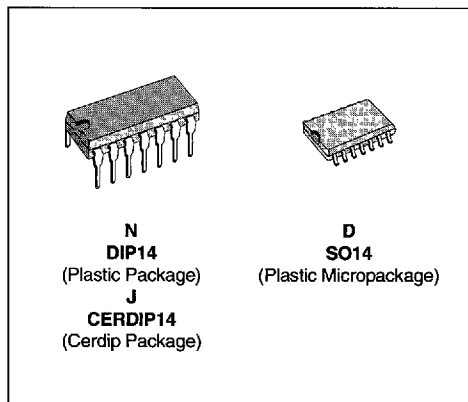


## QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- LOW DISTORTION RATIO
- LOW NOISE
- VERY LOW SUPPLY CURRENT
- LOW INPUT OFFSET CURRENT
- VERY LOW INPUT OFFSET VOLTAGE
- LARGE COMMON-MODE RANGE
- HIGH GAIN
- HIGH OUTPUT CURRENT
- GAIN-BANDWIDTH PRODUCT : 2.5MHz
- TEMPERATURE DRIFT :  $2\mu\text{V}/^\circ\text{C}$
- LONG TERM STABILITY :  $8\mu\text{V}/\text{YEAR}$   
(for  $T_{\text{amb}} \leq 50^\circ\text{C}$ )
- THE TEB4033 AND TEF4033 ARE PIN TO PIN REPLACEMENT OF THE LS204C AND LS204I RESPECTIVELY



### DESCRIPTION

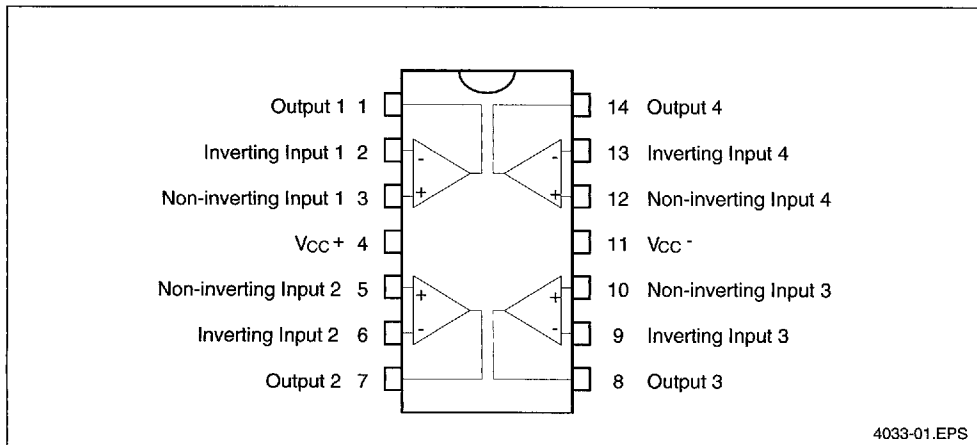
The TEB4033, TEF4033 and TEC4033 are high performance quad-operational amplifiers intended for active filter applications. The internal phase compensation allows stable operation as voltage follower in spite of their high gain-bandwidth products. The circuits present very stable electrical characteristics over the entire supply voltage range.

### ORDER CODES

| Part Number | Temperature Range                       | Package |   |   |
|-------------|-----------------------------------------|---------|---|---|
|             |                                         | N       | J | D |
| TEB4033     | $0^\circ\text{C}, +70^\circ\text{C}$    | •       | • | • |
| TEF4033     | $-40^\circ\text{C}, +105^\circ\text{C}$ | •       | • | • |
| TEC4033     | $-55^\circ\text{C}, +125^\circ\text{C}$ | •       | • | • |

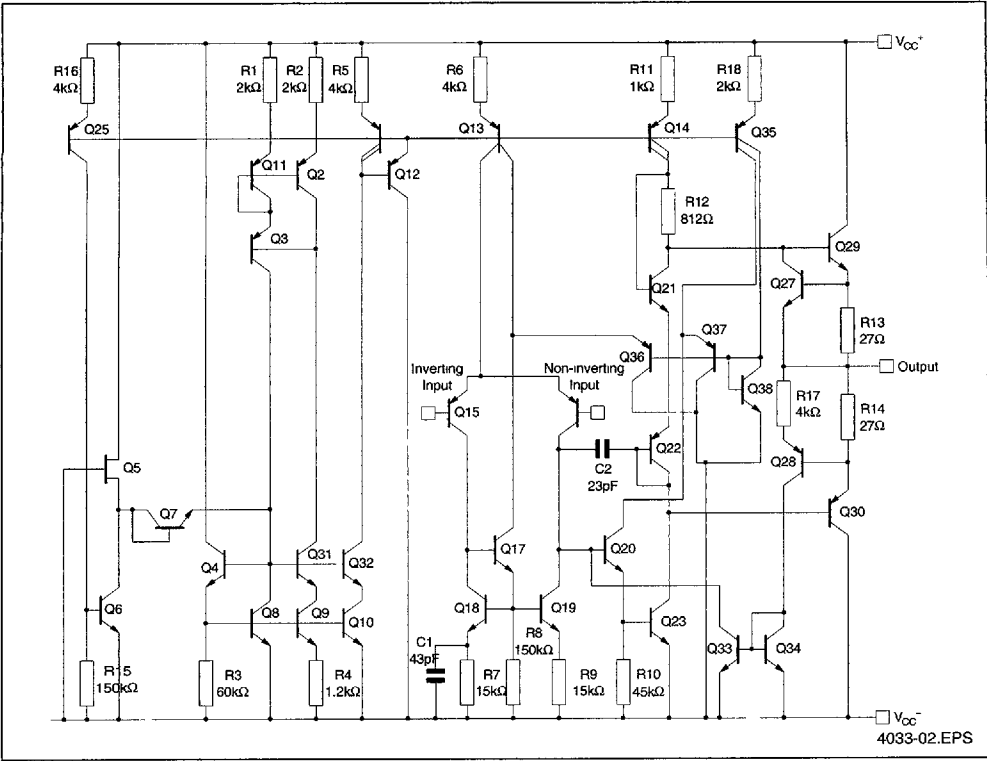
**Example :** TEB4033N

### PIN CONNECTIONS (top view)



4033-01.EPS

BLOCK DIAGRAM (1/4 TEB4033)



ABSOLUTE MAXIMUM RATINGS

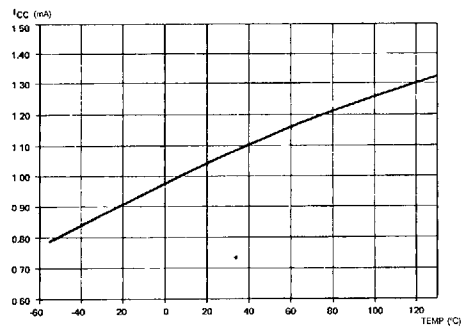
| Symbol            | Parameter                                                             | Value                                  | Unit |
|-------------------|-----------------------------------------------------------------------|----------------------------------------|------|
| V <sub>CC</sub>   | Supply Voltage                                                        | ± 18                                   | V    |
| V <sub>i</sub>    | Input Voltage                                                         | ± V <sub>CC</sub>                      | V    |
| V <sub>id</sub>   | Differential Input Voltage                                            | ± (V <sub>CC</sub> - 1)                | V    |
| P <sub>tot</sub>  | Power Dissipation<br>D suffix<br>N suffix                             | 400<br>665                             | mW   |
| T <sub>oper</sub> | Operating Free-air Temperature Range<br>TEB4033<br>TEF4033<br>TEC4033 | 0 to +70<br>-40 to +105<br>-55 to +125 | °C   |
| T <sub>stg</sub>  | Storage Temperature Range                                             | -65 to +150                            | °C   |

4033-02 TBL

**ELECTRICAL CHARACTERISTICS**V<sub>CC</sub> = ±15V, T<sub>amb</sub> = +25°C (unless otherwise specified)

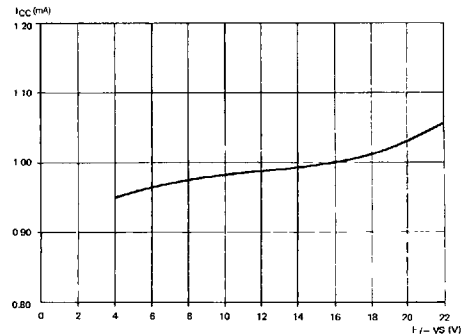
| Symbol                           | Parameter                                                                                                                                                                                                                                                                                                    | TEB 1033<br>TEF 1033<br>TEC 1033 |               |            | Unit                   |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------------|------------|------------------------|
|                                  |                                                                                                                                                                                                                                                                                                              | Min.                             | Typ.          | Max.       |                        |
| V <sub>io</sub>                  | Input Offset Voltage (R <sub>S</sub> ≤ 10kΩ)<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                                          |                                  | 0.3           | 1<br>3     | mV                     |
| DV <sub>io</sub>                 | Input Offset Voltage Drift                                                                                                                                                                                                                                                                                   |                                  | 2             |            | μV/°C                  |
| I <sub>io</sub>                  | Input Offset Current<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                                                                  |                                  | 5             | 20<br>40   | nA                     |
| I <sub>ib</sub>                  | Input Bias Current<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                                                                    |                                  | 50            | 100<br>200 | nA                     |
| A <sub>vd</sub>                  | Large Signal Voltage Gain (R <sub>L</sub> = 2kΩ, V <sub>O</sub> = ±10V)<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                               | 80<br>40                         | 120           |            | V/mV                   |
| SVR                              | Supply Voltage Rejection Ratio (DV <sub>CC</sub> from ±15V to ±4V)<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                    | 80<br>70                         | 100           |            | dB                     |
| I <sub>CC</sub>                  | Supply Current, all Amp, no Load<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                                                      |                                  | 2             | 3<br>4     | mA                     |
| V <sub>icm</sub>                 | Input Common Mode Voltage Range<br>T <sub>amb</sub> = 25°C                                                                                                                                                                                                                                                   | ±12                              |               |            | V                      |
| CMR                              | Common Mode Rejection Ratio (R <sub>S</sub> ≤ 10kΩ, V <sub>I</sub> = ±10V)<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                            | 80<br>70                         | 100           |            | dB                     |
| I <sub>os</sub>                  | Output Short-circuit Current<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>                                                                                                                                                                                          | 10<br>10                         | 23            | 40<br>40   | mA                     |
| ± V <sub>opp</sub>               | Output Voltage Swing<br>T <sub>amb</sub> = 25°C<br>T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub><br>V <sub>CC</sub> = ±4V, R <sub>L</sub> = 2kΩ, T <sub>amb</sub> = 25°C<br>V <sub>CC</sub> = ±6V, R <sub>L</sub> = 600Ω, T <sub>amb</sub> = 25°C<br>R <sub>L</sub> = 2kΩ<br>R <sub>L</sub> = 2kΩ | 13<br>12<br>2.8<br>4.6           | 14<br>3       |            | V                      |
| SR                               | Slew-rate (V <sub>I</sub> = ±10V, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100pF, T <sub>amb</sub> = 25°C, unity gain)                                                                                                                                                                                        | 0.6                              | 1             |            | V/μs                   |
| GBP                              | Gain Bandwidth Product (f = 100kHz, T <sub>amb</sub> = 25°C, V <sub>in</sub> = 10mV, R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 100pF)                                                                                                                                                                           | 1.5                              | 2             |            | MHz                    |
| R <sub>i</sub>                   | Input Resistance                                                                                                                                                                                                                                                                                             |                                  | 1             |            | MΩ                     |
| THD                              | Total Harmonic Distortion (f = 1kHz, A <sub>v</sub> = 20dB, R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 100pF, T <sub>amb</sub> = 25°C, V <sub>O</sub> = 2V <sub>pp</sub> )                                                                                                                                       |                                  | 0.008         | 0.05       | %                      |
| e <sub>n</sub>                   | Equivalent Input Noise Voltage (f = 1kHz)<br>R <sub>S</sub> = 50Ω<br>R <sub>S</sub> = 1kΩ<br>R <sub>S</sub> = 10kΩ                                                                                                                                                                                           |                                  | 8<br>10<br>18 | 15         | $\frac{nV}{\sqrt{Hz}}$ |
| V <sub>OPP</sub>                 | Large Signal Voltage Swing<br>R <sub>L</sub> = 10kΩ, f = 10kHz                                                                                                                                                                                                                                               | 26                               | 28            |            | V                      |
| ∅ <sub>m</sub>                   | Phase Margin                                                                                                                                                                                                                                                                                                 |                                  | 45            |            | Degrees                |
| V <sub>O1</sub> /V <sub>O2</sub> | Channel Separation                                                                                                                                                                                                                                                                                           | 100                              | 120           |            | dB                     |

4033-03 TBL



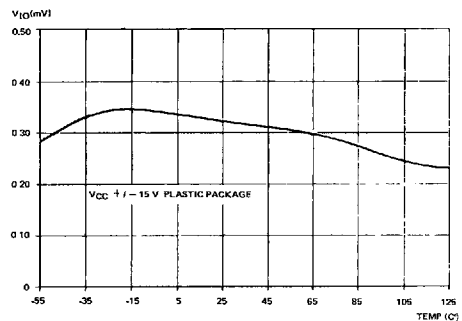
SUPPLY CURRENT VS AMBIENT TEMPERATURE

4033-03 EPS



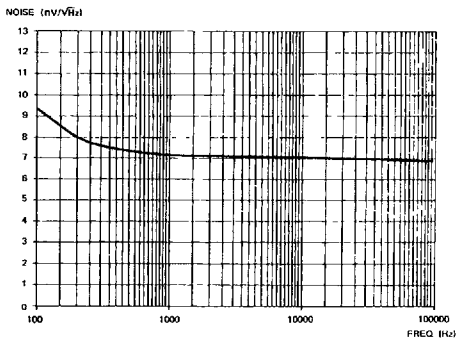
SUPPLY CURRENT VS SUPPLY VOLTAGE

4033-04 EPS



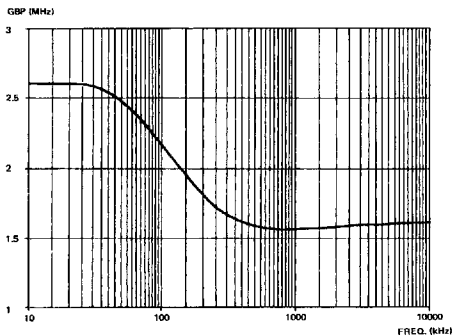
OFFSET VOLTAGE VS. AMBIENT TEMPERATURE

4033-05 EPS



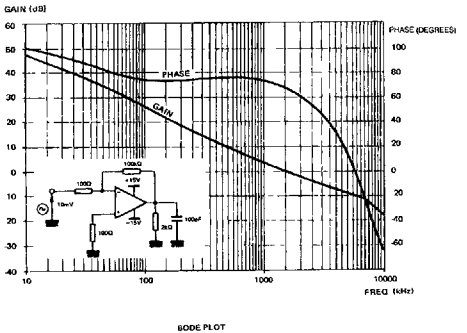
TOTAL INPUT NOISE VS. FREQUENCY

4033-06.EPS



GAIN BANDWIDTH PRODUCT VS. FREQUENCY

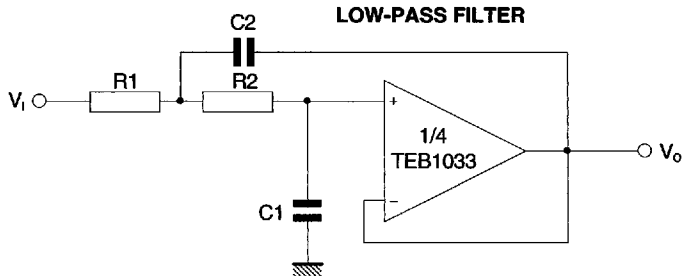
4033-07 EPS



BODE PLOT

4033-08.EPS

## TYPICAL APPLICATION



$$\frac{V_o}{V_i} = \frac{1}{1 + 2\xi \frac{S}{\omega_c} + \frac{S^2}{\omega_c^2}}$$

$\omega_c = 2\pi f_c$ , with  $f_c$  = cutt-off frequency  
 $\xi$  = damping factor

4033-09.EPS