Dual Differential Input Operational Amplifiers

Utilizing the circuit designs perfected for recently introduced Quad Operational Amplifiers, these dual operational amplifiers feature 1) low power drain 2) a common mode input voltage range extending to ground/V_{EE}, 3) Single Supply or Split Supply operation and 4) pin outs compatible with the popular MC1558 dual operational amplifier. The PJ358 Series is equivalent to one half of an PJ324.
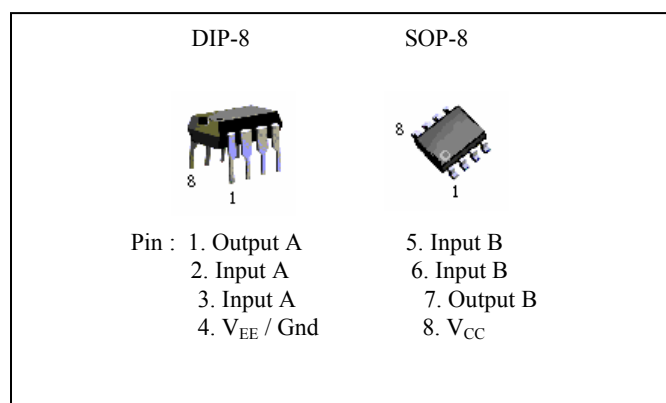
These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications . They can operate at supply voltages as low as 3.0 Volts or as high as 32 Volts with quiescent currents about one fifth of those associated with the LM741 (on a pet amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications.

The output voltage range also includes the negative power supply voltage.

FEATURES

- Short circuit protected outputs

- True differential input stage

- Single supply operation : 3.0 V to 32 Volts

- Low input bias currents

- Internally compensated

- Common mode range extends to negative supply

- Single and split supply operation

- Similar performance to the popular MC1558

| | DIP-8 | SOP-8 |

Pin : 1. Output A   5. Input B
2. Input A   6. Input B
3. Input A   7. Output B
4. V_{EE} / Gnd   8. V_{CC}

ORDERING INFORMATION

Device	Operating Temperature	Package
PJ358CS	-20℃ to +85℃	SOP-8
PJ358CD		DIP-8

MAXIMUM RATINGS (T_A = +25℃, unless otherwise noted.)

Rating	Symbol	PJ358	Unit
Power Supply Voltage Single Supply	V_{CC}	32	Vdc
Split Supplies	V_{CC}, V_{EE}	±16	
Input Differential Voltage Range (1)	V_{IDR}	±32	Vdc
Input Common Mode Voltage Range (2)	V_{ICR}	-0.3 to 32	Vdc
Input forward current (3) (VI --0.3V)	I_{IF}	50	mA
Output Short Circuit Duration	t_S	Continuous	
Junction Temperature Plastic Packages	T_J	150	℃
Storage Temperature Range Plastic Packages	T_{stg}	-55 to +125	℃

NOTE :1. Split Power Supplies.

2. For supply. Voltages less than 32V for the PJ358 the absolute maximum input voltage is equal to the supply voltage.

3. This input curent will only exist when the voltage is negative at any of the input teads. Normal output states will retablish when the input voltage returns to a voltage greater than -0.3V.

PROMAX-JOHNTON

Dual Differential Input Operational Amplifiers

ELECTRICAL CHARACTERISTICS(T_A =25, ℃ Vcc = 5V unless otherwlse noted).

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage V_{CC} = 5.0V to 30V V_{IC} =0V to Vcc -1.7 V, Vo =1.4V, R_S =0Ω	V_{IO}				mV
T_A =25℃		--	2.0	5.0	
T_A =85 ℃ to -20℃		--	--	7.0	
Average Temperature Coefficient of Input Offset Voltage T_A =85 ℃ to -20℃	$\triangle I_{IO}/\triangle T$	--	7.0	--	uV/℃
Input Offset Current T_A =85℃ to -20℃	I_{IO}	-- --	5.0 --	50 150	nA
Average Temperature Coefficient of input Offset Current T_A =85℃ to -20℃	$\triangle I_{IO}/\triangle T$	--	10	--	pA/℃
Input Bias Current T_A =85 t℃ o -20℃	I_{IB}	--	45 50	-250 -500	μA
Input Common-Mode Voltage Range (Note1) V_{CC} = 30 V V_{CC} = 30 V , (T_A =85℃ to -10℃)	V_{ICR}	0 0	-- --	28.3 28	V
Differential Input Voltage Range	V_{IDR}	--	--	V_{CC}	V
Large Signal Open-Loop Voltage Gain R_L = 2.0K , V_{CC} =15V, For Large V_O Swing, T_A =85℃ to -20℃	A_{VOL}	 25 15	 100 --	 -- --	V/mV
Channel Separation 1.0 Khz to 20khz, Input Reterenced	--	--	-120	--	dB
Common Mode Rejection Ratio R_S ≤ 10 kΩ	CMRR	65	70	--	dB
Power Supply Rejection Ratio	PSRR	65	100	--	dB
Output Voltage RangeRL = 2KΩ	V_{OR}	0	--	3.3	V
Output Voltage -- High Limit , (T_A =70 ℃ to 0℃) V_{CC} = 30 V, R_L = 2 kΩ V_{CC} = 30 V, R_L = 10 kΩ	V_{OH}	 26 27	 -- 28	 -- --	V
Output Voltage -- Low Limit , (T_A =70 ℃ to 0℃) V_{CC} = 5.0 V, R_L = 10 kΩ	V_{OL}	--	5.0	20	mV
Output Source Current V_{ID}=+1.0V,V_{CC}=15V	I_{O+}	20	40	--	mA
Output Sink Current V_{ID} = -1.0 V, V_{CC} = 15 V V_{ID} = -1.0 V, V_O = 200 mV	I_{O-}	 10 12	 20 50	 -- --	mA μA
Output Short Circuit to Ground (Note 2)	I_{os}	--	40	60	mA
Power Supply Current , (T_A =-20 ℃ to 85℃) V_{CC} = 30 VV_O = 0 V, R_L = ∞ V_{CC} = 5.0 V, V_O = 0 V, R_L = ∞	I_{CC}	 -- --	 1.5 0.7	 3.0 1.2	mA

Notes :

1. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is Vcc 17 V , but either or   both inputs can go to +32 V .

2. Short circuits from the output to Vcc can cause excessive heating and eventual destruction. Destructive dissipation can resuit from simultaneous shorts on all amplifiers.
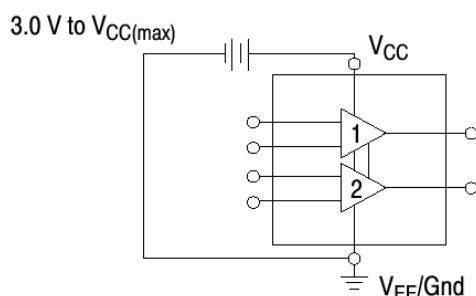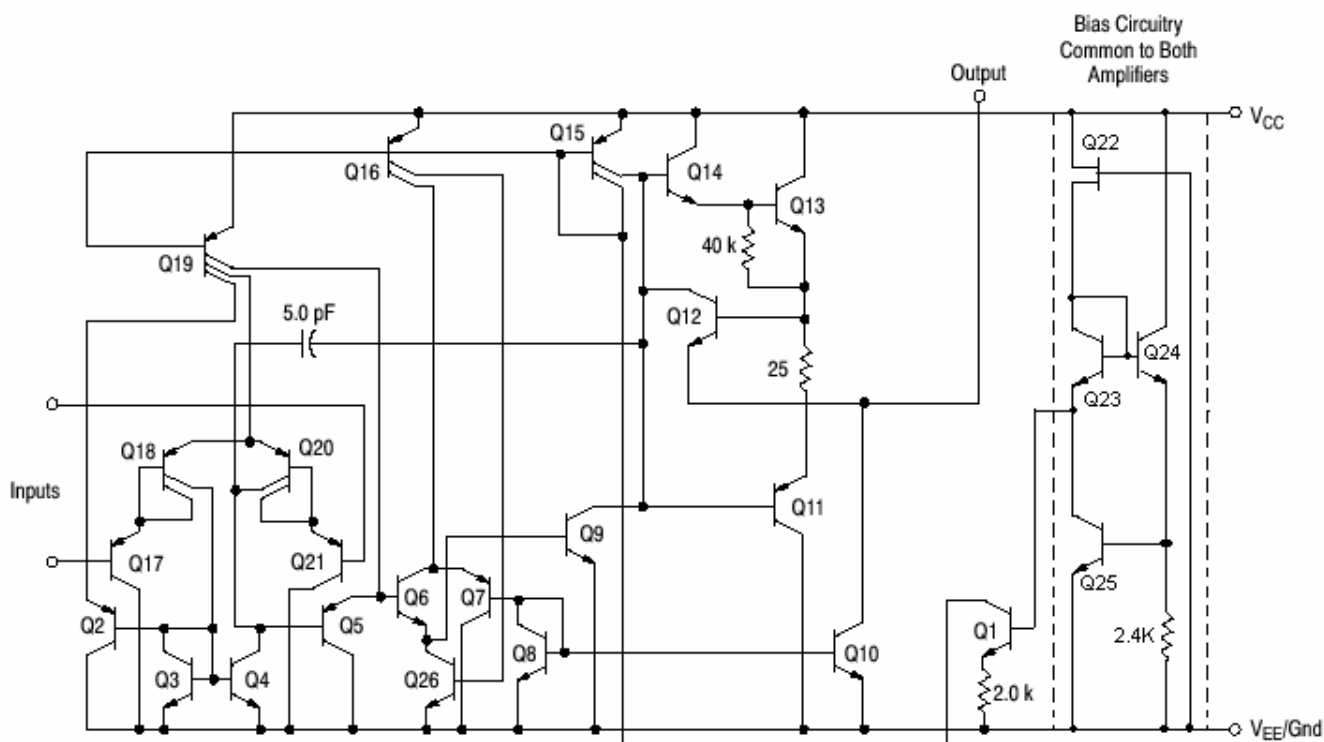

Single Supply

Split Supplies

2002.rev.A
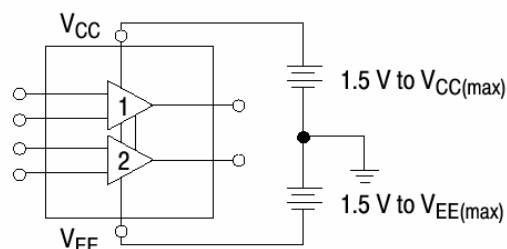
Dual Differential Input Operational Amplifiers

REPRESENTATIVE CIRCUIT SCHEMATIC

CIRCUIT DESCRIPTION

The PJ358 series made using two internally compensated,two-stage operational amplifiers. The first stage of each consists of differential input devices Q20 and Q18 with input buffer transistors Q21 and Q17 and differential to single ended converter Q3 and Q4. The first stage performs not onl the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0pF) can be empllyed, thussaving chip area. The transconductance reduction is accomplished by splitting the collectors of Q20 and Q18.Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

Each amplifier is biased from an internal-voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature chatacteristics as well as excellent power supply rejection.

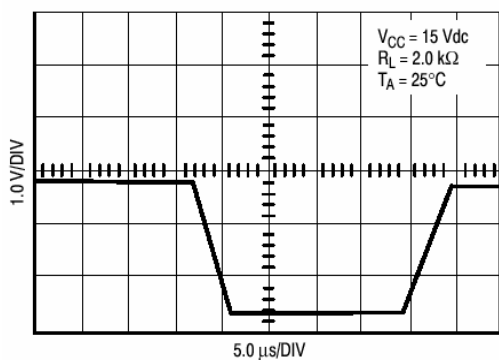# Dual Differential Input Operational Amplifiers
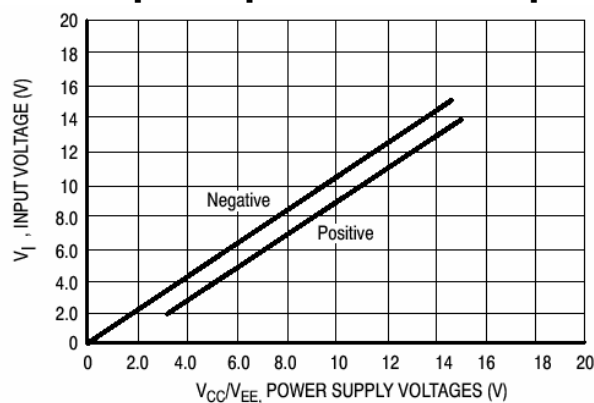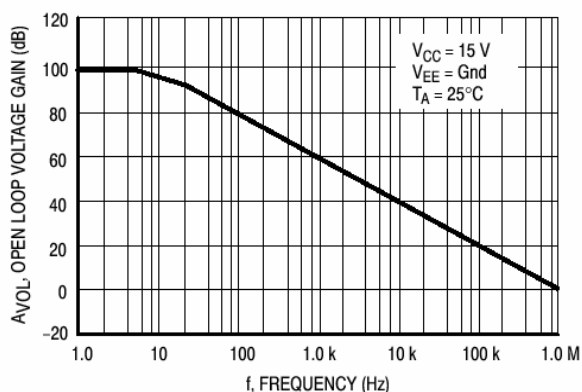

Figure 1. Large Signal Voltage
Follower Response

V_{CC} = 15 Vdc
R_L = 2.0 kΩ
T_A = 25°C

1.0 V/DIV

5.0 µs/DIV

Figure 2. Input Voltage Range

Negative
Positive

V_I, INPUT VOLTAGE (V)
V_{CC}/V_{EE}, POWER SUPPLY VOLTAGES (V)

Figure 3. Large–Signal Open Loop Voltage Gain

V_{CC} = 15 V
V_{EE} = Gnd
T_A = 25°C

A_{VOL}, OPEN LOOP VOLTAGE GAIN (dB)
f, FREQUENCY (Hz)
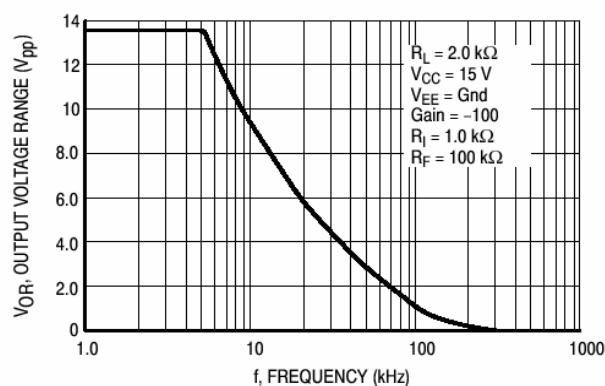
Figure 4. Large–Signal Frequency Response

R_L = 2.0 kΩ
V_{CC} = 15 V
V_{EE} = Gnd
Gain = –100
R_I = 1.0 kΩ
R_F = 100 kΩ

V_{OR}, OUTPUT VOLTAGE RANGE (V_{pp})
f, FREQUENCY (kHz)
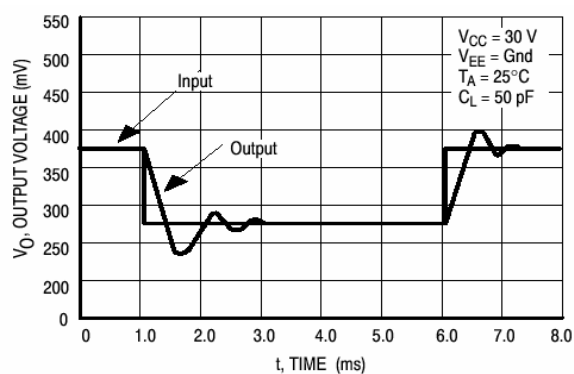
Figure 5. Small Signal Voltage Follower
Pulse Response (Noninverting)

V_{CC} = 30 V
V_{EE} = Gnd
T_A = 25°C
C_L = 50 pF

Input
Output

V_O, OUTPUT VOLTAGE (mV)
t, TIME (ms)
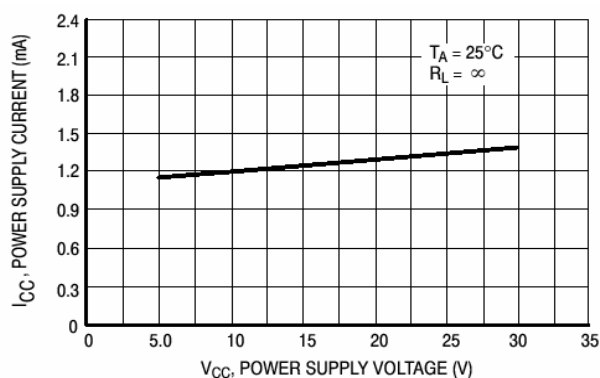
Figure 6. Power Supply Current versus
Power Supply Voltage

T_A = 25°C
R_L = ∞

I_{CC}, POWER SUPPLY CURRENT (mA)
V_{CC}, POWER SUPPLY VOLTAGE (V)
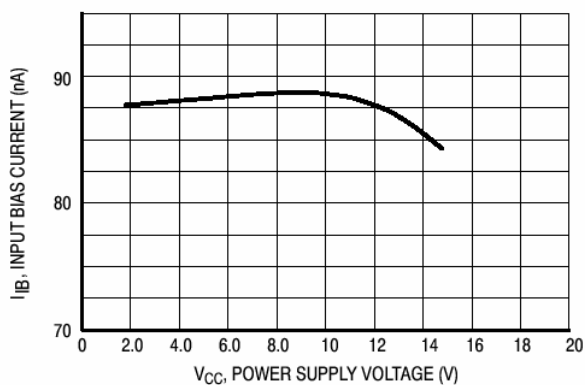
Figure 7. Input Bias Current versus
Supply Voltage

I_{IB}, INPUT BIAS CURRENT (nA)
V_{CC}, POWER SUPPLY VOLTAGE (V)
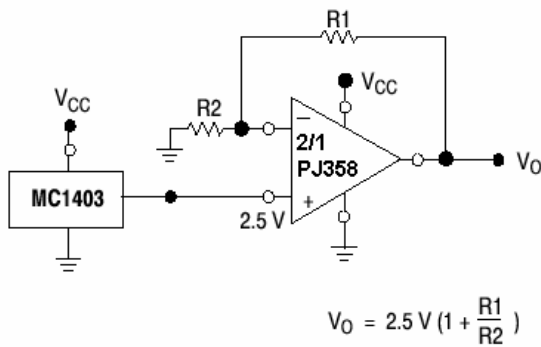
Figure 8 . Voltage Reference

$$V_O = 2.5\,V \left(1 + \frac{R1}{R2}\right)$$
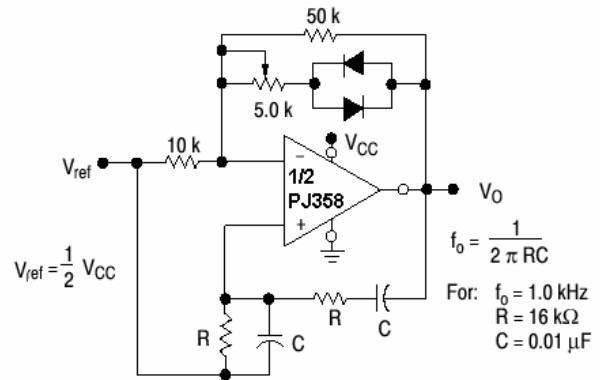
Figure 9 . Wien Bridge Oscillator

$$f_0 = \frac{1}{2\pi RC}$$

For: $f_0 = 1.0\,kHz$
$R = 16\,k\Omega$
$C = 0.01\,\mu F$

$$V_{ref} = \frac{1}{2}\,V_{CC}$$
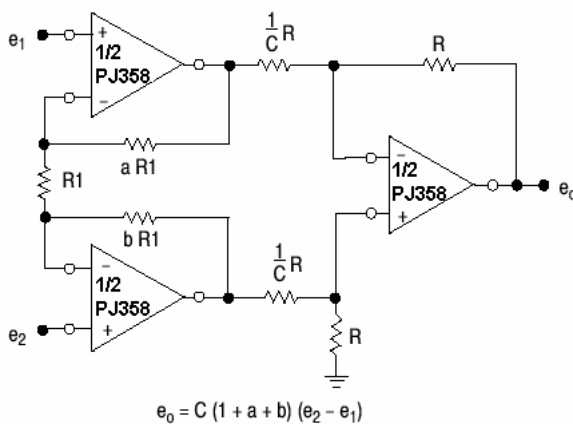
Figure 10. High Impedance Differential Amplifier

$$e_0 = C\,(1 + a + b)\,(e_2 - e_1)$$
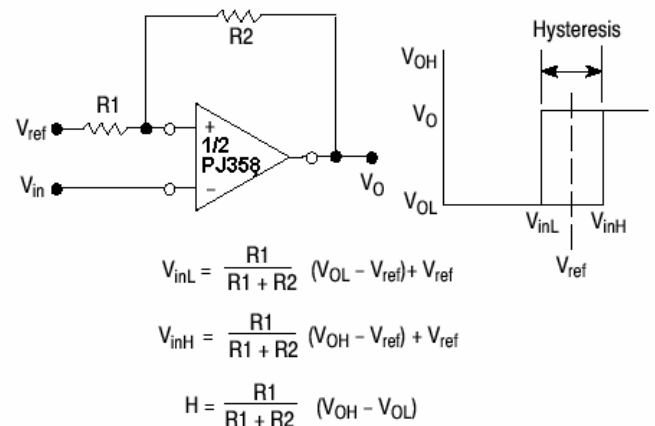
Figure 11. Comparator with Hysteresis

$$V_{inL} = \frac{R1}{R1 + R2}\,(V_{OL} - V_{ref}) + V_{ref}$$

$$V_{inH} = \frac{R1}{R1 + R2}\,(V_{OH} - V_{ref}) + V_{ref}$$

$$H = \frac{R1}{R1 + R2}\,(V_{OH} - V_{OL})$$

Figure 12. Bi–Quad Filter

$$f_0 = \frac{1}{2\pi RC}$$

$$R1 = QR$$

$$R2 = \frac{R1}{T_{BP}}$$

$$R3 = T_N\,R2$$

$$C1 = 10\,C$$

$$V_{ref} = \frac{1}{2}\,V_{CC}$$

For: $f_0 = 1.0\,kHz$
$Q = 10$
$T_{BP} = 1$
$T_N = 1$

Where: T_{BP} = Center Frequency Gain
T_N = Passband Notch Gain

$R = 160\,k\Omega$
$C = 0.001\,\mu F$
$R1 = 1.6\,M\Omega$
$R2 = 1.6\,M\Omega$
$R3 = 1.6\,M\Omega$

Dual Differential Input Operational Amplifiers

$$f = \frac{R1 + R_C}{4 \, CR_f \, R1} \quad \text{if, } R3 = \frac{R2 \, R1}{R2 + R1}$$

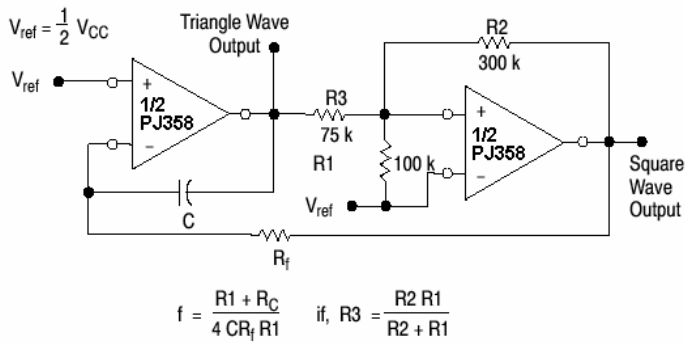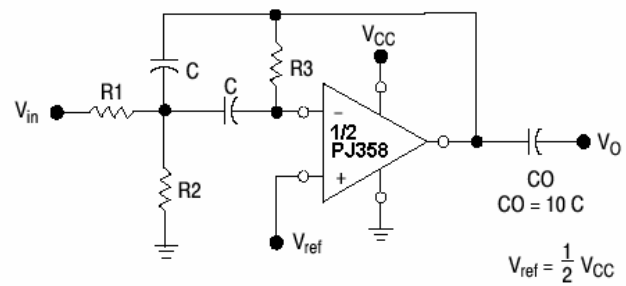**Figure 13. Function Generator**

Given: f_o = center frequency
          $A(f_o)$ = gain at center frequency

Choose value f_o, C

Then: $R3 = \dfrac{Q}{\pi \, f_o \, C}$

         $R1 = \dfrac{R3}{2 \, A(f_o)}$

         $R2 = \dfrac{R1 \, R3}{4Q^2 \, R1 - R3}$

For less than 10% error from operational amplifier. $\dfrac{Q_o \, f_o}{BW} < 0.1$
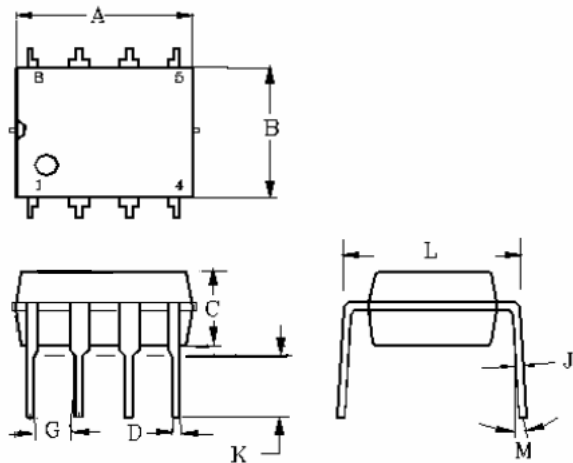
Where f_o and BW are expressed in Hz.
If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 14. Multiple Feedback Bandpass Filter

2002.rev.A

DIP-8 Mechanical drawing

DIP-8

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.32	0.357	0.367
B	6.22	6.48	0.245	0.255
C	3.18	4.43	0.125	0.135
D	0.35	0.55	0.019	0.020
G	2.54BSC		0.10BSC	
J	0.29	0.31	0.011	0.012
K	3.25	3.35	0.128	0.132
L	7.75	8.00	0.305	0.315
M	-	10°	-	10°

SOP-8 Mechanical drawing

SOP-8
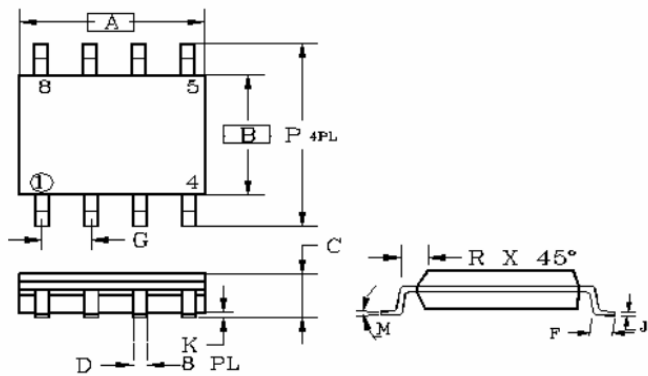
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019