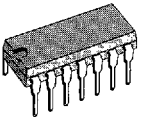
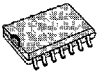
# QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- 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 : 2µV/°C
- LONG TERM STABILITY : 8µV/YEAR (for $T_{amb} \leq 50°C$)
- THE TEB4033 AND TEF4033 ARE PIN TO PIN REPLACEMENT OF THE LS204C AND LS204I RESPECTIVELY





**N**
**DIP14**
(Plastic Package)



**D**
**SO14**
(Plastic Micropackage)

**J**
**CERDIP14**
(Cerdip Package)

## 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.

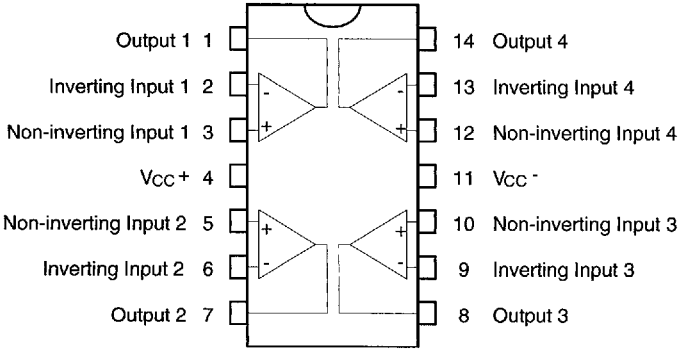
The circuits present very stable electrical characteristics over the entire supply voltage range.

## ORDER CODES

| Part Number | Temperature Range | Package | | |
|---|---|---|---|---|
| | | N | J | D |
| TEB4033 | 0°C, +70°C | • | • | • |
| TEF4033 | −40°C, +105°C | • | • | • |
| TEC4033 | −55°C, +125°C | • | • | • |
| **Example :** TEB4033N | | | | |

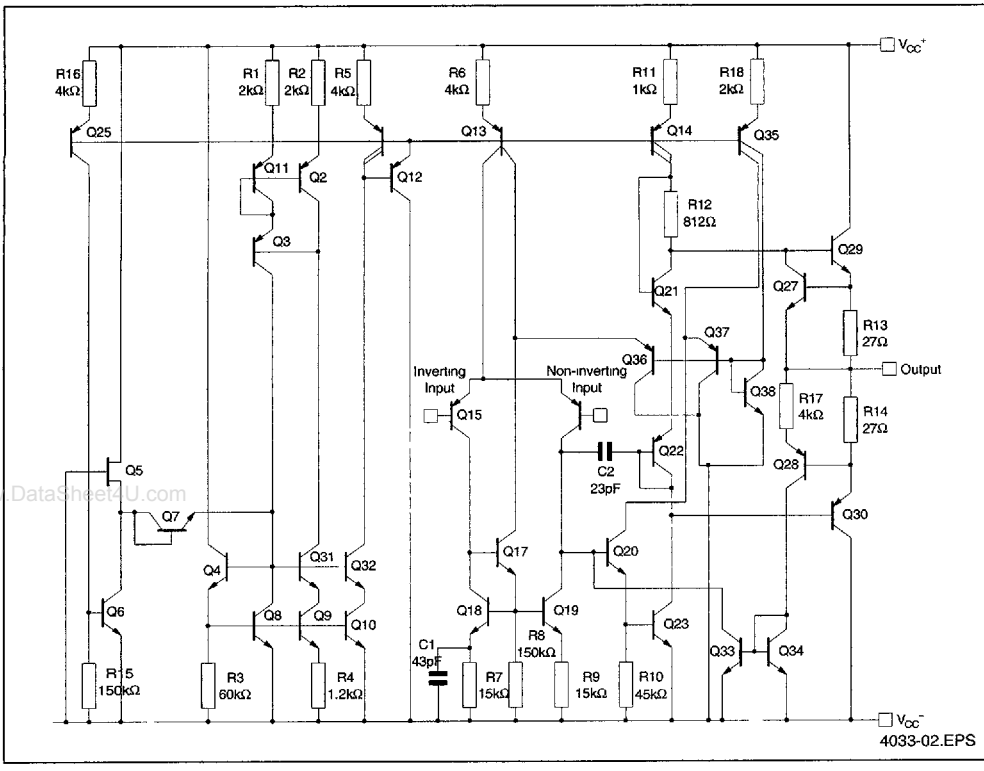
4033-01 TBL

## PIN CONNECTIONS (top view)




4033-01.EPS

## BLOCK DIAGRAM (1/4 TEB4033)






## ABSOLUTE MAXIMUM RATINGS

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

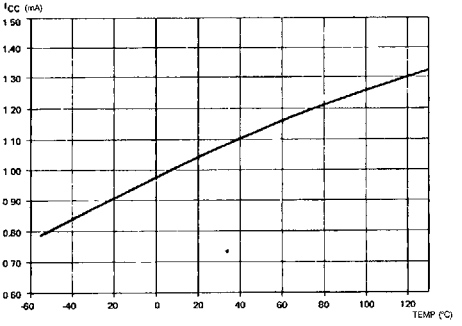
4033-02 TBL

## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = ±15V, $T_{amb}$ = +25°C (unless otherwise specified)

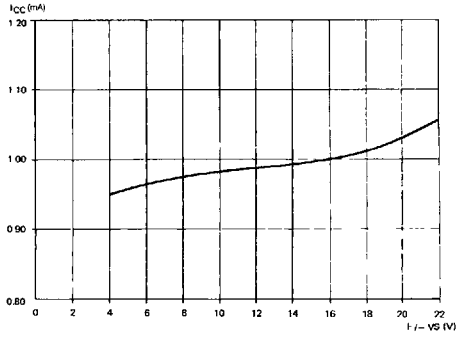
| Symbol | Parameter | TEB 1033 TEF 1033 TEC 1033 | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{io}$ | Input Offset Voltage ($R_S \leq 10k\Omega$)<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 0.3 | 1<br>3 | mV |
| $DV_{io}$ | Input Offset Voltage Drift | | 2 | | µV/°C |
| $I_{io}$ | Input Offset Current<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 5 | 20<br>40 | nA |
| $I_{ib}$ | Input Bias Current<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 50 | 100<br>200 | nA |
| $A_{vd}$ | Large Signal Voltage Gain ($R_L$ = 2kΩ, $V_O$ = ±10V)<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 80<br>40 | 120 | | V/mV |
| SVR | Supply Voltage Rejection Ratio ($DV_{CC}$ from ±15V to ±4V)<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 80<br>70 | 100 | | dB |
| $I_{CC}$ | Supply Current, all Amp, no Load<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 2 | 3<br>4 | mA |
| $V_{icm}$ | Input Common Mode Voltage Range<br>$T_{amb}$ = 25°C | ±12 | | | V |
| CMR | Common Mode Rejection Ratio ($R_S \leq 10k\Omega$, $V_I$ = ±10V)<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 80<br>70 | 100 | | dB |
| $I_{os}$ | Output Short-circuit Current<br>$T_{amb}$ = 25°C<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 10<br>10 | 23 | 40<br>40 | mA |
| ± $V_{opp}$ | Output Voltage Swing<br>$T_{amb}$ = 25°C $R_L$ = 2kΩ<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L$ = 2kΩ<br>$V_{CC}$ = ±4V, $R_L$ = 2kΩ, $T_{amb}$ = 25°C<br>$V_{CC}$ = ±6V, $R_L$ = 600Ω, $T_{amb}$ = 25°C | 13<br>12<br>2.8<br>4.6 | 14<br>3 | | V |
| SR | Slew-rate ($V_I$ = ±10V, $R_L$ = 2 kΩ, $C_L$ = 100pF, $T_{amb}$ = 25°C, unity gain) | 0.6 | 1 | | V/µs |
| GBP | Gain Bandwidth Product (f = 100kHz, $T_{amb}$ = 25°C, $V_{in}$ = 10mV, $R_L$ = 2kΩ, $C_L$ = 100pF) | 1.5 | 2 | | MHz |
| $R_i$ | Input Resistance | | 1 | | MΩ |
| THD | Total Harmonic Distortion (f = 1kHz, $A_v$ = 20dB, $R_L$ = 2kΩ $C_L$ = 100pF, $T_{amb}$ = 25°C, $V_o$ = $2V_{pp}$) | | 0.008 | 0.05 | % |
| $e_n$ | Equivalent Input Noise Voltage (f = 1kHz)<br>$R_S$ = 50Ω<br>$R_S$ = 1kΩ<br>$R_S$ = 10kΩ | | 8<br>10<br>18 | 15 | $\frac{nV}{\sqrt{Hz}}$ |
| $V_{OPP}$ | Large Signal Voltage Swing<br>$R_L$ =10kΩ, f = 10kHz | 26 | 28 | | V |
| Øm | Phase Margin | | 45 | | Degrees |
| $V_{o1}/V_{o2}$ | Channel Separation | 100 | 120 | | dB |

4033-03 TBL




SUPPLY CURRENT VS AMBIENT TEMPERATURE

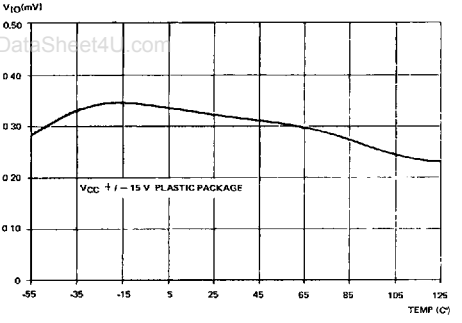
4033-03 EPS




SUPPLY CURRENT VS SUPPLY VOLTAGE

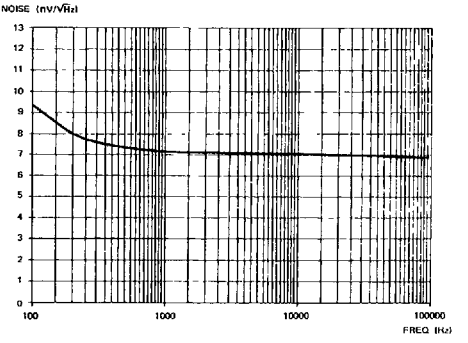
4033-04 EPS





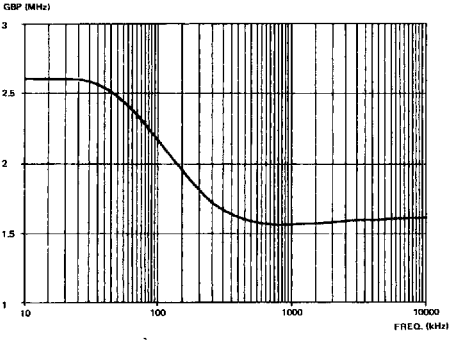

OFFSET VOLTAGE VS. AMBIENT TEMPERATURE

4033-05 EPS



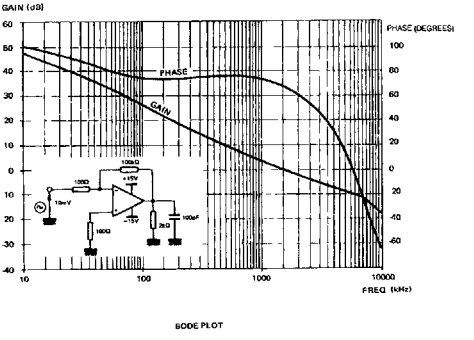

TOTAL INPUT NOISE VS FREQUENCY

4033-06.EPS




GAIN BANDWIDTH PRODUCT VS. FREQUENCY

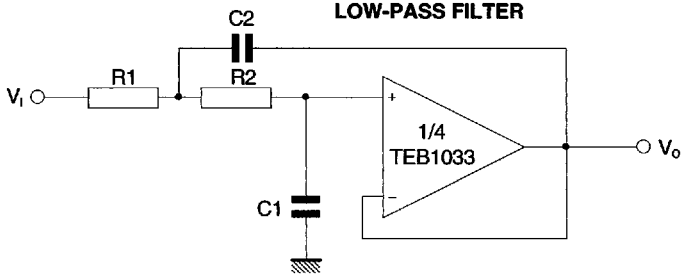
4033-07 EPS




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