ORDERING INFORMATION

Device	Temperature Range	Package
MC1435F	0°C to +70°C	Ceramic Flat
MC1435G	0°C to +70°C	Metal Can
MC1435L	0°C to +70°C	Ceramic DIP
MC1435P	0°C to +70°C	Plastic DIP
MC1535F	−55°C to +125°C	Ceramic Flat
MC1535G	−55°C to +125°C	Metal Can
MC1535L	−55°C to +125°C	Ceramic DIP

MC1435
MC1535

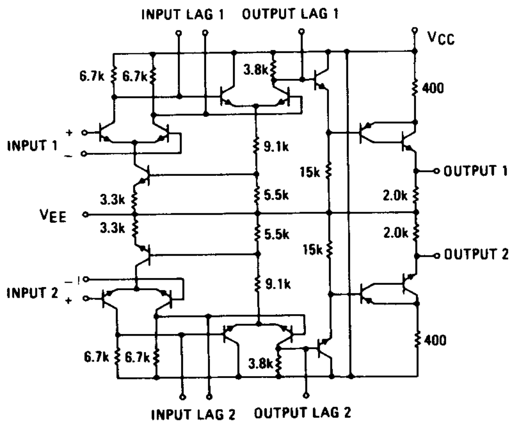
DUAL OPERATIONAL AMPLIFIERS

. . . designed for use as summing amplifiers, integrators, or amplifiers with operating characteristics as a function of the external feedback components. Ideal for chopper stabilized applications where extremely high gain is required with excellent stability.

Typical Amplifier Features:

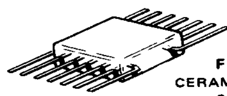
- High Open Loop Gain Characteristics – A_{vol} = 7,000
- Low Temperature Drift – ±10 μV/°C
- Low Input Offset Voltage – 1.0 mV
- Low Input Noise Voltage – 0.5 μV

CIRCUIT SCHEMATIC

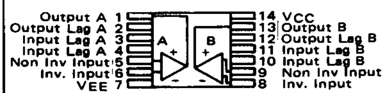


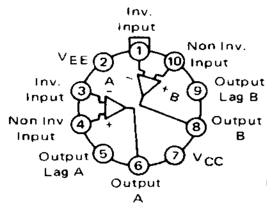
DUAL OPERATIONAL AMPLIFIERS

SILICON MONOLITHIC INTEGRATED CIRCUIT

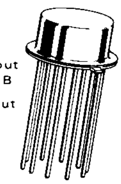


F SUFFIX
CERAMIC PACKAGE
CASE 607

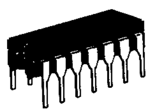




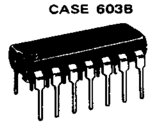
(TOP VIEW)



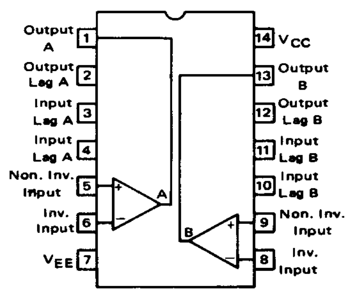
G SUFFIX
METAL PACKAGE
CASE 603B



L SUFFIX
CERAMIC PACKAGE
CASE 632
TO-116



P SUFFIX
PLASTIC PACKAGE
CASE 646



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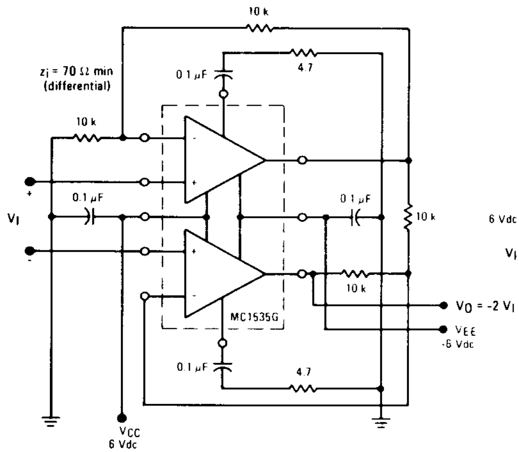
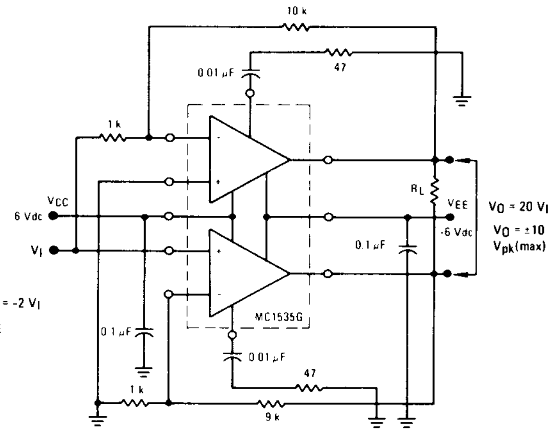
HIGH z_i, DIFFERENTIAL TO SINGLE-ENDED AMPLIFIER



LARGE OUTPUT SWING CONFIGURATION (FLOATING LOAD)



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

Rating	Symbol	MC1535	MC1435	Unit
Power Supply Voltage	V_{CC} V_{EE}	+10 -10	+9.0 -9.0	Vdc
Input Differential Voltage Range	V_{IDR}	±5.0	±5.0	Volts
Common-Mode Input Voltage Range	V_{ICR}	+5.0, -4.0	+5.0 -4.0	Volts
Load Current	I_L	20	20	mA
Output Short-Circuit Duration	t_S	Continuous		
Power Dissipation (Package Limitation)	P_D			
Flat Ceramic Package		500		mW
Derate above T_A = +25°C		3.3		mW/°C
Metal Package		680		mW
Derate above T_A = +25°C		4.6		mW/°C
Ceramic Dual In-Line Package		625		mW
Derate above T_A = +25°C		5.0		mW/°C
Operating Ambient Temperature Range	T_A	-55 to +125	0 to +75	°C
Storage Temperature Range	T_{stg}	-65 to +150	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (Each Amplifier) (V_{CC} = +6.0 Vdc, V_{EE} = −6.0 Vdc, T_A = +25°C unless otherwise noted.)

Characteristics	Symbol	MC1535			MC1435			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Bias Current	I_{IB}							µAdc
$I_{IB} = \frac{I_1 + I_2}{2}$, T_A = +25°C		–	1.2	3.0	–	1.2	5.0	
$T_A = T_{low}$ to T_{high} ①		–	–	6.0	–	–	10	
Input Offset Current	I_{IO}							nAdc
T_A = +25°C		–	50	300	–	50	500	
T_A = +25°C to T_{high}		–	–	300	–	–	1500	
$T_A = T_{low}$ to +25°C		–	–	900	–	–	1500	
Input Offset Voltage	V_{IO}							mVdc
T_A = +25°C		–	1.0	3.0	–	1.0	5.0	
$T_A = T_{low}$ to T_{high}		–	–	5.0	–	–	7.5	
Differential Input Impedance (Open-Loop, f = 20 Hz)								
Parallel Input Resistance	r_i	10	45	–	10	45	–	k ohms
Parallel Input Capacitance	C_i	–	6.0	–	–	–	–	pF
Common-Mode Input Impedance (f = 20 Hz)	z_i	–	250	–	–	250	–	Megohms
Common-Mode Input Voltage Swing See Figure 7.	V_{ICR}	+3.0 -2.0	+3.9 -2.7	– –	+3.0 -2.0	+3.9 -2.7	– –	V_{pk}
Equivalent Input Noise Voltage (A_V = 100, R_s = 10 k ohms, f = 1.0 kHz, BW = 1.0 Hz)	e_n	–	45	–	–	45	–	nV/(Hz)½
Common-Mode Rejection Ratio (f = 100 Hz)	CMRR	-70	-90	–	-70	-90	–	dB
Open Loop Voltage Gain ($T_A = T_{low}$ to T_{high})	A_{vol}	4,000	7,000	12,000	3,500	7,000	–	V/V
Power Bandwidth (See Figure 2, Curve 3A.) (A_V = 1, R_L = 2.0 kohms, THD ≤ 5%, V_O = 20 Vp-p)	BW_P	–	40	–	–	40	–	kHz
Unity Gain Crossover Frequency (open-loop)	f_c	–	2.0	–	–	2.0	–	MHz
Phase Margin (open-loop, unity gain)	ϕm	–	75	–	–	75	–	degrees
Gain Margin	A_M	–	18	–	–	18	–	dB
Step Response								
Gain = 100, 30% overshoot,	t_{PHL}	–	0.3	–	–	0.3	–	µs
R1 = 4.7 kΩ, R2 = 470 kΩ,	t_P	–	0.1	–	–	0.1	–	µs
R3 = 150 Ω, C1 = 1,000 pF	SR	–	0.167	–	–	0.167	–	V/µs
Gain = 10, 10% overshoot,	t_{PHL}	–	1.9	–	–	1.9	–	µs
R1 = 47 kΩ, R2 = 470 kΩ,	t_P	–	0.3	–	–	0.3	–	µs
R3 = 47 Ω, C1 = 0.01 µF	SR	–	0.111	–	–	0.111	–	V/µs
Gain = 1, 5% overshoot,	t_{PHL}	–	27	–	–	27	–	µs
R1 = 47 kΩ, R2 = 47 kΩ,	t_P	–	0.25	–	–	0.25	–	µs
R3 = 4.7 Ω, C1 = 0.1 µF	SR	–	0.013	–	–	0.013	–	V/µs
Output Impedance (f = 20 Hz)	z_o	–	1.7	–	–	1.7	–	k ohms
Short-Circuit Output Current	I_{OS}	–	±17	–	–	±17	–	mAdc
Output Voltage Swing (R_L = 10 k ohms)	V_O	±2.5	±2.8	–	±2.3	±2.7	–	V_{pk}
Power Supply Sensitivity								µV/V
V_{EE} = constant, R_s ≤ 10 k ohms	PSS+	–	50	–	–	50	–	
V_{CC} = constant, R_s ≤ 10 k ohms	PSS−	–	100	–	–	100	–	
Power Supply Current (Total)	I_{CC} I_{EE}	– –	8.3 8.3	12.5 12.5	– –	8.3 8.3	15 15	mAdc
DC Quiescent Power Consumption (Total) (V_O = 0)	P_C	–	100	150	–	100	180	mW

MATCHING CHARACTERISTICS

Characteristics	Symbol	MC1535 Min	MC1535 Typ	MC1535 Max	MC1435 Min	MC1435 Typ	MC1435 Max	Unit
Open Loop Voltage Gain	$A_{vol1}-A_{vol2}$	–	±1.0	–	–	±1.0	–	dB
Input Bias Current	$I_{IB1}-I_{IB2}$	–	±0.15	–	–	±0.15	–	µA
Input Offset Current	$I_{IO1}-I_{IO2}$	–	±0.02	–	–	±0.02	–	µA
Average Temperature Coefficient	$TC_{IIO1}-TC_{IIO2}$	–	±0.1	–	–	±0.1	–	nA/°C
Input Offset Voltage	$V_{IO1}-V_{IO2}$	–	±0.1	–	–	±0.1	–	mV
Average Temperature Coefficient	$TC_{VIO1}-TC_{VIO2}$	–	±0.5	–	–	±0.5	–	µV/°C
Channel Separation (See Fig. 10) (f = 10 kHz)	$\frac{e_{o1}}{e_{o2}}$	–	-60	–	–	-60	–	dB

① T_{low}: 0°C for MC1435
-55°C for MC1535
T_{high}: +75°C for MC1435
+125°C for MC1535

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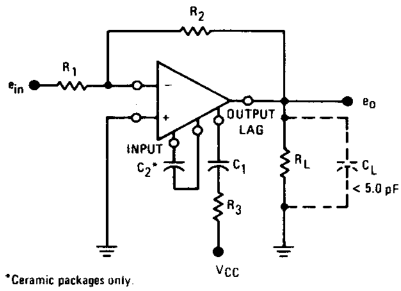
TYPICAL OUTPUT CHARACTERISTICS

(V_{CC} = +6.0 Vdc, V_{EE} = −6.0 Vdc, T_A = +25°C.)

FIGURE 1 – TEST CIRCUIT



*Ceramic packages only.

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS R_1(Ω)	R_2(Ω)	C_1(pF)	R_3(Ω)	C_2(pF)	OUTPUT NOISE mV(RMS)
2	3	1	47 k	47 k	100,000	4.7	0	0.12
	3A	or 1	47 k	47 k	0	∞	50,000	0.46
3	1	100	4.7 k	470 k	1,000	150	0	1.7
		or 100	4.7 k	470 k	0	∞	510	2.1
	2	10	47 k	470 k	10,000	47	0	1.0
		or 10	47 k	470 k	0	∞	5,000	2.1
	3	1	47 k	47 k	100,000	4.7	0	0.12
		or 1	47 k	47 k	0	∞	50,000	0.46
4	1	or A_{vol}	100	∞	1,000	150	0	8.1
		A_{vol}	100	∞	0	∞	510	8.1
	2	or A_{vol}	100	∞	10,000	47	0	5.5
		A_{vol}	100	∞	0	∞	5,000	5.5
	3	A_{vol}	100	∞	100,000	4.7	0	4.4
		or A_{vol}	100	∞	0	∞	50,000	4.4

FIGURE 2 – LARGE SIGNAL SWING versus FREQUENCY

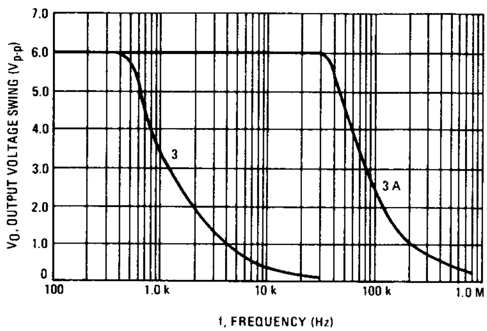


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

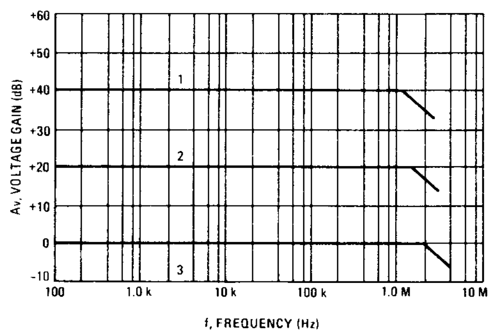


FIGURE 4 – OPEN LOOP VOLTAGE GAIN versus FREQUENCY

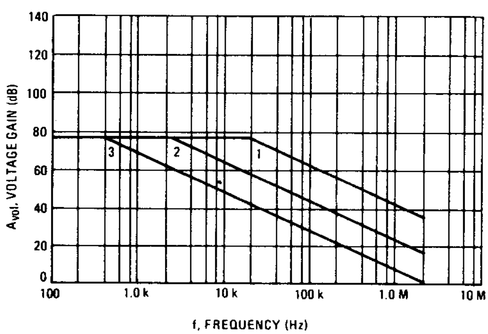
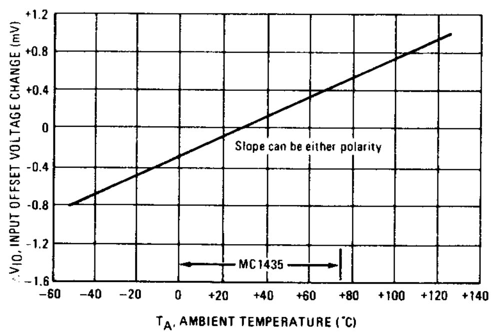


FIGURE 5 – INPUT OFFSET VOLTAGE versus TEMPERATURE



TYPICAL CHARACTERISTICS (continued)

FIGURE 6 — VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

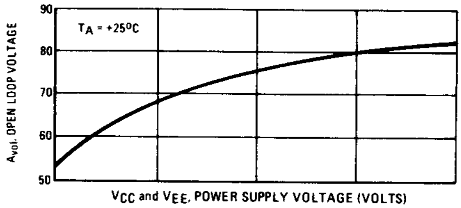


FIGURE 7 — COMMON MODE SWING versus POWER SUPPLY VOLTAGE

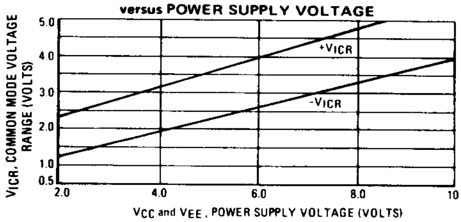


FIGURE 8 — POWER CONSUMPTION versus POWER SUPPLY VOLTAGE

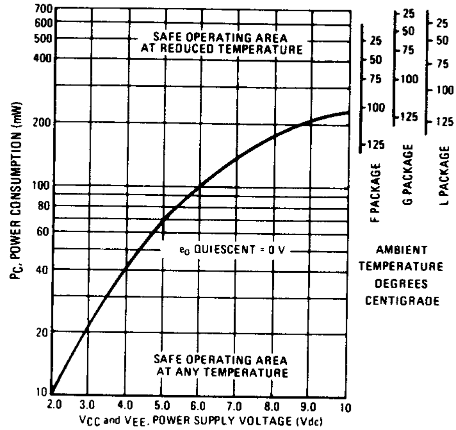


FIGURE 9 — OUTPUT WIDEBAND NOISE VOLTAGE versus SOURCE RESISTANCE

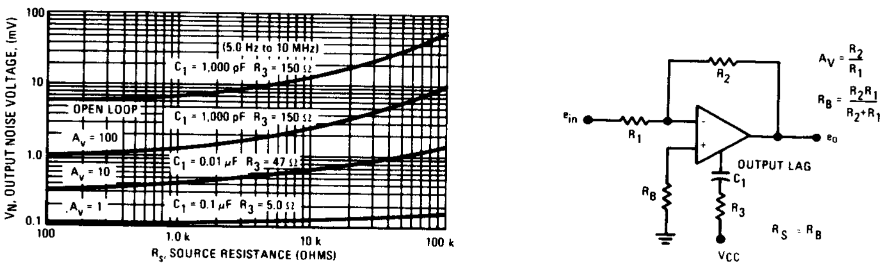
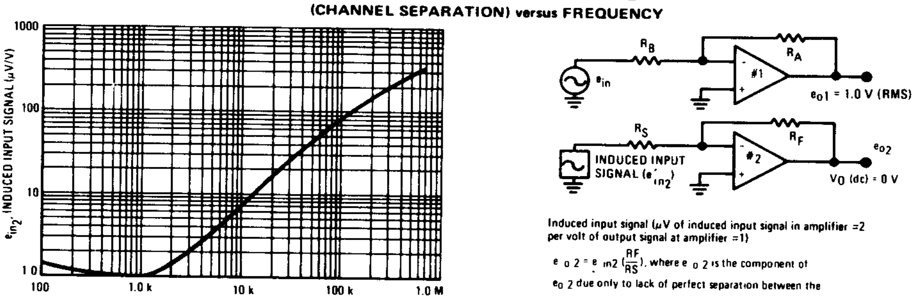


FIGURE 10 — INDUCED INPUT SIGNAL (CHANNEL SEPARATION) versus FREQUENCY



Induced input signal (µV of induced input signal in amplifier =2 per volt of output signal at amplifier =1)

$e_{o2} = e_{in2}\left(\frac{RF}{RS}\right)$, where e_{o2} is the component of e_{o2} due only to lack of perfect separation between the two amplifiers.