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MOTOROLA

MC3458
MC3358

Dual, Low Power Operational Amplifiers

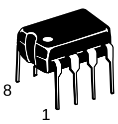
Utilizing the circuit designs perfected for the quad operational amplifiers, these dual operational amplifiers feature: 1) low power drain, 2) a common mode input voltage range extending to ground/V_{EE}, and 3) Single Supply or Split Supply operation.

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 V or as high as 36 V with quiescent currents about one–fifth of those associated with the MC1741C (on a per 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.

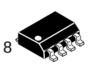
- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 36 V
- Low Input Bias Currents
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Class AB Output Stage for Minimum Crossover Distortion
- Single and Split Supply Operations Available
- Similar Performance to the Popular MC1458

DUAL DIFFERENTIAL INPUT OPERATIONAL AMPLIFIERS

SEMICONDUCTOR TECHNICAL DATA

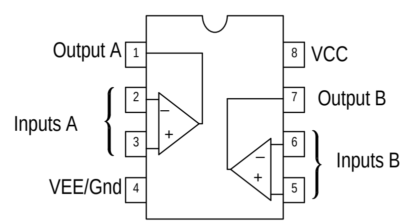


P1 SUFFIX
PLASTIC PACKAGE
CASE 626



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

PIN CONNECTIONS



(Top View)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltages			Vdc
Single Supply	V_{CC}	36	
Split Supplies	V_{CC}, V_{EE}	±18	
Input Differential Voltage Range (1)	V_{IDR}	±30	Vdc
Input Common Mode Voltage Range (2)	V_{ICR}	±15	Vdc
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C
Operating Ambient Temperature Range	T_A		°C
MC3458		0 to +70	
MC3358		–40 to +85	

NOTES: 1. Split Power Supplies.
2. For supply voltages less than ±18 V, the absolute maximum input voltage is equal to the supply voltage.

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC3358P1	T_A = –40° to +85°C	Plastic DIP
MC3458D	T_A = 0° to +70°C	SO–8
MC3458P1		Plastic DIP

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ELECTRICAL CHARACTERISTICS (For MC3458, V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)
(For MC3358, V_{CC} = +14 V, V_{EE} = Gnd, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	MC3458 Min	MC3458 Typ	MC3458 Max	MC3358 Min	MC3358 Typ	MC3358 Max	Unit
Input Offset Voltage	V_{IO}	–	2.0	10	–	2.0	8.0	mV
$T_A = T_{high}$ to T_{low} (Note 1)		–	–	12	–	–	10	
Input Offset Current	I_{IO}	–	30	50	–	30	75	nA
$T_A = T_{high}$ to T_{low}		–	–	200	–	–	250	
Large Signal Open Loop Voltage Gain	A_{VOL}							V/mV
V_O = ±10 V, R_L = 2.0 kΩ,		20	200	–	20	200	–	
$T_A = T_{high}$ to T_{low}		15	–	–	15	–	–	
Input Bias Current	I_{IB}	–	–200	–500	–	–200	–500	nA
$T_A = T_{high}$ to T_{low}		–	–	–800	–	–	–1000	
Output Impedance, f = 20 Hz	z_O	–	75	–	–	75	–	Ω
Input Impedance, f = 20 Hz	z_I	0.3	1.0	–	0.3	1.0	–	MΩ
Output Voltage Range	V_{OR}							V
R_L = 10 kΩ		±12	±13.5	–	12	12.5	–	
R_L = 2.0 kΩ		±10	±13	–	10	12	–	
R_L = 2.0 kΩ, $T_A = T_{high}$ to T_{low}		±10	–	–	10	–	–	
Input Common Mode Voltage Range	V_{ICR}	+13 $-V_{EE}$	+13.5 $-V_{EE}$	–	+13 $-V_{EE}$	+13.5 $-V_{EE}$	–	V
Common Mode Rejection Ratio, R_S ≤ 10 kΩ	CMR	70	90	–	70	90	–	dB
Power Supply Current (V_O = 0) $R_L = \infty$	I_{CC}, I_{EE}	–	1.6	3.7	–	1.6	3.7	mA
Individual Output Short Circuit Current (Note 2)	I_{SC}	±10	±20	±45	±10	±30	±45	mA
Positive Power Supply Rejection Ratio	PSRR+	–	30	150	–	30	150	µV/V
Negative Power Supply Rejection Ratio	PSRR–	–	30	150	–	–	–	µV/V
Average Temperature Coefficient of Input Offset Current, $T_A = T_{high}$ to T_{low}	$\Delta I_{IO}/\Delta T$	–	50	–	–	50	–	pA/°C
Average Temperature Coefficient of Input Offset Current, $T_A = T_{high}$ to T_{low}	$\Delta V_{IO}/\Delta T$	–	10	–	–	10	–	µV/°C
Power Bandwidth A_V = 1, R_L = 2.0 kΩ, V_O = 20 V_{pp}, THD = 5%	BWp	–	9.0	–	–	9.0	–	kHz
Small Signal Bandwidth A_V = 1, R_L = 10 kΩ, V_O = 50 mV	BW	–	1.0	–	–	1.0	–	MHz
Slew Rate A_V = 1, V_I = –10 V to +10 V	SR	–	0.6	–	–	0.6	–	V/µs
Rise Time A_V = 1, R_L = 10 kΩ, V_O = 50 mV	t_{TLH}	–	0.35	–	–	0.35	–	µs
Fall Time A_V = 1, R_L = 10 kΩ, V_O = 50 mV	t_{THL}	–	0.35	–	–	0.35	–	µs
Overshoot A_V = 1, R_L = 10 kΩ, V_O = 50 mV	os	–	20	–	–	20	–	%
Phase Margin A_V = 1, R_L = 2.0 kΩ, C_L = 200 pF	φm	–	60	–	–	60	–	Degrees
Crossover Distortion (V_{in} = 30 mV_{pp}, V_{out} = 2.0 V_{pp}, f = 10 kHz)	–	–	1.0	–	–	1.0	–	%

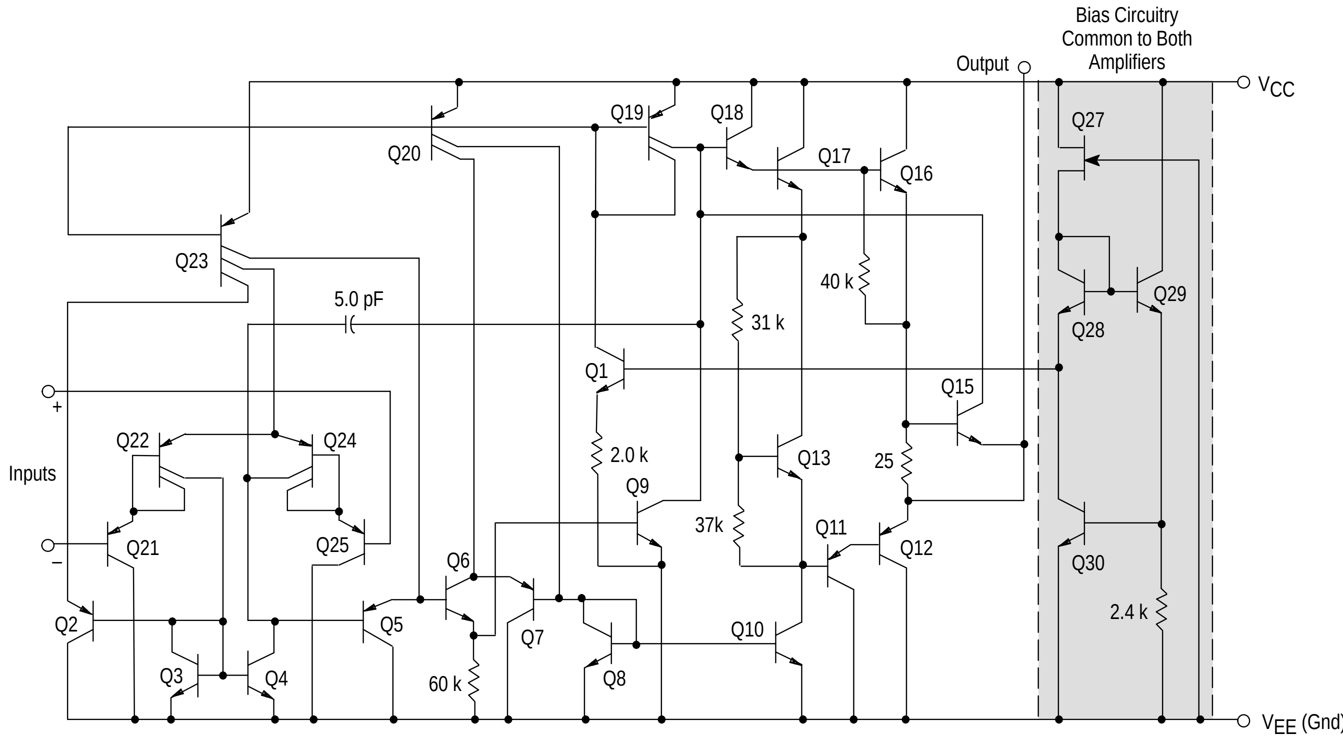
NOTES: 1. T_{high} = 70°C for MC3458, 85°C for MC3358
T_{low} = 0°C for MC3458, –40°C for MC3358
2. Not to exceed maximum package power dissipation.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = Gnd, T_A = 25°C, unless otherwise noted.)

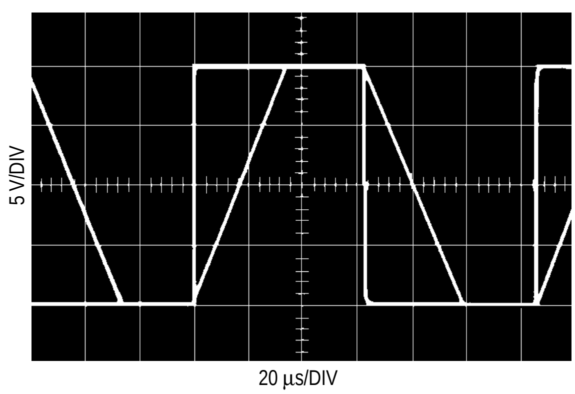
Characteristic	Symbol	MC3458			MC3358			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	–	2.0	5.0	–	2.0	10	mV
Input Offset Current	I_{IO}	–	30	50	–	–	75	nA
Input Bias Current	I_{IB}	–	–200	–500	–	–	–500	nA
Large Signal Open Loop Voltage Gain R_L = 2.0 kΩ,	A_{VOL}	20	200	–	20	200	–	V/mV
Power Supply Rejection Ratio	PSRR	–	–	150	–	–	150	µV/V
Output Voltage Range (Note 3) R_L = 10 kΩ, V_{CC} = 5.0 V R_L = 10 kΩ, 5.0 V ≤ V_{CC} ≤ 30 V	V_{OR}	 3.3 –	 3.5 V_{CC} –1.7	 – –	 3.3 –	 3.5 V_{CC} –1.7	 – –	V_{pp}
Power Supply Current	I_{CC}	–	2.5	7.0	–	2.5	4.0	mA
Channel Separation f = 1.0 kHz to 20 kHz (Input Referenced)	CS	–	–120	–	–	–120	–	dB

NOTE: 3. Output will swing to ground with a 10 kΩ pull down resistor.

Representative Schematic Diagram
(1/2 of Circuit Shown)



Inverter Pulse Response



CIRCUIT DESCRIPTION

The MC3458/3358 is made using two internally compensated, two–stage operational amplifiers. The first stage of each consists of differential input devices Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. 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.

The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operation. This is possible because Class AB operation is utilized.

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

Figure 1. Sine Wave Response

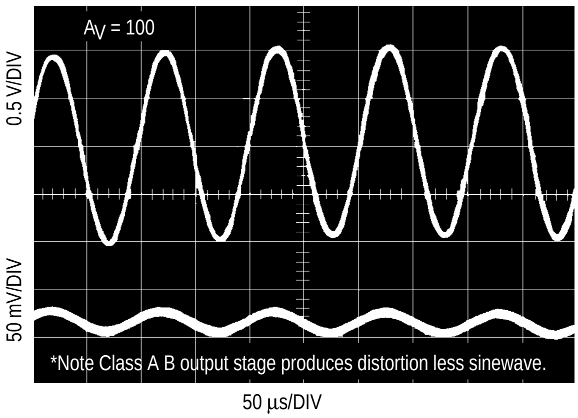


Figure 2. Open Loop Frequency Response

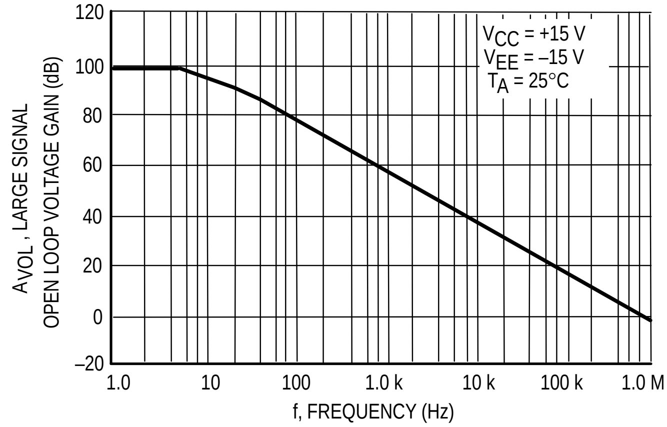


Figure 3. Power Bandwidth

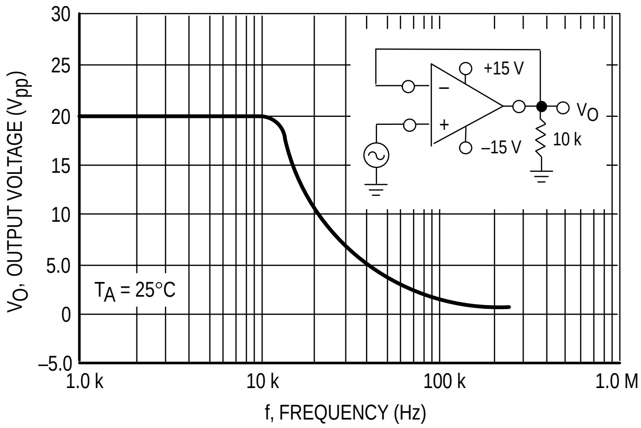


Figure 4. Output Swing versus Supply Voltage

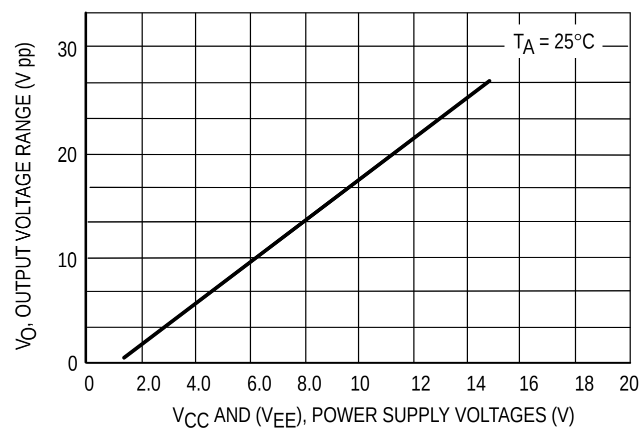


Figure 5. Input Bias Current versus Temperature

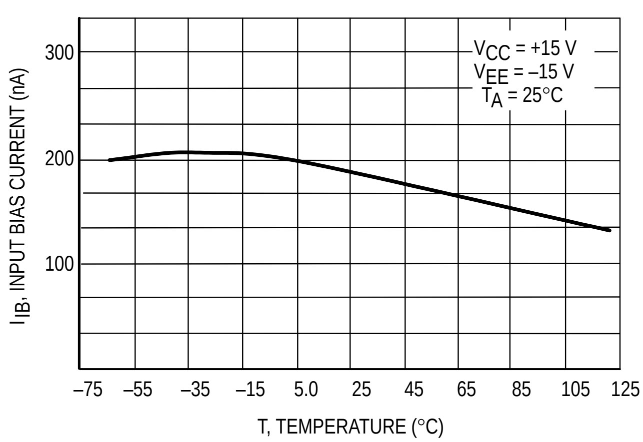


Figure 6. Input Bias Current versus Supply Voltage

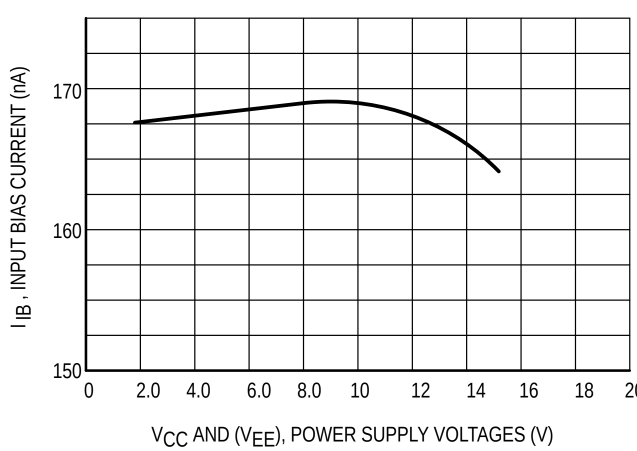
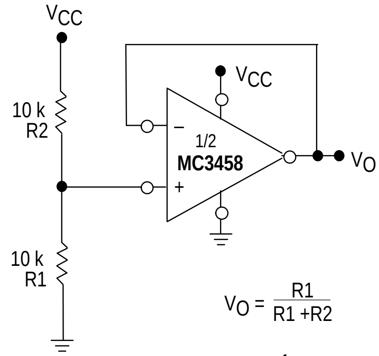


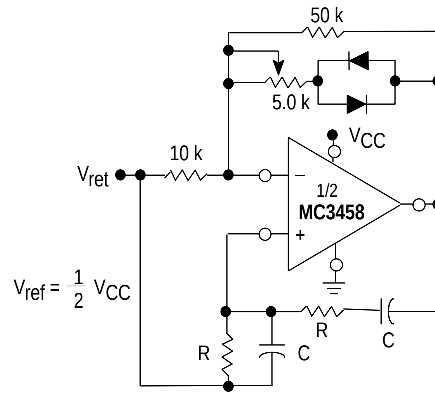
Figure 7. Voltage Reference



$$V_O = \frac{R1}{R1 + R2}$$

$$V_O = \frac{1}{2}\ V_{CC}$$

Figure 8. Wien Bridge Oscillator



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

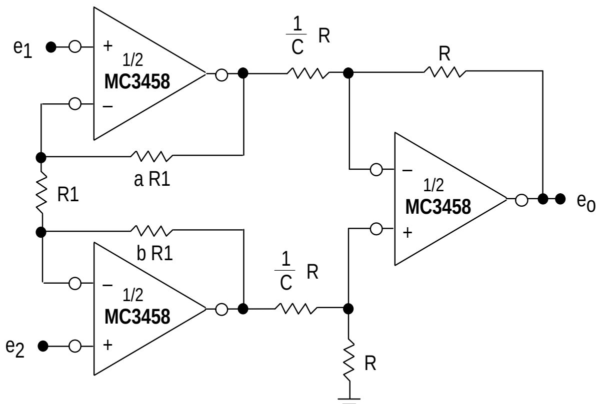
$$f_0 = \frac{1}{2\pi RC}$$

For: f_0 = 1.0 kHz

R = 16 kΩ

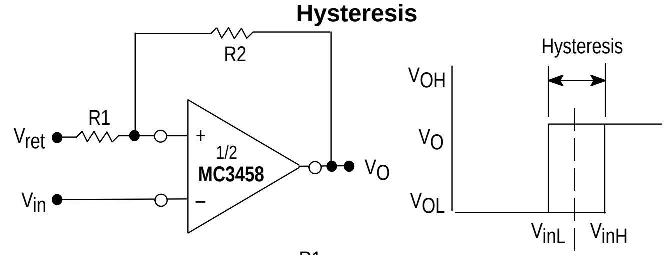
C = 0.01 µF

Figure 9. High Impedance Differential Amplifier



$$e_o = C\ (1 + a + b)\ (e_2 - e_1)$$

Figure 10. Comparator with Hysteresis

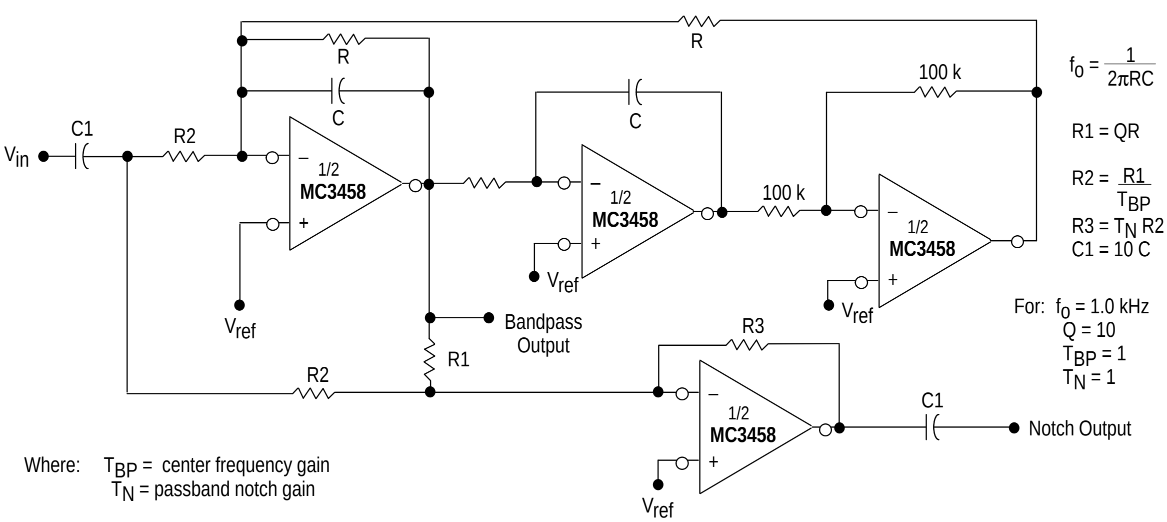


$$V_{inL} = \frac{R1}{R1 + R2}\ (V_{OL} - V_{ref}) + V_{ref}$$

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

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

Figure 11. Bi–Quad Filter



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

R1 = QR

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

$R3 = T_N\ R2$

C1 = 10 C

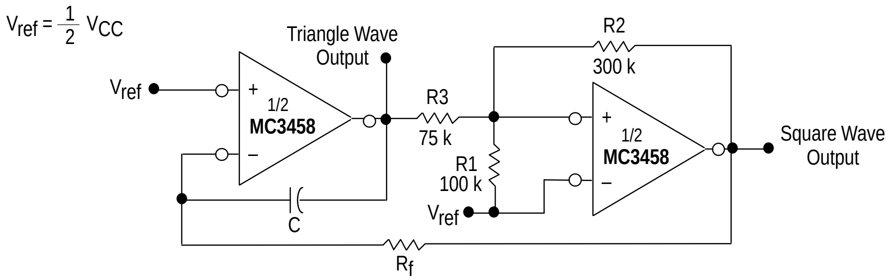
$V_{ref} = \frac{1}{2}\ V_{CC}$

R = 160 kΩ
C = 0.001 µF
R1 = 1.6 MΩ
R2 = 1.6 MΩ
R3 = 1.6 MΩ

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

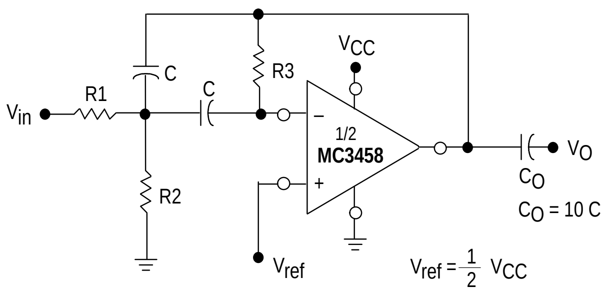
Where: T_{BP} = center frequency gain
T_N = passband notch gain

Figure 12. Function Generator



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

Figure 13. Multiple Feedback Bandpass Filter



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

Choose value f_O, C.

Then: $R3 = \frac{Q}{\pi f_O C}$ $\quad R1 = \frac{R3}{2\,A(f_O)}$ $\quad R2 = \frac{R1\,R5}{4Q^2\,R1 - R3}$

For less than 10% error from operational amplifier $\frac{Q_O\,f_O}{BW} < 0.1$

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.

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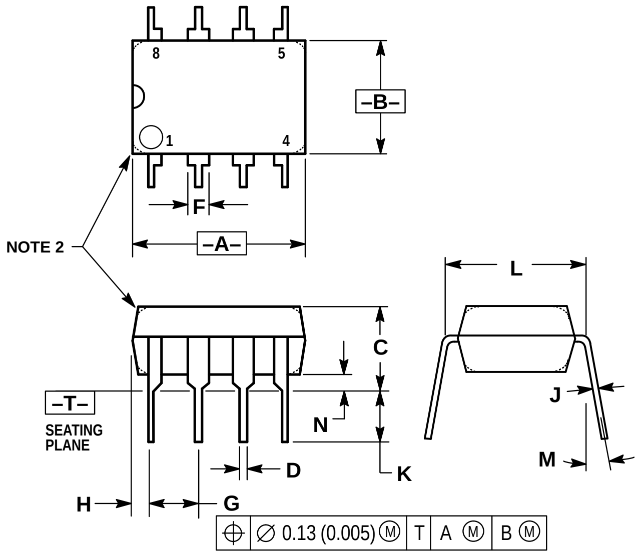
OUTLINE DIMENSIONS

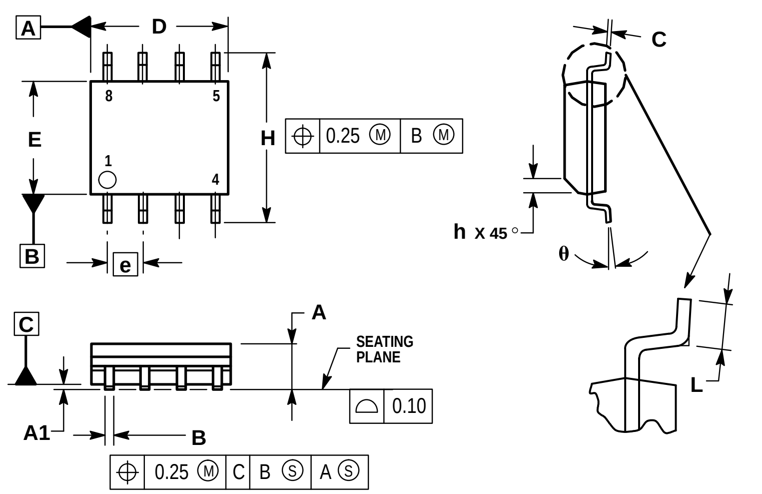
P1 SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K



NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	—	10°	—	10°
N	0.76	1.01	0.030	0.040

D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SO–8)
ISSUE R



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
θ	0°	7°

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