# MC1404

Voltage Reference Family

The MC1404 of ICs is a family of temperature−compensated voltage references for precision data conversion applications, such as A/D, D/A, V/F, and F/V. Advances in laser−trimming and ion−implanted devices, as well as monolithic fabrication techniques, make these devices stable and accurate to 12 bits over both military and commercial temperature ranges. In addition to excellent temperature stability, these parts offer excellent long−term stability and low noise.

- Output Voltages: Standard, 5.0 V, 6.25 V, 10 V
- Trimmable Output: > ±6%
- Wide Input Voltage Range: V_{ref} + 2.5 V to 40 V
- Low Quiescent Current: 1.25 mA Typical
- Temperature Coefficient: 10 ppm/°C Typical
- Low Output Noise: 12 μV p−p Typical
- Excellent Ripple Rejection: > 80 dB Typical

Typical Applications

- Voltage Reference for 8 to 12 Bit D/A Converters
- Low T_C Zener Replacement
- High Stability Current Reference
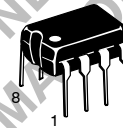- MPU D/A and A/D Applications

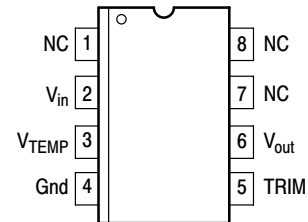**Figure 1. Voltage Output 8−Bit DAC Using MC1404P10**

ON Semiconductor®

http://onsemi.com
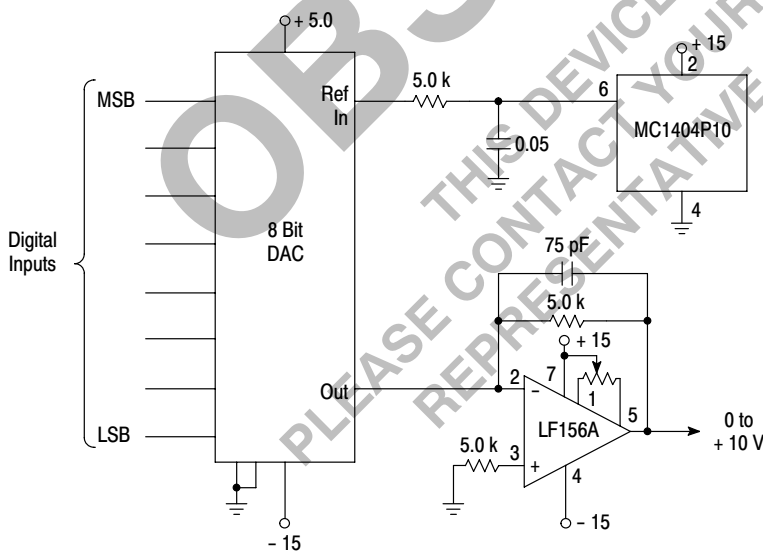
PRECISION LOW DRIFT VOLTAGE REFERENCES

5.0, 6.25, and 10−VOLT OUTPUT VOLTAGES

SEMICONDUCTOR TECHNICAL DATA

P SUFFIX
PLASTIC PACKAGE
CASE 626

PIN CONNECTIONS

NC	1	8	NC
V_{in}	2	7	NC
V_{TEMP}	3	6	V_{out}
Gnd	4	5	TRIM

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC1404P5		Plastic DIP
MC1404P6	$T_A = 0°$ to +70°C	Plastic DIP
MC1404P10		Plastic DIP

MC1404

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	V_{in}	40	V
Storage Temperature	T_{stg}	– 65 to + 150	°C
Junction Temperature	T_J	+ 175	°C
Operating Ambient Temperature Range	T_A	0 to + 70	°C

ELECTRICAL CHARACTERISTICS (V_{in} = 15 V, T_A = 25°C, and Trim Terminal not connected, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit

Output Voltage
(I_O = 0 mA)
  MC1404P5
  MC1404P6
  MC1404P10
	V_O	
		
		4.95
		6.19
		9.9
			
			5.0
			6.25
			10
				
				5.05
				6.31
				10.1
					V

Output Voltage Tolerance	–	–	±0.1	±1.0	%
Output Trim Range (Figure 10) (R_P = 100 kΩ)	ΔV_{TRIM}	±6.0	–	–	%
Output Voltage Temperature Coefficient, Over Full Temperature Range (Note 1)	$\Delta V_O / \Delta T$	–	10	40	ppm/°C

Maximum Output Voltage Change
  Over Temperature Range (Note 1)
  MC1404P5
  MC1404P6
  MC1404P10
	ΔV_O	
		
		–
		–
		–
			
			–
			–
			–
				
				14
				17.5
				28
					mV

Line Regulation (Note 2) (V_{in} = V_{out} + 2.5 V to 40 V, I_{out} = 0 mA)	Reg_{line}	–	2.0	6.0	mV
Load Regulation (Note 2) (0 ≤ I_O ≤ 10 mA)	Reg_{load}	–	–	10	mV
Quiescent Current (I_O = 0 mA)	I_Q	–	1.2	1.5	mA
Short Circuit Current	I_{sc}	–	20	45	mA
Long Term Stability	–	–	25	–	ppm/1000 hrs

NOTE: 1. Guaranteed but not tested.
NOTE: 2. Includes thermal effects.

DYNAMIC CHARACTERISTICS (V_{in} = 15 V, T_A = 25°C, all voltage ranges, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Turn–On Settling Time (to ±0.01%)	t_S	–	50	–	μs
Output Noise Voltage – P to P (Bandwidth 0.1 to 10 Hz)	V_n	–	12	–	μV

Small–Signal Output Impedance
  120 Hz
  500 Hz
	r_o	
		–
		–
			
			0.15
			0.2
				
				–
				–
					Ω

Power Supply Rejection Ratio	PSRR	70	80	–	dB

MC1404

TYPICAL CHARACTERISTICS

Figure 2. Simplified Device Diagram

R	V$_0$
3.75 k	5.0 V
5.0 k	6.25 V
8.75 k	10 V
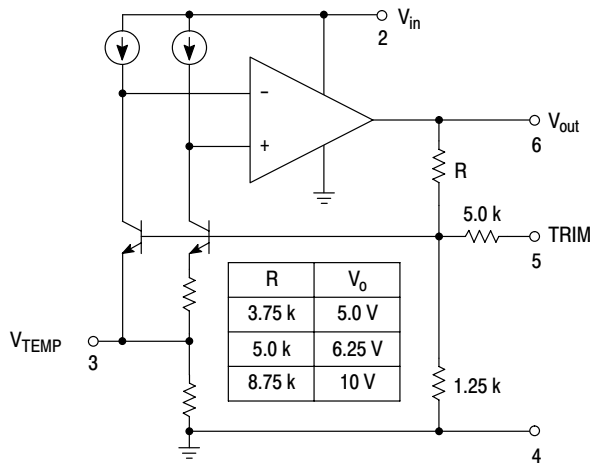
Figure 3. Line Regulation versus Temperature

V_{in} = V_{ref} +2.5 V to 40 V
I_{out} = 0 mA

ΔV_{out}, LINE REGULATION (mV)

T_A, AMBIENT TEMPERATURE (°C)
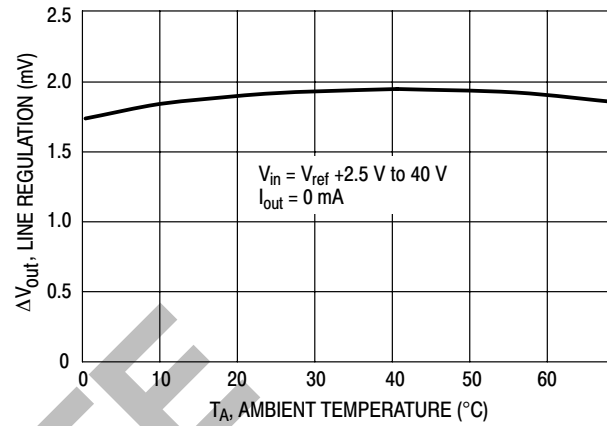
Figure 4. Output Voltage versus Temperature
MC1404P10

V_{out}, OUTPUT VOLTAGE (V)

T_A, AMBIENT TEMPERATURE (°C)
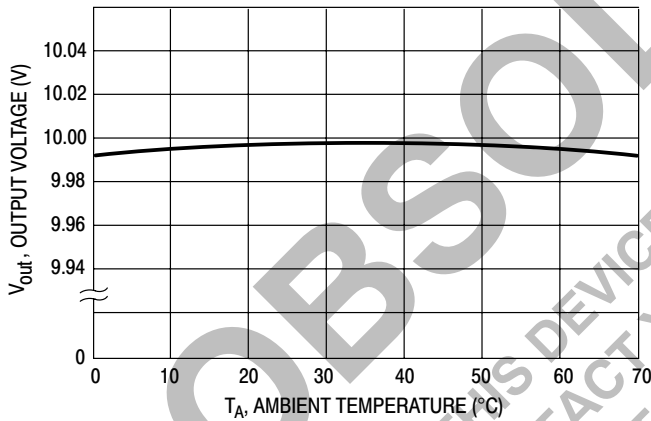
Figure 5. Load Regulation versus Temperature

Load Change 0 to 10 mA

LOAD REGULATION (%/mA)

T_A, AMBIENT TEMPERATURE (°C)
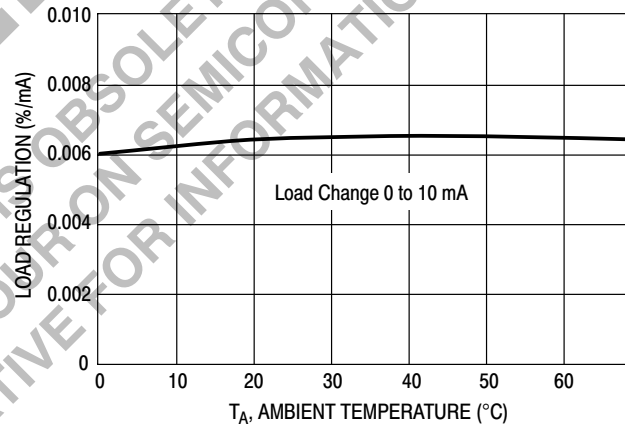
Figure 6. Power Supply Rejection Ratio versus Frequency

PSRR, POWER SUPPLY REJECTION RATIO (dB)

HP209A
3.0 Vrms
0.1 μF
500 μF
1.0 k
21.3 V
Set Node to
20 V Average
DUT
HP3400A

f, FREQUENCY (kHz)
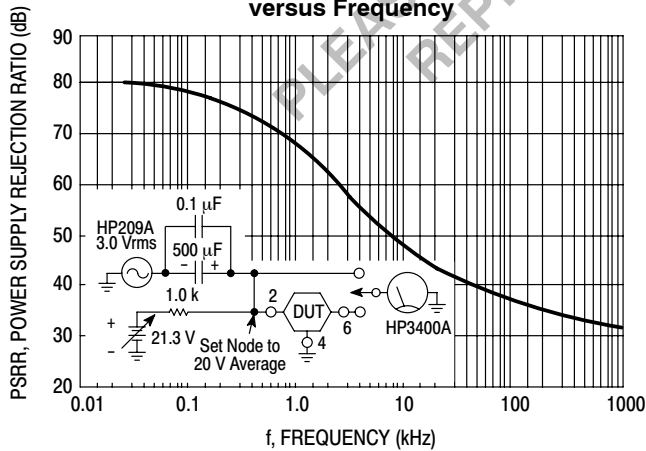
Figure 7. Quiescent Current versus Temperature

V_{in} = 15 V
I_{out} = 0 mA

I_Q, QUIESCENT CURRENT (mA)

T_A, AMBIENT TEMPERATURE (°C)
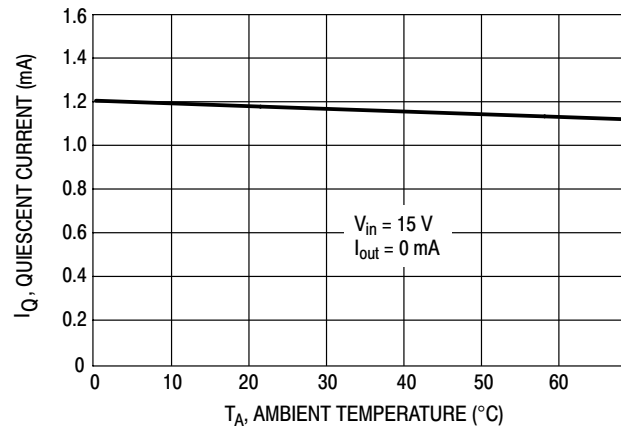
Figure 8. Short Circuit Current versus Temperature
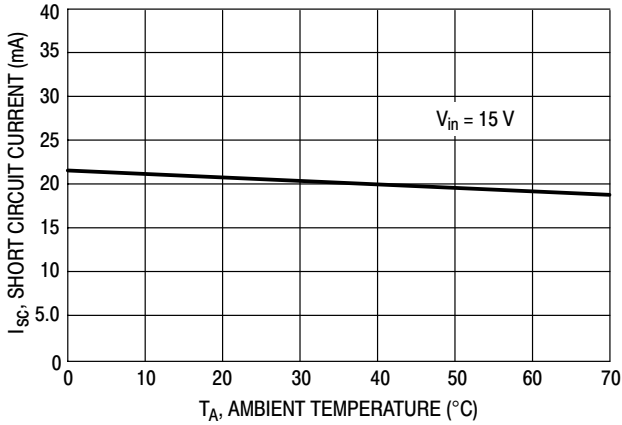
### Figure 9. V_TEMP Output versus Temperature
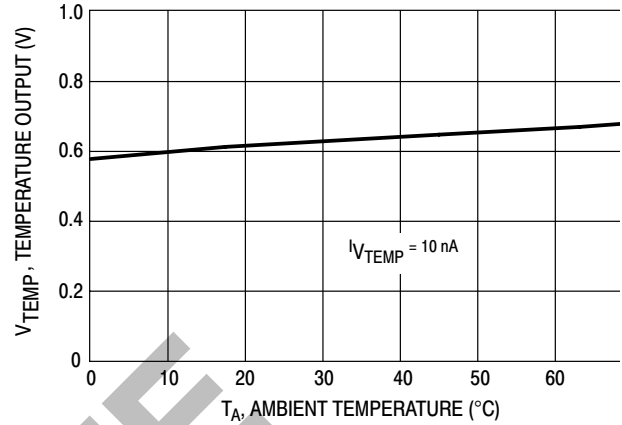
Figure 10. Output Trim Configuration

Output Adjustment
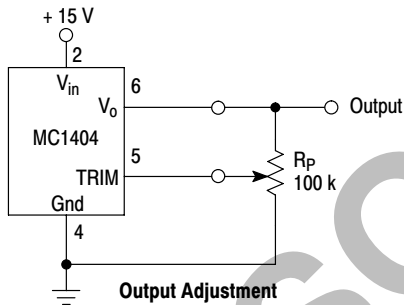
The MC1404 trim terminal can be used to adjust the output voltage over a ±6.0% range. For example, the output can be set to 10.000 V or to 10.240 V for binary applications. For trimming, Bourns type 3059, 100 kΩ or 200 kΩ trimpot is recommended.
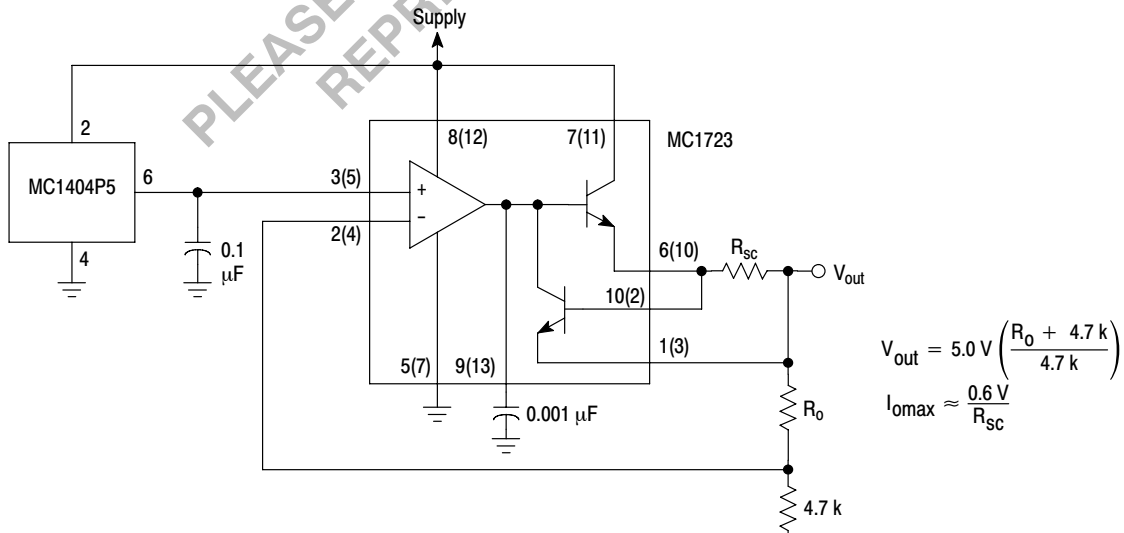
Although Figure 10 illustrates a wide trim range, temperature coefficients may become unpredictable for trim > ±6.0%.

Figure 11. Precision Supply Using MC1404

Output Power Boosting
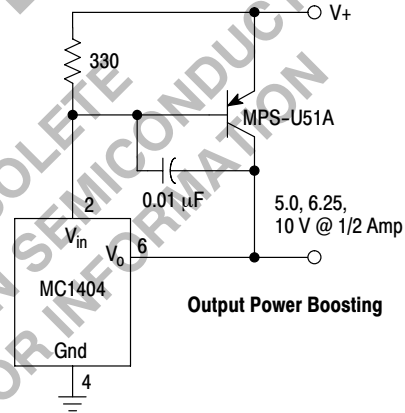
The addition of a power transistor, a resistor, and a capacitor converts the MC1404 into a precision supply with one ampere current capability. At V+ = 15 V, the MC1404 can carry in excess of 14 mA of load current with good regulation. If the power transistor current gain exceeds 75, a one ampere supply can be realized.

Figure 12. Ultra Stable Reference for MC1723 Voltage Regulator

$$V_{out} = 5.0 \, V \left(\frac{R_o + 4.7 \, k}{4.7 \, k} \right)$$

$$I_{omax} \approx \frac{0.6 \, V}{R_{sc}}$$

Figure 13. 5.0 V, 6.0 Amp, 25 kHz Switching Regulator with Separate Ultra−Stable Reference

+ 10 to + 30 In

1000 μF 50 V

0.01 μF 50 V Ceramic

2N5879

33

120 μH

1N3889

5000 μF 6.8 V (Low ESR)

0.01 μF Ceramic

+5.0 V Out 200 mA to 6.0 Amps

2

MC1404P5

6

5

100 k TRIM (opt)

4

130

130

12

8

11

Motorola TL495CN

Pulse Width Modulator

Oscillator

17

18

1

2

3

2.2 k

220 k

0.001 μF

2.2 k

5
0.005 μF

6
10 k

7

9

10

4

14
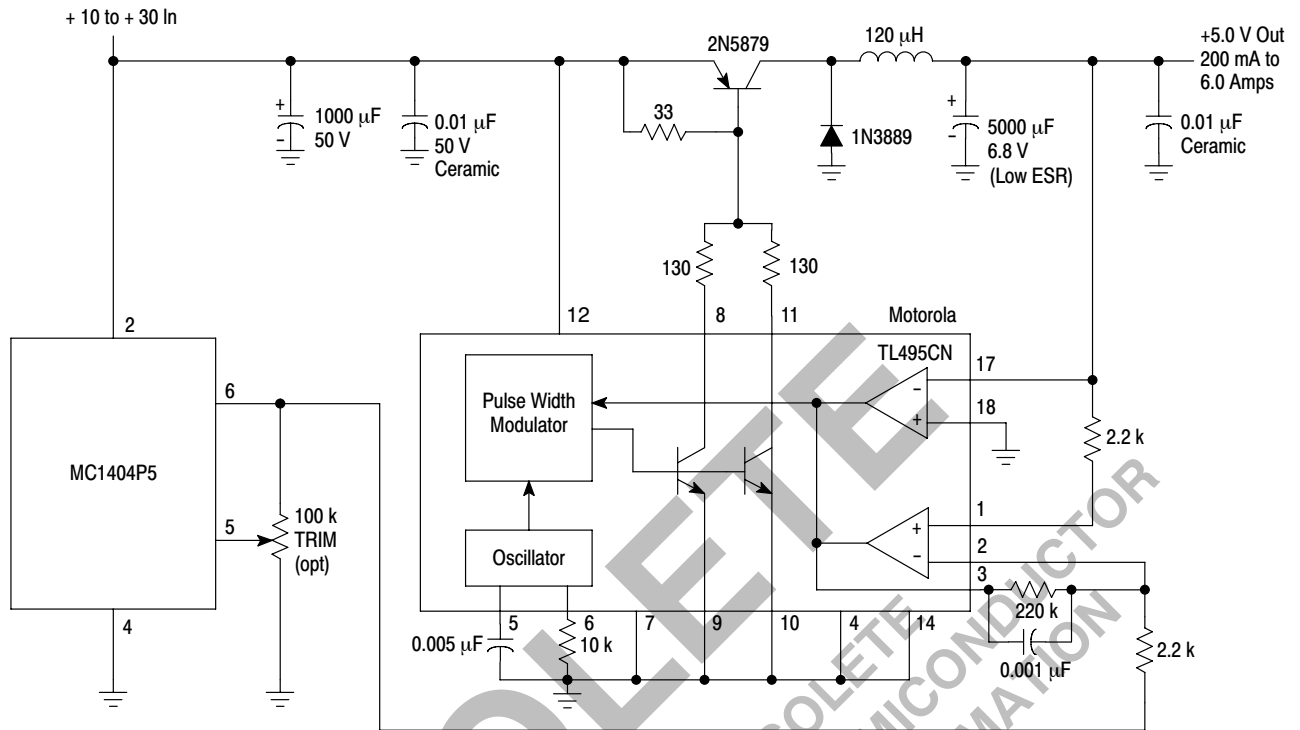
Figure 14. Reference for a High Speed DAC

12.5 to 40 V Input

2

MC1404P10

6

4

10 V Reference

R1 and R2 values depend on the current requirements of the DAC.

0.1 μF

R1

R2

Digital Inputs

Ladder and Switches

Analog Output

High Speed DAC
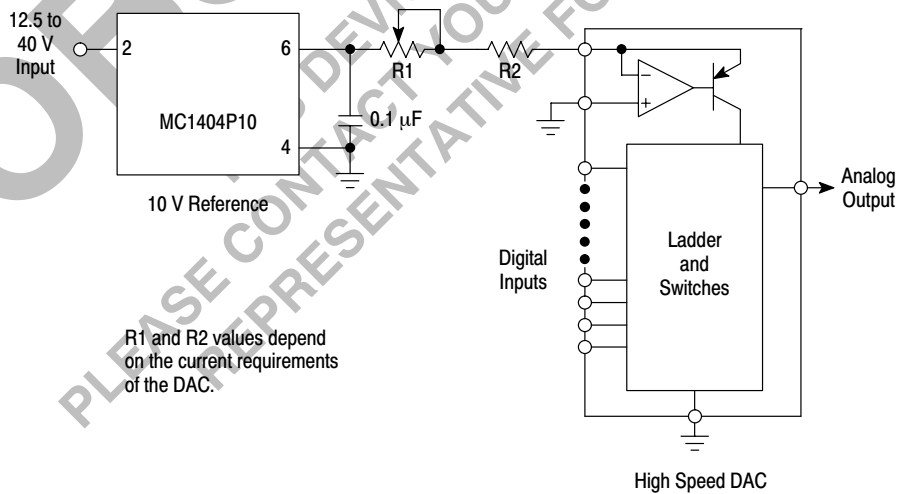
OUTLINE DIMENSIONS

P1 SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K
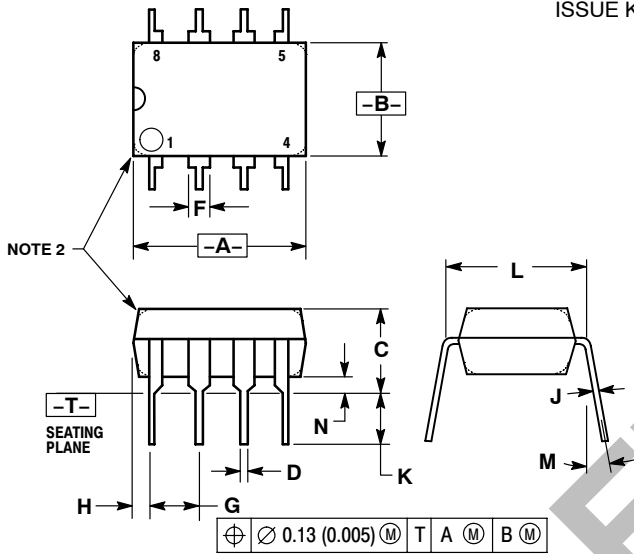
NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	MILLIMETERS		INCHES	
	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