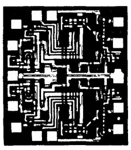
MC1535
MC1435

OPERATIONAL AMPLIFIERS

MONOLITHIC DUAL OPERATIONAL AMPLIFIERS



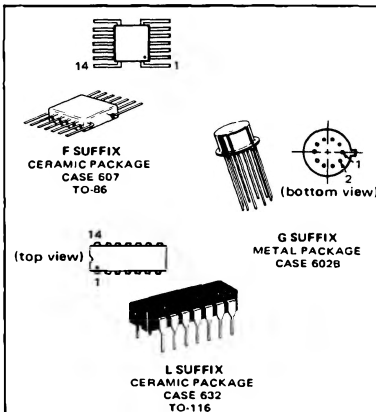
. . . designed for use as summing amplifiers, integrators, or amplifiers with operating characteristics as a function of the external feedback components. Ideal for chopper stabilized applications where extremely high gain is required with excellent stability.

Typical Amplifier Features:

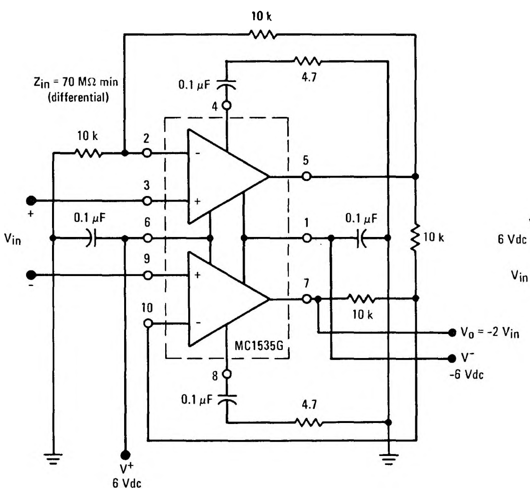
- High Open Loop Gain Characteristics – A_{VOL} = 7,000
- Low Temperature Drift – ±10 μV/°C
- Low Input Offset Voltage – 1.0mV
- Low Input Noise Voltage – 0.5μV

MONOLITHIC DUAL OPERATIONAL AMPLIFIERS INTEGRATED CIRCUIT

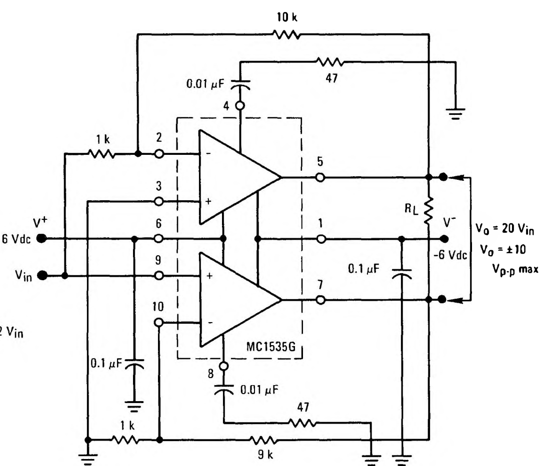
EPITAXIAL PASSIVATED



HIGH Z_{in}, DIFFERENTIAL TO SINGLE-ENDED AMPLIFIER

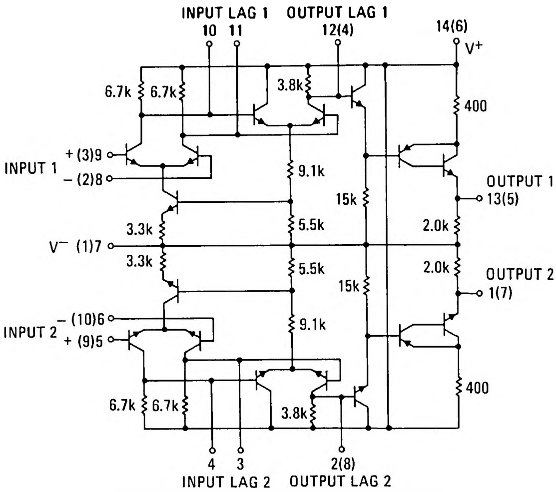


LARGE OUTPUT SWING CONFIGURATION (FLOATING LOAD)

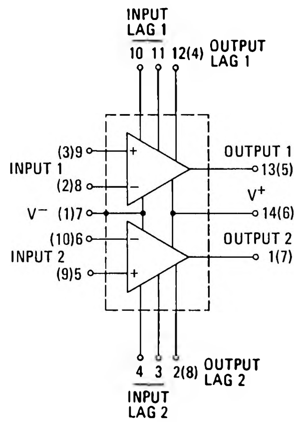


See Packaging Information Section for outline dimensions.

CIRCUIT SCHEMATIC



EQUIVALENT CIRCUIT



Number at end of terminal is pin number for ceramic packages.
Number in parenthesis is pin number for metal package. Input Lag available only in ceramic packages.

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

Rating		Symbol	MC1535	MC1435	Unit
Power Supply Voltage		V^+ V^-	+10 -10	+9.0 -9.0	Vdc
Differential Input Signal		V_{in}	±5.0	±5.0	Volts
Common-Mode Input Swing		CMV_{in}	+5.0 -4.0	+5.0 -4.0	Volts
Load Current		I_L	20	20	mA
Output Short Circuit Duration		T_{SC}	Continuous		
Power Dissipation (Package Limitation)		P_D			
Flat Ceramic Package	MC1535F, MC1435F		500		mW
Derate above T_A = +25°C			3.3		mW/°C
Metal Package	MC1535G, MC1435G		680		mW
Derate above T_A = +25°C			4.6		mW/°C
Ceramic Dual In-Line Package	MC1435L		625		mW
Derate above T_A = +25°C			5.0		mW/°C
Operating 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^+ = +6.0 Vdc, V^- = -6.0 Vdc, T_A = +25°C unless otherwise noted)

Characteristics	Symbol	MC1535 Min	MC1535 Typ	MC1535 Max	MC1435 Min	MC1435 Typ	MC1435 Max	Unit
Input Bias Current	I_b							
$I_b = \frac{I_1 + I_2}{2}$, T_A = +25°C		–	1.2	3.0	–	1.2	5.0	µAdc
$T_A = T_{low}$ to T_{high} ①		–	–	6.0	–	–	10	
Input Offset Current	$\lvert I_{io} \rvert$							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	$\lvert V_{io} \rvert$							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_p	10	45	–	10	45	–	kohms
Parallel Input Capacitance	C_p	–	6.0	–	–	–	–	pF
Common-Mode Input Impedance (f = 20 Hz)	$Z_{(in)}$	–	250	–	–	250	–	Meg ohms
Common-Mode Input Voltage Swing	CMV_{in}	+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 kohms, f = 1.0 kHz, BW = 1.0 Hz)	e_n	–	45	–	–	45	–	nV/(Hz)½
Common-Mode Rejection Ratio (f = 100 Hz)	CM_{rej}	-70	-90	–	-70	-90	–	dB
Open Loop Voltage Gain ($T_A = T_{low}$ to T_{high})	A_{VOL}	4,000	7,000	10,000	3,500	7,000	–	V/V
Power Bandwidth (A_V = 1, R_L = 2.0 kohms, THD ≤ 5%, V_o = 20 Vp-p)	P_{BW}	–	40	–	–	40	–	kHz
Unity Gain Crossover Frequency (open-loop)		–	1.0	–	–	1.0	–	MHz
Phase Margin (open-loop, unity gain)		–	75	–	–	75	–	degrees
Gain Margin		–	18	–	–	18	–	dB
Step Response								
Gain = 100, 30% overshoot,	t_f	–	0.3	–	–	0.3	–	µs
R1 = 4.7 kΩ, R2 = 470 kΩ,	t_{pd}	–	0.1	–	–	0.1	–	µs
R3 = 150 Ω, C1 = 1,000 pF	dV_{out}/dt ②	–	0.167	–	–	0.167	–	V/µs
Gain = 10, 10% overshoot,	t_f	–	1.9	–	–	1.9	–	µs
R1 = 47 kΩ, R2 = 470 kΩ,	t_{pd}	–	0.3	–	–	0.3	–	µs
R3 = 47 Ω, C1 = 0.01 µF	dV_{out}/dt ②	–	0.111	–	–	0.111	–	V/µs
Gain = 1, 5% overshoot,	t_f	–	27	–	–	27	–	µs
R1 = 47 kΩ, R2 = 47 kΩ,	t_{pd}	–	0.25	–	–	0.25	–	µs
R3 = 4.7 Ω, C1 = 0.1 µF	dV_{out}/dt ②	–	0.013	–	–	0.013	–	V/µs
Output Impedance (f = 20 Hz)	Z_{out}	–	1.7	–	–	1.7	–	kohms
Short-Circuit Output Current	I_{SC}	–	±17	–	–	±17	–	mAdc
Output Voltage Swing (R_L = 2.0 kohms)	V_o	±2.5	±2.8	–	±2.3	±2.7	–	Vp
Power Supply Sensitivity								µV/V
V^- = constant, R_s ≤ 10 kohms	S+	–	50	–	–	50	–	
V^+ = constant, R_s ≤ 10 kohms	S-	–	100	–	–	100	–	
Power Supply Current (Total)	I_D^+ I_D^-	– –	8.3 8.3	12.5 12.5	– –	8.3 8.3	15 15	mAdc
DC Quiescent Power Dissipation (Total) (V_o = 0)	P_D	–	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	$I_{b1}-I_{b2}$	–	±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)	$\frac{e_{out\,1}}{e_{out\,2}}$	–	-60	–	–	-60	–	dB

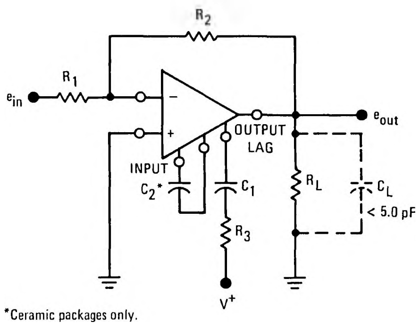
① T_{low}: 0°C for MC1435
-55°C for MC1535
T_{high}: +75°C for MC1435
+125°C for MC1535

② dV_{out}/dt = Slew Rate

TYPICAL OUTPUT CHARACTERISTICS

(V^+ = +6.0 Vdc, V^- = -6.0 Vdc, T_A = +25°C

FIGURE 1 – TEST CIRCUIT



*Ceramic packages only.

FIGURE NO.	CURVE NO.	VOLTAGE GAIN	TEST CONDITIONS					OUTPUT NOISE (mV rms)
			R_1(Ω)	R_2(Ω)	C_1(pF)	R_3(Ω)	C_2(pF)	
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	AVOL	100	∞	1,000	150	0	8.1
		or AVOL	100	∞	0	∞	510	8.1
	2	AVOL	100	∞	10,000	47	0	5.5
		or AVOL	100	∞	0	∞	5,000	5.5
	3	AVOL	100	∞	100,000	4.7	0	4.4
		or AVOL	100	∞	0	∞	50,000	4.4

FIGURE 2 – LARGE SIGNAL SWING versus FREQUENCY

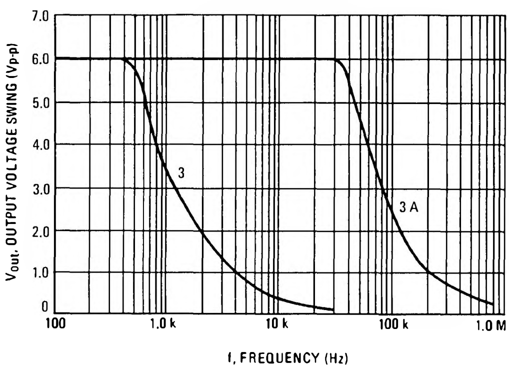


FIGURE 3 – VOLTAGE GAIN versus FREQUENCY

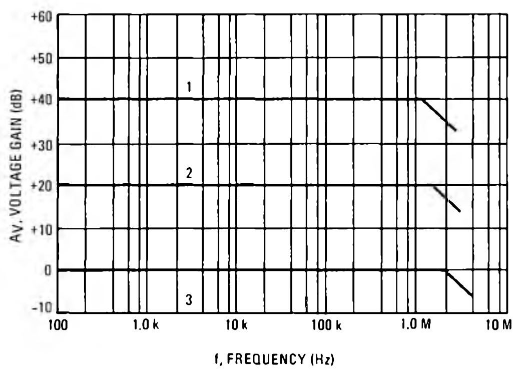


FIGURE 4 – OPEN LOOP VOLTAGE GAIN versus FREQUENCY

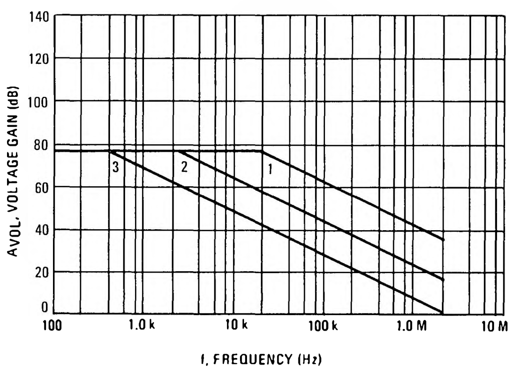


FIGURE 5 – INPUT OFFSET VOLTAGE versus TEMPERATURE

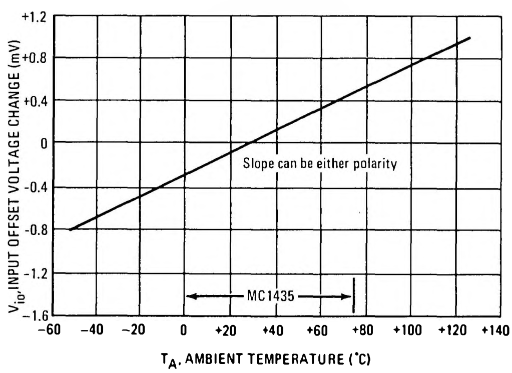


FIGURE 6 – VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

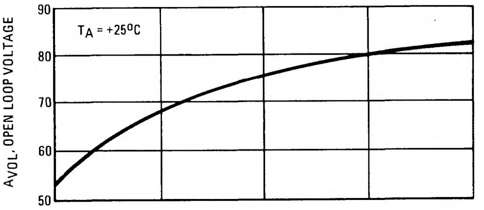


FIGURE 7 – COMMON MODE SWING versus POWER SUPPLY VOLTAGE

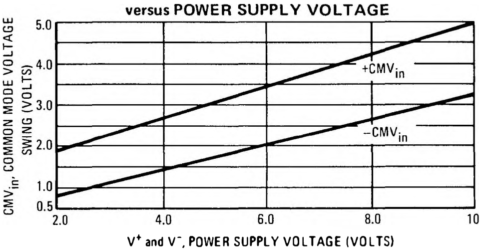


FIGURE 8 – POWER DISSIPATION versus POWER SUPPLY VOLTAGE

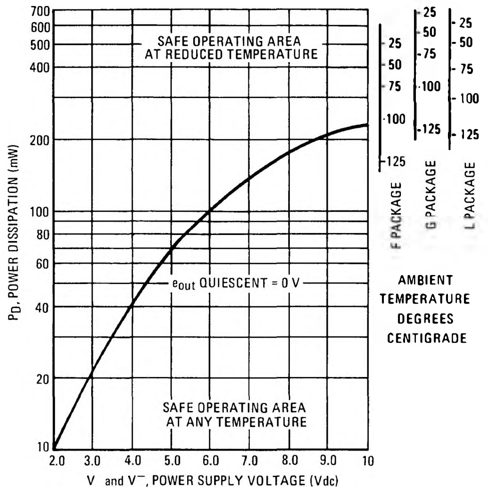
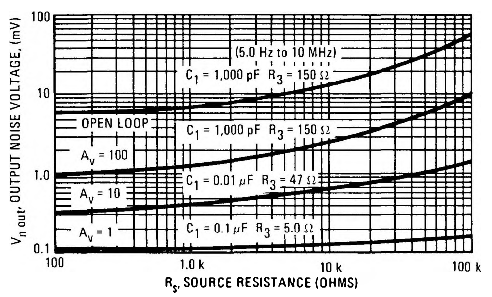


FIGURE 9 – OUTPUT WIDEBAND NOISE VOLTAGE versus SOURCE RESISTANCE



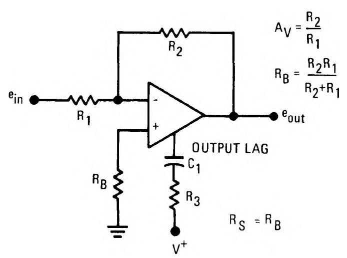
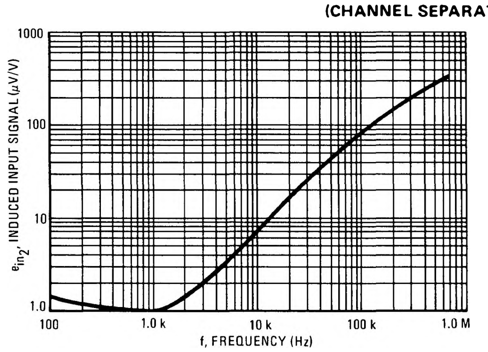
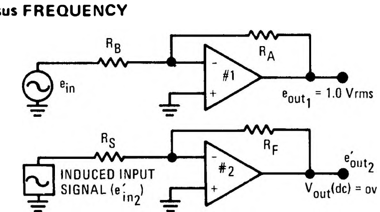


FIGURE 10 – INDUCED INPUT SIGNAL (CHANNEL SEPARATION) versus FREQUENCY





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

$e'_{out2} = e'_{in2} \left(\frac{R_F}{R_S}\right)$, where e'_{out2} is the component of e_{out_2} due only to lack of perfect separation between the two amplifiers.