FREQUENCY DEVICES™, INC.

Model 900

Tunable Active Filter Instruments

Single Channel- CE Certified

Description

Frequency Devices' Model 900 instruments furnish the user with a 4 or 8-pole low-pass or high-pass instrument that has a field replaceable filter module and is tunable by front panel controls. The controls allow the user to select a corner frequency between 0.1Hz and 49.9kHz with a resolution of 1:499 for each of the four selectable ranges.

The instrument exhibits an input impedance of 1 MΩ shunted by 47pF to a single ended signal source. When configured in the differential mode, the instrument has a common mode rejection ratio (CMRR) which exceeds 60dB; in this mode the instrument presents an input impedance of 2 MΩ shunted by 47pF to a double ended single source. Front panel gain control also enables the operator to select a gain factor of 0, 10, or 20dB.

Standard operational features include:

1) Plug-in Filter Module
2) Adjustable Frequency Control
3) Differential Input Amplifiers
4) Adjustable Gain Control
5) Off-set Adjustment
6) Bypass Control
7) BNC Connectors for Signal I/O

An optional battery powered version (900B)is available and is particularly well suited to applications requiring isolation from an electrically noisy primary power source.

Compact size and manual rotary switch front panel controls make 900 instruments a popular, cost effective, easy-to-use solution for signal conditioning applications in the following areas:

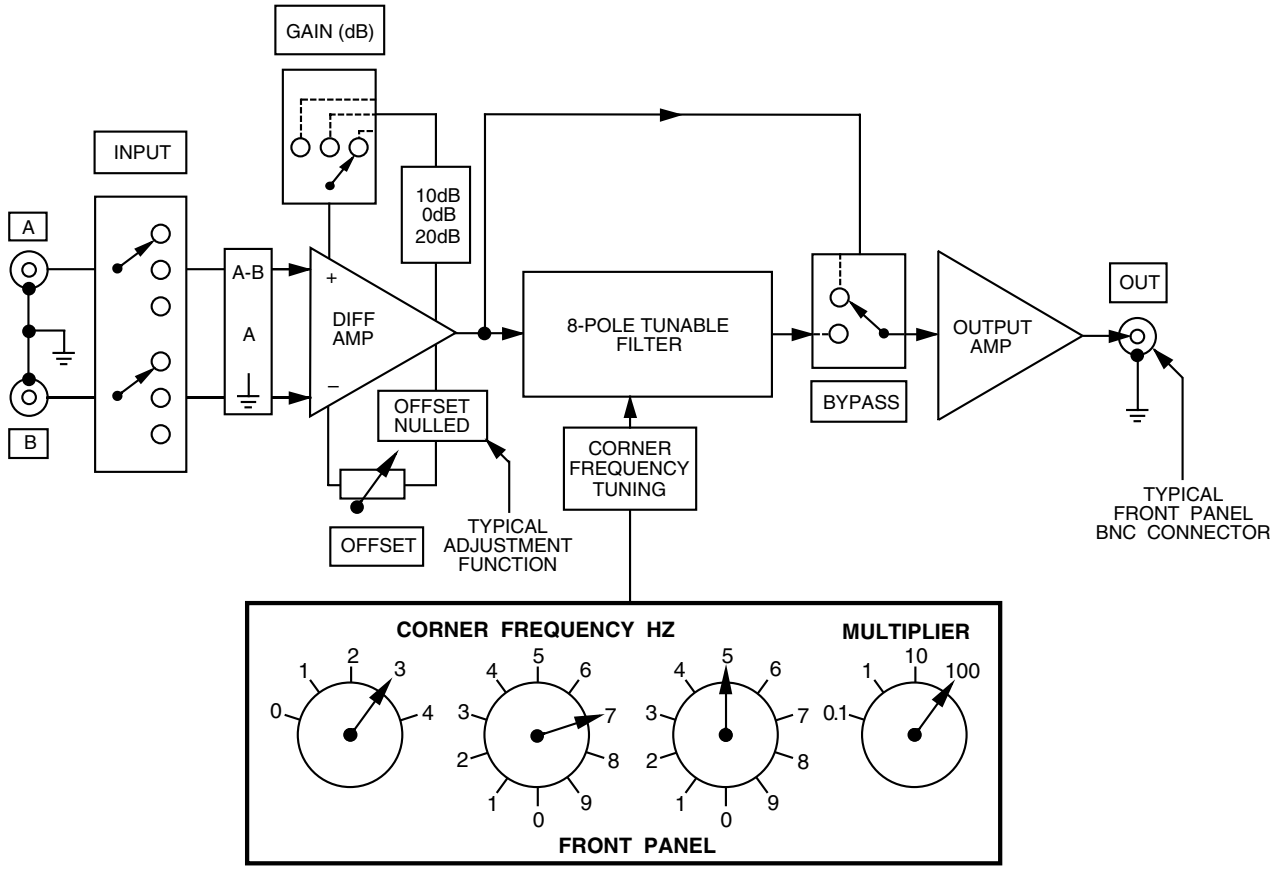
Anti-aliasing Filters
Biomedical/Biotechnology Applications
Data Recording/Playback
Data Smoothing
EKG/EEG Signal Filtering
FDM/PCM Signal Filtering
Medical Research
Industrial Process Control
Seismic Analysis
Vibration Analysis

Chassis:

900C Standard AC powered chassis
900B AC powered, with battery powered option

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

BLOCK DIAGRAM



25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Model	9L4B	9L4L	9L8B	9L8L
Product Specifications				
Transfer Function	4-Pole, Butterworth	4-Pole, Bessel	8-Pole, Butterworth	8-Pole, Bessel
Range f_c,	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz
Theoretical Transfer Characteristics	Appendix A Page 7	Appendix A Page 2	Appendix A Page 9	Appendix A Page 4
Tuning Resolution	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade
Passband Ripple (theoretical)	0.0 dB	0.0 dB	0.0 dB	0.0 dB
DC Voltage Gain (non-inverting)	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.
Stopband Attenuation	24 dB/octave	24 dB/octave	48 dB/octave	48 dB/octave
Cutoff Frequency Accuracy	f_c ± 2% max. ± 2% max. ± 0.5% typ.	f_c ± 2% max. ± 2% max. ± 0.5% typ.	f_c ± 2% max. ± 2% max. ± 0.5% typ.	f_c ± 2% max. ± 2% max. ± 0.5% typ.
Stability	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.
Amplitude	-3dB	-3dB	- 3 dB	- 3 dB
Phase	-180°	-121°	-360°	-182°
Filter Attenuation (theoretical)	0.67 dB 0.80 f_c 3.01 dB 1.00 f_c 30.0 dB 2.37 f_c 40.0 dB 3.16 f_c	1.86 dB 0.80 f_c 3.01 dB 1.00 f_c 30.0 dB 3.50 f_c 40.0 dB 4.72 f_c	0.12 dB 0.80 f_c 3.01 dB 1.00 f_c 60.0 dB 2.37 f_c 80.0 dB 3.16 f_c	1.91 dB 0.80 f_c 3.01 dB 1.00 f_c 60.0 dB 4.52 f_c 80.0 dB 6.07 f_c
Total Harmonic Distortion @ 1 kHz	< - 90 dB typ.	< - 90 dB typ.	< - 90 dB typ.	< - 90 dB typ.
Wide Band Noise (5 Hz - 2 MHz)	200 μVrms typ	200 μVrms typ	200 μVrms typ.	200 μVrms typ.
Narrow Band Noise (5 Hz - 100 kHz)	50 μVrms typ.	50 μVrms typ.	50 μVrms typ.	50 μVrms typ.

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Model	9L8E	9L8EY	9L8D80	9L8D10
Product Specifications				
Transfer Function	8-Pole, 6 zero, Elliptic	8-Pole, 6 zero Elliptic	8-Pole, 6 zero Constant Delay	8-Pole, 6 zero, Constant Delay
Range f_c, f_r	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz
Theoretical Transfer Characteristics	Appendix A Page 24	Appendix A Page 25	Appendix A Page 21	Appendix A Page 22
Tuning Resolution	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade
Passband Ripple (theoretical)	± 0.035 dB	-0.05 dB	0.15 dB	0.15 dB
DC Voltage Gain (non-inverting)	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.	0 ± 0.2 dB max. 0 ± 0.1 dB typ.
Stopband Attenuation	-80 dB typ.	-100 dB typ.	-80 dB typ.	-100 dB typ.
Cutoff Frequency	f_r ± 2% max.	f_r ± 2% max.	f_c ± 2% max.	f_c ± 2% max.
Accuracy	± 2% max. ± 0.5% typ.	± 2% max. ± 0.5% typ.	± 2% max. ± 0.5% typ.	± 2% max. ± 0.5% typ.
Stability	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.
Amplitude	-0.035 dB	-0.05 dB	- 3 dB	- 3 dB
Phase	- 323°	-419°	-306°	- 311°
Filter Attenuation (theoretical)	0.035 dB 1.00 f_r 3.01 dB 1.13 f_r 60.0 dB 1.67 f_r 80.0 dB 1.77 f_r	0.05 dB 1.00 f_r 3.01 dB 1.06 f_r 80.0 dB 1.83 f_r 100.0 dB 2.00 f_r	3.01 dB 1.00 f_c 60.0 dB 3.08 f_c 80.0 dB 3.57 f_c	3.01 dB 1.00 f_c 80.0 dB 4.45 f_c 100.0 dB 5.20 f_c
Total Harmonic Distortion @ 1 kHz	< - 90 dB typ.	< - 88 dB typ.	< - 90 dB typ.	< - 88 dB typ.
Wide Band Noise (5 Hz - 2 MHz)	250 μVrms typ.	250 μVrms typ.	200 μVrms typ.	200 μVrms typ.
Narrow Band Noise (5 Hz - 100 kHz)	75 μVrms typ.	75 μVrms typ.	50 μVrms typ.	50 μVrms typ.

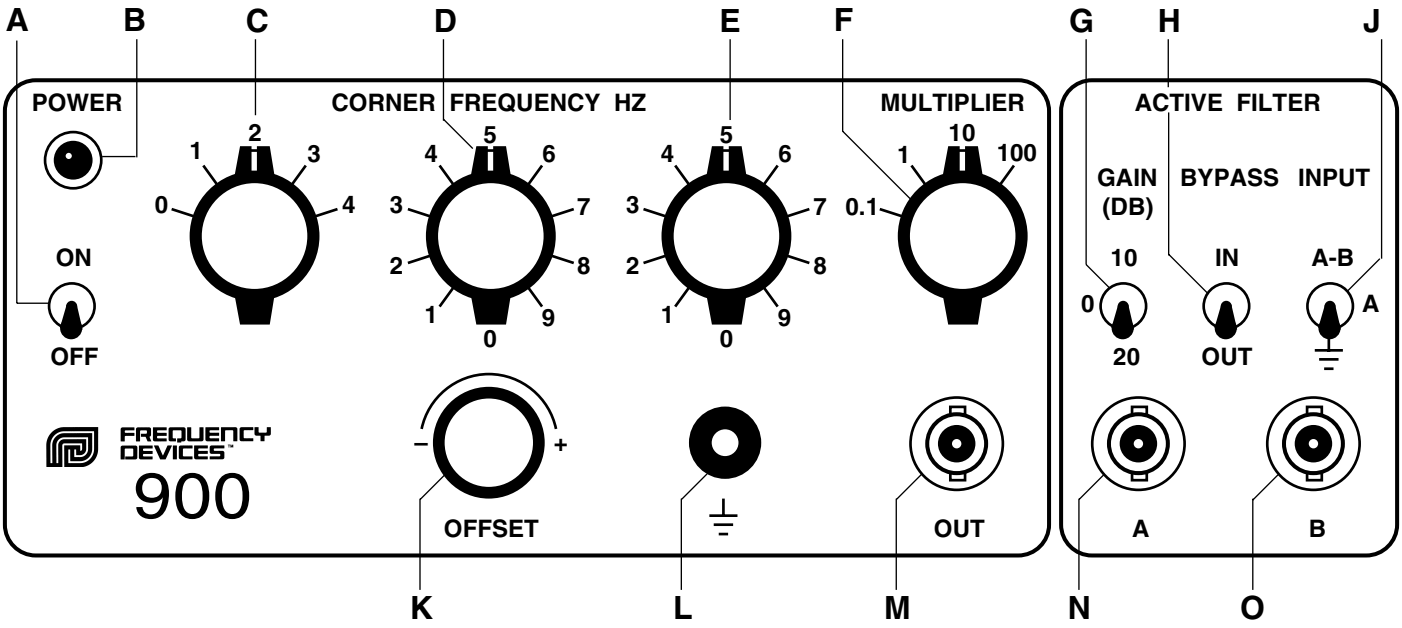
25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Model	9H4B	9H8B	9H8E	9H8EY
Product Specifications				
Transfer Function	4-Pole Butterworth	8-Pole Butterworth	8-Pole, 6 zero Elliptic	8-Pole, 6 zero Elliptic
Range f_c, f_r	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz	0.1 Hz to 49.9 kHz
Theoretical Transfer Characteristics	Appendix A Page 27	Appendix A Page 29	Appendix A Page 37	Appendix A Page 38
Tuning Resolution	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade	1 part in 499 within each decade
Passband Ripple (theoretical)	0.0 dB	0.0 dB	± 0.035 dB	- 0.05 dB
Voltage Gain (non-inverting)	0 ± 0.2 dB to 100 kHz 0 ± 0.5 dB to 120 kHz	0 ± 0.2 dB to 100 kHz 0 ± 0.5 dB to 120 kHz	0 ± 0.2 dB to 100 kHz max. 0 ± 0.5 dB to 120 kHz typ.	0 ± 0.2 dB to 100 kHz max. 0 ± 0.5 dB to 120 kHz typ.
Power Bandwidth	120 kHz	120 kHz	120 kHz	120 kHz
Stopband Attenuation	24 dB/octave	48 dB/octave	-80 dB typ.	-100 dB typ.
Cutoff Frequency Accuracy	f_c ± 2% max. ± 2% max. ± 0.5% typ.	f_c ± 2% max. ± 2% max. ± 0.5% typ.	f_r ± 2% max. ± 2% max. ± 0.5% typ.	f_r ± 2% max. ± 2% max. ± 0.5% typ.
Stability	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.	± 0.01% /°C max. ± 0.01% /°C typ.	± 0.02% /°C max. ± 0.01% /°C typ.
Amplitude	- 3 dB	- 3 dB	- 0.035 dB	- 0.5 dB
Phase	-180°	-360°	-323°	-419°
Filter Attenuation (theoretical)	40 dB 0.31 f_c 30 dB 0.42 f_c 3.01 dB 1.00 f_c 0.02 dB 2.00 f_c	80 dB 0.31 f_c 60 dB 0.42 f_c 3.01 dB 1.00 f_c 0.00 dB 2.00 f_c	80 dB 0.56 f_r 60.0 dB 0.60 f_r 3.01 dB 0.88 f_r 0.03 dB 1.00 f_r 0.00 dB 2.00 f_r	100 dB 0.50 f_r 80.0 dB 0.55 f_r 3.01 dB 0.94 f_r 0.03 dB 1.00 f_r 0.00 dB 2.00 f_r
Total Harmonic Distortion	< - 88 dB typ.	< - 88 dB typ.	< - 88 dB typ.	< - 88 dB typ.
Wide Band Noise (5 Hz - 2 MHz)	400 μVrms typ.	400 μVrms typ.	400 μVrms typ.	500 μVrms typ.
Narrow Band Noise (5 Hz - 100 kHz)	100 μVrms typ.	100 μVrms typ.	100 μVrms typ.	150 μVrms typ.

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Location of Front Panel Terminals and Controls

Location of Front Panel Terminals and Controls



A. **POWER ON/OFF Switch:** A two position toggle switch that interrupts/completes the internal DC power circuit and resets the battery protection circuit.

B. **POWER Status Lamp:** This red LED indicates whether or not the power to the analog filter circuitry of a Model 900 instrument is correct. With the POWER switch in the ON position the LED glows continuously if the internal DC power levels are correct, flashes for low DC power levels, and goes off for grossly improper DC power levels. See power lamp status, page 14.

C. **CORNER FREQUENCY** Selector Switch (0-400): This five position rotary switch selects the 100's digit value of the corner frequency designator. The switch selectable values are 0, 100, 200, 300, and 400 in five discrete steps.

D. **CORNER FREQUENCY** Selector Switch (0-90): This ten position rotary switch selects the 10's digit of the desired corner frequency between 0 and 90, in discrete increments of 10.

E. **CORNER FREQUENCY** Selector Switch (0-9): This ten position rotary switch selects the 1's digit of the desired corner frequency between 0 and 9, in discrete increments of 1.

F. **MULTIPLIER** Selector Switch: This four position rotary switch multiplies by a factor of either 0.1, 1, 10, or 100, the aggregate value set on the three CORNER FREQUENCY selector switches. (C, D & E).

G. **GAIN** Switch: This three position toggle switch selects an overall filter gain of either 0, 10, or 20dB.

H. **BYPASS** Switch: OUT and IN setting of this two position toggle switch routes the input signal to the internal low-pass filter or around it, respectively. For either case, the GAIN switch remains operational.

J. **INPUT** Switch: This three position toggle configures the instrument for either differential inputs (A-B), a single-ended input (A), or input nulling (⏚) which grounds both the (A) and (B) input terminals.

K. **OFFSET** Adjust: This adjustment is intended to zero the offset that results from the instruments own circuitry and does not provide for wide range offset to remove dc input signals.

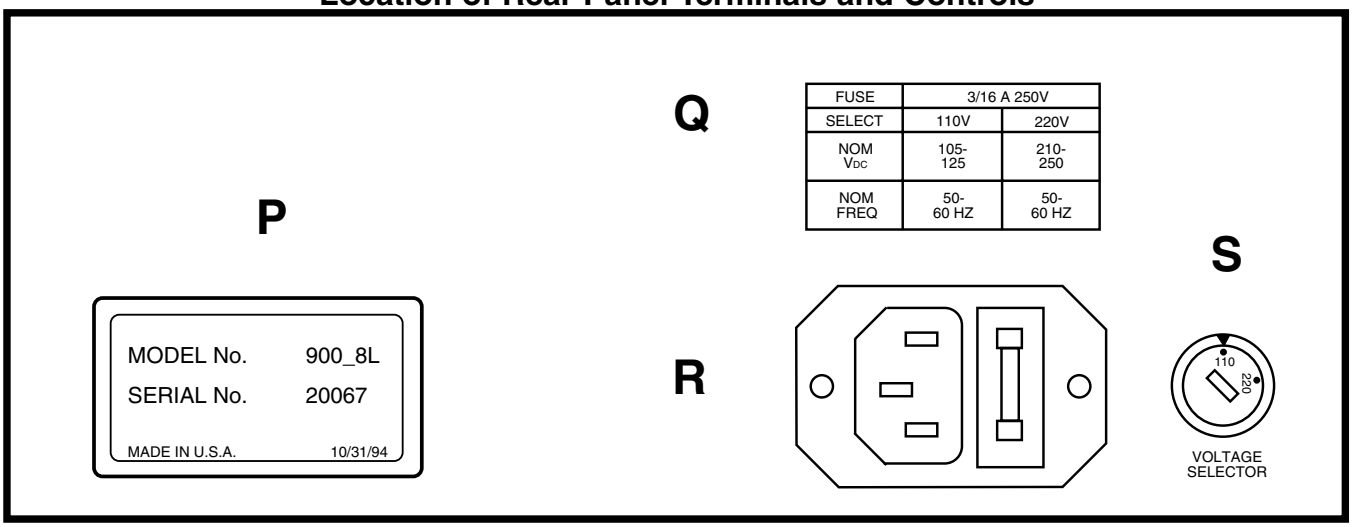
L. **GROUND** (⏚) Terminal: This "Banana" type test jack provides neat and secure access to the internal ground. This terminal is a convenient junction for grounding external system and measurement instrumentation and/or apparatus.

M. **OUT** Terminal: This terminal is a female BNC connector. The shield on the BNC is internally connected to the instrument ground.

N & O. **(A) and (B) Input** Terminals: This pair of shielded, female BNC connectors accept signal inputs (A) and (B). The instrument applies a non-inverting gain to input (A) and an equal but opposite inverting gain to input (B) while the GAIN switch sets the magnitude of differential gain to either 0, 10, or 20dB. The BNC shields have been internally connected to the instrument ground.

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Location of Rear Panel Terminals and Controls



P. **IDENTIFICATION LABEL**: This label identifies the filter type, serial number and date of manufacture.

Q. **POWER** designation: This label identifies operating power limits and fuse requirements of the instrument.

R. **POWER CONNECTION**: Denotes plug and fuse location.

S. **VOLTAGE** Selector Switch: This two position switch determines the operating voltage (110 Vac or 220 Vac). ***At time of shipment, the voltage select switch is preset in the 110 Vac position. For 220 Vac operation, this switch must be rotated to the 220 Vac position.***

POWER Lamp Status

LAMP STATUS	POWER SOURCE: AC POWER LINE	POWER SOURCE: INTERNAL BATTERY
ON	Operating Normally	Operating Normally
FLASHING	Line and internal voltages are correct Possible Causes: Low AC line voltage	Sufficient battery charge Possible Causes: Batteries near exhaustion
OFF	Fault external causing power overload Internal instrument fault Possible Causes: POWER Switch off Momentary power line drop-out tripped protection circuit.* Open line fuse	(approximately 30 minutes of operation remain Possible Causes: POWER Switch off Internal protection circuit tripped.*

**Reset by cycling POWER Switch off then on.*

Filter Replacement Instructions:

Steps to Follow:

1. Unplug (disconnect from Power) instrument.
2. Turn chassis over.
3. With black instrument supports facing up, remove mounting screws.
4. Holding cover in place, turn unit to up-right position and remove top cover.
5. Locate black filter module and carefully remove from channel board.
6. Match replacement filter module pin locations with insertion holes in channel board and gently insert replacement module.
7. Replace instrument top cover, carefully turn over and install instrument supports and screws.

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Initial Setup

Select desired operating voltage 110 Vac or 220 Vac. See note "S" page 14.

Set the POWER ON/OFF Switch to ON. A continuously lit POWER status lamp denotes proper internal dc voltages, an essential indication for battery powered models. Allow the instrument a three minute warm-up period to achieve thermal equilibrium.

To perform initial adjustment and/or operational testing, set the remaining front panel controls as follows:

a) The three base CORNER FREQUENCY switches and the MULTIPLIER to the desired corner frequency...

b) The OFFSET control to approximately mid-range...

c) The GAIN switch to the desired value...

d) The BYPASS switch to OUT...

e) The INPUT switch to ground (⏚)...

Connect a dc-coupled oscilloscope, of vertical sensitivity 10mV/CM or better, or a digital voltmeter (DVM) to the instrument front panel BNC connector labeled OUT.

Set the OFFSET control for a zero-volt reading on the scope.

Subsequent changes of CORNER FREQUENCY, GAIN or BYPASS control settings will introduce a small dc output offset which should be zeroed for critical applications.

Leaving all other controls unchanged, set the Input Switch to (A-B) and apply a 5Vdc signal simultaneously to input BNCs (A) and (B). The voltage measured at the OUT BNC should be 5-5=OVdc. This completes preliminary test and adjustment.

Corner Frequency Selection

To select a corner frequency, simply set the three CORNER FREQUENCY switches and the MULTIPLIER switch for the desired numerical value.

The CORNER FREQUENCY switch weighings follow standard decimal positional convention.

The C, D and E switches combined can select base corner frequency values ranging from 1 to 499 Hz in 1Hz steps, with switch weighings as just described.

The accuracy of the corner frequency is improved by selecting the largest possible base frequency and down scaling by the MULTIPLIER. The greatest accuracy is obtained with the largest base 400, and the 0.1X MULTIPLIER switch 400 setting.

Relative accuracy of selected 40 Hz actual corner frequency for different multiplier switch settings.

BASE FREQ			X MULT.	RELATIVE
msd			lsd	TUNING
C	D	E	F	ACCURACY
4	0	0	0.1X	GREATEST
0	4	0	1X	LESS
0	0	4	10X	LEAST

The instrument utilizes a differential input amplifier to reject prevalent forms of electrical interference, while presenting desirable input characteristics to the signal source requiring filtering.

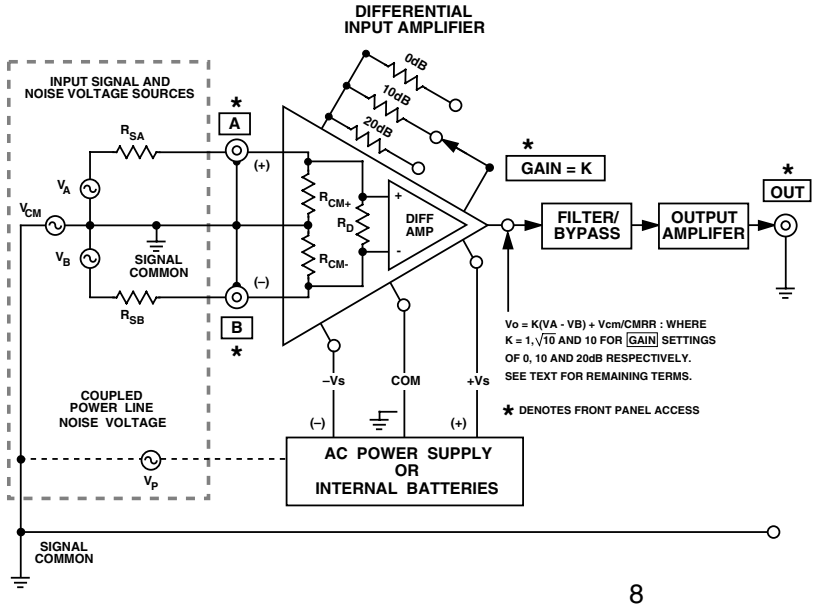
The differential Input

The differential input configuration is ideal for measuring the difference between two values rather than the values themselves. Bridge circuits utilizing strain gages, thermocouples and a variety of other types of transducers generate differential full scale output voltages in the order of millivolts that are often superimposed upon volt-level reference and noise values.

The importance of CMRR

In actual system environments, each signal and power return conductor can generate an interference voltage proportional to the net conductor resistance and the electrical current level. Any such interference voltages appear as common mode signals to the amplifier, and are rejected as such.

Circuit model illustrating relationship between filter's differential input amplifier and external signal and error sources.



25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

FREQUENCY DEVICES™, INC.

Model 900

Specifications

(@25°C and rated Power Input)

Input Characteristics

Input Impedance:	
Differential	2 MΩ Shunted by 47pF
Single Ended	1 MΩ Shunted by 47pF
Input Voltage:	
Linear Differential*	20V p-p (Gain Set at 0 dB)
Max Safe Differential	Any Continuous Value between +/-100V
Max Safe Common Mode	Any Continuous Value between +/-100V
Bias Current	175pA max.; 30pA typ.
Common Mode Rejection Ratio with 2kΩ Source Unbalance and 0 dB Gain	> 60dB, dc to 50kHz

Output Characteristics

Full Power Bandwidth**	dc to 600kHz
Maximum Output Voltage	10V p-p for R_L = 50Ω 20V p-p for R_L = 2kΩ
Short Circuit Output Current	+/-100 mA continuous
Output Protection	+/-200 mA without damage Short Circuit to Ground Only
Output Impedance	50Ω
Offset Voltage	Adjustable to Zero at Front Panel (Range +/-500mV dc)

Power Supply

AC Line Operation:	
Power	20 Watts max.
Voltage Frequency Range-Rear Panel:	
110 V	105 to 125Vac @ 50/60Hz
220 V	210 to 250Vac @ 50Hz
Fuse	3/16 Amp

Battery Operation (Optional)

Time for full Charge	14 to 16 Hrs. @ 20 °C
Battery Life	Approx. 500 Charge-Discharge Cycles
Battery Charger	Automatic Uninterruptible
Charge Status Indicator-Front Panel	3 Status Levels
Battery Operation	9 hours typ. (See graph)

Temperature

Operating Temperature:	
With Batteries	+5 °C to +50 °C
AC Line	0 °C to +50 °C
Storage Temperature	-25 °C to +70 °C

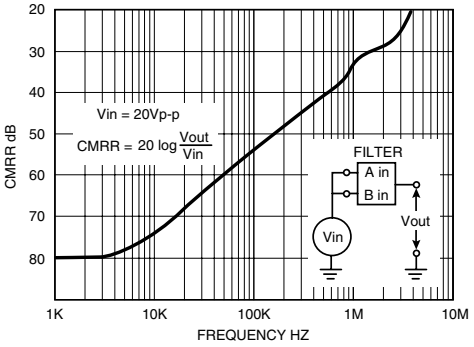
Mechanical

Dimensions	3.5"H x 8.5"W x 9.3"D 8.89cmH x 21.59cmW x 23.62cmD
Weight with Battery	4.5 lbs; 2.04 kgs.
without Battery	3.5 lbs; 1.59 kgs
Case Material	ABS plastic
Color	PC Bone

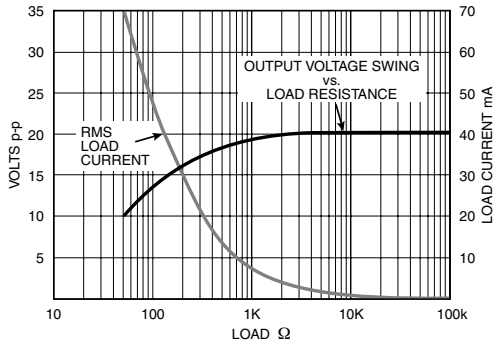
** Signal plus common mode voltage cannot exceed 20V peak for a linear output.*

*** Output characteristics of input amp with filter by-passed.*

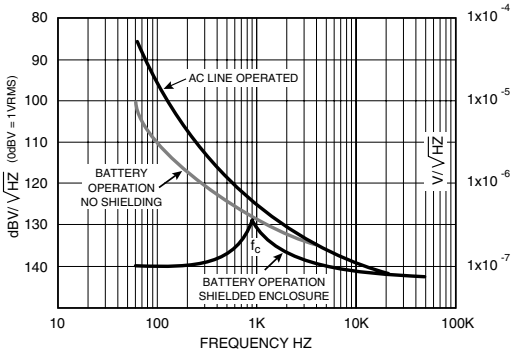
Common Mode Rejection Ratio vs. Frequency



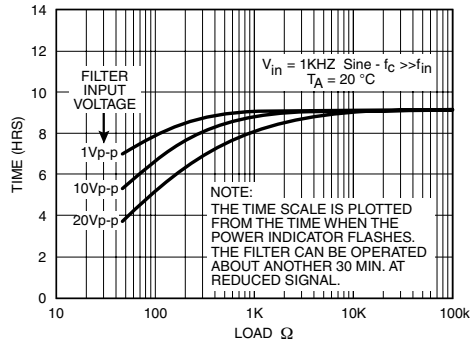
Output Voltage Swing vs. Load Resistance



Voltage Noise vs. Frequency



Battery Life vs. Load Resistance



25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com

Model 900 INSTRUMENT ORDERING GUIDE

A. CHASSIS

1.	900C	Standard AC powered chassis[1]
2.	900B	AC powered, with battery powered option[1]

FILTER TRANSFER FUNCTIONS AVAILABLE[2,4]

B. LOW-PASS

BUTTERWORTH

1.	9L4B	4-pole Butterworth
2.	9L8B	8-pole Butterworth

BESSEL

3.	9L4L	4-pole Bessel
4.	9L8L	8-pole Bessel

ELLIPTIC

5.	9L8E	8-pole elliptic, 1.77, 80dB
6.	9L8EY	8-pole elliptic, 2.00, 100dB

CONSTANT DELAY

7.	9L8D80	8-pole constant delay, 80dB
8.	9L8D10	8-pole constant delay, 100dB

C. HIGH-PASS

BUTTERWORTH

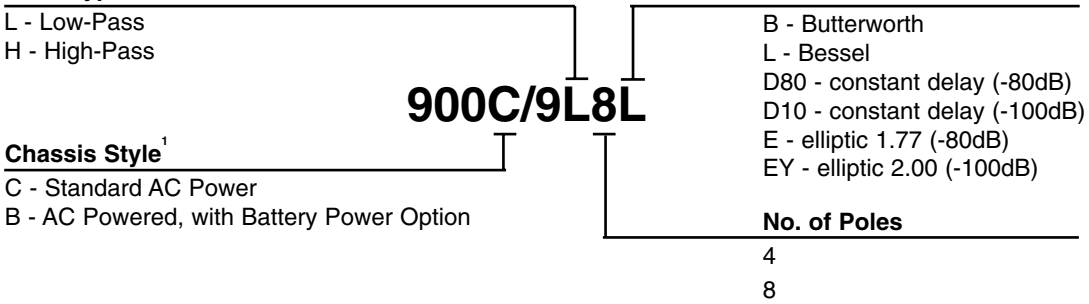
1.	9H4B	4-pole Butterworth
2.	9H8B	8-pole Butterworth

ELLIPTIC

3.	9H8E	8-pole elliptic, 1.77, 80dB
4.	9H8EY	8-pole elliptic, 2.00, 100dB

To order, simply specify the chassis style and filter model number that incorporates the desired features.

Ordering Information



NOTE:
1. See page 14, Item **S - Voltage** Select Switch: At time of shipment, voltage select switch is preset in the 110 Vac position. For 220 Vac operation, this switch must be rotated to the 220 Vac position.
2. Individual filter modules can be purchased for field replacement.
3. All models tunable from 0.1 Hz to 49.9 kHz.
4. See page 8 for Filter Replacement Instructions.

25 Locust St, Haverhill, Massachusetts 01830 • Tel: 800/252-7074, 978/374-0761 • FAX: 978/521-1839
e-mail: sales@freqdev.com • Web Address: http://www.freqdev.com