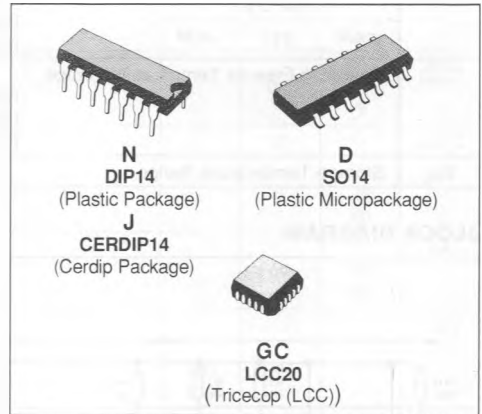


## BIPOLAR QUAD OPERATIONAL AMPLIFIERS

- 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 : 2.5 MHz
- 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 LS404C AND LS404 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.

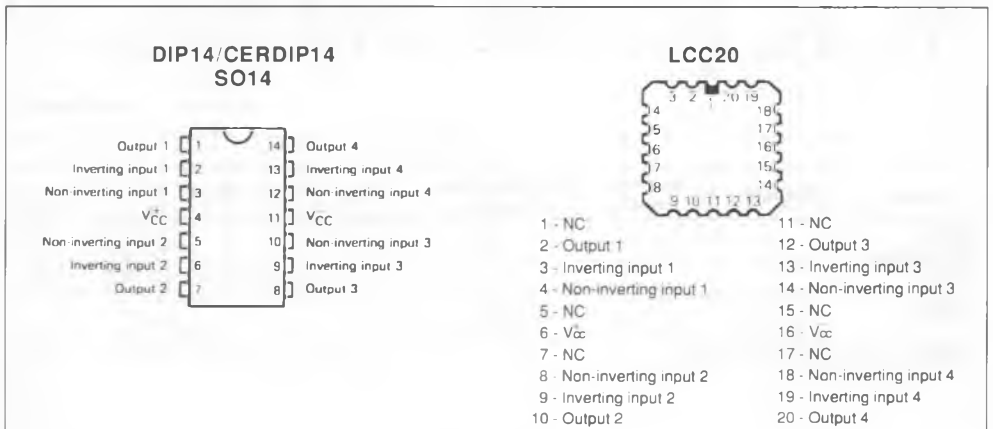
The circuits present very stable electrical characteristics over the entire supply voltage range.

### ORDERING INFORMATION

Part Number	Temperature Range	Package		
		N	D	GC
<b>TEB4033</b>	0 °C to + 70 °C	•	•	
<b>TEF4033</b>	- 40 °C to + 105 °C	•	•	
<b>TEC4033</b>	- 55 °C to + 125 °C			•

**Examples** : TEB4033N, TEC4033GC

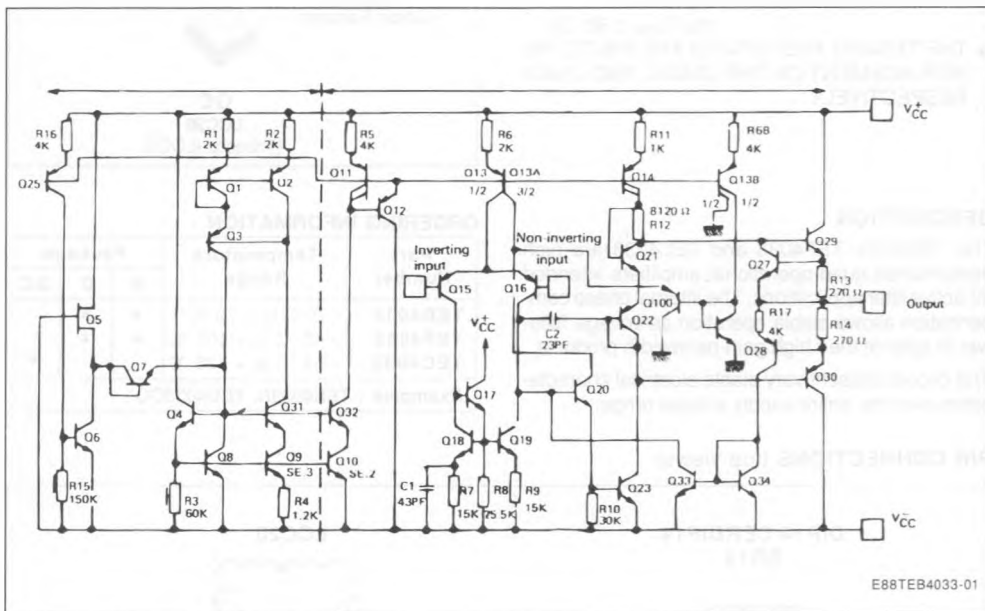
### PIN CONNECTIONS (top views)



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit	
$V_{CC}$	Supply Voltage	$\pm 18$	V	
$V_I$	Input Voltage	$\pm V_{CC}$	V	
$V_{ID}$	Differential Input Voltage	$\pm (V_{CC} - 1)$	V	
$P_{tot}$	Power Dissipation	TEB4033D, TEF4033D TEB4033N, TEF4033N TEC4033GC	400 665 665	mW
$T_{oper}$	Operating Free-air Temperature Range	TEB4033 TEF4033 TEC4033	0 to + 70 - 40 to + 105 - 55 to + 125	$^{\circ}\text{C}$
$T_{stg}$	Storage Temperature Range		- 65 to + 150	$^{\circ}\text{C}$

## BLOCK DIAGRAM



Case	Outputs	Inverting Inputs	Non-inverting Inputs	$V_{CC}$	$V_{CC}$	N. C.
DIP14 CERDIP14 SO14	1, 7 8, 14	2, 6 9, 13	3, 5 10, 12	4	11	
LCC20	2, 10 12, 20	3, 9 13, 19	4, 8 14, 18	6	16	*

\* LCC20 : Other pins are not connected.

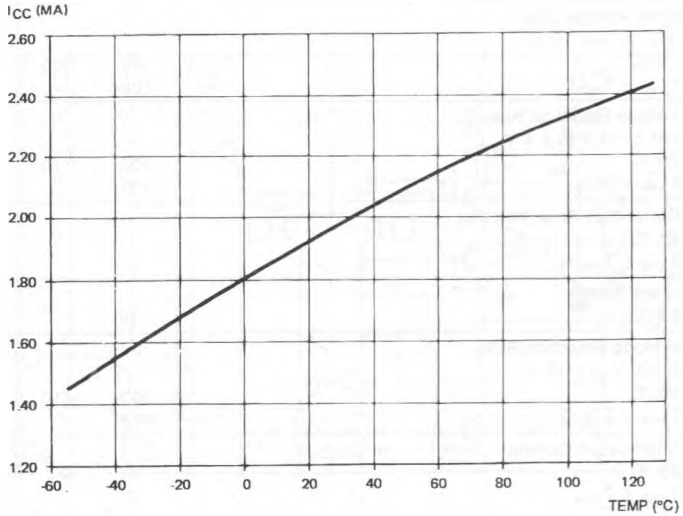
## ELECTRICAL CHARACTERISTICS

 $V_{CC} = \pm 15 \text{ V}$  (unless otherwise specified)
TEC 4033 :  $-55 \leq T_{amb} \leq +125 \text{ }^\circ\text{C}$ TEF 4033 :  $-40 \leq T_{amb} \leq +105 \text{ }^\circ\text{C}$ TEB 4033 :  $0 \leq T_{amb} \leq +70 \text{ }^\circ\text{C}$ 

Symbol	Parameter	TEB 4033 TEF 4033 TEC 4033			Unit
		Min.	Typ.	Max.	
$V_{IO}$	Input Offset Voltage $T_{amb} = 25 \text{ }^\circ\text{C}$ ( $R_S \leq 10 \text{ k}\Omega$ ) $T_{min} \leq T_{amb} \leq T_{max}$		0.3	1 3	mV
$DV_{IO}$	Input Offset Voltage Drift		2		$\mu\text{V}/^\circ\text{C}$
$I_{IO}$	Input Offset Current $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		5	20 40	nA
$I_{IB}$	Input Bias Current $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		50	100 200	nA
$A_{vd}$	Large Signal Voltage Gain ( $R_L = 2 \text{ k}\Omega$ , $V_O = \pm 10 \text{ V}$ ) $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	100 100	300		V/mV
SVR	Supply Voltage Rejection Ratio $DV_{CC}$ from $\pm 15 \text{ V}$ to $\pm 4 \text{ V}$ $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	100 100	110		dB
$I_{CC}$	Supply Current, all Amp, no Load $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		2	3 4	mA
$V_I$	Input Voltage Range $T_{amb} = 25 \text{ }^\circ\text{C}$	- 12		+ 12	V
CMR	Common Mode Rejection Ratio ( $R_S \leq 10 \text{ k}\Omega$ , $V_I = \pm 10 \text{ V}$ ) $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	100 100	110		dB
$I_{OS}$	Output Short-circuit Current $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	10 10	23	40 40	mA
$\pm V_{OPP}$	Output Voltage Swing $T_{amb} = 25 \text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = \pm 4 \text{ V}$ , $R_L = 2 \text{ k}\Omega$ $V_{CC} = \pm 6 \text{ V}$ , $R_L = 600 \Omega$		$R_L = 2 \text{ k}\Omega$ 13 12 2.8 4.6	14 3	V
$S_{VO}$	Slew-rate ( $V_I = \pm 10 \text{ V}$ , $R_L = 2 \text{ k}\Omega$ , $C_L \leq 100 \text{ pF}$ , $T_{amb} = 25 \text{ }^\circ\text{C}$ , unity gain)	0.6	1	3	$\text{V}/\mu\text{s}$
GBP	Gain Bandwidth Product ( $f = 100 \text{ KHz}$ , $T_{amb} = 25 \text{ }^\circ\text{C}$ , $V_{IN} = 10 \text{ mV}$ , $R_L = 2 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$ )	1.8	2.5	3.2	MHz
$R_I$	Input Resistance ( $T_{amb} = 25 \text{ }^\circ\text{C}$ )		1		$\text{M}\Omega$

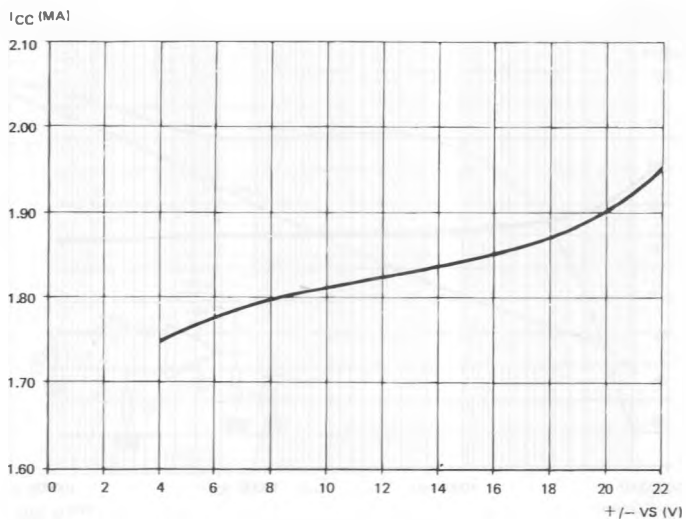
ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	TEB 4033 TEF 4033 TEC 4033			Unit
		Min.	Typ.	Max.	
THD	Total Harmonic Distortion ( $f = 1\text{KHz}$ , $A_v = 20\text{ dB}$ , $R_L = 2\text{ k}\Omega$ $C_L \leq 100\text{ pF}$ , $T_{amb} = 25\text{ }^\circ\text{C}$ , $V_o = 2 V_{pp}$ )		0.008	0.05	%
$V_n$	Equivalent Input Noise Voltage ( $f = 1\text{ KHz}$ ) $R_S = 50\ \Omega$ $R_S = 1\text{ k}\Omega$ $R_S = 10\text{ k}\Omega$		8 10 18	15	nV/ $\sqrt{\text{Hz}}$
$V_{OPP}$	Large Signal Voltage Swing $R_L = 10\text{ k}\Omega$ , $f = 10\text{ KHz}$	26	28		V
$\phi M$	Phase Margin		45		Degrees
$V_{o1}/V_{o2}$	Channel Separation	100	120		dB



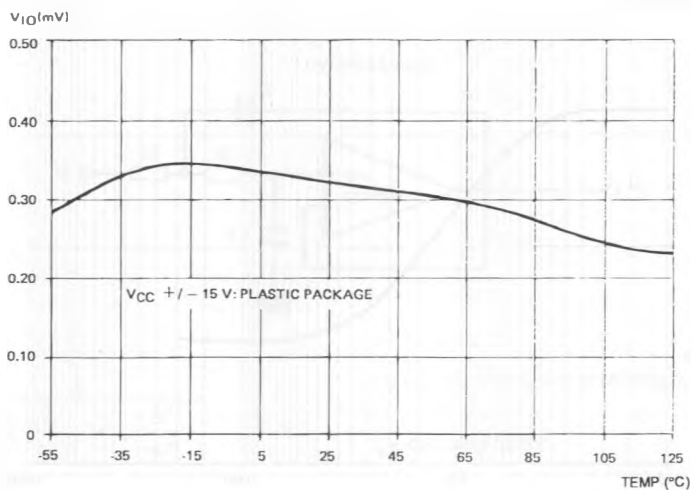
SUPPLY CURRENT VS. AMBIENT TEMPERATURE

E88TEB4033-02



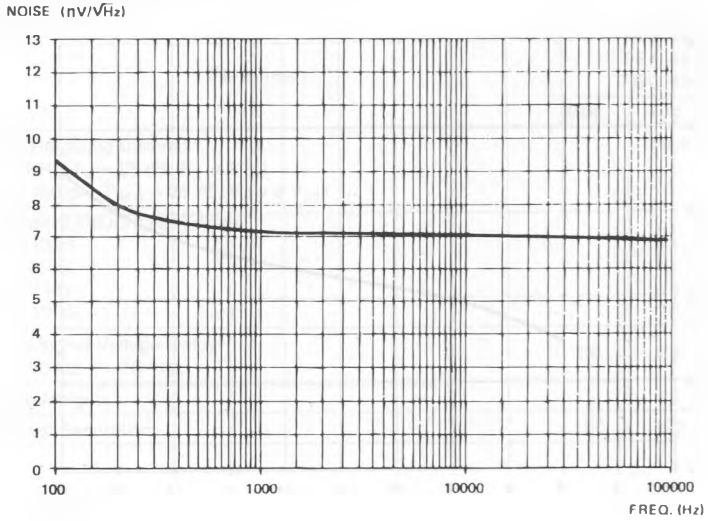
SUPPLY CURRENT VS. SUPPLY VOLTAGE

E88TEB4033-03



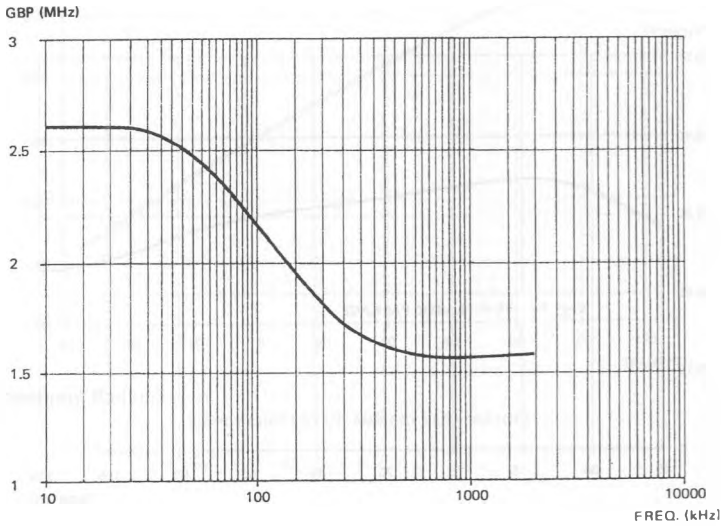
OFFSET VOLTAGE VS. AMBIENT TEMPERATURE

E88TEB4033-04



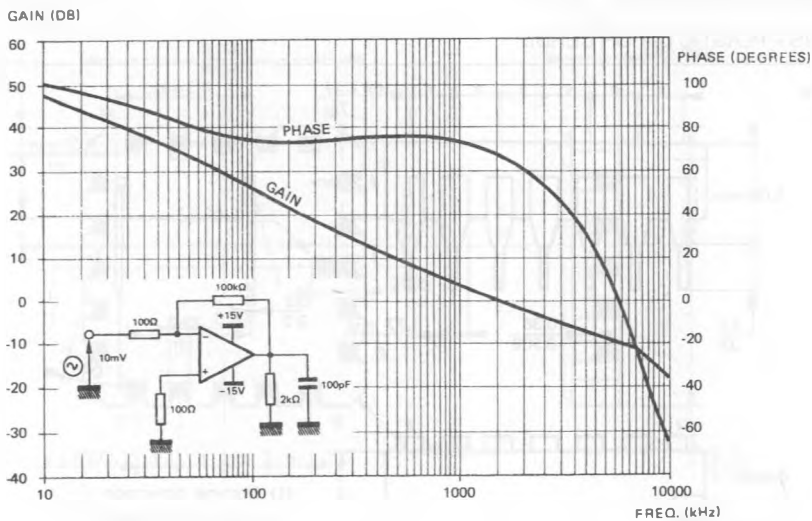
TOTAL INPUT NOISE VS. FREQUENCY

E88TEB4033-05



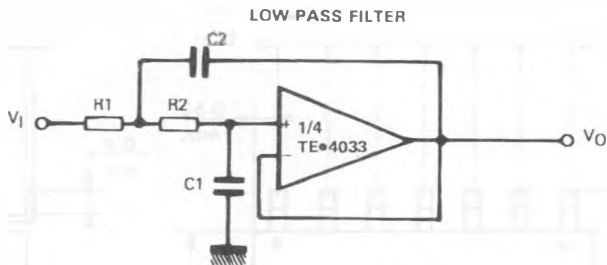
GAIN BANDWIDTH PRODUCT VS. FREQUENCY

E88TEB4033-06



E88TEB4033-07

## TYPICAL APPLICATION



E88TEB4033-08

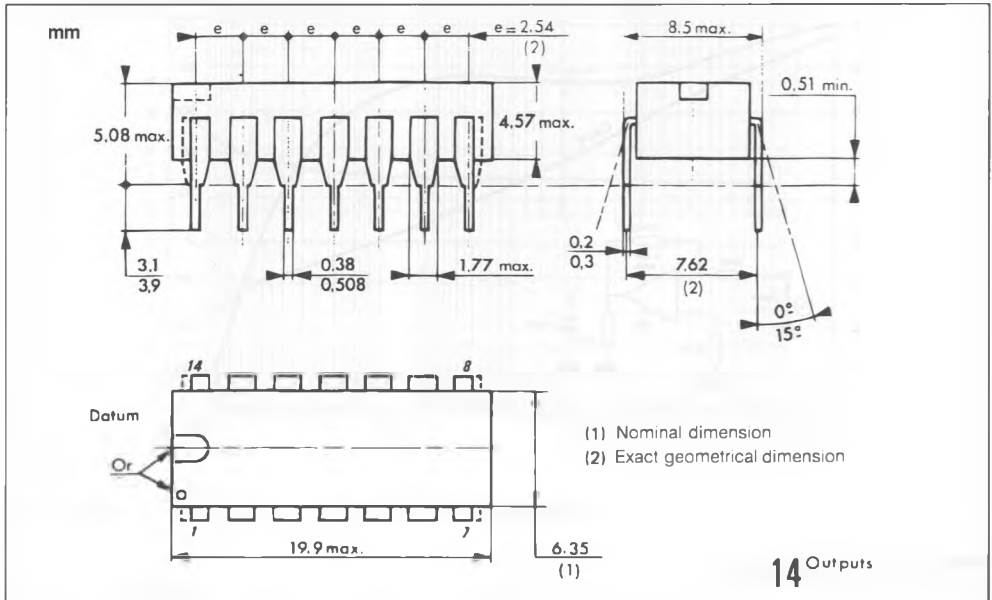
$$\frac{V_o}{V_i} = \frac{1}{1 + 2\xi \frac{s}{\omega_c} + \frac{s^2}{\omega_c^2}}$$

 $\omega_c = 2\pi f_c$ , with  $f_c$  = cut-off frequency

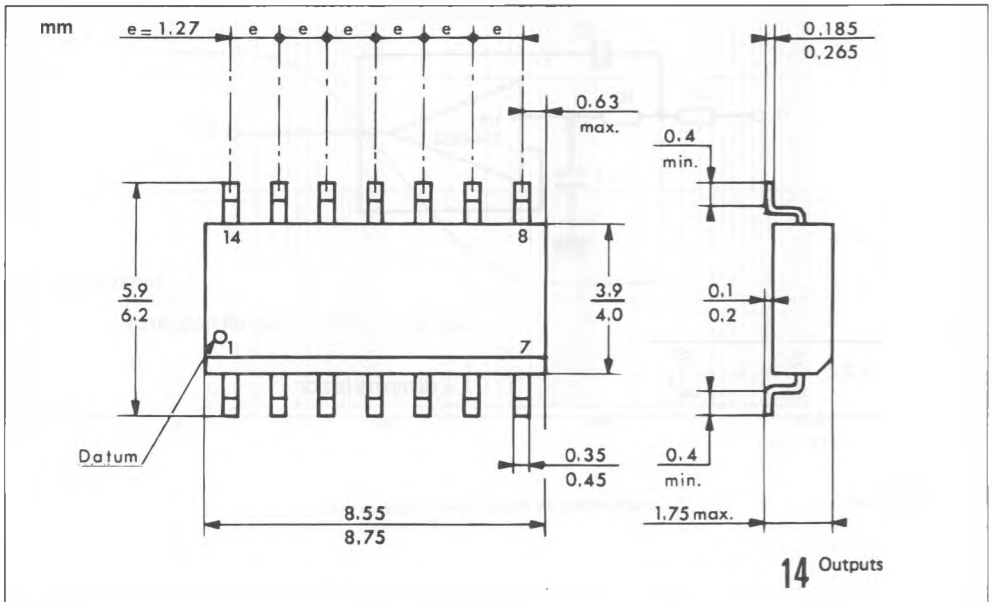
 $\xi$  = damping factor

PACKAGE MECHANICAL DATA

14 PINS – PLASTIC DIP OR CERDIP



14 PINS – PLASTIC MICROPACKAGE (SO)





## 20 PINS – TRICECOP (LCC)

