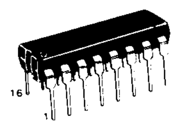
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

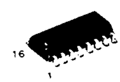
MC14573
MC14574
MC14575

CMOS MSI

QUAD PROGRAMMABLE OPERATIONAL AMPLIFIER
QUAD PROGRAMMABLE COMPARATOR
PROGRAMMABLE DUAL OP AMP/ DUAL COMPARATOR



P SUFFIX
PLASTIC DIP
CASE 648



D SUFFIX
SOG
CASE 751B

ORDERING INFORMATION

MC1457xP	Plastic DIP
MC1457xD	SOG Package

QUAD PROGRAMMABLE OEPRATIONAL AMPLIFIER
QUAD PROGRAMMABLE COMPARATOR
PROGRAMMABLE DUAL OP AMP/DUAL COMPARATOR

The MC14573, MC14574, and MC14575 are a family of quad operational low power amplifiers and comparators using the complementary P-channel and N-channel enhancement MOS devices in a single monolithic structure. The operating current is externally programmed with a resistor to provide a choice in the tradeoff of power dissipation and slew rates. The operational amplifiers are internally compensated.

These low cost units are excellent building blocks for consumer, industrial, automotive and instrument applications. Active filters, voltage reference, function generators, oscillators, limit set alarms, TTL-to-CMOS or CMOS-to-CMOS up converters, A-to-D converters and zero crossing detectors are some applications. These units are useful in both battery and line operated systems.

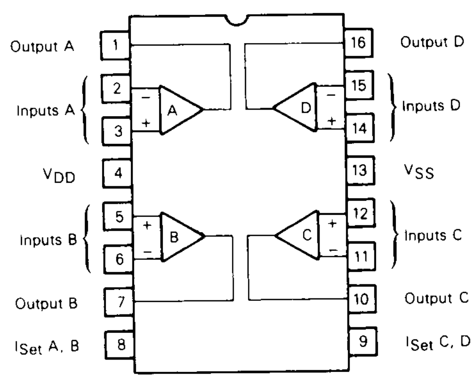
- Operating Temperature Range: −40 to 85°C
- Power Supply — Single 3.0 to 15 V
  Dual ±1.5 to ±7.5 V
- Wide Input Voltage Range
- Common Mode Range 0.0 to V_{DD} − 2.0 V for Single Supply
- Externally Programmable Power Consumption with One or Two Resistors
- Internally Compensated Operational Amplifiers
- High Input Impedance
- Comparators — JEDEC B-Series Compatible
- Chip Complexities: MC14573 — 30 FETs
  MC14574 — 46 FETs
  MC14575 — 38 FETs

PIN ASSIGNMENT

MC14573
Quad Op Amplifier

MC14574
Quad Comparator

MC14575
Dual Op Amplifier (A & B) plus
Dual Comparator (C & D)



MAXIMUM RATINGS† (Voltages referenced to V_{SS})

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	−0.5 to +18	V
Input Voltage, All Inputs	V_{in}	−0.5 to V_{DD} +0.5	V
DC Input Current, per Pin	I_{in}	±10	mA
Programming Current Range	I_{Set}	2	mA
Operating Temperature Range	T_A	−40 to +85	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Package Power Dissipation*	P_D	800	mW

*Derate above 25°C @ 4.6 mW/°C

†Maximum Ratings are those values beyond which damage to the device may occur.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$

RECOMMENDED OPERATING RANGE

Rating		Symbol	Value	Unit
DC Supply Voltage		V_{DD} to V_{SS}	+3.0 to +15	V
Programming Current	V_{DD} = 3 V	I_{Set}	2 to 50	μA
	5 V < V_{DD} < 15 V		2 to 750	

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OPERATIONAL AMPLIFIER ELECTRICAL CHARACTERISTICS

(I_{Set} = 20 μA, R_L = 10 MΩ, C_L = 15 pF, T_A = 25°C, unless otherwise indicated, Voltages Referenced to V_{SS})

Characteristic	Symbol	V_{DD} V	Min	Typ#	Max	Unit
Input Common Mode Voltage Range	V_{ICR}	3	0	–	1.5	V
		5	0	–	3.5	
		10	0	–	8.5	
		15	0	–	13.5	
Output Voltage Range R_L = 1 MΩ to V_{SS}	V_{OR}	3	0.05	–	2.95	V
		5	0.05	–	4.95	
		10	0.05	–	9.95	
		15	0.05	–	14.90	
Input Offset Voltage MC14573, MC14575	V_{IO}	3	–	±5	±30	mV
		5	–	±8	±30	
		10	–	±10	±30	
		15	–	±10	±30	
Average Temperature Coefficient of V_{IO}	$\Delta V_{IO}/\Delta T$	–	–	15	–	μV/°C
Input Capacitance	C_{in}	–	–	5	10	pF
Input Bias Current	I_{IB}	–	–	1	50	pA
Input Bias Current T_A = −40°C to +85°C	I_{IB}	–	–	–	1	nA
Input Offset Current	I_{IO}	–	–	–	100	pA
Open Loop Voltage Gain V_O = 1 V p-p	A_{VOL}	3	2	8	–	V/mV
V_O = 3 V p-p		5	5	10	–	
V_O = 6 V p-p		10	8	12	–	
V_O = 9 V p-p		15	8	12	–	
Power Supply Rejection Ratio MC14573, MC14575	PSRR	3	45	57	–	dB
		5	54	67	–	
		10	54	67		
		15	54	67	–	
Common Mode Rejection Ratio MC14573, MC14575	CMRR	3	45	70	–	dB
		5	50	73	–	
		10	54	75	–	
		15	54	75	–	
Output Source Current V_{OH} = V_{DD} −0.6 V	I_{OH}	5	55	80	–	μA
Output Sink Current V_{OL} = 0.4 V	I_{OL}	3	2.1	4.2	–	mA
V_{in+} = $V_{DD}/2+0.5$ V_{OL} = 0.4 V		5	2.5	5.0	–	
V_{in-} = $V_{DD}/2-0.5$ V_{OL} = 0.5 V		10	5.5	11.0	–	
V_{OL} = 1.5 V		15	15	30	–	
Slew Rate	S_R	–	0.6	0.8	–	V/μs
Unity Gain Bandwidth	G_{BW}	5	0.5	1	–	MHz
Phase Margin	φM	–	–	45	–	Degrees
Channel Separation	–	–	–	80	–	dB
Supply Current, Per Pair R_L = ∞, I_{Set} = 20 μA, V_{in+} = 1.0 V, V_{in-} = 0 V)	I_{DD}	5	–	260	340	μA
(R_L = ∞, Pins 8 and 9 = V_{DD})		15	–	0.05	1.0	

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

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OPERATIONAL AMPLIFIER ELECTRICAL CHARACTERISTICS

(I_{Set} = 200 µA, R_L = 10 MΩ, C_L = 15 pF, T_A = 25°C, unless otherwise indicated, Voltages Referenced to V_{SS})

Characteristic		Symbol	V_{DD} V	Min	Typ#	Max	Unit
Input Common Mode Voltage Range		V_{ICR}	5 10 15	0 0 0	– – –	3 8 13	V
Output Voltage Range R_L = 100 k to V_{SS}		V_{OR}	5 10 15	0.1 0.1 0.1	– – –	4.8 9.8 14.8	V
Input Offset Voltage MC14573, MC14575		V_{IO}	5 10 15	– – –	± 8 ± 10 ± 12	± 30 ± 30 ± 30	mV
Average Temperature Coefficient of V_{IO}		$\Delta V_{IO}/\Delta T$	–	–	20	–	µV/°C
Input Capacitance		C_{in}	–	–	5	10	pF
Input Bias Current		I_{IB}	–	–	1	50	pA
Input Bias Current	T_A = – 40°C to + 85°C	I_{IB}	–	–	–	1	nA
Input Offset Current		I_{IO}	–	–	–	100	pA
Open Loop Voltage Gain	V_O = 3 V p-p V_O = 6 V p-p V_O = 9 V p-p	A_{VOL}	5 10 15	1 1 1	2 3 4	– – –	V/mV
Power Supply Rejection Ratio MC14573, MC14575		PSRR	5 10 15	45 54 54	54 67 67	– – –	dB
Common Mode Rejection Ratio MC14573, MC14575		CMRR	5 10 15	40 50 50	55 67 70	– – –	dB
Output Source Current	V_{OH} = V_{DD} – 1.5 V	I_{OH}	15	550	800	–	µA
Output Sink Current	V_{OL} = 0.4 V V_{OL} = 0.5 V V_{OL} = 1.5 V	I_{OL}	5 10 15	2.2 5.0 15	4.2 10.0 30	– – –	mA
Slew Rate		S_R	–	5	7	–	V/µs
Unity Gain Bandwidth		G_{BW}	5	1.5	3	–	MHz
Phase Margin		φM	–	–	48	–	Degrees
Channel Separation		–	–	–	80	–	dB
Supply Current, Per Pair	(R_L = ∞, V_{in+} = 1.0 V, V_{in-} = 0 V)	I_{DD}	15	–	2.6	3.4	mA

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COMPARATOR ELECTRICAL CHARACTERISTICS

(I_{Set} = 20 μA, R_L = 10 MΩ, C_L = 50 pF, T_A = 25°C, unless otherwise indicated, Voltages Referenced to V_{SS})

Characteristic		Symbol	V_{DD} V	Min	Typ #	Max	Unit
Input Common Mode Voltage Range		V_{ICR}	3	0	–	1.5	V
			5	0	–	3.5	
			10	0	–	8.5	
			15	0	–	13.5	
Output Voltage Range "0" Level		V_{OL}	3	–	0	0.05	V
			5	–	0	0.05	
			10	–	0	0.05	
			15	–	0	0.05	
Output Voltage Range "1" Level		V_{OH}	3	2.95	3	–	V
			5	4.95	5	–	
			10	9.95	10	–	
			15	14.95	15	–	
Input Offset Voltage MC14574, MC14575		V_{IO}	3	–	±8	±30	mV
			5	–	±8	±30	
			10	–	±10	±30	
			15	–	±10	±30	
Average Temperature Coefficient of V_{IO}		$\Delta V_{IO}/\Delta T$	–	–	15	–	μV/°C
Input Capacitance		C_{in}	–	–	5	10	pF
Input Bias Current		I_{IB}	–	–	1	50	pA
Input Bias Current	T_A = −40°C to +85°C	I_{IB}	–	–	–	1	nA
Input Offset Current		I_{IO}	–	–	–	100	pA
Open Loop Voltage Gain	V_O = 1 Vp-p	A_{VOL}	3	1	20	–	V/mV
	V_O = 3 Vp-p		5	1	10	–	
	V_O = 6 Vp-p		10	1	6	–	
	V_O = 9 Vp-p		15	1	6	–	
Power Supply Rejection Ratio MC14574, MC14575		PSRR	3	45	57	–	dB
			5	54	67	–	
			10	54	67	–	
			15	54	67	–	
Common Mode Rejection Ratio MC14574, MC14575		CMRR	3	45	55	–	dB
			5	50	65	–	
			10	54	67	–	
			15	54	67	–	
Output Source Current	V_{OH} = 2.6 V	I_{OH}	3	−0.35	−0.65	–	mA
	V_{OH} = 2.5 V		5	−2.5	−5.0	–	
	V_{OH} = 4.6 V		5	−0.60	−1.1	–	
	V_{OH} = 9.5 V		10	−1.3	−2.5	–	
	V_{OH} = 13.5 V		15	−5.0	−9.5	–	
Output Sink Current	V_{OL} = 0.4 V	I_{OL}	3	1.3	2.6	–	mA
	V_{OL} = 0.4 V		5	1.9	3.8	–	
	V_{OL} = 0.5 V		10	3.5	6.5	–	
	V_{OL} = 1.5 V		15	14	25	–	
Output Rise and Fall Time, 100 mV Overdrive		t_{TLH}, t_{THL}	3	–	140	250	ns
			5	–	100	180	
			10	–	120	200	
			15	–	140	250	
Propagation Delay Time, 5 mV Overdrive		t_d	3	–	15	30	μs
			5	–	10	20	
			10	–	12	24	
			15	–	15	30	
Propagation Delay Time, 100 mV Overdrive		t_d	3	–	4	8	μs
			5	–	2	4	
			10	–	3	6	
			15	–	4	8	
Channel Separation		–	–	–	80	–	dB
Supply Current, Per Pair (R_L = ∞, I_{Set} = 20 μA, V_{in+} = 1.0 V, V_{in-} = 0 V)		I_{DD}	5	–	180	250	μA

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COMPARATOR ELECTRICAL CHARACTERISTICS

(I_{Set} = 200 μA, R_L = 10 MΩ, C_L = 50 pF, T_A = 25°C, unless otherwise indicated, Voltages Referenced to V_{SS})

Characteristic		Symbol	V_{DD} V	Min	Typ#	Max	Unit
Input Common Mode Voltage Range		V_{ICR}	5 10 15	0 0 0	– – –	3 8 13	V
Output Voltage Range "0" Level		V_{OL}	5 10 15	– – –	0 0 0	0.05 0.05 0.05	V
Output Voltage Range "1" Level		V_{OH}	5 10 15	4.95 9.95 14.95	5 10 15	– – –	V
Input Offset Voltage MC14574, MC14575		V_{IO}	5 10 15	– – –	±10 ±13 ±15	±30 ±30 ±30	mV
Average Temperature Coefficient of V_{IO}	T_A = –40°C to +85°C	$\Delta V_{IO}/\Delta T$	–	–	20	–	μV/°C
Input Capacitance		C_{in}	–	–	5	10	pF
Input Bias Current		I_{IB}	–	–	1	50	pA
Input Bias Current	T_A = –40°C to +85°C	I_{IB}	–	–	–	1	nA
Input Offset Current		I_{IO}	–	–	–	100	pA
Open Loop Voltage Gain	V_O = 3 Vp-p V_O = 6 Vp-p V_O = 9 Vp-p	A_{VOL}	5 10 15	2 1 1	7 4 4	– – –	V/mV
Power Supply Rejection Ratio MC14574, MC14575		PSRR	5 10 15	45 54 54	67 67 67	– – –	dB
Common Mode Rejection Ratio MC14574, MC14575		CMRR	5 10 15	40 50 50	65 67 67	– – –	dB
Output Source Current	V_{OH} = 2.5 V V_{OH} = 4.6 V V_{OH} = 9.5 V V_{OH} = 13.5 V	I_{OH}	5 5 10 15	–2.5 –0.60 –1.3 –5.0	–5.0 –1.1 –2.5 –9.5	– – – –	mA
Output Sink Current	V_{OL} = 0.4 V V_{OL} = 0.5 V V_{OL} = 1.5 V	I_{OL}	5 10 15	1.9 3.5 14	3.8 6.5 25	– – –	mA
Output Rise and Fall Time, 100 mV Overdrive		t_{TLH}, t_{THL}	5 10 15	– – –	75 50 45	150 100 90	ns
Propagation Delay Time, 5 mV Overdrive		t_d	5 10 15	– – –	2.5 3.5 5	5.0 7 10	μs
Propagation Delay Time, 100 mV Overdrive		t_d	5 10 15	– – –	0.6 0.75 0.75	1.2 1.5 1.5	μs
Channel Separation		–	–	–	80	–	dB
Supply Current, Per Pair	(R_L = ∞, V_{in+} = 1.0 V, V_{in-} = 0 V)	I_{DD}	15	–	1.8	2.5	mA

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The programming current I_{Set} is fixed by an external resistor R_{Set} connected between V_{SS} and either one or both of the I_{Set} pins (8 and 9). When two external programming resistors are used, the set currents for each op amp pair or comparator are given by:

$$I_{Set}\ (\mu A) \approx \frac{V_{DD} - V_{SS} - 1.5}{R_{Set}\ (M\Omega)}$$

Pins 8 and 9 may be tied together for use with a single programming resistor. The set currents for each op amp pair or comparator pair are then given by:

$$I_{Set}\ A,\ B = I_{Set}\ C,\ D\ (\mu A) \approx \frac{V_{DD} - V_{SS} - 1.5}{2\ R_{Set}\ (M\Omega)}$$

The total device current is typically 13 times I_{Set} per pair if the outputs are in the low state, and 5 times I_{Set} per pair if the outputs are in the high state. For op amps with an output in the linear region the device current will be between the values of 5 times and 13 times I_{Set}.

If a pair of op amps is not used, the I_{Set} pin for that pair may be tied to V_{DD} for minimum power consumption. To minimize power consumption in an unused pair of comparators this is not effective. The comparators should use a high value set resistor and the inputs should be set to a voltage that will force the output to V_{DD} (i.e., $+in = V_{DD}$, $-in = V_{SS}$).

It should be noted that increasing I_{Set} for comparators will decrease propagation delay for that comparator.

For operational amplifiers, the maximum obtainable output voltage (V_{OH}) for a given load resistor connected to V_{SS} is given by:

$$V_{OH} = 4 \times I_{Set} \times R_L - 0.05\ V,\ R_L \text{ in } \Omega,\ I_{Set} \text{ in A}$$

Note: V_{OH} Max $= V_{DD}$

Typical op amp slew rates are given by:

$$S_R \approx 0.04\ I_{Set}\ (V/\mu s),\ I_{Set} \text{ in } \mu A$$

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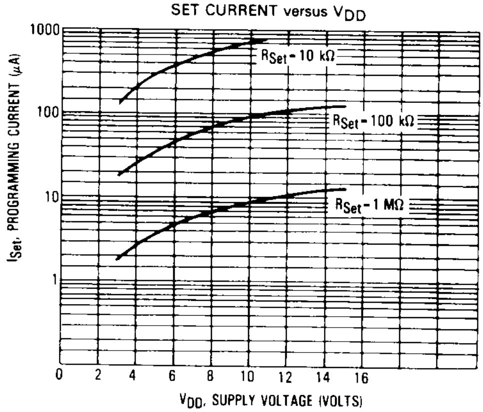
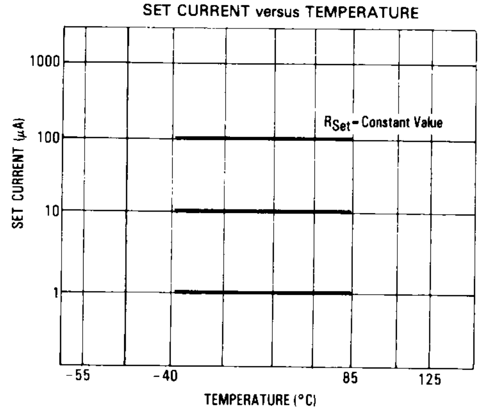
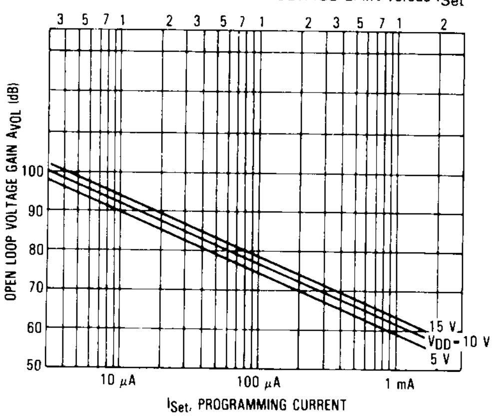
SET CURRENT versus V_{DD}



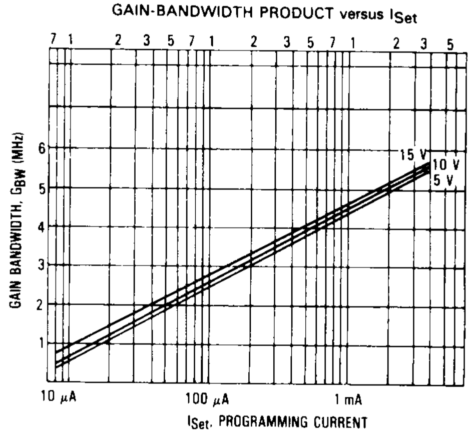
SET CURRENT versus TEMPERATURE



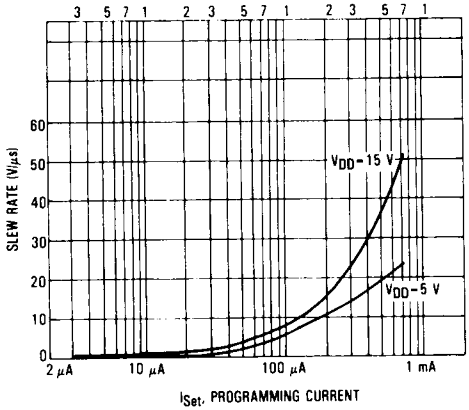
LOW FREQUENCY OPEN LOOP VOLTAGE GAIN versus I_{Set}



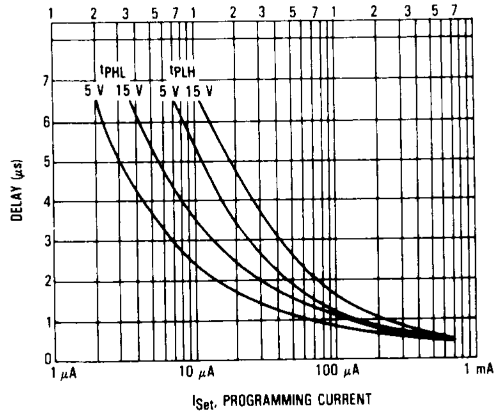
GAIN-BANDWIDTH PRODUCT versus I_{Set}



SLEW RATE versus I_{Set}



COMPARATOR PROPAGATION DELAY versus I_{Set}
(±50 mV OVERDRIVE)



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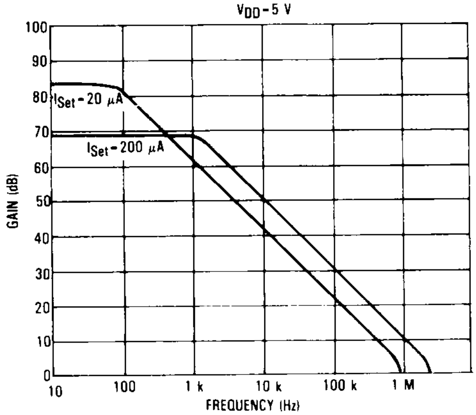
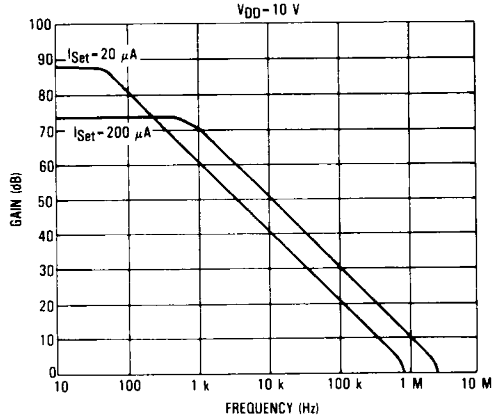
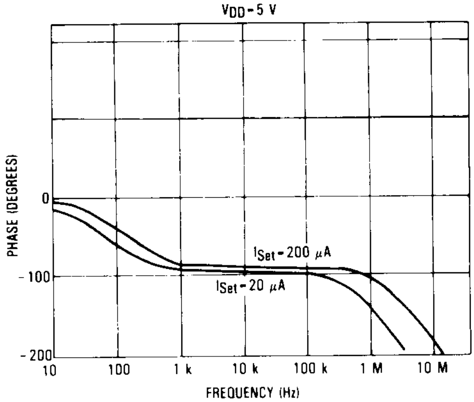
OPEN LOOP GAIN versus FREQUENCY
V_{DD} = 5 V



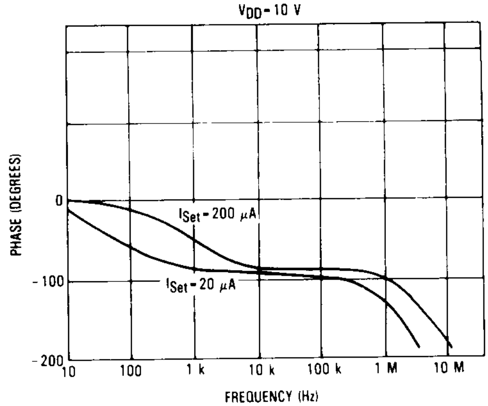
OPEN LOOP GAIN versus FREQUENCY
V_{DD} = 10 V



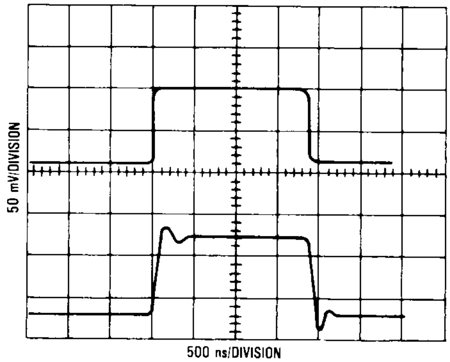
OPEN LOOP PHASE DELAY versus FREQUENCY
V_{DD} = 5 V



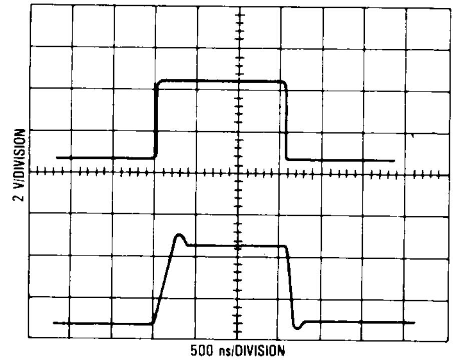
OPEN LOOP PHASE DELAY versus FREQUENCY
V_{DD} = 10 V



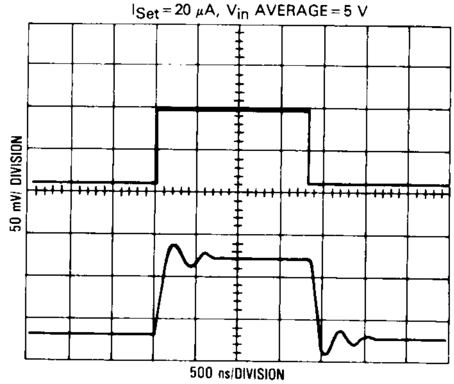
SMALL SIGNAL TRANSIENT RESPONSE
V_{DD} = 10 V NON-INVERTING UNITY GAIN
I_{Set} = 200 µA, V_{in} AVERAGE = 5 V



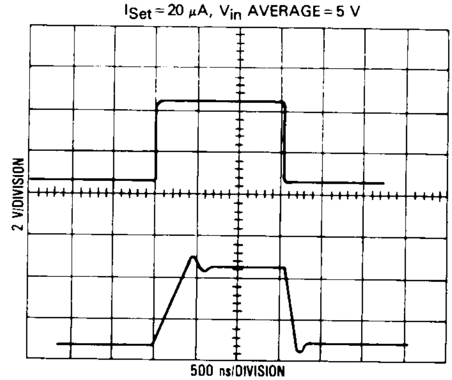
LARGE SIGNAL TRANSIENT RESPONSE
V_{DD} = 10 V NON-INVERTING UNITY GAIN
I_{Set} = 200 µA, V_{in} AVERAGE = 5 V



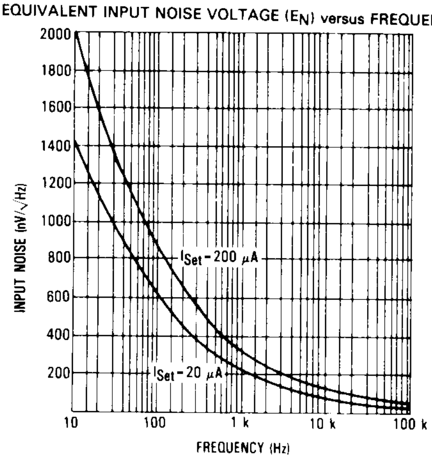
SMALL SIGNAL TRANSIENT RESPONSE
V_{DD} = 10 V NON-INVERTING UNITY GAIN
I_{Set} = 20 µA, V_{in} AVERAGE = 5 V



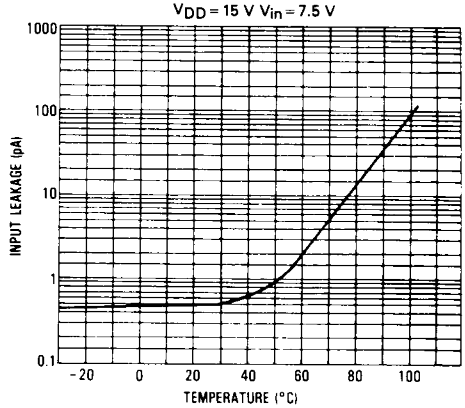
LARGE SIGNAL TRANSIENT RESPONSE
V_{DD} = 10 V NON-INVERTING UNITY GAIN
I_{Set} = 20 µA, V_{in} AVERAGE = 5 V



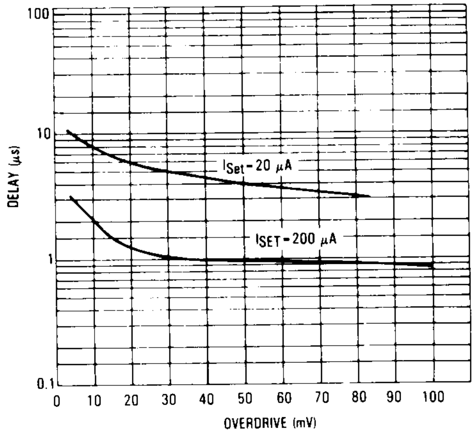
EQUIVALENT INPUT NOISE VOLTAGE (E_N) versus FREQUENCY



TYPICAL INPUT LEAKAGE versus TEMPERATURE
V_{DD} = 15 V V_{in} = 7.5 V

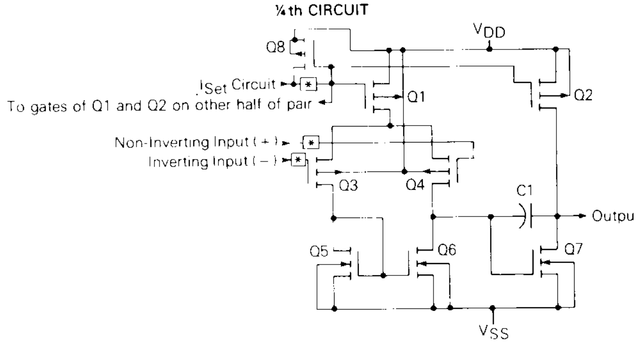


COMPARATOR PROPAGATION DELAY versus OVERDRIVE*
V_{DD} = 10 V, t_{PLH} and t_{PHL}



*A 10 mV overdrive is a signal on one input of a comparator that ranges from 10 mV less than the other input to 10 mV more than the other input.

OPERATIONAL AMPLIFIER SCHEMATIC
¼th CIRCUIT



COMPARATOR SCHEMATIC
¼th CIRCUIT