National Semiconductor

AF121, AF122 DTMF Bandpass Filters

General Description

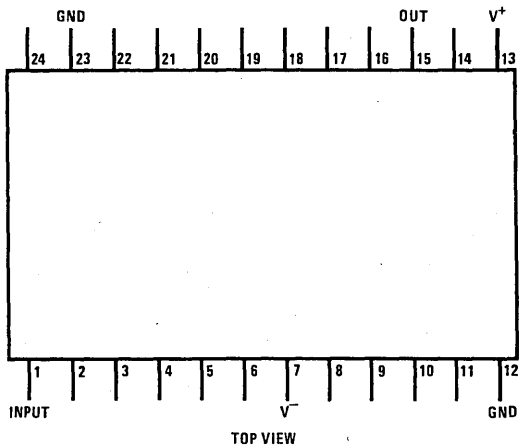
The AF121 and AF122 are 6th order elliptic bandpass filters designed for use with digital DTMF detectors. These filters are compatible with tone detector circuits such as the Rockwell CRC8030 and the Mostek MK5102 DTMF digital receivers. The filters provide 40 dB separation between the high and low frequency signaling groups and the dial tone frequencies. The bandpass feature eliminates the need for a separate dial tone reject filter.

Features

- Compatible with Rockwell CRC8030 and Mostek MK5102
- Gain 0 ±0.5 dB
- Ripple 2 dB peak to peak
- Input Impedance 175 kΩ min
- Power Supply ±5V to ±18V

Connection Diagram

Dual-In-Line Package



TOP VIEW

Unspecified pins are for internal use only and should not be used for external connection.

Order Number
AF121-1CJ, AF121-2CJ
AF122-1CJ, AF122-2CJ

Absolute Maximum Ratings

Supply Voltage	±18V
Power Dissipation	1W
Input Voltage	±100V
Output Short Circuit Duration	Infinite
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	−25°C to +100°C
Lead Temperature (Soldering, 10 seconds)	300°C

Electrical Characteristics $V_S = \pm12V$ to $\pm15V$, $T_A = 0°C$ to $70°C$ unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	AF121-2CJ			AF121-1CJ			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
A_O	Gain	f = 800 Hz	−0.5	0	0.5	−1.5	0	1.5	dB
A_{MAX}	Ripple (Pk to Pk)	697 Hz ≤ f ≤ 950 Hz		1.5	2			5	dB
A_{MIN}	Rejection	f ≤ 500 Hz, f ≥ 1200 Hz	−40			−38			dB
Z_{IN}	Input Impedance		175			175			kΩ
Z_{OUT}	Output Impedance			1			1		Ω
V_{OS}	DC Offset			30	80		30	130	mV
P_D	Power Dissipation	$T_A = 25°C$, $V_S = \pm15V$		165			165		mW
					270			270	mW
V_{CC}	Power Supply	$V_{CC} = (V^+) - (V^-)$	10		36	10		36	V_{DC}

SYMBOL	PARAMETER	CONDITIONS	AF122-2CJ			AF122-1CJ			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
A_O	Gain	f = 1405 Hz	−0.5	0	0.5	−1.5	0	1.5	dB
A_{MAX}	Ripple (Pk to Pk)	1209 Hz ≤ f ≤ 1633 Hz		1.2	2			4	dB
A_{MIN}	Rejection	f ≥ 2200 Hz, f ≤ 950 Hz	−40			−38			dB
Z_{IN}	Input Impedance		175			175			kΩ
Z_{OUT}	Output Impedance			1			1		Ω
V_{OS}	DC Offset			20	70		20	120	mV
P_D	Power Dissipation	$T_A = 25°C$, $V_S = \pm15V$		165			165		mW
					270			270	mW
V_{CC}	Power Supply	$V_{CC} = (V^+) - (V^-)$	10		36	10		36	V_{DC}

Typical Performance Characteristics

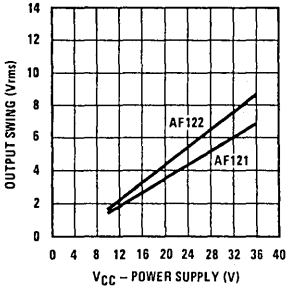


FIGURE 1. Output Swing vs Power Supply Voltage

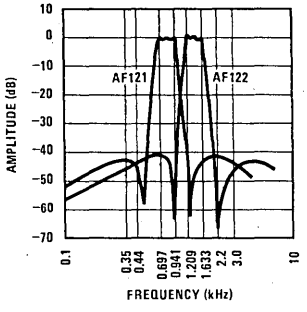


FIGURE 2. Typical Amplitude Response

Applications Information

The DTMF receivers used to detect signals from push-button telephones require at least 2 filters. In recent years single chip integrated circuits have been designed to detect the signaling tones and perform the logic functions required in DTMF receivers. These receivers still require input band splitting filters to separate the 2 input tones. Two such detectors are the Rockwell CRC8030 and the Mostek MK5102. The National Semiconductor AF121-2CJ and AF122-2CJ are bandpass filters which provide 40 dB separation between the bands. The AF121 and AF122 filters are 6th order elliptic bandpass filters. The AF121-2CJ and AF122-2CJ have 0 dB ± 0.5 dB gain at the center of the pass band with a maximum ripple of 2 dB peak to peak. The stop band rejection is greater than 40 dB. *Figure 2* shows the typical amplitude response of the 2 filters.

Figure 3 is the block diagram of a tone receiver system using the AF121 and AF122 to split the input signal into low group and high group signals. The signals are next passed through AGC circuits which provide amplitude correction to equalize the signal level in the 2 channels and to provide a known level to the limiters. The limiters have a threshold setting circuit such that signals which exceed the threshold will appear at the inputs of the digital tone detector.

The input bandpass filters reject the dial tone signals, when present, and provide enough rejection to noise and extraneous signals to assure a low error rate system. The AGC amplifiers equalize the tone levels in each band. This allows the detection of signals with large twists. The AGC amplifiers also provide up to 24 dB gain to the tone signal, allowing operation over a wide range of input levels.

The National Semiconductor AF104 AGC amplifier is a linear fixed gain device with an input attenuator controlled by the average output amplitude. Additional circuitry provides fast recovery when a burst of signal is applied to the input. The typical recovery time of the circuit is one half cycle of the input frequency.

The limiters can be built of discrete components using a comparator such as the National Semiconductor LM339. The limiter threshold can be set by using the internal reference of the AF104, which is a +5V regulator. This provides a stable threshold independent of the system power supply. Since none of the analog circuits are dependent on the power supply for a reference and all the circuits have good common-mode rejection, a simple power supply is all that is required as long as the supply voltages remain greater than ±9V.

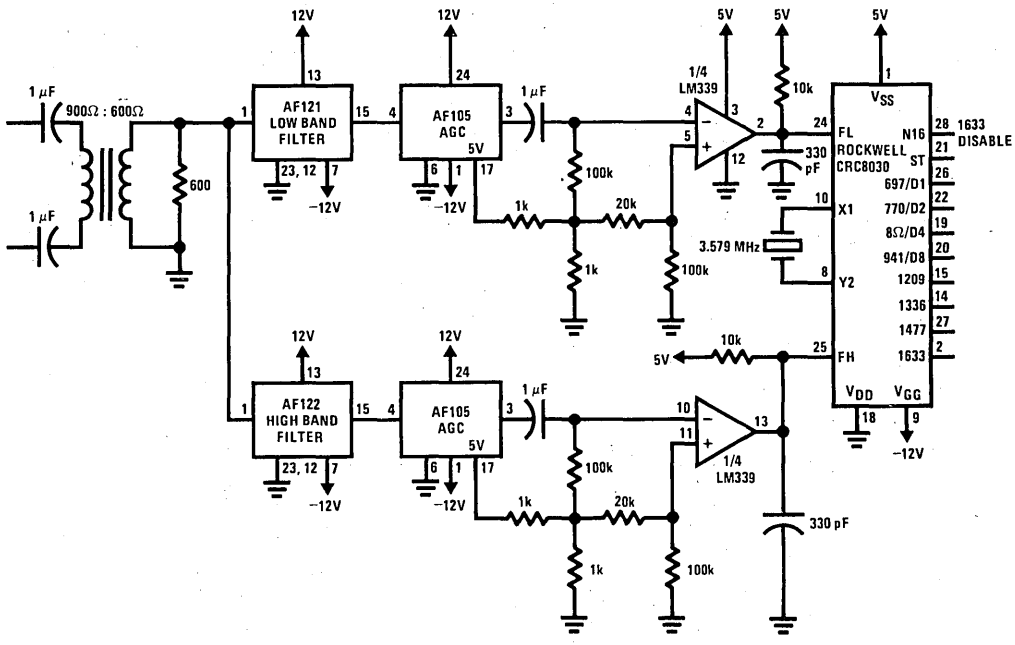


FIGURE 3. Tone Receiver Block Diagram Using Rockwell CRC8030

Applications Information (Continued)

Figure 4 shows a complete circuit for interfacing to Mostek's MK5102. The limiters are formed using a single LM2901 and provide hysteresis to prevent oscillations at the input of the decoder.

The AF121-1CJ and AF122-1CJ are DTMF band splitter filters for applications with less stringent electrical requirements.

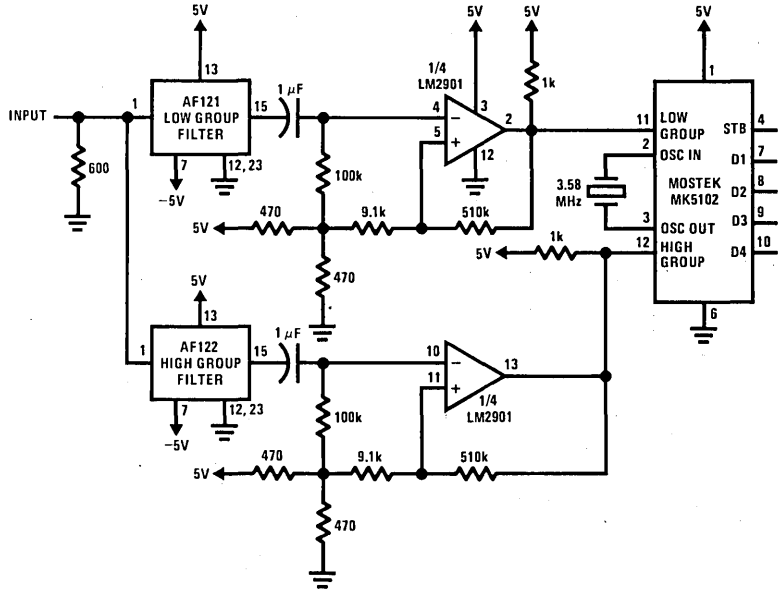


FIGURE 4. Tone Receiver Circuit Using Mostek MK5102