF total	150 Ω and 1 μF total	150 Ω and 2 μF total	150 Ω and 4.4 μF total
Cap. load	100 nF (0 – 200 nF)	220 nF (0 – 440 nF)	500 nF (0 – 1 μF)	1 μF (0 – 2 μF)	2.2 μF (0 – 4.4 μF)
-3 dB fc vs. load 1)	7.28 kHz (4.4 – 15.6 kHz)	3.3 kHz (2 – 7.1 kHz)	1.5 kHz (0.88 – 3.1 kHz)	728 Hz (440 – 1560 Hz)	330 Hz (200 – 710 Hz)
Group delay 1)	26 µs (11 – 41 µs)	57 μs (24 – 90 μs)	130 μs (55 – 205 μs)	260 µs (110 – 410 µs)	570 μs (240 – 900 μs)
Max. voltage 2)	200 V	200 V	200 V	200 V	150 V
Max. current	140 mA	140 mA	140 mA	140 mA	140 mA
Max. AC voltage 3)	100 V (LF) / 10 V (HF)	100 V (LF) / 10 V (HF)	100 V (LF) / 10 V (HF)	100 V (LF) / 10 V (HF)	100 V (LF) / 10 V (HF)

1) The -3 dB cutoff frequency fc, and the group delay are specified for the nominal capacitive load and for zero Ω source resistance. The variation over the capacitive load range is listed.

2) The sum of DC voltage, and peak AC voltage

3) The permissible AC input voltage must be reduced for high frequencies; Consult the graphs on the next page,

Filters for the reduction of noise from piezo drivers need to be designed for high voltages. Commonly found filters for signaling are typically specified for too low a voltage, if the voltage is specified at all. In the FP series of filters you will find high-grade film capacitors rated at more than 50 % above the specified maximum voltage of the filter. The resistors used are surge types that ensure the filter withstands sudden discharges, or sudden connections to an energized rail. For safety reasons the FP2 series includes a bleeder resistor across the input.

The FP2 series are RC-filters, with no inductors, due to the high impedance levels and to ensure the filter behaves well over a large range of capacitive loads. With a capacitive load connected to the output, the filter effectively acts as a third order filter. When you connect loads of increasing capacitance, the cut-off frequency will go down, and the group delay will increase. Very large capacitive loads, beyond the nominal load range, will form a dominant pole, located at the product of 2 times π , the filter's series resistance and the capacitance of the load.

In addition to the load capacitance the DC-resistance from input to output is a parameter to consider. For a large current drive capability you need to select a filter with a low DC-resistance. On the other hand, if you have relaxed requirements to the current drive capability you may use filters with a low cut-off frequency.



The graphs show the typical attenuation and relative group delay responses for nominal, double and zero capacitive load, with the frequency relative to the nominal cut-off.

Do you need piezo filters with other characteristics? Call Apparateq and find out how we may customize the FP2 series.

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Application notes

The maximum AC input voltage depends on the frequency, and is determined by the dissipation in primarily the input resistor.

The graphs below show the allowed RMS voltage for a sine wave over the frequency range for each of the three resistance values available. In all cases the sum of the DC voltage and the peak AC value must stay within the specified maximum voltage of the filter.



The graphs above assume a nominal capacitive load. For a shorted output, do not apply more than 40 V RMS to the input of the 3 k Ω filter, 20 V RMS to the 600 Ω filter, and 10 V RMS to the 150 Ω filter.

The FP2 series is a single ended filter, specifically targeting single ended (unipolar) piezo drivers, or drivers with a balanced (bipolar) output where only one of the two outputs is used. Should you need to filter a balanced output this can be done by simply using two FP2 series filters, one for each output, and then connecting the piezo unit between the outputs of the two filters.



Simplified diagram of a single-ended drive (above) and a balanced drive (below), using one and two FP2 series piezo filters. To avoid hazardous voltages on the BNC ground terminals do not use one filter for a balanced drive.



An example of a piezo ring stack, glued to a mirror, prepared for deployment in a setup to be driven by an FP2 series filter.

Apparateq provides solutions to measurement challenges within science, research and metrology. Check out our web pages, or call us, to learn how we may help you.

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