MOTOROLA

MC1400,A
MC1500,A

Specifications and Applications Information

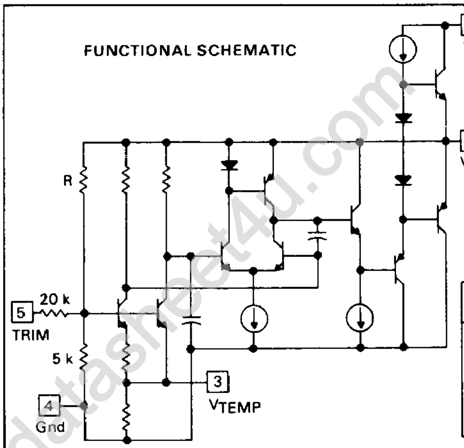
TIGHT-TOLERANCE, LOW-DRIFT VOLTAGE REFERENCE FAMILY

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: ±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

FUNCTIONAL SCHEMATIC

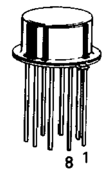


V_{out}	R
2.5 V	5 kΩ
5.0 V	15 kΩ
6.25 V	20 kΩ
10.0 V	35 kΩ

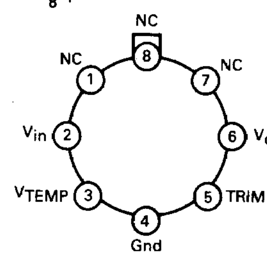
PRECISION VOLTAGE REFERENCES

2.5, 5.0, 6.25 and 10-VOLT

LASER-TRIMMED SILICON MONOLITHIC INTEGRATED CIRCUIT



G SUFFIX
METAL PACKAGE
CASE 601-04



(Top View)

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

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MAXIMUM RATINGS

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

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

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

NOTES:

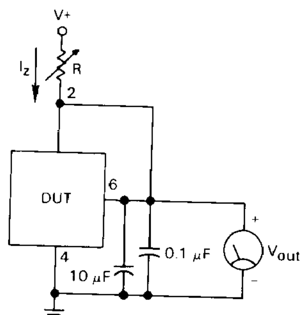
1. T_{min} = −55°C for MC1500,A
   = 0°C for MC1400,A
   T_{max} = +125°C for MC1500,A
   = +70°C for MC1400,A
2. Line Regulation is defined as the maximum excursion in output voltage over a given change in input voltage with zero load current and junction temperature constant.
3. Load Regulation is 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.
4. 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/°C.

DYNAMIC CHARACTERISTICS (V_{in} = 15 V, T_A = 25°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 ±0.01%)	t_S	—	50	—	—	50	—	μs
Output Noise Voltage — P to P (0.1≤f≤10 Hz) G2, AG2	V_n	—	8.0	—	—	8.0	—	μV
G5, AG5		—	12	—	—	12	—	
G6, AG6		—	14	—	—	14	—	
G10, AG10		—	16	—	—	16	—	
Small-Signal Output Impedance (f = 120 Hz)	z_O	—	0.3	—	—	0.3	—	Ω
Power Supply Rejection Ratio (f = 120 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 SETTLING TIME TEST CIRCUIT

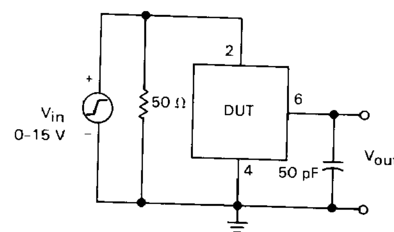


FIGURE 3 — NORMALIZED OUTPUT VOLTAGE versus TEMPERATURE

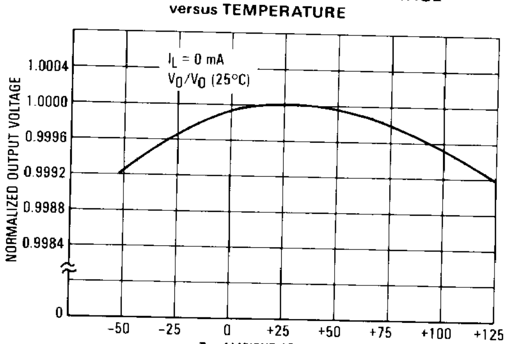


FIGURE 4 — LINE REGULATION versus TEMPERATURE

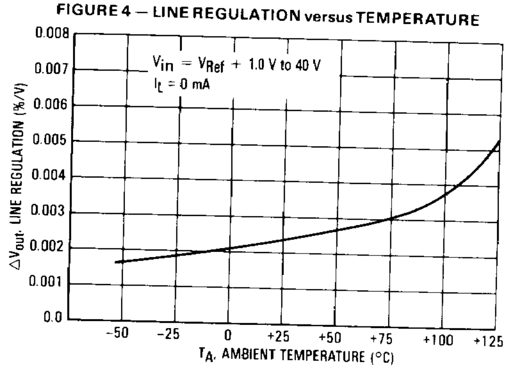


FIGURE 5 — LOAD REGULATION versus TEMPERATURE

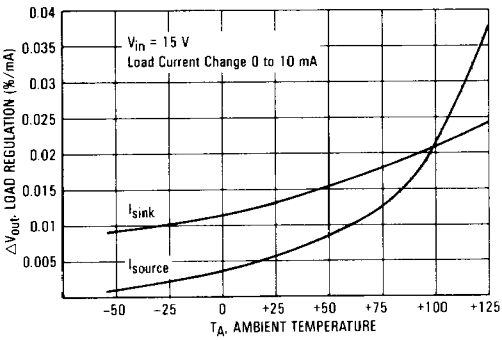


FIGURE 6 — ZENER MODE REGULATION versus TEMPERATURE

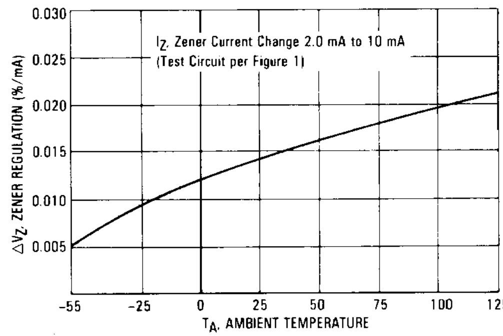


FIGURE 7 — OUTPUT IMPEDANCE versus FREQUENCY

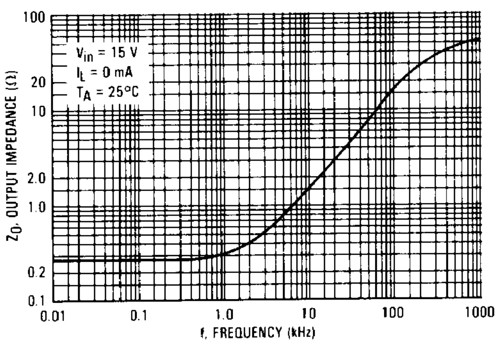


FIGURE 8 — POWER SUPPLY REJECTION RATIO versus FREQUENCY

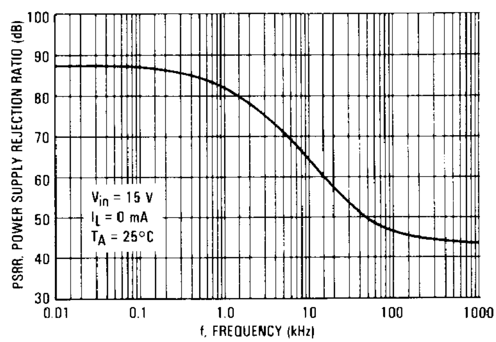


FIGURE 9 — QUIESCENT CURRENT versus TEMPERATURE

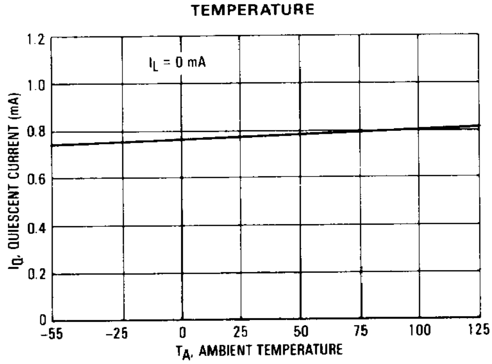


FIGURE 10 — V_{TEMP}, OUTPUT versus TEMPERATURE

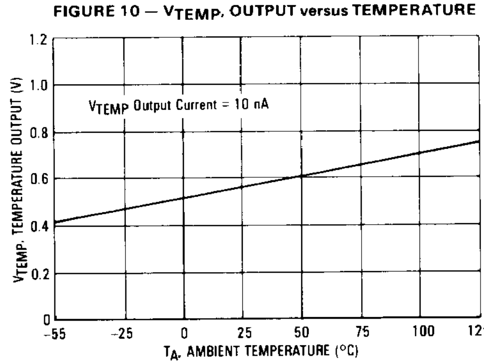
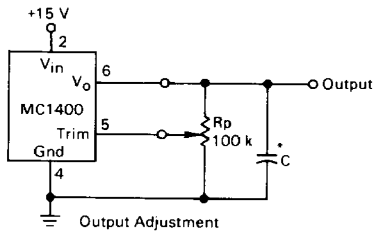


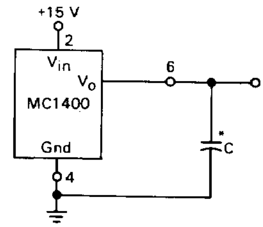
FIGURE 11 — OUTPUT TRIM CONFIGURATION



The MC1400 trim terminal can be used to adjust the output voltage over a ±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 kΩ or 200 kΩ trimpot is recommended.

Although the circuit of Figure 11 allows a wide trim range, trimming should be kept to ≤ ±6% in applications requiring low temperature coefficents.

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

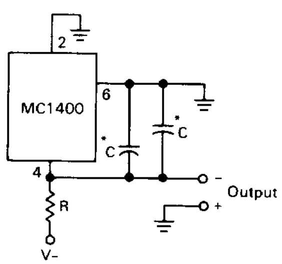
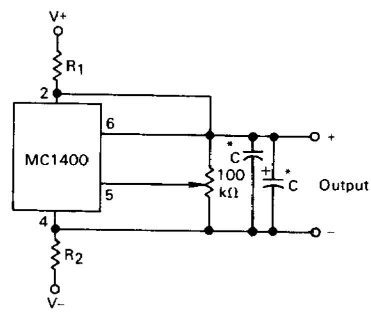


FIGURE 14 — TRIMMABLE FLOATING REFERENCE OPERATION



*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.