



PROGRAMMABLE QUAD OPERATIONAL AMPLIFIERS

- PROGRAMMABLE ELECTRICAL CHARACTERISTICS
- BATTERY POWERED OPERATION
- LOW SUPPLY CURRENT (250 μ A/amplifier)
- GAIN-BANDWIDTH PRODUCT : 1 MHz
- LARGE DC VOLTAGE GAIN : 120 dB
- LOW NOISE VOLTAGE : 28 nV/ $\sqrt{\text{Hz}}$
- WIDE POWER SUPPLY RANGE : ± 1.5 V TO ± 22 V
- CLASSE AB OUTPUT STAGE. NO CROSS-OVER DISTORTION
- OVERLOAD PROTECTION FOR INPUTS AND OUTPUTS

DESCRIPTION

The LM346 consists of four independent, high gain, internally compensated, low power programmable amplifiers. Two external resistors (R_{set}) allow the user to program the gain-bandwidth product, slew rate, supply current, input bias current, input offset current and input noise. For example the user can trade-off supply current for bandwidth or optimize noise figure for a given source resistance. In a similar way other amplifier characteristics can be tailored to the application.

Except for the two programming pins at the end of the package the LM346 pin out is the same as the LM324 and LM348.

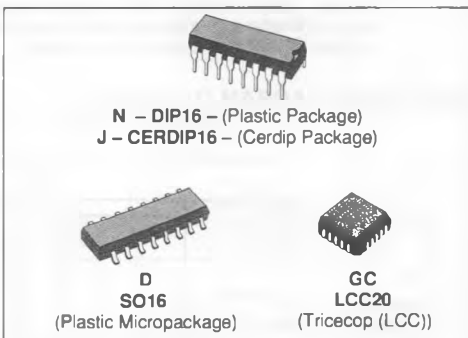
PROGRAMMING EQUATIONS :

Total supply current = 1 mA ($I_{\text{set}} = 10 \mu\text{A}$)

Gain-bandwidth product = 1 MHz ($I_{\text{set}} = 10 \mu\text{A}$)

Slew rate = 0.5 V/ μ s ($I_{\text{set}} = 10 \mu\text{A}$)
Input bias current ≈ 30 nA ($I_{\text{set}} = 10 \mu\text{A}$)
 I_{set} = current into pin 8 and pin 9 (see schematic diagram)

$$I_{\text{set}} = \frac{V_{\text{oc}} - V_{\text{cc}} - 0.6 \text{ V}}{R_{\text{set}}}$$



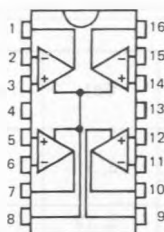
ORDER CODES

Part Number	Temperature Range	Package			
		N	J	D	GC
LM146	- 55 °C to + 125 °C	•	•		•
LM246	- 40 °C to + 105 °C	•	•	•	
LM346	0 °C to + 70 °C	•	•	•	

Note : Hi-rel Versions Available
Examples : LM146J, LM246N

PIN CONNECTIONS (top views)

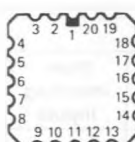
**DIP16 / CERDIP16
SO16**



- 1 - Output 1
- 2 - Inverting input 1
- 3 - Non-inverting input 1
- 4 - V_{cc}
- 5 - Non-inverting input 2
- 6 - Inverting input 2
- 7 - Output 2
- 8 - Set
- 9 - Set
- 10 - Output 3
- 11 - Inverting input 3
- 12 - Non-inverting input 3
- 13 - V_{cc}
- 14 - Non-inverting input 4
- 15 - Inverting input 4
- 16 - Output 4

E88LM146-01

LCC20



- 1 - NC
- 2 - Output 1
- 3 - Inverting input 1
- 4 - Non-inverting input 1

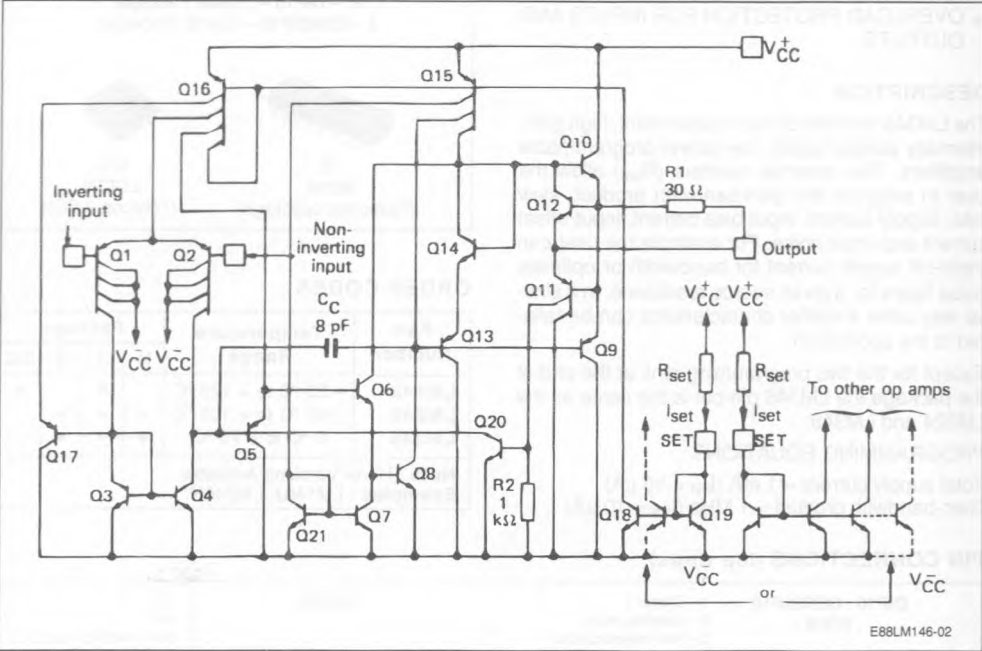
- 5 - V_{cc}
- 6 - NC
- 7 - Non-inverting input 2
- 8 - Inverting input 2
- 9 - Output 2
- 10 - Set 1, 2, 4
- 11 - NC
- 12 - Set 3
- 13 - Output 3
- 14 - Inverting input 3
- 15 - Non-inverting input 3
- 16 - NC
- 17 - V_{cc}
- 18 - Non-inverting input 4
- 19 - Inverting input 4
- 20 - Output 4

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM146	LM246	LM346	Unit
V _{CC}	Supply Voltage	± 22	± 22	± 22	V
V _I	Input Voltage (note 1)	± 15	± 15	± 15	V
V _{ID}	Differential Input Voltage	± 30	± 30	± 30	V
	Output Short-circuit Duration (note 2)	Indefinite	Indefinite	Indefinite	
P _{tot}	Power Dissipation	N/D Suffix GC Suffix J Suffix 665 900	500 900	500 900	mW
T _{oper}	Operating Free-air Temperature Range	− 55 to + 125	− 40 to + 105	0 to + 70	°C
T _{stg}	Storage Temperature Range	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

Notes : 1. For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.
2. Any of the amplifier outputs can be shorted to ground indefinitely ; however more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

SCHEMATIC DIAGRAM (1/4 LM146)



Case	Inverting Inputs	Non-Inverting Inputs	V _{CC}	V _{CC}	Outputs	Set	N.C.
DIP16 CERDIP16 SO16	3, 5, 12, 14	2, 6, 11, 15	13	4	1, 7, 10, 16	8, 9	
LCC 20	3, 8, 14, 19	4, 7, 15, 18	17	5	2, 9, 13, 20	10, 12	*

* LCC20 : Other pins are not connected.

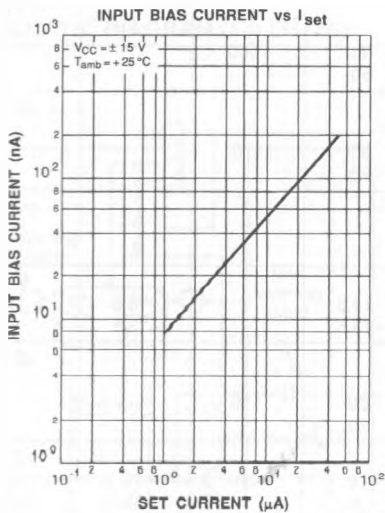
ELECTRICAL CHARACTERISTICS

LM346 : $0^{\circ}\text{C} \leq T_{\text{amb}} \leq +70^{\circ}\text{C}$, $V_{\text{CC}} = \pm 15\text{ V}$, $I_{\text{set}} = 10\text{ }\mu\text{A}$ LM246 : $-40^{\circ}\text{C} \leq T_{\text{amb}} \leq +105^{\circ}\text{C}$, $V_{\text{CC}} = \pm 15\text{ V}$, $I_{\text{set}} = 10\text{ }\mu\text{A}$ LM146 : $-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +125^{\circ}\text{C}$, $V_{\text{CC}} = \pm 15\text{ V}$, $I_{\text{set}} = 10\text{ }\mu\text{A}$

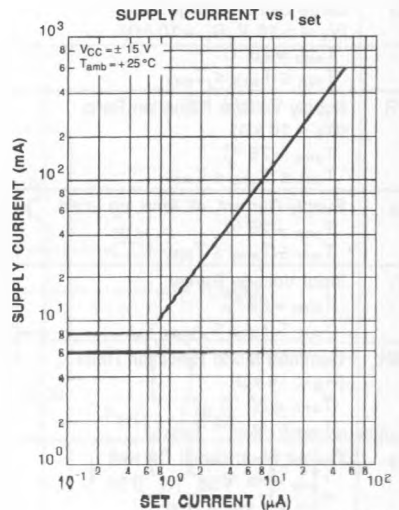
Symbol	Parameter	LM146-LM246-LM346			Unit
		Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_{\text{S}} \leq 10\text{ k}\Omega$) $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		0.5	3 5	mV
I_{IO}	Input Offset Current $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		2	20 25	nA
I_{IB}	Input Bias Current $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		30	100 100	nA
A_{vd}	Large Signal Voltage Gain ($V_{\text{O}} = \pm 10\text{ V}$, $R_{\text{L}} = 10\text{ k}\Omega$) $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	100 50	1000		V/mV
SVR	Supply Voltage Rejection Ratio ($R_{\text{S}} \leq 10\text{ k}\Omega$) $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	80 80	110		dB
I_{CC}	Supply Current, all Amp, no Load $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		1	2 2	mA
V_{I}	Input Voltage Range $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	-13.5 -13.5		+13.5 +13.5	V
CMR	Common Mode Rejection Ratio ($R_{\text{S}} \leq 10\text{ k}\Omega$) $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	80 70	110		dB
I_{OS}	Output Short-circuit Current $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	10 4	20	30 35	mA
$\pm V_{\text{opp}}$	Output Voltage Swing $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ $R_{\text{L}} = 10\text{ k}\Omega$ $R_{\text{L}} = 10\text{ k}\Omega$	12 12	14		V
S_{vo}	Slew-rate ($V_{\text{I}} = \pm 10\text{ V}$, $R_{\text{L}} = 10\text{ k}\Omega$, $C_{\text{L}} \leq 100\text{ pF}$, $T_{\text{amb}} = 25^{\circ}\text{C}$, Unity Gain)	0.3	0.5		V/ μs
R_{I}	Input Resistance, $T_{\text{amb}} = 25^{\circ}\text{C}$		1		M Ω
C_{I}	Input Capacitance, $T_{\text{amb}} = 25^{\circ}\text{C}$		2		pF

ELECTRICAL CHARACTERISTICS (continued)

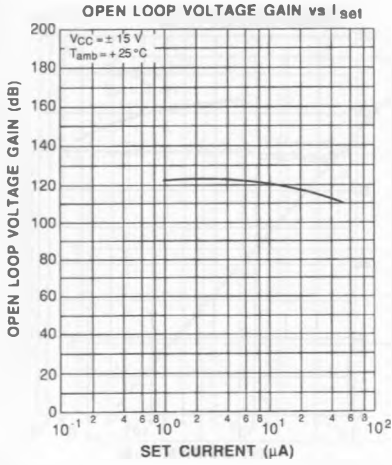
Symbol	Parameter	LM146-LM246-LM346			Unit
		Min.	Typ.	Max.	
V_{O1}/V_{O2}	Channel Separation ($R_L \geq 10\text{ K}\Omega$) ($V_o = 12\text{ V}_{pp}$)		120		dB
GPB	Gain Bandwidth Product ($V_i = 10\text{ mV}$, $R_L = 10\text{ K}\Omega$, $C_L \leq 100\text{ pF}$ $f = 100\text{ KHz}$, $T_{amb} = 25^\circ\text{C}$)	0.8	1	1.6	MHz
THD	Total Harmonic Distortion ($f = 1\text{ KHz}$, $A_v = 20\text{ dB}$, $R_L = 10\text{ K}\Omega$ $C_L \leq 100\text{ pF}$, $T_{amb} = 25^\circ\text{C}$, $V_o = 2\text{ V}_{pp}$)		0.015		%
V_n	Equivalent Input Noise Voltage ($f = 1\text{ KHz}$, $R_g = 100\text{ }\Omega$)		28		$\text{nV}/\sqrt{\text{Hz}}$



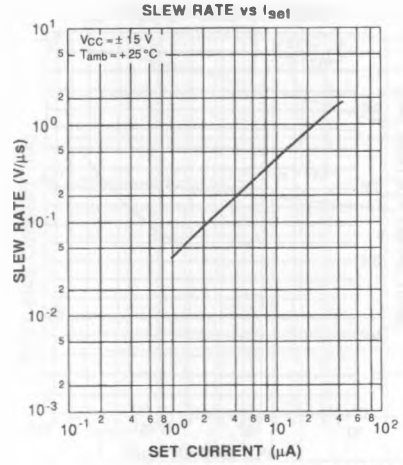
E88LM146-03



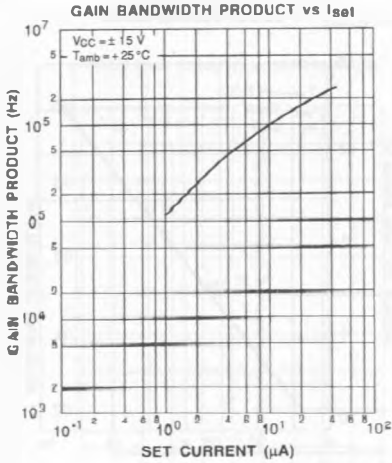
E88LM146-04



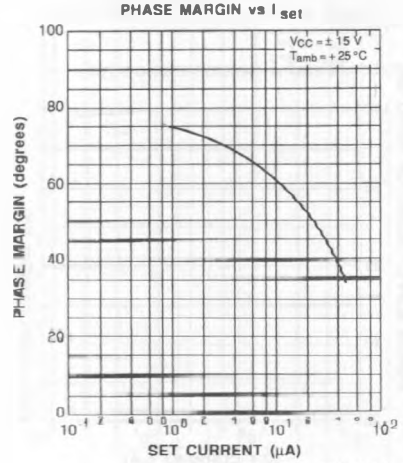
E88LM146-05



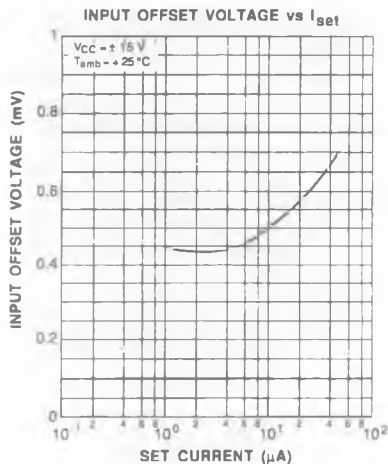
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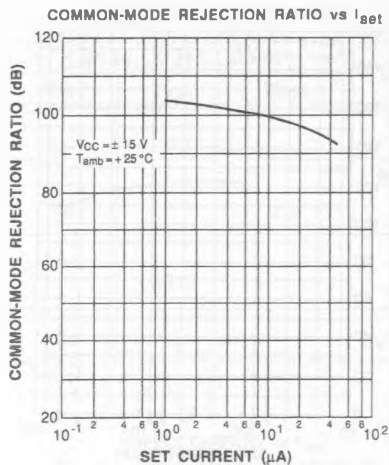
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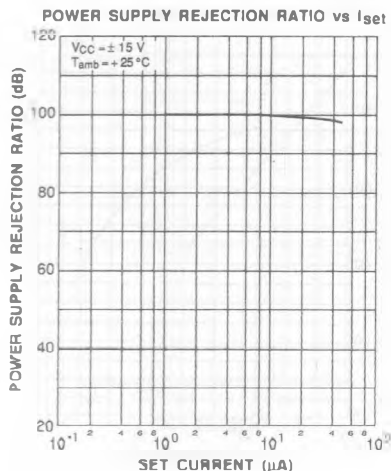
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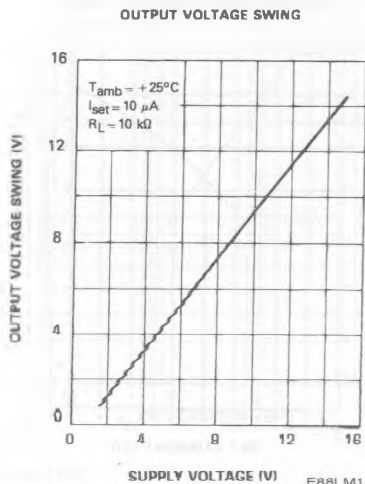
E88LM146-09



E88LM146-10

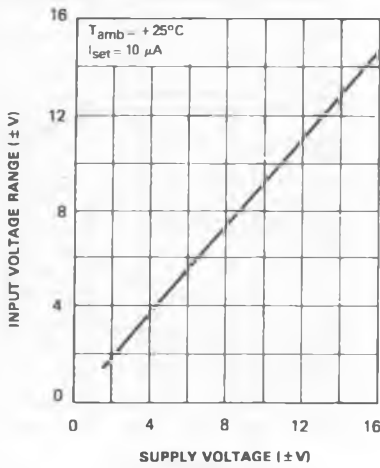


E88LM146-11



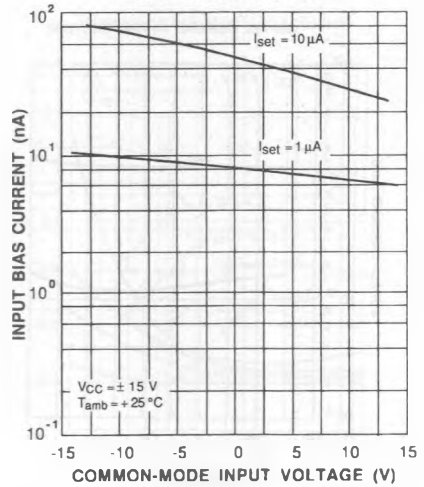
E88LM146-12

INPUT VOLTAGE RANGE



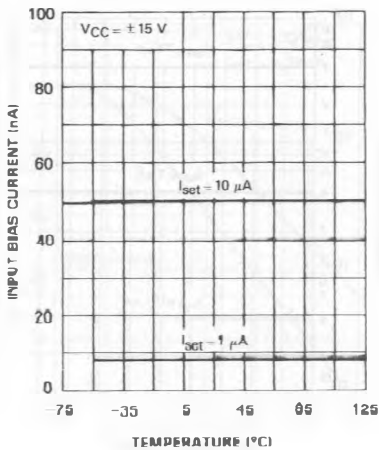
E88LM146-13

INPUT BIAS CURRENT



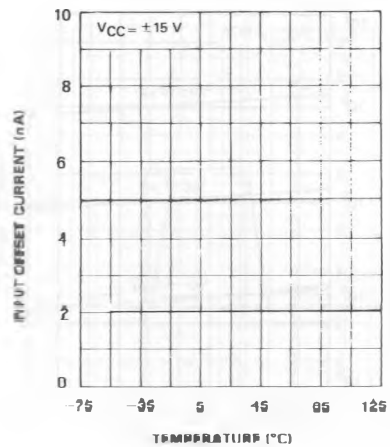
E88LM146-14

INPUT BIAS CURRENT vs TEMPERATURE



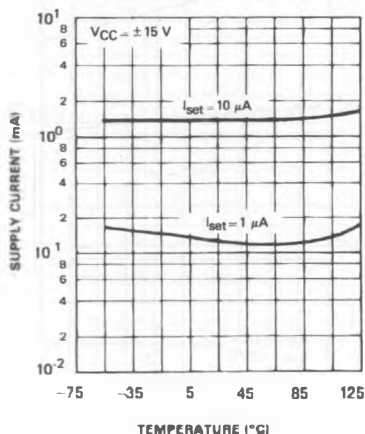
E88LM146-15

INPUT OFFSET CURRENT vs TEMPERATURE



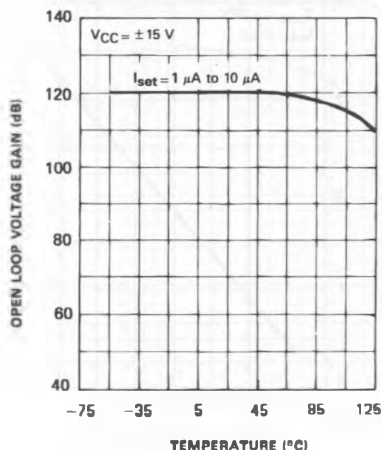
E88LM146-16

SUPPLY CURRENT vs TEMPERATURE



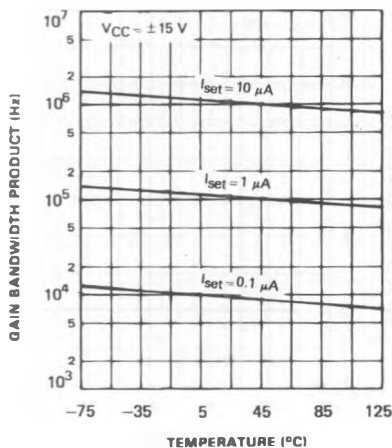
E88LM146-17

OPEN LOOP VOLTAGE GAIN vs TEMPERATURE



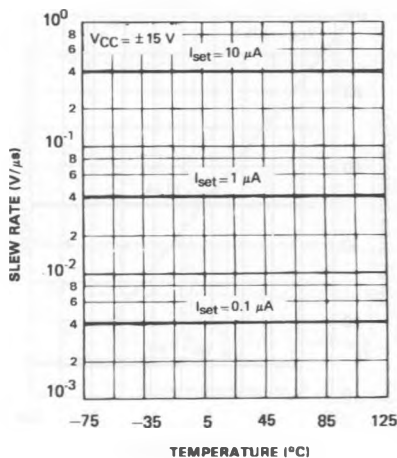
E88LM146-18

GAIN BANDWIDTH PRODUCT vs TEMPERATURE



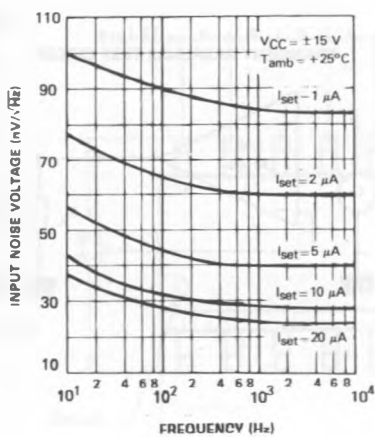
E88LM146-19

SLEW RATE vs TEMPERATURE



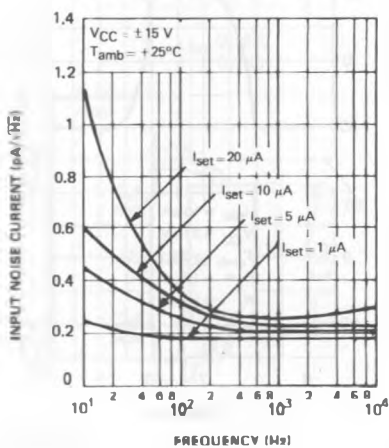
E88LM146-20

INPUT NOISE VOLTAGE vs FREQUENCY



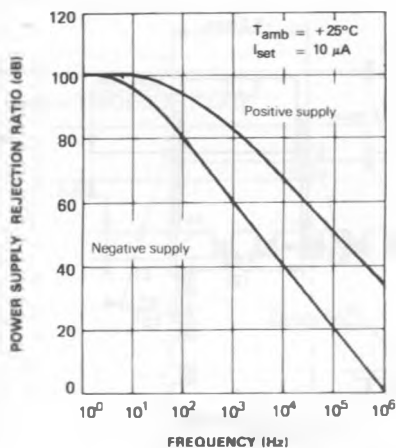
E00LM146-21

INPUT NOISE CURRENT vs FREQUENCY



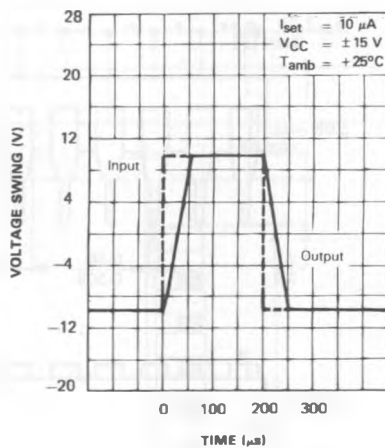
E00LM146-22

POWER SUPPLY REJECTION RATIO

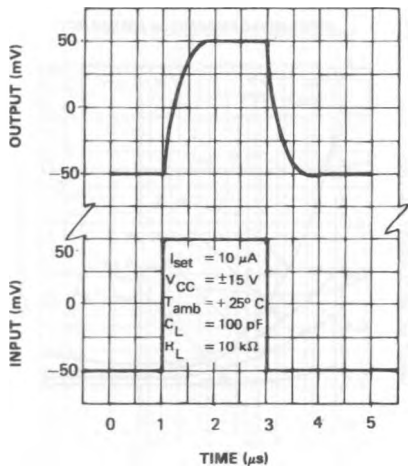


E88LM146-23

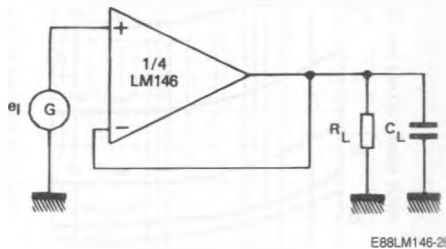
VOLTAGE FOLLOWER PULSE RESPONSE



E88LM146-24



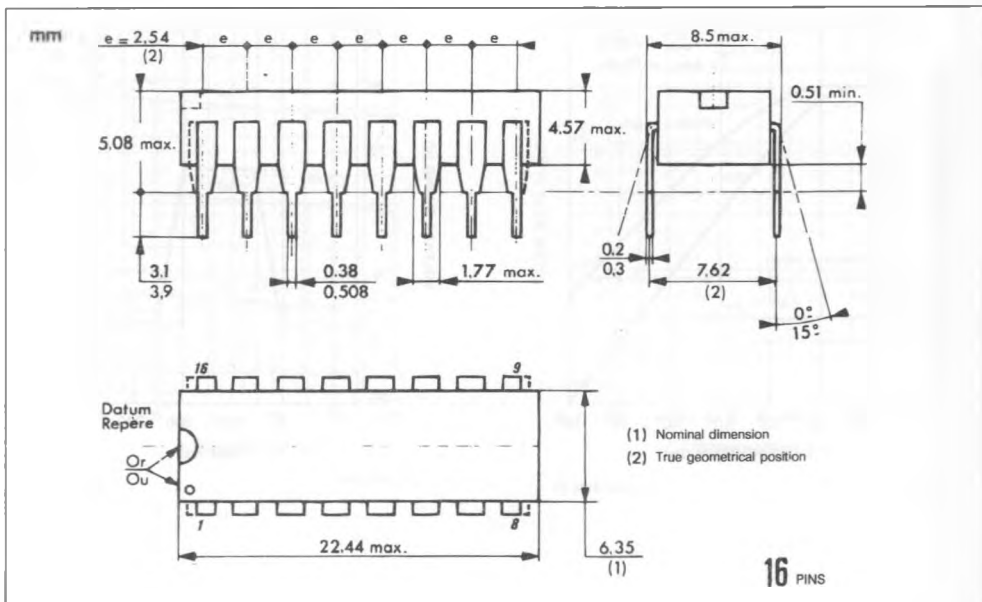
TRANSIENT RESPONSE TEST CIRCUIT



E88LM146-25

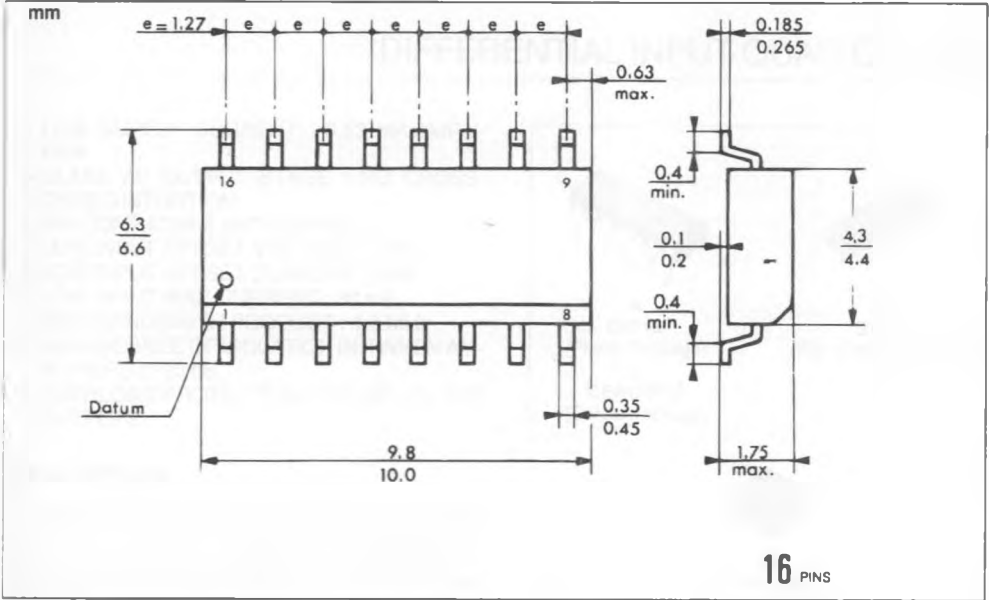
PACKAGE MECHANICAL DATA

16 PINS – PLASTIC DIP OR CERP



PACKAGE MECHANICAL DATA (continued)

16 PINS – PLASTIC MICROPACKAGE (SO)



20 PINS – TRICECOP (LCC)

