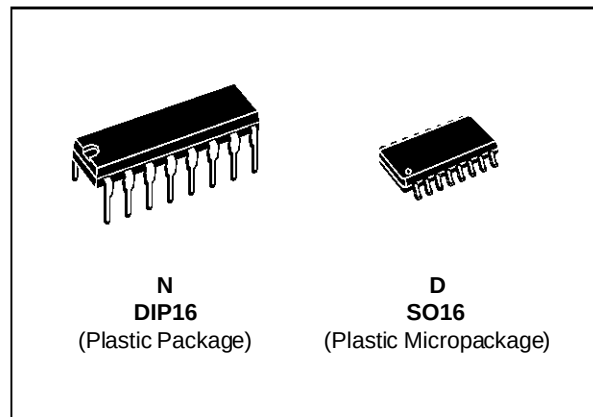


## PROGRAMMABLE QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- PROGRAMMABLE ELECTRICAL CHARACTERISTICS
- BATTERY POWERED OPERATION
- LOW SUPPLY CURRENT (250µA/amplifier)
- GAIN-BANDWIDTH PRODUCT : 1MHz
- LARGE DC VOLTAGE GAIN : 120dB
- LOW NOISE VOLTAGE : 28nV/VHz
- WIDE POWER SUPPLY RANGE : ±1.5V to ±22V
- 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 = 1mA ( $I_{set} = 10\mu A$ )

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

Slew rate = 0.5V/µs ( $I_{set} = 10\mu A$ )

Input bias current ≈ 30 nA ( $I_{set} = 10\mu A$ )

$I_{set}$  = current into pin 8 and pin 9

(see schematic diagram)

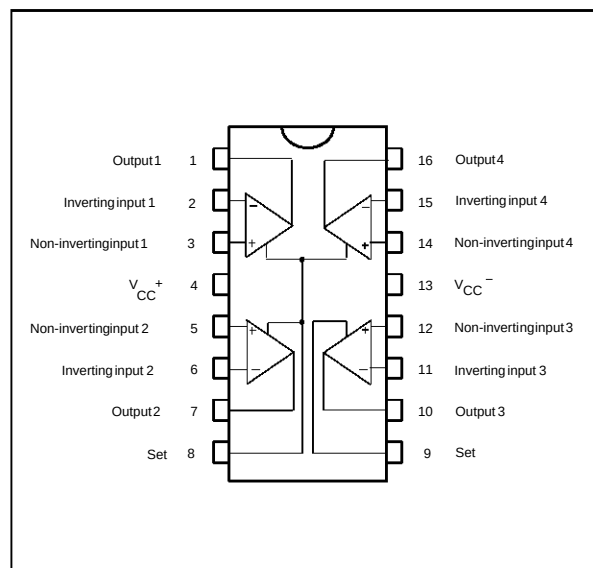
$$I_{set} = \frac{V_{CC}^{+} - V_{CC}^{-} - 0.6V}{R_{set}}$$

### ORDER CODES

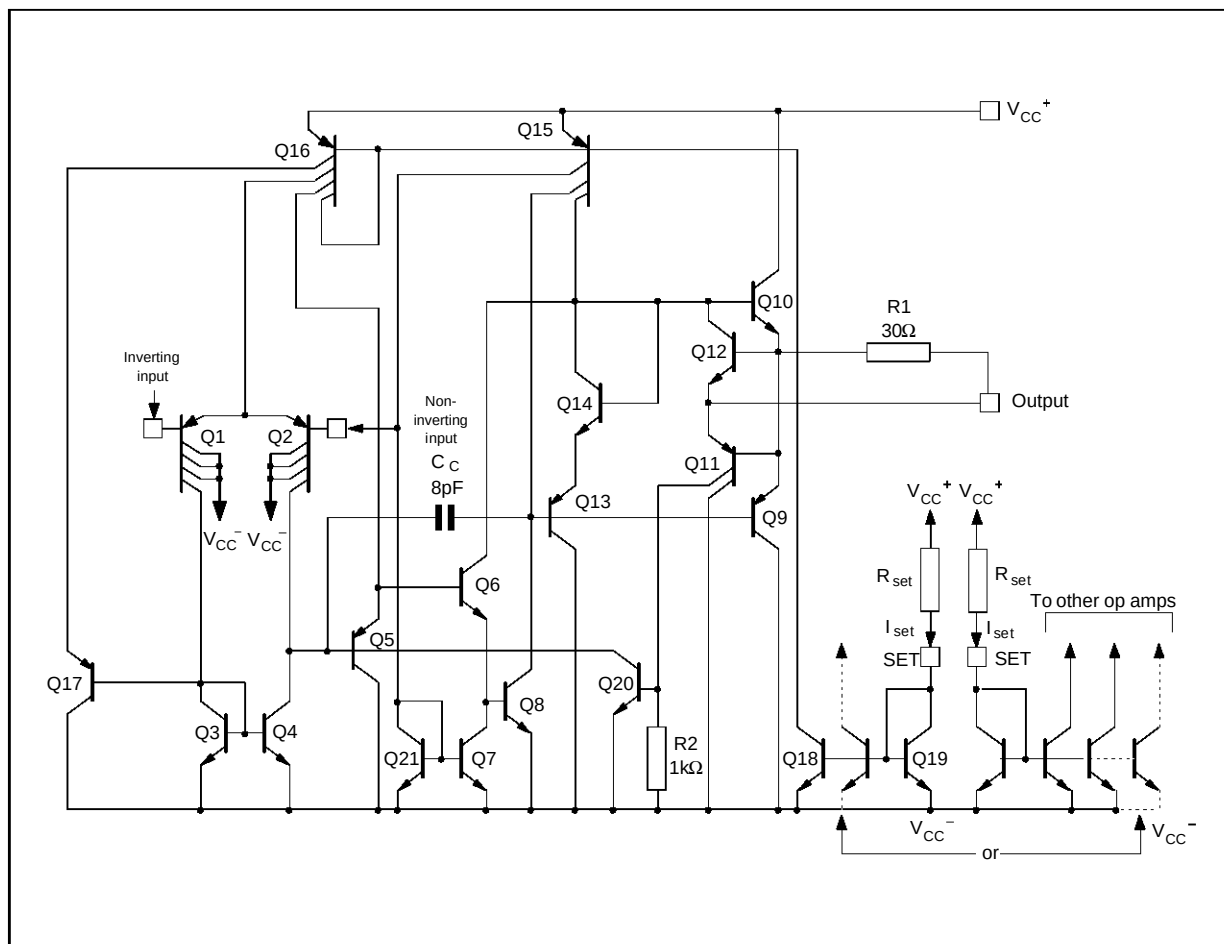
| Part Number | Temperature Range | Package |   |
|-------------|-------------------|---------|---|
|             |                   | N       | D |
| LM146       | -55°C, +125°C     | •       | • |
| LM246       | -40°C, +105°C     | •       | • |
| LM346       | 0°C, +70°C        | •       | • |

**Example : LM246N**

### PIN CONNECTIONS (top view)



## SCHEMATIC DIAGRAM (1/4 LM146)



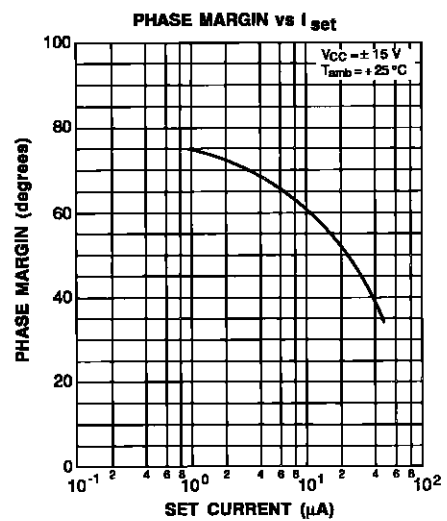
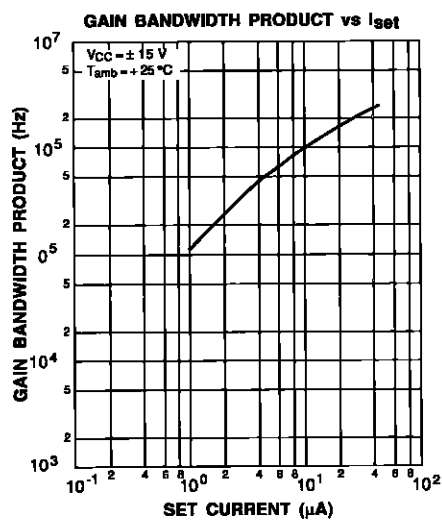
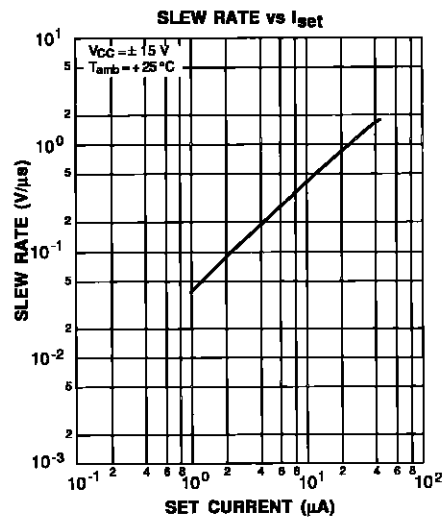
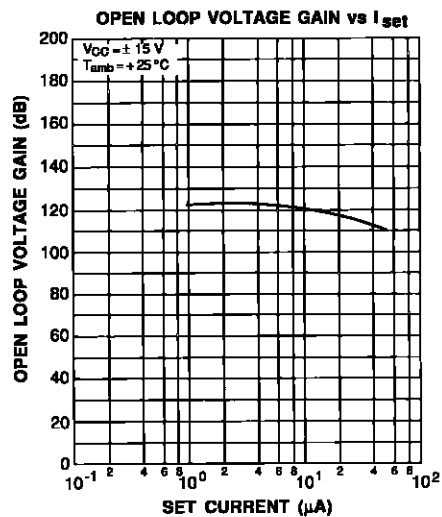
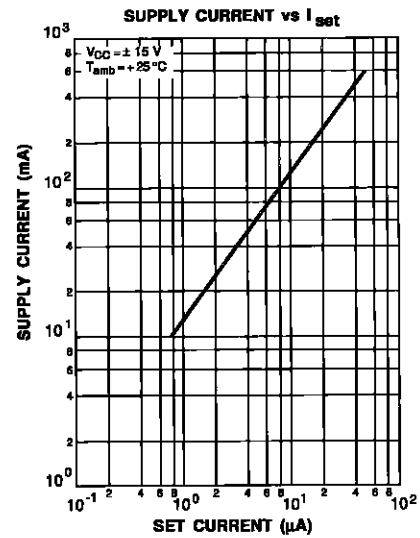
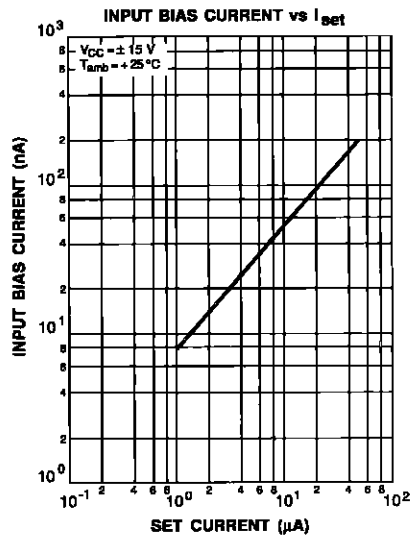
## ABSOLUTE MAXIMUM RATINGS

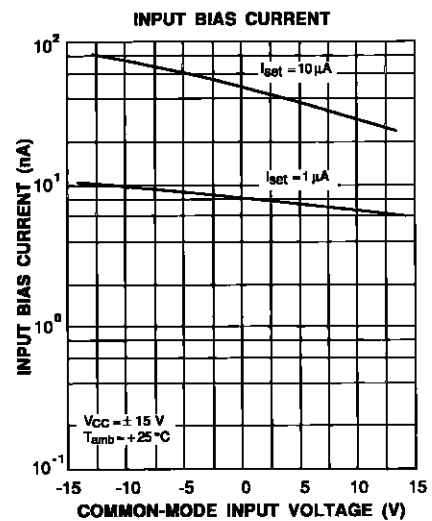
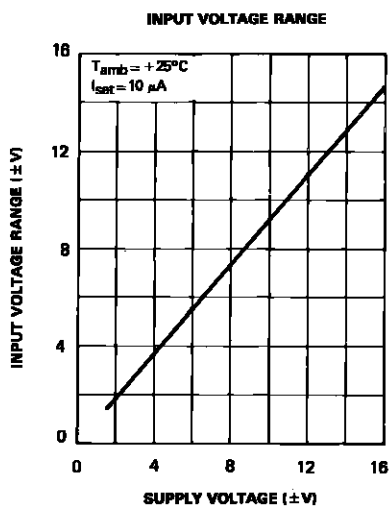
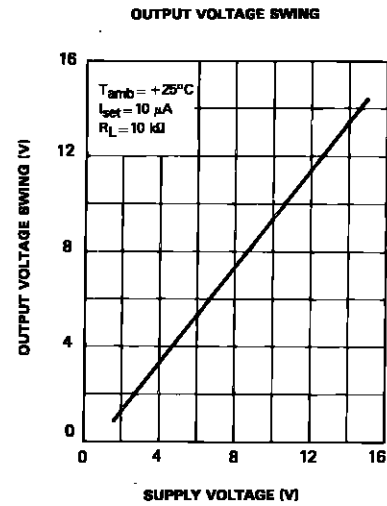
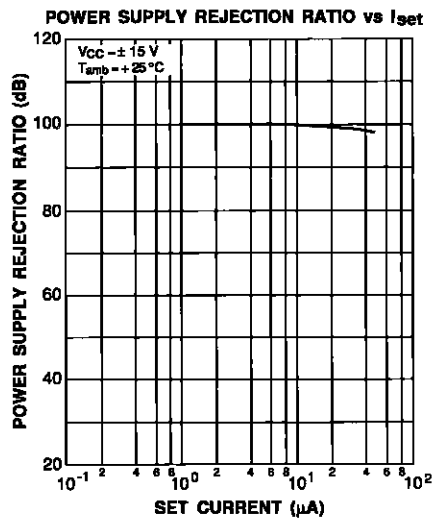
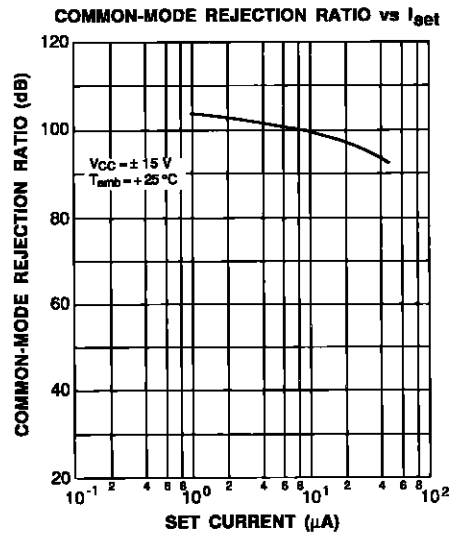
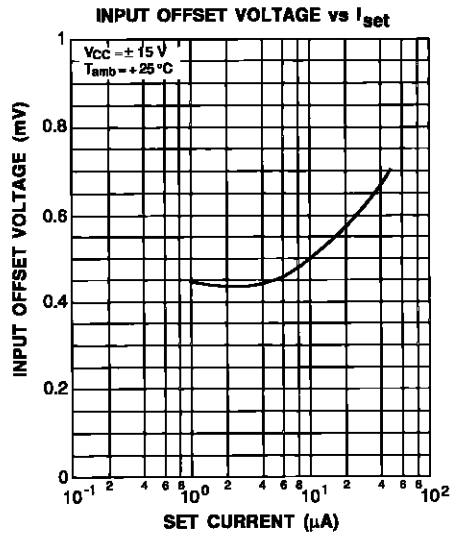
| Symbol            | Parameter                                | LM146       | LM246       | LM346       | Unit |
|-------------------|------------------------------------------|-------------|-------------|-------------|------|
| V <sub>CC</sub>   | Supply Voltage                           | ±22         | ±22         | ±22         | V    |
| V <sub>i</sub>    | Input Voltage - (note 1)                 | ±15         | ±15         | ±15         | V    |
| V <sub>id</sub>   | Differential Input Voltage               | ±30         | ±30         | ±30         | V    |
|                   | Output Short-circuit Duration - (note 2) | Infinite    |             |             |      |
| P <sub>tot</sub>  | Power Dissipation<br>N/D Suffix          | 500         |             |             | mW   |
| T <sub>oper</sub> | Operating Free-air Temperature Range     | -55 to +125 | -40 to +105 | 0 to +70    | °C   |
| T <sub>stg</sub>  | Storage Temperature Range                | -65 to +150 | -65 to +150 | -65 to +150 | °C   |

**Notes :** 1. For supply voltages less than ±15V, 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.

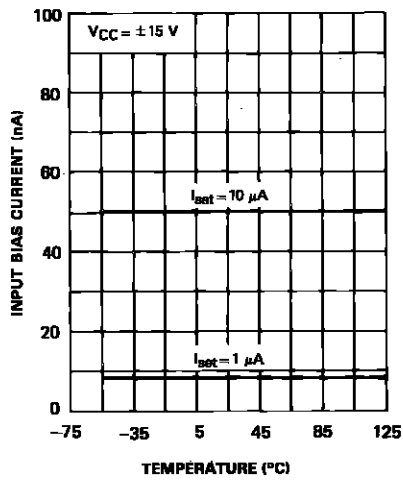
**ELECTRICAL CHARACTERISTICS**
 $V_{CC} = \pm 15V$ ,  $I_{set} = 10\mu A$ ,  $T_{amb} = +25^{\circ}C$  (unless otherwise specified)

| Symbol          | Parameter                                                                                                                                | LM146                    |       |            | LM246 - LM346            |       |            | Unit                   |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------|------------|--------------------------|-------|------------|------------------------|
|                 |                                                                                                                                          | Min.                     | Typ.  | Max.       | Min.                     | Typ.  | Max.       |                        |
| $V_{io}$        | Input Offset Voltage ( $R_S \leq 10k\Omega$ )<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                        |                          | 0.5   | 3<br>5     |                          | 0.5   | 5<br>6     | mV                     |
| $I_{io}$        | Input Offset Current<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                                                 |                          | 2     | 20<br>25   |                          | 2     | 100<br>100 | nA                     |
| $I_{ib}$        | Input Bias Current<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                                                   |                          | 30    | 100<br>100 |                          | 30    | 250<br>250 | nA                     |
| $A_{vd}$        | Large Signal Voltage Gain<br>( $V_o = \pm 10V$ , $R_L = 10k\Omega$ )<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 100<br>50                | 1000  |            | 50<br>25                 | 1000  |            | V/mV                   |
| SVR             | Supply Voltage Rejection Ratio ( $R_S \leq 10k\Omega$ )<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$              | 80<br>80                 | 110   |            | 80<br>80                 | 110   |            | dB                     |
| $I_{CC}$        | Supply Current, all Amp, no Load<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                                     |                          | 1     | 2<br>2     |                          | 1     | 2<br>2     | mA                     |
| $V_{icm}$       | Input Common Mode Voltage Range<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                                      | $\pm 13.5$<br>$\pm 13.5$ |       |            | $\pm 13.5$<br>$\pm 13.5$ |       |            | V                      |
| CMR             | Common Mode Rejection Ratio ( $R_S \leq 10k\Omega$ )<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                 | 80<br>70                 | 110   |            | 80<br>70                 | 110   |            | dB                     |
| $I_{os}$        | Output Short-circuit Current<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                                         | 10<br>4                  | 20    | 30<br>35   | 10<br>4                  | 20    | 30<br>35   | mA                     |
| $\pm V_{opp}$   | Output Voltage Swing ( $R_L = 10k\Omega$ )<br>$T_{amb} = 25^{\circ}C$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                           | 12<br>12                 | 14    |            | 12<br>12                 | 14    |            | V                      |
| SR              | Slew Rate ( $V_I = \pm 10V$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , unity Gain)                                                            | 0.3                      | 0.5   |            | 0.3                      | 0.5   |            | V/ $\mu s$             |
| $R_I$           | Input Resistance                                                                                                                         |                          | 1     |            |                          | 1     |            | M $\Omega$             |
| $C_I$           | Input Capacitance                                                                                                                        |                          | 2     |            |                          | 2     |            | pF                     |
| $V_{o1}/V_{o2}$ | Channel Separation ( $R_L = 10k\Omega$ , $V_o = 12V_{pp}$ )                                                                              |                          | 120   |            |                          | 120   |            | dB                     |
| GBP             | Gain Bandwidth Product<br>( $V_I = 10 mV$ , $R_L = 10k\Omega$ , $C_L = 100pF$<br>$f = 100kHz$ )                                          | 0.8                      | 1     |            | 0.5                      | 1     |            | MHz                    |
| THD             | Total Harmonic Distortion<br>( $f = 1kHz$ , $A_v = 20dB$ , $R_L = 10k\Omega$<br>$C_L = 100pF$ , $v_o = 2V_{pp}$ )                        |                          | 0.015 |            |                          | 0.015 |            | %                      |
| $e_n$           | Equivalent Input Noise Voltage<br>( $f = 1kHz$ , $R_S = 100\Omega$ )                                                                     |                          | 28    |            |                          | 28    |            | $\frac{nV}{\sqrt{Hz}}$ |

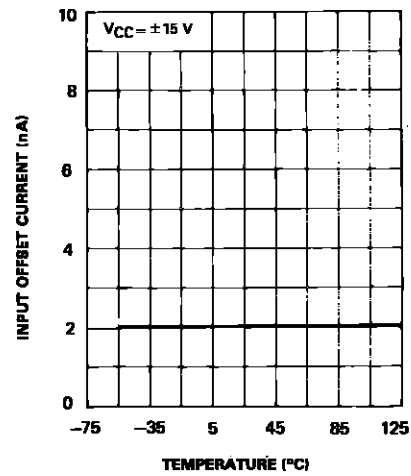




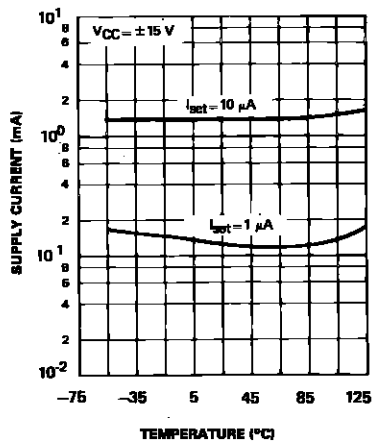
INPUT BIAS CURRENT vs TEMPERATURE



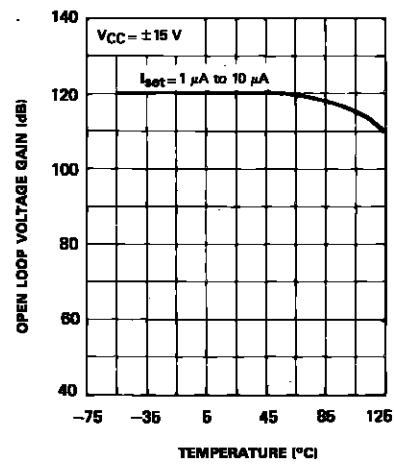
INPUT OFFSET CURRENT vs TEMPERATURE



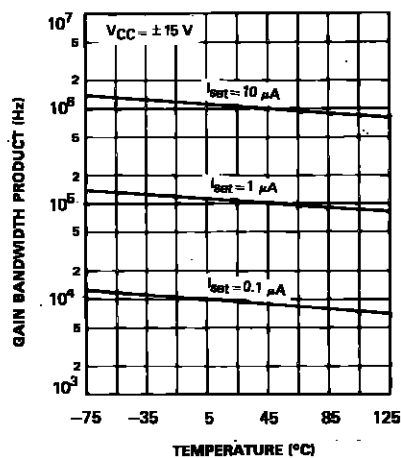
SUPPLY CURRENT vs TEMPERATURE



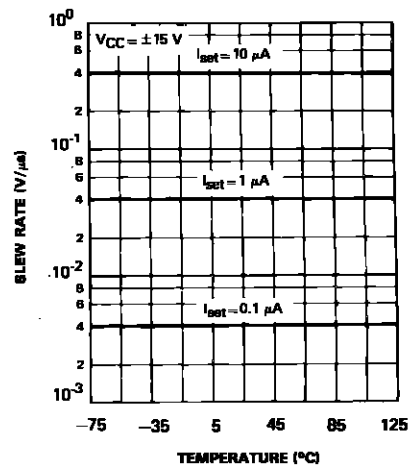
OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

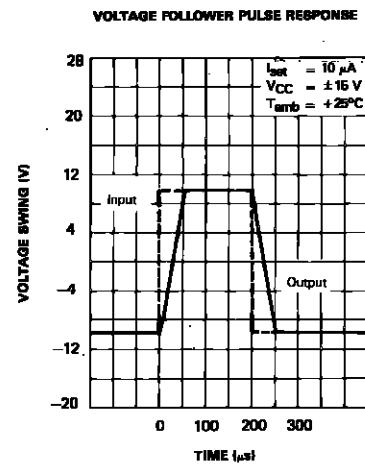
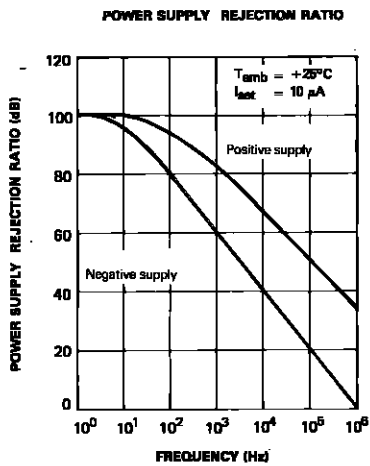
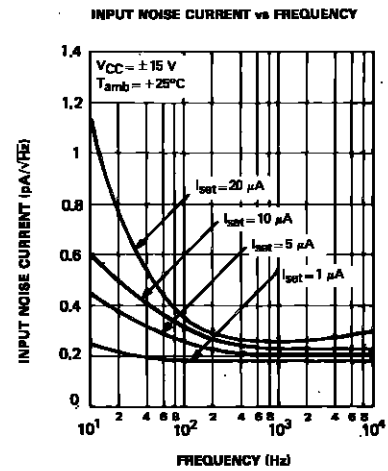
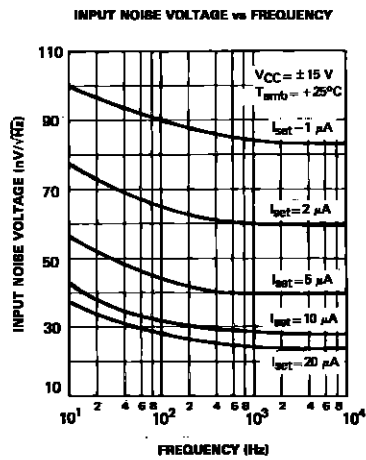


GAIN BANDWIDTH PRODUCT vs TEMPERATURE

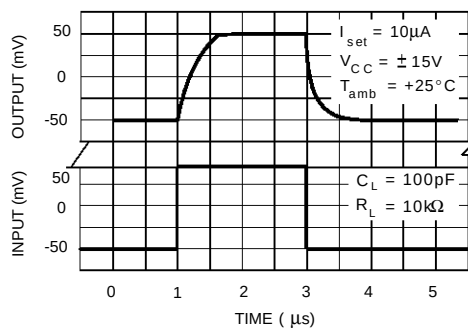


SLEW RATE vs TEMPERATURE

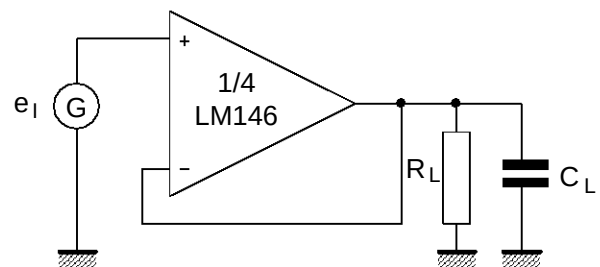




## VOLTAGE FOLLOWER TRANSIENT RESPONSE

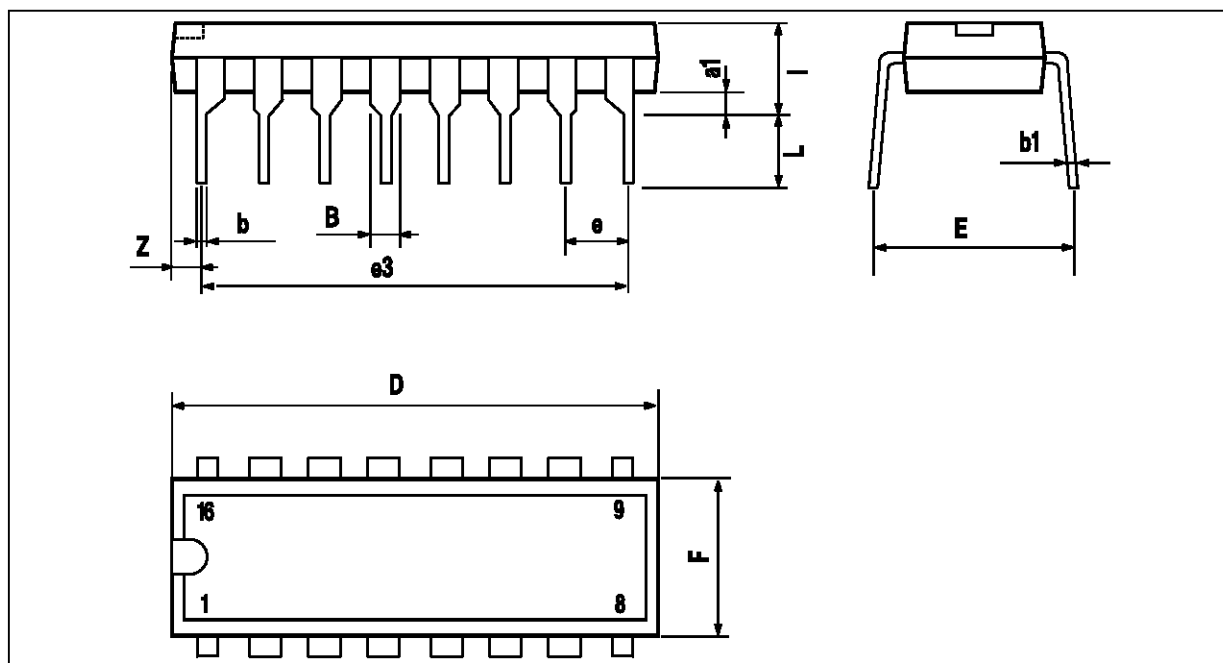


## TRANSIENT RESPONSE TEST CIRCUIT



**PACKAGE MECHANICAL DATA**

16 PINS - PLASTIC DIP



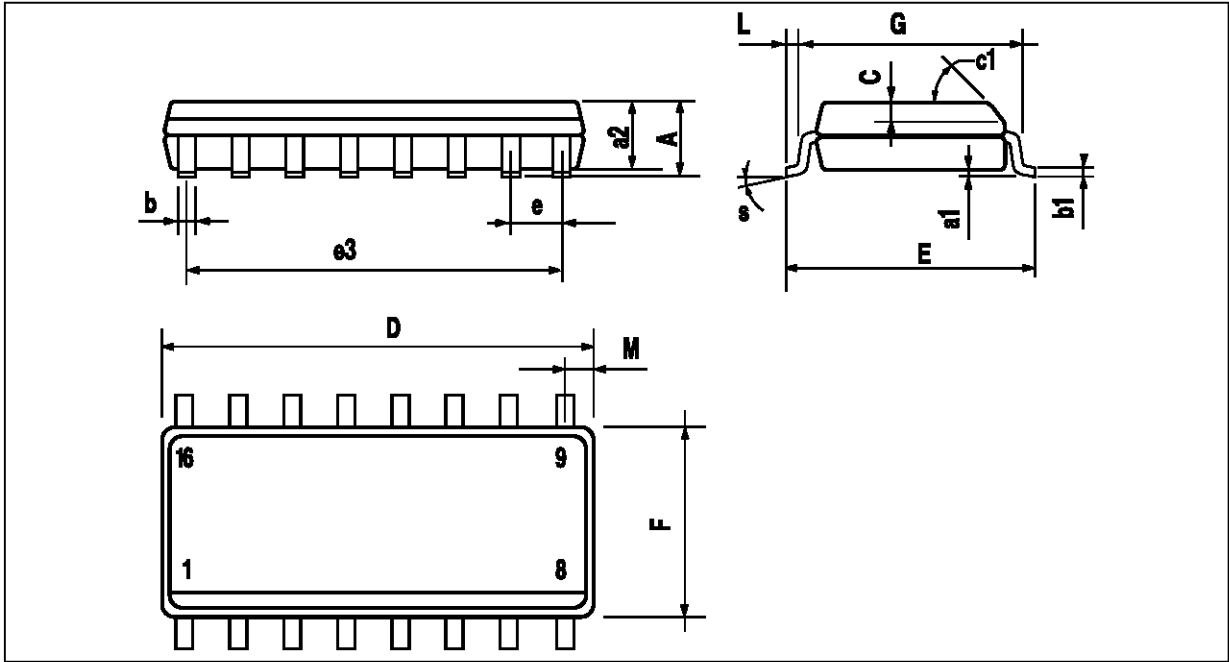
PM-DIP16EPS

| Dimensions | Millimeters |       |      | Inches |       |       |
|------------|-------------|-------|------|--------|-------|-------|
|            | Min.        | Typ.  | Max. | Min.   | Typ.  | Max.  |
| a1         | 0.51        |       |      | 0.020  |       |       |
| B          | 0.77        |       | 1.65 | 0.030  |       | 0.065 |
| b          |             | 0.5   |      |        | 0.020 |       |
| b1         |             | 0.25  |      |        | 0.010 |       |
| D          |             |       | 20   |        |       | 0.787 |
| E          |             | 8.5   |      |        | 0.335 |       |
| e          |             | 2.54  |      |        | 0.100 |       |
| e3         |             | 17.78 |      |        | 0.700 |       |
| F          |             |       | 7.1  |        |       | 0.280 |
| i          |             |       | 5.1  |        |       | 0.201 |
| L          |             | 3.3   |      |        | 0.130 |       |
| Z          |             |       | 1.27 |        |       | 0.050 |

DIP16.TBL



**PACKAGE MECHANICAL DATA**  
16 PINS - PLASTIC MICROPACKAGE (SO)



| Dimensions | Millimeters |      |      | Inches |       |       |
|------------|-------------|------|------|--------|-------|-------|
|            | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A          |             |      | 1.75 |        |       | 0.069 |
| a1         | 0.1         |      | 0.2  | 0.004  |       | 0.008 |
| a2         |             |      | 1.6  |        |       | 0.063 |
| b          | 0.35        |      | 0.46 | 0.014  |       | 0.018 |
| b1         | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| C          |             | 0.5  |      |        | 0.020 |       |
| c1         | 45° (typ.)  |      |      |        |       |       |
| D          | 9.8         |      | 10   | 0.386  |       | 0.394 |
| E          | 5.8         |      | 6.2  | 0.228  |       | 0.244 |
| e          |             | 1.27 |      |        | 0.050 |       |
| e3         |             | 8.89 |      |        | 0.350 |       |
| F          | 3.8         |      | 4.0  | 0.150  |       | 0.157 |
| G          | 4.6         |      | 5.3  | 0.181  |       | 0.209 |

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