



MOTOROLA

**MC1400,A
MC1500,A**

**Specifications and Applications
Information**

**TIGHT-TOLERANCE, LOW-DRIFT
VOLTAGE REFERENCE FAMILY**

The MC1400 series of ICs is a family of temperature-compensated voltage references for precision data conversion and instrumentation applications. Advances in thin-film resistors, laser-trimming techniques, ion-implanted devices, and monolithic fabrication techniques make this reference both temperature and time stable in applications demanding accuracy to the 12-bit level.

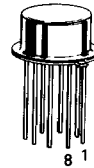
These devices offer simple, no-external-component operation as three-terminal, positive-voltage references, and also simple, one-external-resistor operation as either positive or negative references. Unique circuitry permits these devices to either source or sink greater than 10 mA of load current with excellent regulation. This feature means that the buffer amplifiers and current sources normally required for precision zener references can be eliminated.

- Four Different Output Voltages: 2.5, 5.0, 6.25, 10 V
- Tight Absolute Accuracy: $\pm 0.2\%$ Maximum Initial Tolerance
- Single-Component Output Trimming Without Degrading Temperature Coefficient
- Wide Input Voltage Range: $(V_{out} + 1.0 V) \leq V_{in} \leq 40 V$
- Three-Terminal Operation:
Positive References That Can Source and Sink Current
- Two-Terminal Operation:
Positive or Negative References
Floating References
- Low Current Consumption: 1.0 mA Typical
- Very Low Temperature Coefficient
- Low Output Noise Voltage
- Excellent Ripple Rejection: 87 dB Typical at 120 Hz
- Excellent Long Term Stability: 25 ppm/1000 Hrs Typical

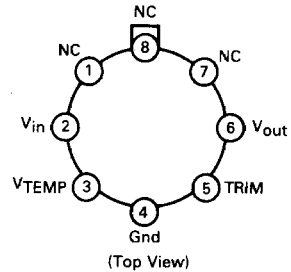
**PRECISION
VOLTAGE REFERENCES**

2.5, 5.0, 6.25 and 10-VOLT

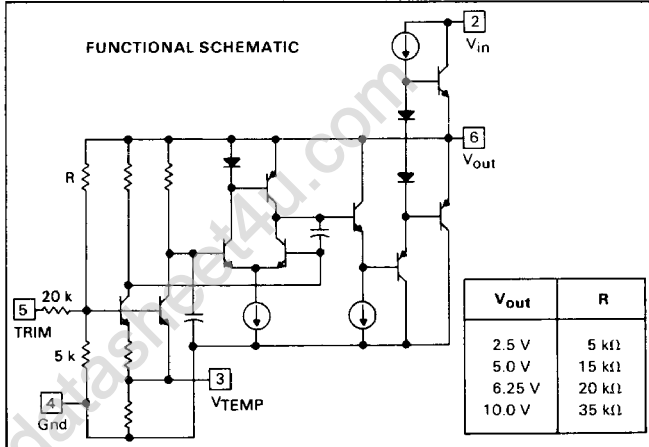
**LASER-TRIMMED SILICON
MONOLITHIC INTEGRATED CIRCUIT**



**G SUFFIX
METAL PACKAGE
CASE 601-04**



FUNCTIONAL SCHEMATIC



ORDERING INFORMATION

Device	Temperature Range
2.5 Volts	
MC1500G2	-55°C to +125°C
MC1500AG2	-55°C to +125°C
MC1400G2	0°C to +70°C
MC1400AG2	0°C to +70°C
5.0 Volts	
MC1500G5	-55°C to +125°C
MC1500AG5	-55°C to +125°C
MC1400G5	0°C to +70°C
MC1400AG5	0°C to +70°C
6.25 Volts	
MC1500G6	-55°C to +125°C
MC1500AG6	-55°C to +125°C
MC1400G6	0°C to +70°C
MC1400AG6	0°C to +70°C
10 Volts	
MC1500G10	-55°C to +125°C
MC1500AG10	-55°C to +125°C
MC1400G10	0°C to +70°C
MC1400AG10	0°C to +70°C

MC1400,A, MC1500,A

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Applied Voltages	V_{in}	-0.3 to +40	V
	V_{TRIM}	-0.3 to +5.0	
Load Current V_{TEMP} , Pin 3 Output, Pin 6	I_{TEMP}	± 50	μA
	I_{out}	± 40	mA
Output Short Circuit Duration To Ground To V_{in}	t_{sc}	Continuous 10	seconds
	T_{stg}	-65 to +150	$^{\circ}C$
Storage Temperature	T_J	+150	$^{\circ}C$
Operating Ambient Temperature Range MC1500,A MC1400,A	T_A	-55 to +125 0 to +70	$^{\circ}C$

5

ELECTRICAL CHARACTERISTICS ($V_{in} = 15$ Volts, $T_A = 25^{\circ}C$ and Trim Terminal not connected unless otherwise noted)

Characteristic	Symbol	MC1400,A			MC1500,A			Unit	
		Min	Typ	Max	Min	Typ	Max		
Output Voltage ($I_O = 0$ mA)	V_O	G2, AG2	2.495	2.500	2.505	2.495	2.500	2.505	Volts
		G5, AG5	4.990	5.000	5.010	4.990	5.000	5.010	
		G6, AG6	6.240	6.250	6.260	6.240	6.250	6.260	
		G10, AG10	9.980	10.000	10.020	9.980	10.000	10.020	
Output Voltage Tolerance	—	—	0.05	0.20	—	0.05	0.20	%	
Output Trim Range ($R_P = 100$ k Ω)	ΔV_{TRIM}	± 6.0	—	—	± 6.0	—	—	%	
Temperature Coefficient (Notes 1, 4) (T_{min} to T_{max})	TCV O	MC1400/1500	—	—	25	—	—	40	ppm/ $^{\circ}C$
		MC1400A/1500A	—	—	10	—	—	10	
Line Regulation (Note 2) ($V_{in} = 3.5$ V to 40 V) ($V_{in} = 6.0$ V to 40 V) ($V_{in} = 7.5$ V to 40 V) ($V_{in} = 11.5$ V to 40 V)	Reg $_{line}$	G2, AG2	—	1.0	3.0	—	1.0	3.0	mV
		G5, AG5	—	1.5	4.0	—	1.5	4.0	
		G6, AG6	—	1.5	4.0	—	1.5	4.0	
		G10, AG10	—	2.0	4.0	—	2.0	4.0	
Load Regulation (Note 3) ($-10 \leq I_L \leq +10$ mA)	Reg $_{load}$	G2, AG2	—	6.0	10	—	6.0	10	mV
		G5, AG5	—	8.0	20	—	8.0	20	
		G6, AG6	—	8.0	20	—	8.0	20	
		G10, AG10	—	8.0	20	—	8.0	20	
Quiescent Current ($I_O = 0$ mA)	I_Q	—	0.77	1.5	—	0.77	1.5	mA	
Zener Mode Regulation (Figure 1) ($1.0 \leq I_Z \leq 10$ mA)	V_Z	G2, AG2	—	3.0	—	—	3.0	—	mV
		G5, AG5	—	6.0	—	—	6.0	—	
		G6, AG6	—	8.0	—	—	8.0	—	
		G10, AG10	—	12	—	—	12	—	
Long Term Stability	—	—	25	—	—	25	—	ppm/1000 hrs	

NOTES:

- $T_{min} = -55^{\circ}C$ for MC1500,A
 $= 0^{\circ}C$ for MC1400,A
 $T_{max} = +125^{\circ}C$ for MC1500,A
 $= +70^{\circ}C$ for MC1400,A
- Line Regulation is defined as the maximum excursion in output voltage over a given change in input voltage with zero load current and junction temperature constant.
- Load Regulation is defined as the maximum excursion in output voltage over a given change in load current with a constant input supply voltage of +15 volts and a constant junction temperature.
- Temperature Coefficient of the output voltage (TCV O) is defined as the maximum change in output voltage over applicable temperature divided by the device operating temperature range and expressed as ppm/ $^{\circ}C$.

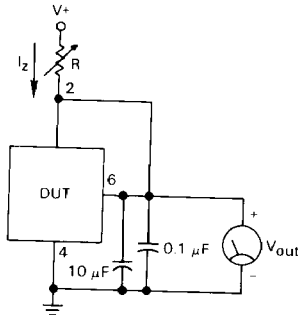
MC1400,A, MC1500,A

DYNAMIC CHARACTERISTICS ($V_{in} = 15\text{ V}$, $T_A = 25^\circ\text{C}$ all voltage ranges unless otherwise noted)

Characteristic	Symbol	MC1400,A			MC1500,A			Unit
		Min	Typ	Max	Min	Typ	Max	
Turn-On Settling Time (Figure 2) (to $\pm 0.01\%$)	t_S	—	50	—	—	50	—	μs
Output Noise Voltage — P to P ($0.1 \leq f \leq 10\text{ Hz}$)	V_n	—	8.0	—	—	8.0	—	μV
G2, AG2			12			12		
G5, AG5			14			14		
G6, AG6			16			16		
G10, AG10								
Small-Signal Output Impedance ($f = 120\text{ Hz}$)	z_o	—	0.3	—	—	0.3	—	Ω
Power Supply Rejection Ratio ($f = 120\text{ Hz}$)	PSRR	60	87	—	60	87	—	dB

TYPICAL CHARACTERISTICS

FIGURE 1 — ZENER MODE REGULATION TEST CIRCUIT



NOTE I_z is the net current flowing into the device.

FIGURE 2 — TURN-ON SETTTLING TIME TEST CIRCUIT

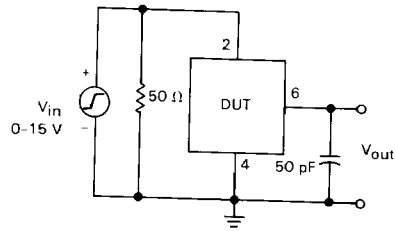


FIGURE 3 — NORMALIZED OUTPUT VOLTAGE versus TEMPERATURE

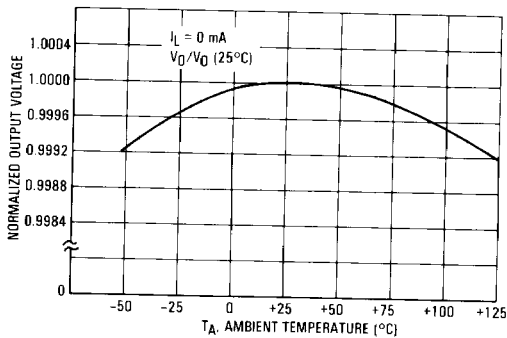


FIGURE 4 — LINE REGULATION versus TEMPERATURE

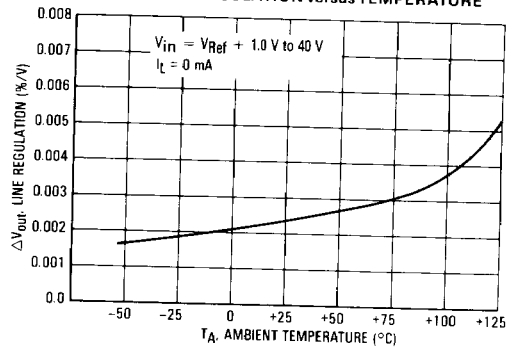


FIGURE 5 — LOAD REGULATION versus TEMPERATURE

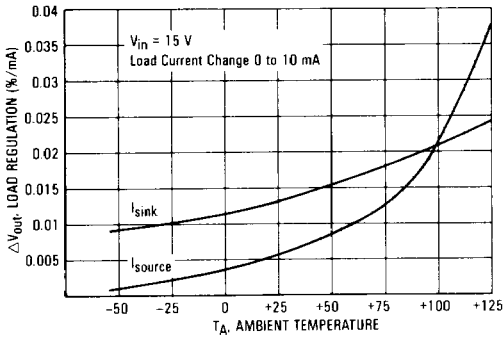


FIGURE 6 — ZENER MODE REGULATION versus TEMPERATURE

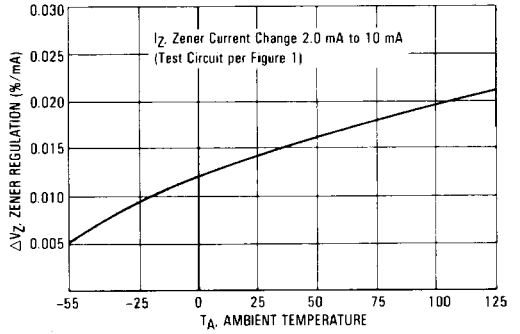


FIGURE 7 — OUTPUT IMPEDANCE versus FREQUENCY

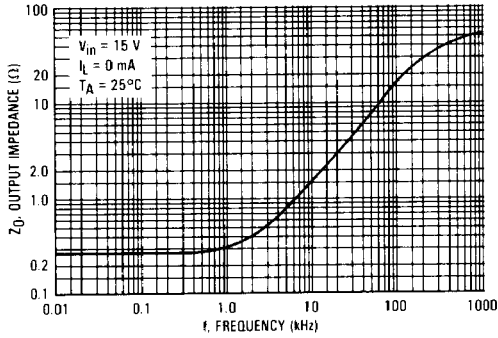


FIGURE 8 — POWER SUPPLY REJECTION RATIO versus FREQUENCY

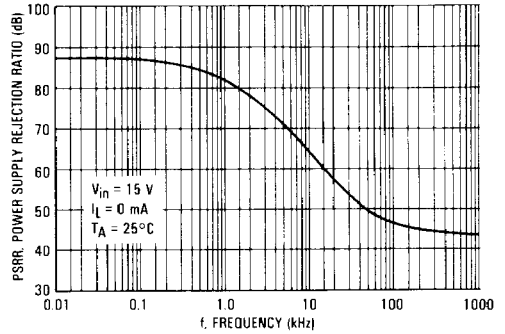


FIGURE 9 — QUIESCENT CURRENT versus TEMPERATURE

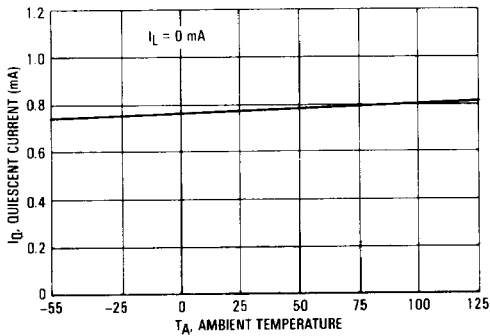
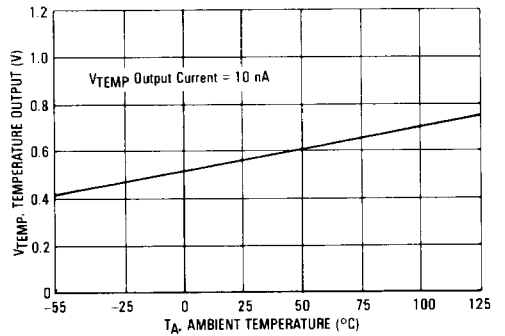
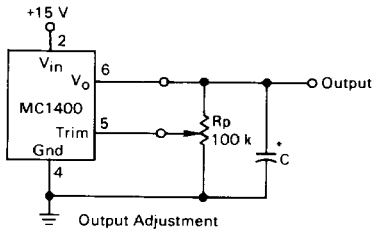


FIGURE 10 — VTEMP, OUTPUT versus TEMPERATURE



MC1400,A, MC1500,A

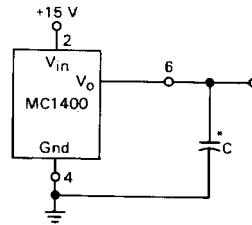
FIGURE 11 — OUTPUT TRIM CONFIGURATION



The MC1400 trim terminal can be used to adjust the output voltage over a $\pm 6\%$ 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 k Ω or 200 k Ω trimpot is recommended.

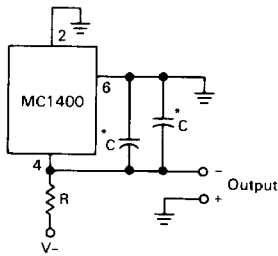
Although the circuit of Figure 11 allows a wide trim range, trimming should be kept to $\leq \pm 6\%$ in applications requiring low temperature coefficients.

FIGURE 12 — FIXED REFERENCE



*For better stability, transient response, and minimum noise voltage, the device should be bypassed with a 0.1 μF ceramic capacitor from Pins 6 to 4 as shown.

FIGURE 13 — NEGATIVE REFERENCE OPERATION



*For better stability, transient response, and minimum noise voltage, the device should be bypassed with a 0.1 μF ceramic and a 10 μF electrolytic capacitor from Pins 6 to 4 as shown.

FIGURE 14 — TRIMMABLE FLOATING REFERENCE OPERATION

