FREQUENCY DEVICES™, INC.

# D78 & DP78 Series

## 1.0 Hz to 100 kHz Fixed Frequency

## 32 Pin DIP 8-Pole Filters

### Description

The D78 and DP78 Series of low-power, fixed-frequency, linear active filters are high performance, 8-pole filters in a compact package. These Butterworth and Bessel low-pass and Butterworth high-pass filters (D78 only) combine linear active filter design with the space savings of a 32-pin dual in-line package (DIP). Each model comes factory tuned to a user-specified corner frequency between 1 Hz and 100 kHz (DP78, 1 Hz to 5kHz). These fully self-contained units require no external components or adjustments and operate with dynamic input voltage range from non-critical ±5V to ±18V power supplies.


### Features/Benefits:

- Low cost solution for low frequency signal conditioning
- Compact DIP design minimizes board space requirements
- Plug-in ready-to-use, reducing engineering design and manufacturing time
- Factory tuned, no external clocks or adjustments needed saving time and labor of other discrete assembly solutions
- Low harmonic distortion and wide signal-to-noise ratio to 12 bit resolution

### Applications

- Anti-alias filtering
- Vibration & shock analysis
- Automatic test equipment
- Aerospace, navigation and sonar
- Communication systems
- Medical electronics
- Sound and vibration testing
- Noise elimination
- Process control

### Available Low-Pass Models:

**D78L8B** 8-pole Butterworth . . . . . . . . . . . . . . . .2
**DP78L8B** 8-pole Butterworth (Low Power) . . . . .2
**D78L8L** 8-pole Bessel . . . . . . . . . . . . . . . . . . .2
**DP78L8L** 8-pole Bessel (Low Power) . . . . . . . .2

### Available High-Pass Models:

**D78H8B** 8-pole Butterworth . . . . . . . . . . . . . . . .2

### General Specifications:

Pin-out/package data & ordering information . . . .3



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# D78 & DP78 Series

## Fixed Frequency 8-Pole Low-Pass and High-Pass Filters

| Model | D78L8B & DP78L8B | D78L8L & DP78L8L | Model | D78H8B |
|---|---|---|---|---|
| **Product Specifications** | **Low-Pass** | **Low-Pass** | | **High-Pass** |
| **Transfer Function** | 8-Pole, Butterworth | 8-Pole, Bessel | **Transfer Function** | 8-Pole, Butterworth, |
| **Size**<br>**D78** 1.00 Hz to 1.00 kHz<br>**D78** 1.01 kHz to 100 kHz<br>**DP78** 1.00 Hz to 5.00 kHz | <br>1.8″ x 0.8″ x 0.5″<br>1.8″ x 0.8″ x 0.3″<br>1.8″ x 0.8″ x 0.5″ | <br>1.8″ x 0.8″ x 0.5″<br>1.8″ x 0.8″ x 0.3″<br>1.8″ x 0.8″ x 0.5″ | **Size**<br>**D78** 1.00 Hz to 1.00 kHz<br>**D78** 1.01 kHz to 100 kHz | <br>1.8″ x 0.8″ x 0.5″<br>1.8″ x 0.8″ x 0.3″ |
| **Range fc**<br>**D78**<br>**DP78** | <br>1 Hz to 100 kHz<br>1 Hz to 5 kHz | <br>1 Hz to 100 kHz<br>1 Hz to 5 kHz | **Range fc**<br>**D78** | <br>1 Hz to 100 kHz |
| **Theoretical Transfer Characteristics** | Appendix A<br>Page 9 | Appendix A<br>Page 4 | **Theoretical Transfer Characteristics** | Appendix A<br>Page 29 |
| **Passband Ripple**<br>(theoretical) | 0.0 dB | 0.0 dB | **Passband Ripple**<br>(theoretical) | 0.0 dB |
| **DC Voltage Gain**<br>(non-inverting) | 0 ± 0.1 dB typ. | 0 ± 0.1 dB typ. | **Voltage Gain**<br>(non-inverting) | 0 ± 0.1 dB to 100 kHz |
| **Stopband Attenuation Rate** | 48 dB/octave | 48 dB/octave | **Stopband Attenuation Rate** | 48 dB/octave |
| | | | **Power Bandwidth** | 120 kHz |
| | | | **Small Signal Bandwidth** | (-6 dB) 1 MHz |
| **Cutoff Frequency**<br>**Stability**<br>**Amplitude**<br>**Phase** | fc ± 2% max.<br>± 0.03% /°C<br>-3 dB<br>-360° | fc ± 2% max.<br>± 0.03% /°C<br>-3 dB<br>-182° | **Cutoff Frequency**<br>**Stability**<br>**Amplitude**<br>**Phase** | fc ± 2% max.<br>± 0.03% /°C<br>-3 dB<br>-360° |
| **Filter Attenuation**<br>(theoretical) | 0.12 dB 0.80 fc<br>3.01 dB 1.00 fc<br>60.0 dB 2.37 fc<br>80.0 dB 3.16 fc | 1.91 dB 0.80 fc<br>3.01 dB 1.00 fc<br>60.0 dB 4.52 fc<br>80.0 dB 6.07 fc | **Filter Attenuation**<br>(theoretical) | 80 dB .31 fc<br>60 dB .42 fc<br>3.01 dB 1.00 fc<br>0.00 dB 2.0 fc |
| **Total Harmonic Distortion @ 1 kHz**<br>**D78**<br>**DP78** | <br><-70 dB<br><-70 dB | <br><-70 dB<br><-70 dB | **Total Harmonic Distortion @ 1 kHz**<br>**D78** | <br><-70 dB |
| **Wide Band Noise**<br>(5 Hz - 2 MHz) | 200 µVrms typ. | 200 µVrms typ. | **Wide Band Noise**<br>(5 Hz - 2 MHz) | 400 µVrms typ. |
| **Narrow Band Noise**<br>(20 Hz - 100 kHz) | 50 µVrms typ. | 50 µVrms typ. | **Narrow Band Noise**<br>(20 Hz - 100 kHz) | 100 µVrms typ. |
| **Filter Mounting Assembly** | FMA-01A | FMA-01A | **Filter Mounting Assembly** | FMA-01A |



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# D78 & DP78 Series

## Specification
(25°C and Vs ± 15 Vdc)

## Pin-Out and Package Data
## Ordering Information

**Analog Input Characteristics**[1]

| | |
|---|---|
| Impedance | 10 kΩ min. |
| Voltage Range | ± 10 Vpeak |
| Max. Safe Voltage | ± Vs |

**Analog Output Characteristics**

| | | |
|---|---|---|
| Impedance | | 1 Ω |
| Linear Operating Range | | ± 10 V |
| Maximum Current[2] | | |
| | D78 | ± 10 mA |
| | DP78 | ± 5 mA |
| Offset Voltage | | 20 mV max.<br>3 mV typ. |
| Offset Temp. Coeff. | | 20 µV / °C typ. |

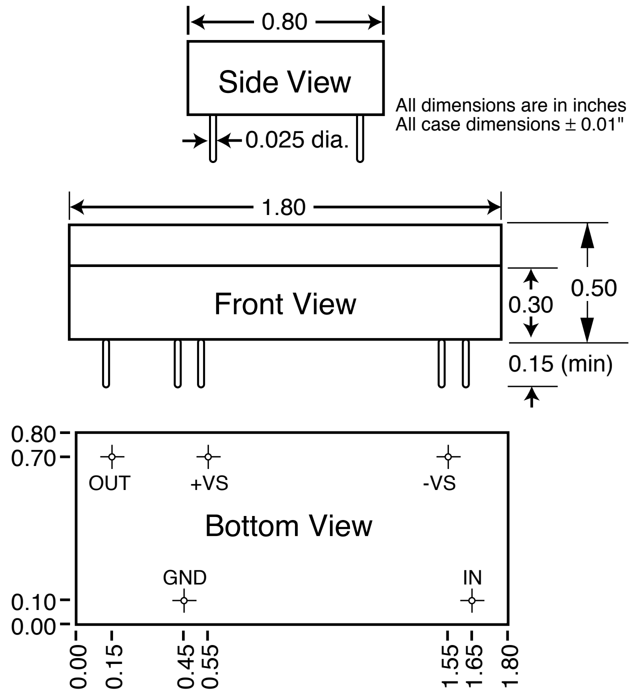
**Power Supply (±V)**

| | |
|---|---|
| Rated Voltage | ± 15 Vdc |
| Operating Range | ± 5 to ± 18 Vdc |
| Maximum Safe Voltage | ± 18 Vdc |
| Quiescent Current **D78** | 12 mA max.<br>8 mA typ. |
| Quiescent Current **DP78** | 2.5 mA max.<br>1.5 mA typ. |

**Temperature**

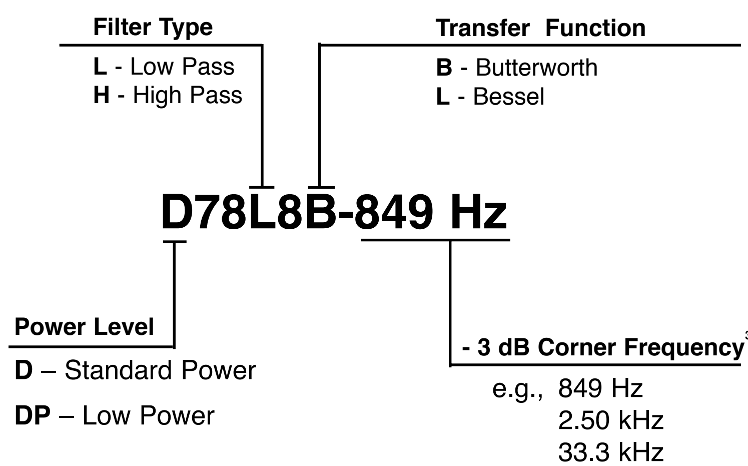
| | |
|---|---|
| Operating | 0 to + 70 °C |
| Storage | - 25 to + 85 °C |

Notes:
1. Input and output signal voltage referenced to supply common.
2. Output is short circuit protected to common. DO NOT CONNECT TO ±Vs.




**Filter Mounting Assembly-See FMA-01A**

## Ordering Information




3. How to Specify Corner Frequency:
Corner frequencies are specified by attaching a three digit frequency designator to the basic model number. Corner frequencies can range from 1 Hz to 100 kHz.


IN-00D78-00



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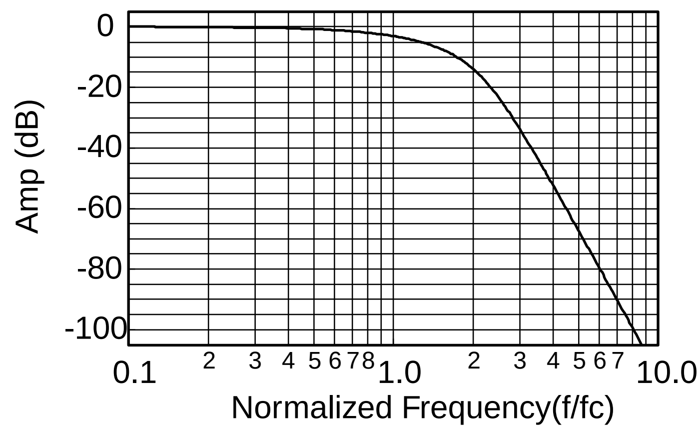
## Theoretical Transfer Characteristics

| f/fc (Hz) | Amp (dB) | Phase (deg) | Delay[1] (sec) |
|---|---|---|---|
| 0.00 | 0.00 | 0.00 | .506 |
| 0.10 | -0.029 | -18.2 | .506 |
| 0.20 | -0.117 | -36.4 | .506 |
| 0.30 | -0.264 | -54.7 | .506 |
| 0.40 | -0.470 | -72.9 | .506 |
| 0.50 | -0.737 | -91.1 | .506 |
| 0.60 | -1.06 | -109 | .506 |
| 0.70 | -1.45 | -128 | .506 |
| 0.80 | -1.91 | -146 | .506 |
| 0.85 | -2.16 | -155 | .506 |
| 0.90 | -2.42 | -164 | .506 |
| 0.95 | -2.71 | -173 | .506 |
| 1.00 | -3.01 | -182 | .506 |
| 1.10 | -3.67 | -200 | .506 |
| 1.20 | -4.40 | -219 | .506 |
| 1.30 | -5.20 | -237 | .506 |
| 1.40 | -6.10 | -255 | .505 |
| 1.50 | -7.08 | -273 | .504 |
| 1.60 | -8.16 | -291 | .502 |
| 1.70 | -9.36 | -309 | .498 |
| 1.80 | -10.7 | -327 | .492 |
| 1.90 | -12.1 | -345 | .482 |
| 2.00 | -13.7 | -362 | .468 |
| 2.25 | -18.1 | -402 | .417 |
| 2.50 | -23.1 | -436 | .352 |
| 2.75 | -28.3 | -465 | .291 |
| 3.00 | -33.4 | -489 | .241 |
| 3.25 | -38.3 | -509 | .201 |
| 3.50 | -43.1 | -526 | .170 |
| 4.00 | -51.8 | -552 | .126 |
| 5.00 | -66.8 | -587 | .077 |
| 6.00 | -79.2 | -610 | .052 |
| 7.00 | -89.8 | -626 | .038 |
| 8.00 | -99.0 | -638 | .029 |
| 9.00 | -107 | -647 | .023 |
| 10.0 | -114 | -655 | .018 |

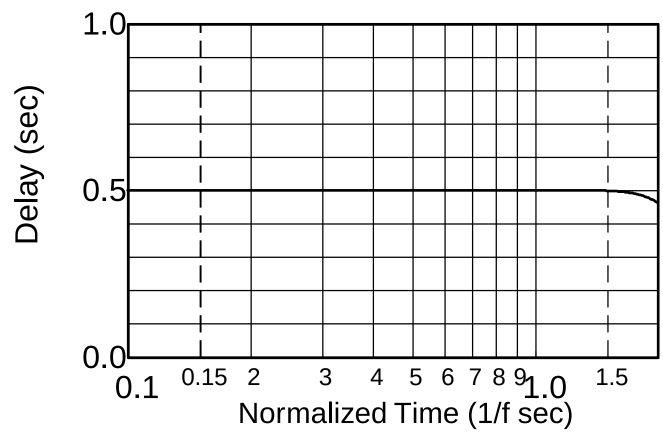
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$

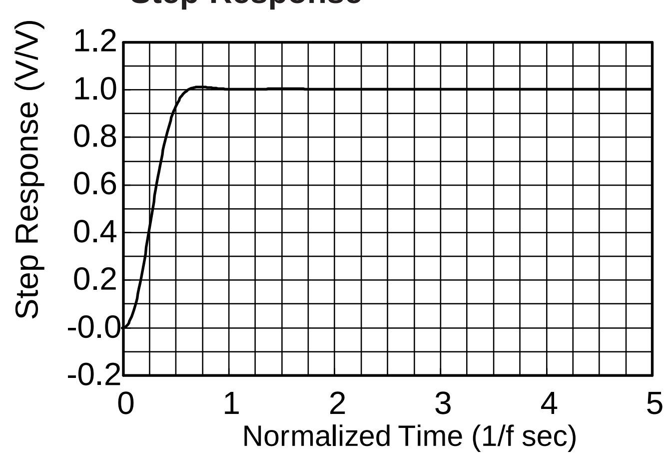
## Frequency Response




## **Delay** (Normalized)




## Step Response



# Low-Pass

**8-Pole**

**Butterworth**

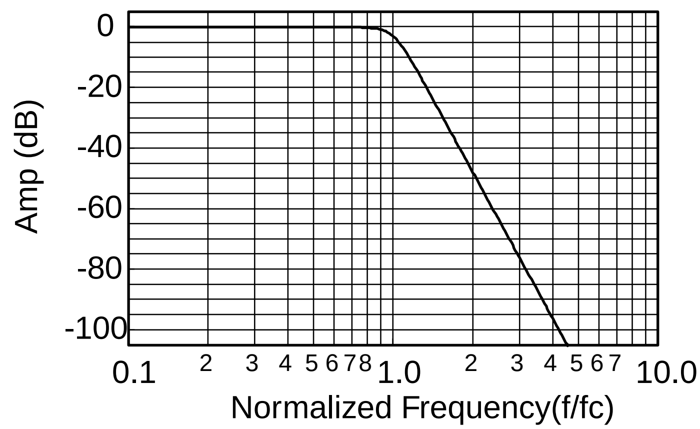
## Theoretical Transfer Characteristics

| f/fc (Hz) | Amp (dB) | Phase (deg) | Delay[1] (sec) |
|---|---|---|---|
| 0.00 | 0.00 | 0.00 | .816 |
| 0.10 | 0.00 | -29.4 | .819 |
| 0.20 | 0.00 | -59.0 | .828 |
| 0.30 | 0.00 | -89.1 | .843 |
| 0.40 | 0.00 | -120 | .867 |
| 0.50 | 0.00 | -152 | .903 |
| 0.60 | -0.001 | -185 | .956 |
| 0.70 | -0.014 | -221 | 1.04 |
| 0.80 | -0.121 | -261 | 1.19 |
| 0.85 | -0.311 | -283 | 1.29 |
| 0.90 | -0.738 | -307 | 1.40 |
| 0.95 | -1.58 | -333 | 1.48 |
| 1.00 | -3.01 | -360 | 1.46 |
| 1.10 | -7.48 | -408 | 1.17 |
| 1.20 | -12.9 | -445 | .873 |
| 1.30 | -18.2 | -472 | .672 |
| 1.40 | -23.4 | -494 | .540 |
| 1.50 | -28.2 | -511 | .448 |
| 1.60 | -32.7 | -526 | .380 |
| 1.70 | -36.9 | -539 | .328 |
| 1.80 | -40.8 | -550 | .287 |
| 1.90 | -44.6 | -560 | .253 |
| 2.00 | -48.2 | -568 | .226 |
| 2.25 | -56.3 | -586 | .174 |
| 2.50 | -63.7 | -600 | .139 |
| 2.75 | -70.3 | -611 | .113 |
| 3.00 | -76.3 | -621 | .094 |
| 3.25 | -81.9 | -629 | .080 |
| 3.50 | -87.1 | -635 | .069 |
| 4.00 | -96.3 | -646 | .052 |
| 5.00 | -112 | -661 | .033 |
| 6.00 | -125 | -671 | .023 |
| 7.00 | -135 | -678 | .017 |
| 8.00 | -144 | -683 | .013 |
| 9.00 | -153 | -687 | .010 |
| 10.0 | -160 | -691 | .008 |

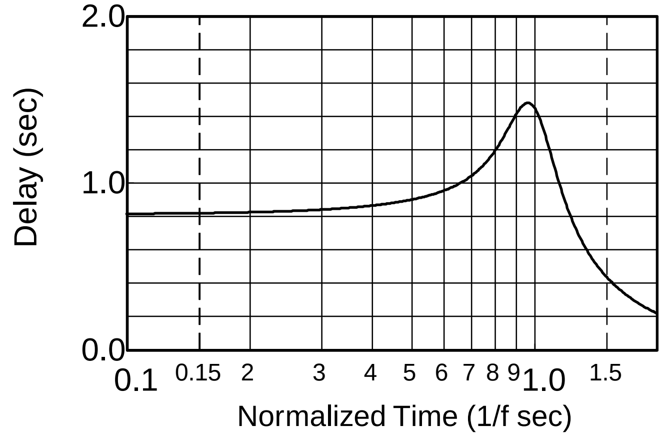
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$

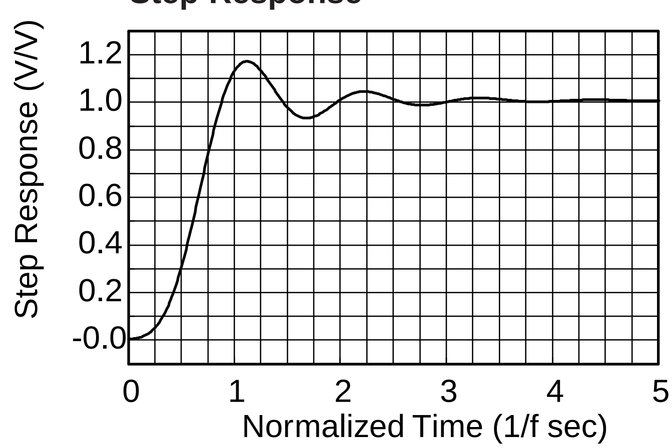
## Frequency Response




## Delay (Normalized)




## Step Response



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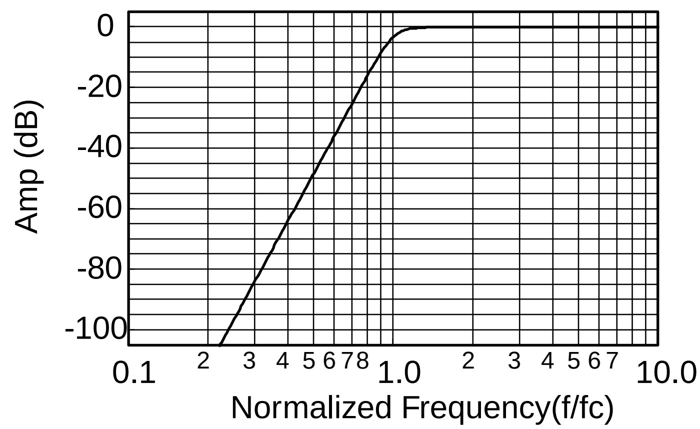
## Theoretical Transfer Characteristics

| f/fc (Hz) | Amp (dB) | Phase (deg) | Delay[1] (sec) |
|---|---|---|---|
| 0.10 | -160 | 691 | 0.819 |
| 0.20 | -112 | 661 | 0.828 |
| 0.30 | -83.7 | 631 | 0.843 |
| 0.40 | -63.7 | 600 | 0.867 |
| 0.50 | -48.2 | 568 | 0.903 |
| 0.60 | -35.5 | 535 | .956 |
| 0.70 | -24.8 | 499 | 1.04 |
| 0.80 | -15.6 | 459 | 1.19 |
| 0.85 | -11.6 | 437 | 1.29 |
| 0.90 | -8.06 | 413 | 1.40 |
| 0.95 | -5.15 | 386 | 1.48 |
| 1.00 | -3.01 | 360 | 1.46 |
| 1.20 | -0.229 | 275 | 0.873 |
| 1.40 | -0.020 | 226 | 0.540 |
| 1.60 | -0.002 | 194 | 0.380 |
| 1.80 | 0.00 | 170 | 0.287 |
| 2.00 | 0.00 | 152 | 0.226 |
| 2.50 | 0.00 | 120 | 0.139 |
| 3.00 | 0.00 | 99.2 | 0.094 |
| 4.00 | 0.00 | 74.0 | 0.052 |
| 5.00 | 0.00 | 59.0 | 0.033 |
| 6.00 | 0.00 | 49.0 | 0.023 |
| 7.00 | 0.00 | 42.1 | 0.017 |
| 8.00 | 0.00 | 36.8 | 0.013 |
| 9.00 | 0.00 | 32.7 | 0.010 |
| 10.0 | 0.00 | 29.4 | 0.008 |

## Frequency Response




1.**Normalized Group Delay:**
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$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$



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