MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MC1436,C
MC1536

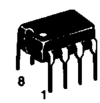
High Voltage, Internally Compensated Operational Amplifier

OPERATIONAL AMPLIFIER

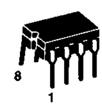
SILICON MONOLITHIC INTEGRATED CIRCUIT

The MC1436, C was designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.

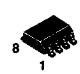
- Maximum Supply Voltage: ±40 Vdc (MC1536)
- Output Voltage Swing:
  ±30 $V_{pk(min)}$ (V_{CC} = +36 V, V_{EE} = −36 V) (MC1536)
  ±22 $V_{pk(min)}$ (V_{CC} = +28 V, V_{EE} = −28 V)
- Input Bias Current: 20 nA max (MC1536)
- Input Offset Current: 3.0 nA max (MC1536)
- Fast Slew Rate: 2.0 V/μs typ
- Internally Compensated
- Offset Voltage Null Capability
- Input Overvoltage Protection
- A_{VOL}: 500,000 typ
- Characteristics Independent of Power Supply Voltages: (±5.0 Vdc to ±36 Vdc)



P1 SUFFIX
PLASTIC PACKAGE
CASE 626



U SUFFIX
CERAMIC PACKAGE
CASE 693



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-8)

Figure 1. Differential Amplifier with ±20 V Common Mode Input Voltage Range

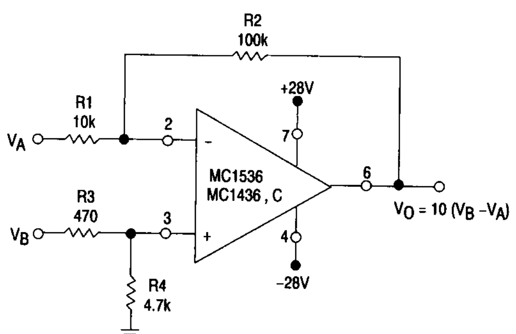
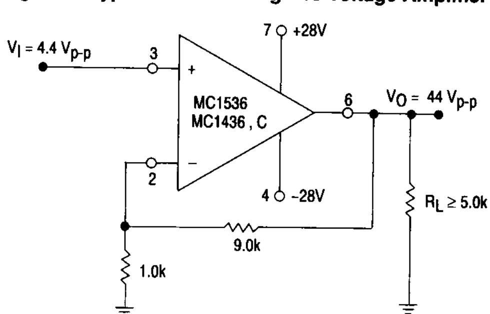
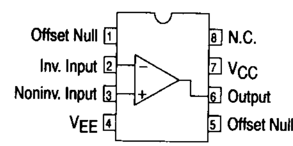


Figure 2. Typical Noninverting X10 Voltage Amplifier



PIN CONNECTIONS



ORDERING INFORMATION

Device	Temperature Range	Package
MC1436CD,D	0° to +70°C	SO-8
MC1436P1,CP1		Plastic DIP
MC1436CU,U		Ceramic DIP
MC1536U	−55° to +125°C	Ceramic DIP

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

Rating	Symbol	MC1536	MC1436	MC1436C	Unit
Power Supply Voltage	V_{CC} V_{EE}	+40 –40	+34 –34	+30 –30	Vdc
Input Differential Voltage Range	V_{IDR}	Note 3			V
Input Common Mode Voltage Range	V_{ICR}	Note 3			V
Output Short Circuit Duration (V_{CC} = V_{EE} = 28 Vdc, V_O = 0)	t_{SC}	5.0			sec
Power Dissipation (Package Limitation) Derate above T_A = +25°C	P_D	680 4.6			mW mW/°C
Operating Ambient Temperature Range	T_A	–55 to +125	0 to +70		°C
Storage Temperature Range	T_{stg}	–65 to +150			°C

ELECTRICAL CHARACTERISTICS (V_{CC} = +28 V, V_{EE} = –28 V, T_A = 25°C, unless otherwise noted.)

Characteristics	Symbol	MC1536			MC1436			MC1436C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Bias Current T_A = +25°C T_A = T_{low} to T_{high} (See Note 1)	I_{IB}	 — —	 8.0 —	 20 35	 — —	 15 —	 40 55	 — —	 25 —	 90 —	nAdc
Input Offset Current T_A = +25°C T_A = +25°C to T_{high} T_A = T_{low} to +25°C	I_{IO}	 — — —	 1.0 — —	 3.0 4.5 7.0	 — — —	 5.0 — —	 10 14 14	 — — —	 10 — —	 25 — —	nAdc
Input Offset Voltage T_A = +25°C T_A = T_{low} to T_{high}	V_{IO}	 — —	 2.0 —	 5.0 7.0	 — —	 5.0 —	 10 14	 — —	 5.0 —	 12 —	mVdc
Differential Input Impedance (Open-loop, f ≤ 5.0 Hz) Parallel Input Resistance Parallel Input Capacitance	 rp Cp	 — —	 10 2.0	 — —	 — —	 10 2.0	 — —	 — —	 10 2.0	 — —	MΩ pF
Common Mode Input Impedance (f ≤ 5.0 Hz)	z_{ic}	—	250	—	—	250	—	—	250	—	MΩ
Input Common Mode Voltage Range	V_{ICR}	±24	±25	—	±22	±25	—	±18	±20	—	Vpk
Equivalent Input Noise Voltage (A_V = 100, R_S = 10 kΩ, f = 1.0 kHz, BW = 1.0 Hz)	e_n	—	50	—	—	50	—	—	50	—	nV/(Hz)$^{1}/_{2}$
Common Mode Rejection (dc)	CMR	80	110	—	70	110	—	50	90	—	dB
Large Signal DC Open-Loop Voltage Gain (V_O = ±10 V, R_L = 100 kΩ) { T_A = +25°C (V_O = ±10 V, R_L = 100 kΩ) { T_A = T_{low} to T_{high} (V_O = ±10 V, R_L = 10 kΩ, T_A = +25°C)	A_{VOL}	 100,000 50,000 —	 500,000 — 200,000	 — — —	 70,000 50,000 —	 500,000 — 200,000	 — — —	 50,000 — —	 500,000 — 200,000	 — — —	V/V
Power Bandwidth (Voltage Follower) (A_V = 1, R_L = 5.0 kΩ, THD ≤ 5%, V_O = 40 V_{p-p})	BWp	—	23	—	—	23	—	—	23	—	kHz
Unity Gain Crossover Frequency (Open-loop)	f_c	—	1.0	—	—	1.0	—	—	1.0	—	MHz
Phase Margin (Open-loop, Unity Gain)	ϕ_m	—	50	—	—	50	—	—	50	—	Degrees
Gain Margin	A_M	—	18	—	—	18	—	—	18	—	dB
Slew Rate (Unity Gain)	SR	—	2.0	—	—	2.0	—	—	2.0	—	V/µs
Output Impedance (f ≤ 5.0 Hz)	z_O	—	1.0	—	—	1.0	—	—	1.0	—	kΩ
Short Circuit Output Current	I_{SC}	—	±17	—	—	±17	—	—	±19	—	mAdc
Output Voltage Range (R_L = 5.0 kΩ) V_{CC} = +28 Vdc, V_{EE} = –28 Vdc V_{CC} = +36 Vdc, V_{EE} = –36 Vdc	V_O	 ±22 ±30	 ±23 ±32	 — —	 ±20 —	 ±22 —	 — —	 ±20 —	 ±22 —	 — —	V_{pk}
Power Supply Rejection V_{EE} = Constant, R_s ≤ 10 kΩ V_{CC} = Constant, R_s ≤ 10 kΩ	 PSR + PSR –	 — —	 15 15	 100 100	 — —	 35 35	 200 200	 — —	 50 50	 — —	µV/V
Power Supply Current (See Note 2)	I_{CC} I_{EE}	— —	2.2 2.2	4.0 4.0	— —	2.6 2.6	5.0 5.0	— —	2.6 2.6	5.0 5.0	mAdc
DC Quiescent Power Consumption (V_O = 0)	P_C	—	124	224	—	146	280	—	146	280	mW

NOTES:
1. T_{low} = 0°C for MC1436,C; –55°C for MC1536. T_{high} = +70°C for MC1436,C; +125°C for MC1536
2. V_{CC} = V_{EE} = 5.0 Vdc to 36 Vdc for MC1536
   V_{CC} = V_{EE} = 5.0 Vdc to 30 Vdc for MC1436
   V_{CC} = V_{EE} = 5.0 Vdc to 28 Vdc for MC1436C
3. Either or both input voltages must not exceed the magnitude of V_{CC} or V_{EE} +3.0 V.

Figure 3. Low-Drift Sample and Hold

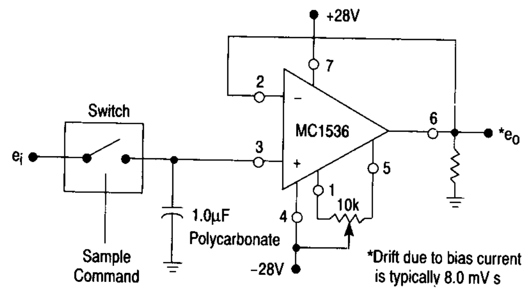

Figure 4. Power Bandwidth

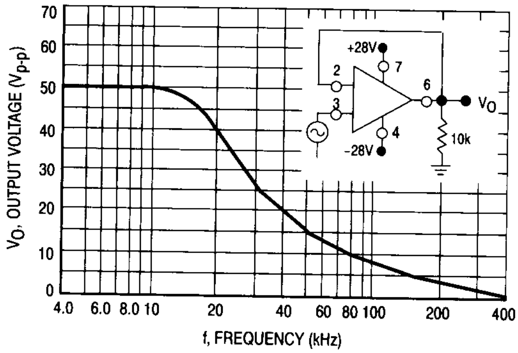

Figure 5. Peak Output Voltage Swing versus Power Supply Voltage

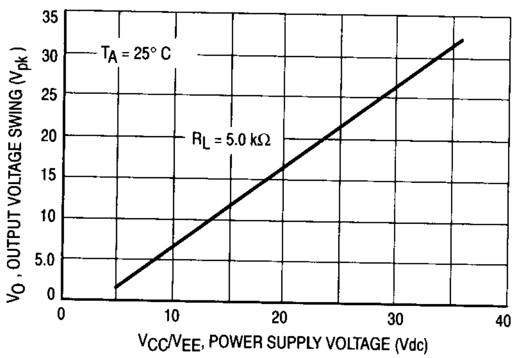

Figure 6. Open-Loop Frequency Response

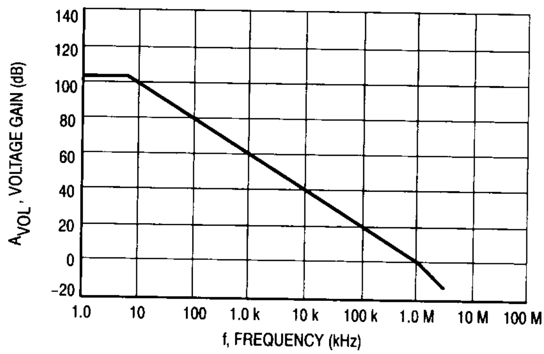

Figure 7. Output Short Circuit Current versus Temperature

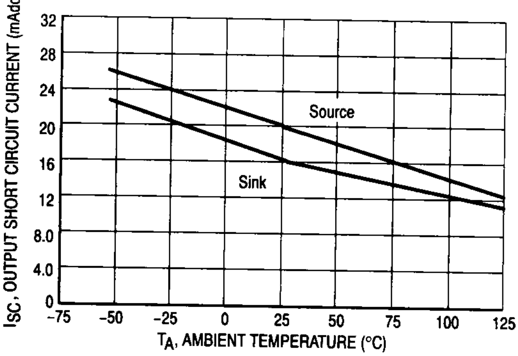

Figure 8. Input Bias Current versus Temperature

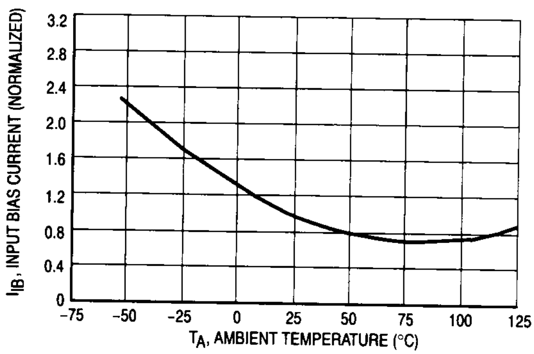

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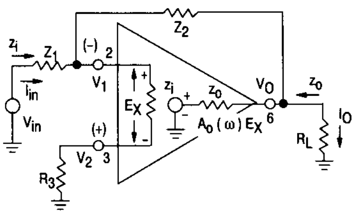
Figure 9. Inverting Feedback Model



$$z_o = z_o \frac{1 + Z_2/Z_1}{A_o(\omega)}$$

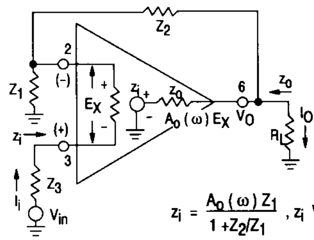
If: $A_o(\omega) \rightarrow \infty$

$$\frac{V_O}{V_i} = -\frac{Z_2}{Z_1}$$

If: $R_3 \ll Z_1$

$z_i \approx Z_1$

Figure 10. Noninverting Feedback Model



$$z_i = \frac{A_o(\omega)\,Z_1}{1 + Z_2/Z_1}, \; z_i \text{ Very High}$$

$$z_o = z_o \frac{1 + Z_2/Z_1}{A_o(\omega)} \qquad \frac{V_O}{V_i} = 1 + Z_2/Z_1, \text{ when } A_O(\omega) \rightarrow \infty$$

$Z_o \rightarrow 0$
$A_o(\omega) \rightarrow \infty$

Figure 11. Audio Amplifier

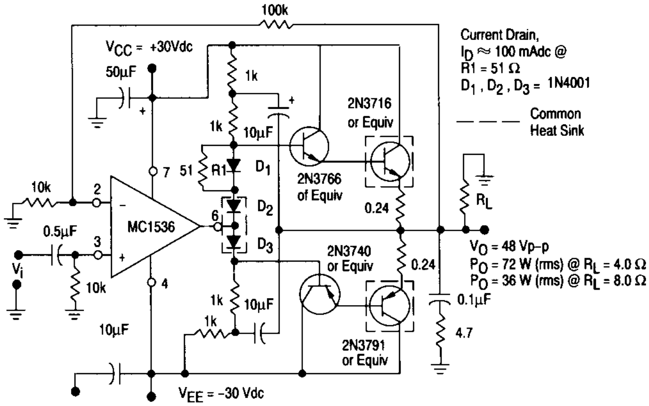
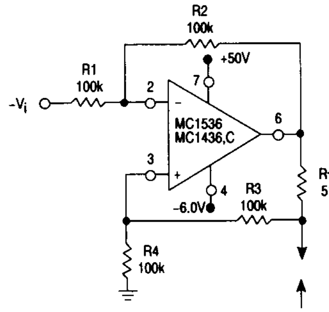


Figure 12. Voltage Controlled Current Source or Transconductance Amplifier with 0 V to 40 V Compliance



$$\frac{I_O}{V_i} = \frac{1}{R_{TC}} = 2.0 \text{ mA/V}$$

$$Z_O = \frac{R1 R_{TC}\,(R3 + R4)}{R1\,(R_{TC} + R3) - R2\,R4}$$

Figure 13. Representative Circuit Schematic

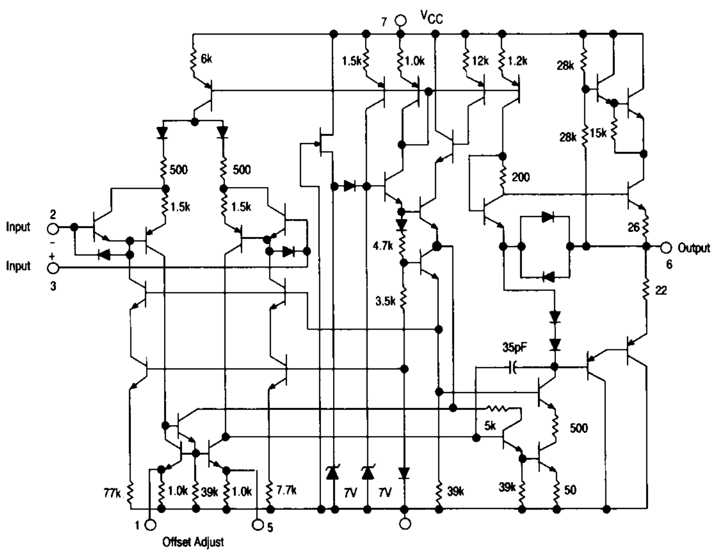


Figure 14. Equivalent Circuit