



### Band Pass

#### Description:

The 824BP Series is a 2-pole-pair digitally programmable precision band-pass active filter that provides high performance in a compact 2" x 2" footprint. These new filters take advantage of the company's proprietary designs using surface-mount technology to provide a low profile, compact package in minimal board space. 824BP filters are factory tuned to one of three factory set tuning ranges or 8-bit custom ranges from 1 Hz to 25.6 kHz. Each filter type features a near theoretical amplitude/phase response along with low output voltage noise enabling these filters to achieve a 10,000:1 or better dynamic signal range.

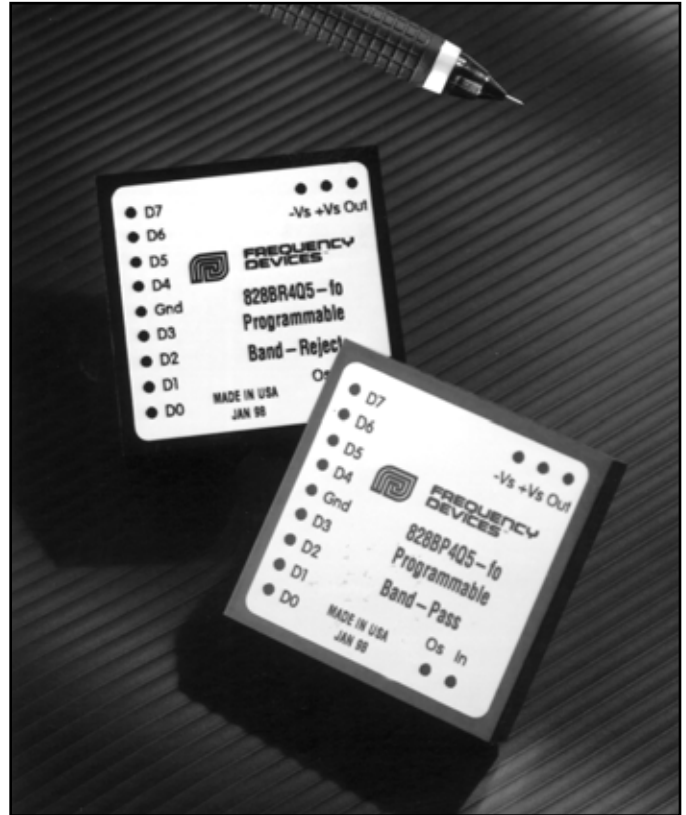
Pretuned to within  $\pm 2\%$  of the center frequency, band-pass 824BP filters pass all frequencies lying between the upper and lower -3dB points of the amplitude response curve. Available Q's for 824BP models are 1, 2, 5, or 10.

#### Features/Benefits:

- Compact 2.0"L x 2.0"W footprint minimizes board space requirements.
- Plug-in ready-to-use, reducing engineering design and manufacturing cycle time.
- Factory tuned, no external clocks or adjustments needed.
- Broad range of center frequencies to meet a wide range of applications.

#### Applications

- Power line interference rejection
- Transducer output filtering
- Production test instrumentation
- Medical electronics equipment and research
- Comb filtering and equalization
- Noise and harmonic analysis
- RMS measurements
- Frequency spectrum analysis



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## Digital Tuning & Control Characteristics

### 8-Bit Programmable Filters

#### Digital Tuning Characteristics

The digital tuning interface circuits are a parallel set of eight (8) 4053 CMOS switches which accept CMOS compatible inputs for the eight tuning bits (D<sub>0</sub> - D<sub>7</sub>).

Filter tuning follows the tuning equation given below:

$$f_c = (f_{max}/256) [ 1 + D_7 \times 2^7 + D_6 \times 2^6 + D_5 \times 2^5 + D_4 \times 2^4 + D_3 \times 2^3 + D_2 \times 2^2 + D_1 \times 2^1 + D_0 \times 2^0 ]$$

where D<sub>1</sub> - D<sub>7</sub> = "0" or "1", and

f<sub>max</sub> = Maximum tuning frequency;

f<sub>c</sub> = corner frequency;

Minimum tunable frequency = f<sub>max</sub>/256 (D<sub>0</sub> thru D<sub>7</sub> = 0);

Minimum frequency step (Resolution) = f<sub>max</sub>/256

#### Data Input Specifications

##### Input Data Levels (CMOS Logic)

Input Voltage (V<sub>s</sub> = 15 Vdc)

Low Level In	0 Vdc min.	4 Vdc max.
High Level In	11 Vdc min.	15 Vdc max.

Input Current

High Level In	- 10 <sup>-5</sup> μA typ.	-1 μA max..
Low Level In	+10 <sup>-5</sup> μA typ.	+1 μA max.

Input Capacitance 5 pF typ 7.5 pF max.

##### Input Data Format Frequency Select Bits

Positive Logic Logic "1" = +V<sub>s</sub>  
Logic "0" = Gnd

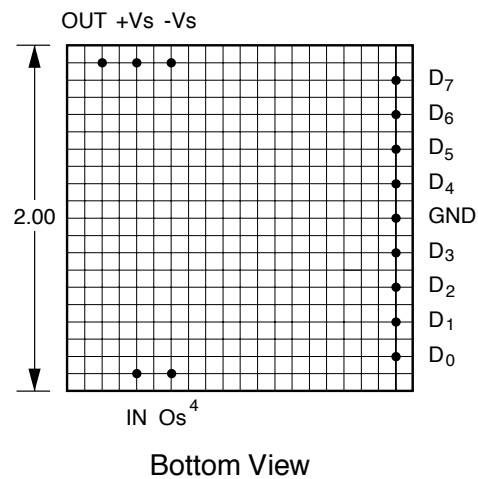
Bit Weighting (Binary-Coded)

D<sub>0</sub> LSB (least significant bit)  
D<sub>7</sub> MSB (most significant bit)

Frequency Range 256 : 1, Binary Weighted

#### Pin-Out Key

IN	Analog Input Signal	D <sub>7</sub> Tuning Bit 7 (MSB)
OUT	Analog Output Signal	D <sub>6</sub> Tuning Bit 6
GND	Power and Signal Return	D <sub>5</sub> Tuning Bit 5
+V <sub>s</sub>	Supply Voltage, Positive	D <sub>4</sub> Tuning Bit 4
-V <sub>s</sub>	Supply Voltage, Negative	D <sub>3</sub> Tuning Bit 3
Os	Offset Adjustment	D <sub>2</sub> Tuning Bit 2
		D <sub>1</sub> Tuning Bit 1
		D <sub>0</sub> Tuning Bit 0 (LSB)



MSB	---	---	---	---	---	---	LSB	Bit Weight
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	f <sub>c</sub> Corner Frequency
0	0	0	0	0	0	0	0	f <sub>max</sub> /256
0	0	0	0	0	0	0	1	f <sub>max</sub> /128
0	0	0	0	0	0	1	1	f <sub>max</sub> /64
0	0	0	0	0	1	1	1	f <sub>max</sub> /32
0	0	0	0	1	1	1	1	f <sub>max</sub> /16
0	0	0	1	1	1	1	1	f <sub>max</sub> /8
0	0	1	1	1	1	1	1	f <sub>max</sub> /4
0	1	1	1	1	1	1	1	f <sub>max</sub> /2
1	1	1	1	1	1	1	1	f <sub>max</sub>



### Band-Pass

Model	824BP2
<b>Product Specifications</b>	Band-Pass
<b>Size Model 2 Model 3 &amp; 4</b>	2.0" x 2.0" x 0.5" 2.0" x 2.0" x 0.4"
<b>Range <math>f_o</math></b>	1 Hz to 25.6 kHz
<b>Available "Q's"</b>	1, 2, 5, 10
<b>"Q" Accuracy</b>	±10 %
<b>Theoretical Transfer Characteristics</b>	Appendix A Pages 39 & 40
<b>Pass-Band Gain</b> (non-inverting)	0 ± 0.25 dB typ 0 ± 0.50 dB max.
<b>Attenuation Rate</b>	12 dB/octave
<b>Center Frequency</b>	$f_o$ ±2% max.
<b>Stability</b>	±0.01%/°C
<b>Filter Mounting Assembly</b>	FMA-02A

1. Q – Quality Factor for band-pass filters.  $Q = f_o / (f_H - f_L)$

$$f_o = \sqrt{f_H f_L}$$



## Specification

(25°C and Vs ±15Vdc)

## Pin-Out and Package Data Ordering Information

### Analog Input Characteristics<sup>1</sup>

Impedance 10 k Ω min.  
Voltage Range ± 10 Vpeak  
Max. Safe Voltage ±Vs

### Analog Output Characteristics

Impedance (Closed Loop) 1 Ω typ.  
10 Ω max.  
Linear Operating Range ±10V  
Maximum Current<sup>2</sup> ±2 mA  
Offset Voltage<sup>3</sup> 2 mV typ.  
20 mV max.  
Offset Temp. Coeff. 50 μV/°C

### Power Supply (±V)

Rated Voltage ±15 Vdc  
Operating Range ±12 to ±18 Vdc  
Maximum Safe Voltage ±18 Vdc

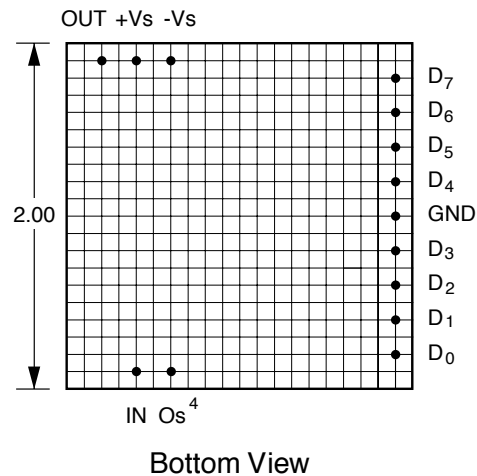
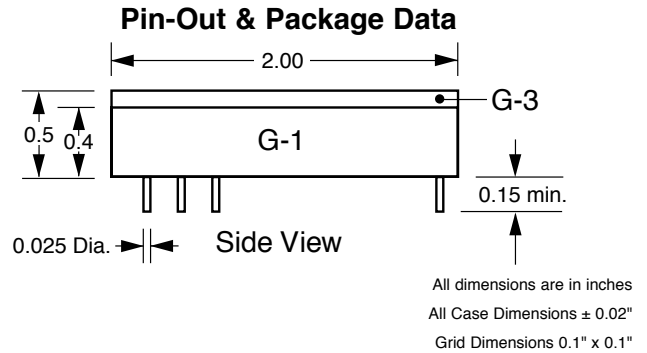
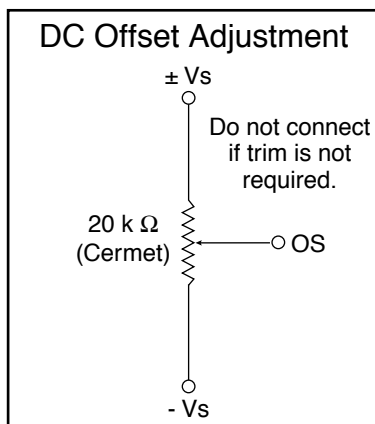
Quiescent Current ±13 mA typ.  
±20 mA max.

### 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.
3. Adjustable to zero.
4. Units operate with or without offset pin connected.



Filter Mounting Assembly-See FMA-02A

## Ordering Information

### 824BP2/10-3

"Q"  
1, 2, 5, 10

### Model

Model Number	Tuning Range (Hz)	Minimum Step(Hz)	Case
2	1.0 to 256	1.0	G-3
3	10 to 2560	10	G-1
4	100 to 25.6k	100	G-1

We hope the information given here will be helpful. The information is based on data and our best knowledge, and we consider the information to be true and accurate. Please read all statements, recommendations or suggestions herein in conjunction with our conditions of sale which apply to all goods supplied by us. We assume no responsibility for the use of these statements, recommendations or suggestions, nor do we intend them as a recommendation for any use which would infringe any patent or copyright. **PR-824BP-01**



## Programmable Filter Modules Power Sequence & ESD

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November 2000

### Programmable Filters Modules

**818, 824, 828, 828BP, 828BR, 854, 858, R854, R858**

#### I. Scope

The following precautions are necessary when handling and installing Frequency Devices programmable filter modules.

#### II. Digital Circuit Description

The digital input pins connect directly to 4000 series CMOS logic, such as the 4053 analog switch. The power supply (V<sub>ss</sub>) for the digital logic on the module comes directly from the +15 Volt pin on the module. This sets the threshold voltage at 11.0 V minimum to 15.0 V maximum for a "1" (High) level and 0.0 V minimum to 4.0 V maximum for a "0" (Low) level. Applying a voltage between 4.0 and 11.0 V will produce unpredictable operation. Connecting 5 Volt or 3.3 V logic devices directly to the filter module without using a voltage translator will result in erratic operation of the filter.

#### III. (VERY IMPORTANT) Power-Up and Power-Down Sequence

**Do not plug-in or un-plug module while power is applied.** It is imperative that power is supplied to the + 15 V pin on the filter module before or at the same instance that any digital pin is pulled High (> 0.0 V). Failure to do this will result in excessive current flowing through the digital input pin and through a protection diode internal to the 4000 logic, which will result in damage to the module. The proper power-up and power-down sequence is:

1. Connect filter module ground.
2. Connect filter module +15 V.
3. Connect filter module -15 V.
4. Connect the input signal.

All four of the above steps can also occur simultaneously. Power-down should occur in the reverse order.

#### IV. ESD Issues

Like most modern electronic equipment, the modules can be damaged by electrostatic discharge (ESD). The modules are shipped from the factory in sealed, anti-static packaging and should be kept in the sealed package prior to mounting on a circuit board. The following additional rules should also be observed when handling the modules after they are removed from the factory packaging:

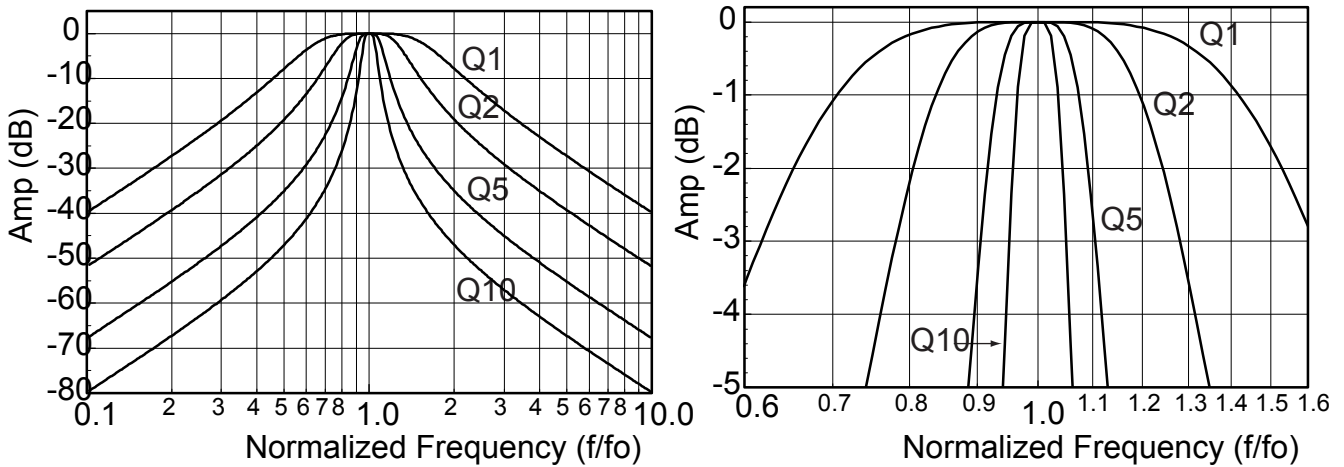
1. Only a person wearing a properly grounded wrist strap should handle the modules.
2. Any work surface that the modules are placed on must be properly ESD grounded.
3. Any insulating materials capable of generating static charge (such as paper) should be kept away from the modules.

Static generating clothing should be covered with an ESD-protective smock.



Appendix A

**Amplitude Response Curves**

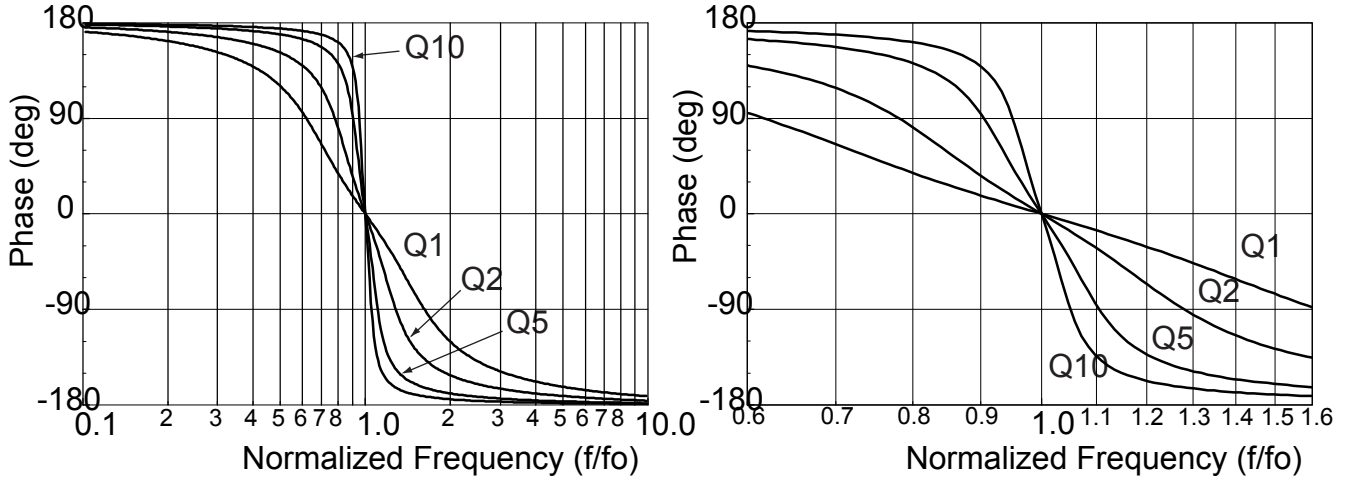


Amp (dB)	Q = 1		Q = 2		Q = 5		Q = 10	
	$f_L < f_o < f_H$		$f_L < f_o < f_H$		$f_L < f_o < f_H$		$f_L < f_o < f_H$	
	$f/f_o$	$f/f_o$	$f/f_o$	$f/f_o$	$f/f_o$	$f/f_o$	$f/f_o$	$f/f_o$
-0.10	0.824	1.214	0.907	1.102	0.962	1.040	0.981	1.020
-0.25	0.783	1.277	0.884	1.131	0.952	1.051	0.976	1.025
-0.50	0.747	1.338	0.863	1.159	0.943	1.061	0.971	1.030
-1.00	0.705	1.418	0.837	1.194	0.931	1.074	0.965	1.036
-1.50	0.677	1.478	0.820	1.220	0.923	1.083	0.961	1.041
-2.00	0.654	1.529	0.805	1.242	0.916	1.091	0.957	1.045
-2.50	0.635	1.574	0.792	1.262	0.910	1.098	0.954	1.048
-3.00	0.618	1.617	0.781	1.280	0.905	1.105	0.951	1.051
-5.00	0.563	1.776	0.742	1.348	0.886	1.129	0.941	1.062
-10.00	0.457	2.189	0.657	1.523	0.842	1.188	0.917	1.090
-15.00	0.368	2.720	0.572	1.748	0.792	1.263	0.889	1.125
-20.00	0.290	3.445	0.485	2.062	0.733	1.364	0.855	1.170
-25.00	0.225	4.439	0.399	2.506	0.664	1.507	0.811	1.233
-30.00	0.173	5.795	0.319	3.130	0.585	1.709	0.758	1.320
-35.00	0.131	7.630	0.250	3.999	0.500	2.000	0.693	1.443
-40.00	0.099	10.09	0.193	5.192	0.414	2.414	0.618	1.618
-45.00	0.075	13.41	0.147	6.814	0.333	3.001	0.535	1.869
-50.00	0.056	17.83	0.111	9.002	0.262	3.819	0.449	2.228
-55.00	0.042	23.75	0.084	11.94	0.202	4.945	0.365	2.737
-60.00	0.032	31.65	0.063	15.87	0.154	6.479	0.290	3.453
-65.00	0.024	42.19	0.047	21.13	0.117	8.552	0.225	4.443
-70.00	0.018	56.25	0.036	28.15	0.088	11.33	0.172	5.798
-75.00	0.013	75.00	0.027	37.52	0.066	15.06	0.131	7.632
-80.00	0.010	100.0	0.020	50.01	0.050	20.05	0.099	10.10



Appendix A

**Phase Response Curves**



**Normalized Theoretical Phase Data**

Phase Mag (deg)	Q = 1		Q = 2		Q = 5		Q = 10	
	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)
	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>	f / f <sub>0</sub>
1.0	0.994	1.006	0.997	1.003	0.999	1.001	0.999	1.001
2.5	0.985	1.016	0.992	1.008	0.997	1.003	0.998	1.002
5.0	0.970	1.031	0.985	1.016	0.994	1.006	0.997	1.003
10.0	0.940	1.063	0.970	1.031	0.988	1.012	0.994	1.006
15.0	0.913	1.096	0.955	1.047	0.982	1.018	0.991	1.009
20.0	0.886	1.128	0.941	1.062	0.976	1.025	0.988	1.012
25.0	0.861	1.161	0.928	1.078	0.970	1.030	0.985	1.015
30.0	0.838	1.194	0.915	1.093	0.965	1.036	0.982	1.018
35.0	0.815	1.227	0.902	1.108	0.960	1.042	0.980	1.021
40.0	0.794	1.259	0.891	1.123	0.955	1.048	0.977	1.024
45.0	0.774	1.292	0.879	1.138	0.950	1.053	0.974	1.026
50.0	0.755	1.324	0.868	1.152	0.945	1.059	0.972	1.029
60.0	0.719	1.391	0.846	1.182	0.935	1.069	0.967	1.034
70.0	0.685	1.460	0.825	1.212	0.925	1.081	0.962	1.040
80.0	0.652	1.535	0.803	1.245	0.916	1.092	0.957	1.045
90.0	0.618	1.618	0.781	1.281	0.905	1.105	0.951	1.051
105.0	0.564	1.772	0.743	1.346	0.887	1.128	0.941	1.062
120.0	0.502	1.991	0.695	1.439	0.862	1.160	0.928	1.077
135.0	0.424	2.356	0.628	1.594	0.825	1.212	0.908	1.101
150.0	0.320	3.126	0.520	1.923	0.758	1.319	0.869	1.150
165.0	0.177	5.639	0.327	3.058	0.593	1.686	0.764	1.310
180.0	0	inf	0	inf	0	inf	0	inf