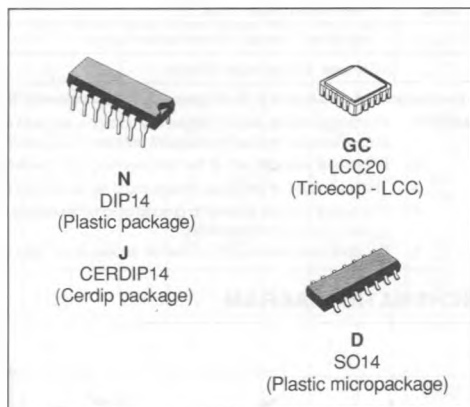


LOW POWER J-FET INPUT QUAD OP-AMPS

- VERY LOW POWER CONSUMPTION
- WIDE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES
- LOW INPUT BIAS AND OFFSET CURRENTS
- TYPICAL SUPPLY CURRENT : 200 μ A
- OUTPUT SHORT-CIRCUIT PROTECTION
- HIGH INPUT IMPEDANCE J-FET INPUT STAGE
- INTERNAL FREQUENCY COMPENSATION
- LATCH UP FREE OPERATION
- HIGH SLEW RATE : 3.5 V/ μ s (typ)



DESCRIPTION

The TL064, TL064A and TL064B are high speed J-FET input quad operational amplifiers. Each of these J-FET input operational amplifiers incorporates well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias current and offset currents, and low offset voltage temperature coefficient.

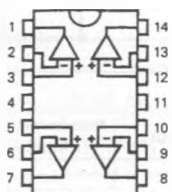
Part Number	Temperature Range	Package			
		N	J	D	GC
TL064M	- 55 °C to + 125 °C	•	•		•
TL064I	- 40 °C to + 105 °C	•			
TL064C	0 °C to + 70 °C	•		•	
TL064AC	0 °C to + 70 °C	•		•	
TL064BC	0 °C to + 70 °C	•		•	

Note : Hi-Rel versions available
Examples : TL064 MJ, TL064 CN

PIN CONNECTIONS (Top views)

**DIP14
CERDIP14
SO14**

- 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 - Output 3
- 9 - Inverting input 3
- 10 - Non-inverting input 3
- 11 - V_{CC}
- 12 - Non-inverting input 4
- 13 - Inverting input 4
- 14 - Output 4



LCC20



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

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

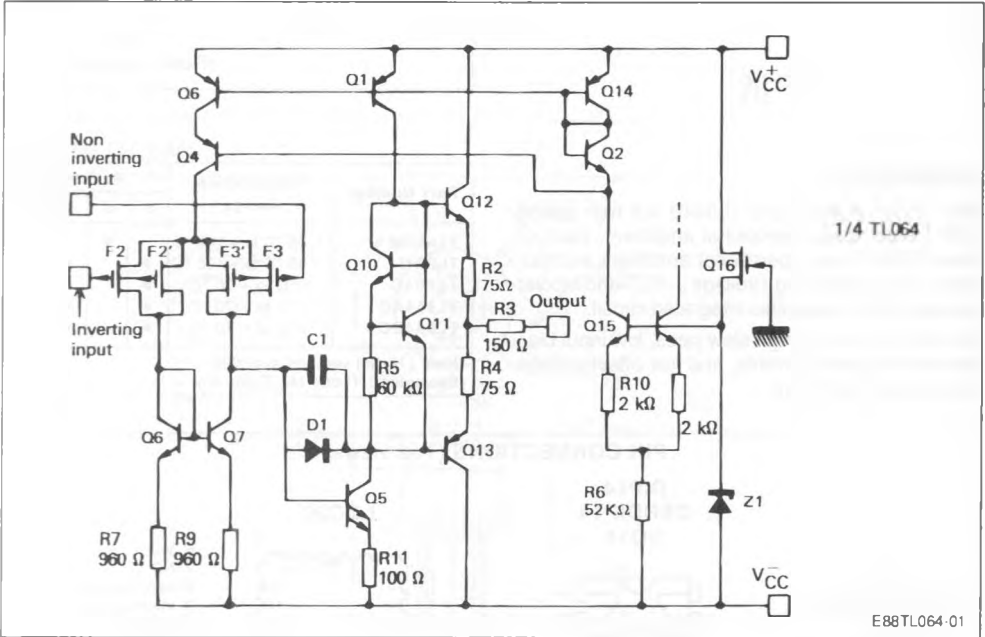
MAXIMUM RATINGS

Symbol	Parameter	TL064M	TL064I	TL064C	Unit
V _{CC}	Supply Voltage (note 1)	± 18	± 18	± 18	V
V _{ID}	Differential Input Voltage (note 2)	± 30	± 30	± 30	V
V _I	Input Voltage (note 3)	± 15	± 15	± 15	V
	Output Short-circuit Duration (note 4)	Indefinite	Indefinite	Indefinite	
P _{tot}	Power Dissipation (note 5)	680	680	680	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

* Devices bonded on a 6 cm x 0.15 cm glass epoxy substrate with 30 mm² of 35 μm thick copper.

- Notes :
- 1. All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC} and V_{CC}.
 - 2. Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.
 - 3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
 - 4. The output may be shorted to ground or to either supply. Temperature and /or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
 - 5. For operation above + 25 °C free-air temperature, refer to dissipation derating table.

SCHEMATIC DIAGRAM



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

* LCC20 Other pins are not connected.

ELECTRICAL CHARACTERISTICS

TL064M : $-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +125^{\circ}\text{C}$ TL064I : $-40^{\circ}\text{C} \leq T_{\text{amb}} \leq +105^{\circ}\text{C}$ TL064C : $0^{\circ}\text{C} \leq T_{\text{amb}} \leq +70^{\circ}\text{C}$ $V_{\text{CC}} = \pm 15\text{V}$.

All characteristics are specified under open-loop conditions unless otherwise specified.

Symbol	Parameter	TL064M			TL064I			TL064C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_{\text{S}} = 50\ \Omega$) $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		3	6 15		3	6 9		3	15 20	mV
αV_{IO}	Temperature Coefficient of Input Offset Voltage ($R_{\text{S}} = 50\ \Omega$)		10			10			10		$\mu\text{V}/^{\circ}\text{C}$
I_{IO}	Input Offset Current * $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		5	100 20		5	100 10		5	200 5	pA 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	200 50		30	200 20		30	400 10	pA nA
V_{I}	Input Common-mode Voltage Range ($T_{\text{amb}} = +25^{\circ}\text{C}$)	± 11	± 12		± 11.5	± 12		± 10	± 11		V
V_{OPP}	Output Voltage Swing : $R_{\text{L}} = 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$ $R_{\text{L}} \geq 10\ \text{k}\Omega$, $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	20 20	27		20 20	27		20 20	27		V
A_{VD}	Large Signal Voltage Gain ($R_{\text{L}} \geq 10\ \text{k}\Omega$, $V_{\text{O}} = \pm 10\ \text{V}$) $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	4 4	6		4 4	6		3 3	6		V/mV
GWR	Small Signal Bandwidth ($T_{\text{amb}} = +25^{\circ}\text{C}$, $R_{\text{L}} = 10\ \text{k}\Omega$)		1			1			1		MHz
R_{I}	Input Resistance ($T_{\text{amb}} = +25^{\circ}\text{C}$)		10^{12}			10^{12}			10^{12}		Ω
CMR	Common-mode Rejection Ratio ($R_{\text{S}} \leq 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$)	80	86		80	86		70	76		dB
SVR	Supply Voltage Rejection Ratio ($\Delta V_{\text{CC}}/\Delta V_{\text{IO}}$) $R_{\text{S}} \leq 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$	80	95		80	95		70	95		dB
I_{CC}	Supply Current (per amplifier) $T_{\text{amb}} = +25^{\circ}\text{C}$, no Load, no Signal		200	250		200	250		200	250	μA
$V_{\text{O1}}/V_{\text{O2}}$	Channel Separation ($A_{\text{VD}} = 100$, $T_{\text{amb}} = +25^{\circ}\text{C}$)		120			120			120		dB
P_{D}	Total Power Consumption (each amplifier) $T_{\text{amb}} = +25^{\circ}\text{C}$, no Load, no Signal		6	7.5		6	7.5		6	7.5	mW

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

 $V_{\text{CC}} = \pm 15\text{V}$, $T_{\text{amb}} = +25^{\circ}\text{C}$.

Symbol	Parameter	TL064M			TL064I, C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
S_{VO}	Slew Rate ($e_{\text{I}} = 10\ \text{V}$, $R_{\text{L}} = 10\ \text{k}\Omega$, $C_{\text{L}} = 100\ \text{pF}$, $A_{\text{V}} = 1$)	2	3.5			3.5		V/ μs
t_{r}	Rise Time ($e_{\text{I}} = 20\ \text{mV}$, $R_{\text{L}} = 10\ \text{k}\Omega$, $C_{\text{L}} = 100\ \text{pF}$, $A_{\text{V}} = 1$) (see fig. 1)		0.2			0.2		μs
K_{OV}	Overshoot Factor ($e_{\text{I}} = 20\ \text{mV}$, $R_{\text{L}} = 10\ \text{k}\Omega$, $C_{\text{L}} = 100\ \text{pF}$, $A_{\text{V}} = 1$) (see fig. 1)		10			10		%
V_{n}	Equivalent Input Noise Voltage ($R_{\text{S}} = 100\ \text{k}\Omega$, $f = 1\ \text{kHz}$)		42			42		nV/ $\sqrt{\text{Hz}}$

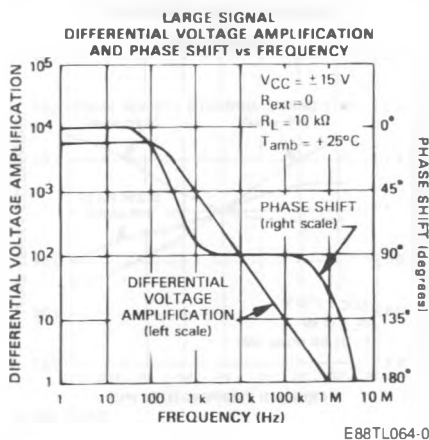
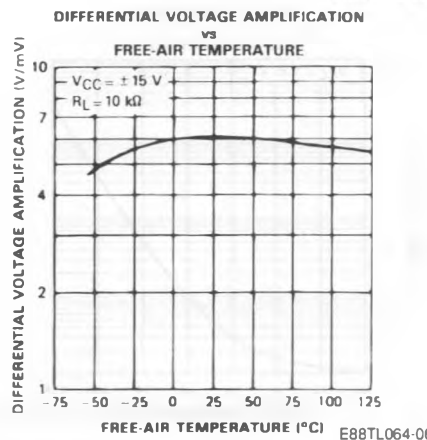
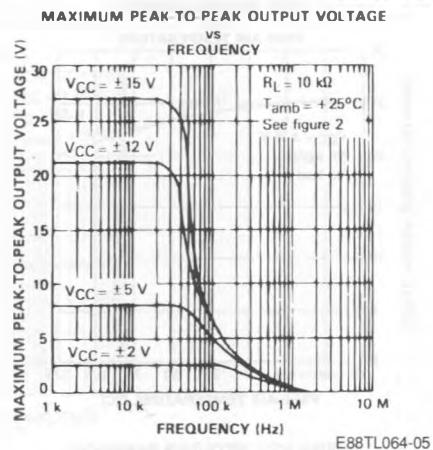
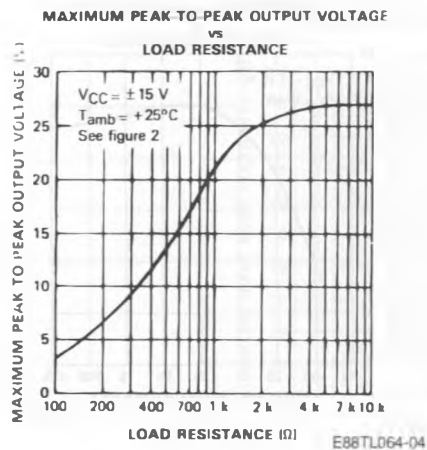
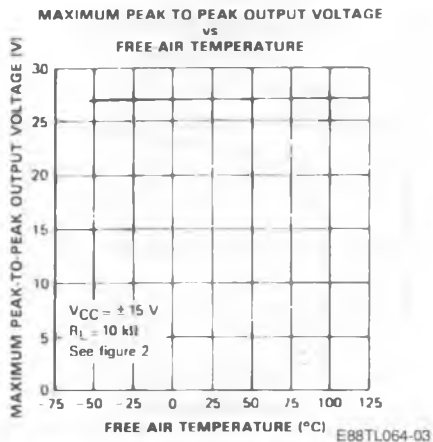
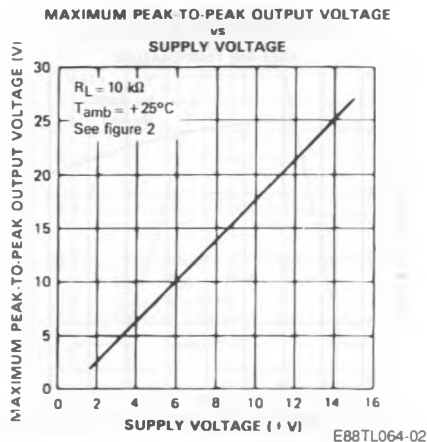
ELECTRICAL CHARACTERISTICS
TL064C : $0^{\circ}\text{C} \leq T_{\text{amb}} \leq +70^{\circ}\text{C}$
 $V_{\text{CC}} = \pm 15\text{V}$

All characteristics are specified under open-loop conditions unless otherwise specified.

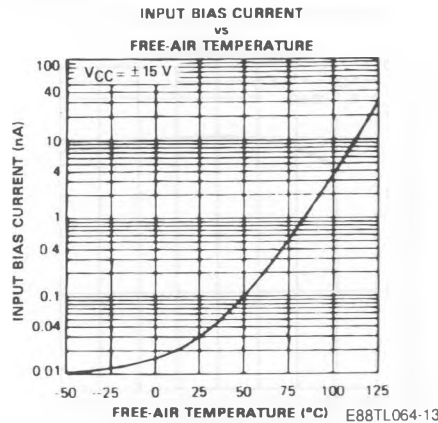
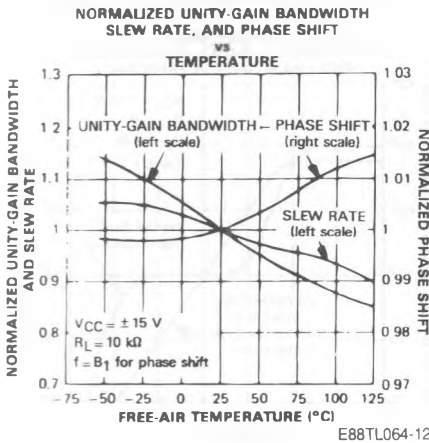
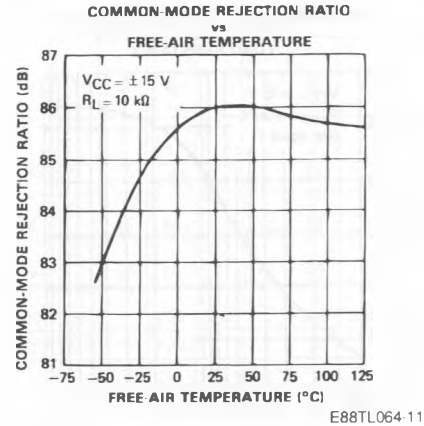
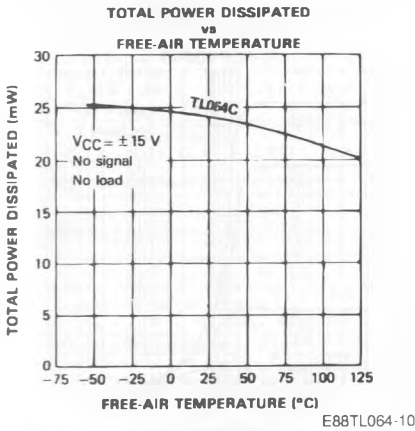
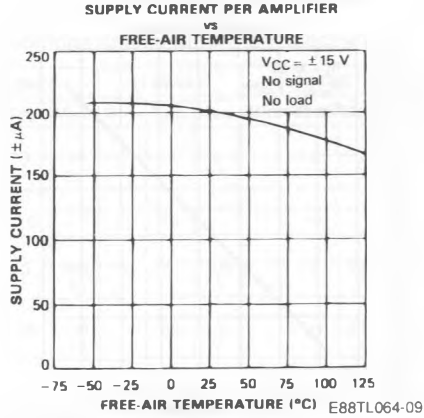
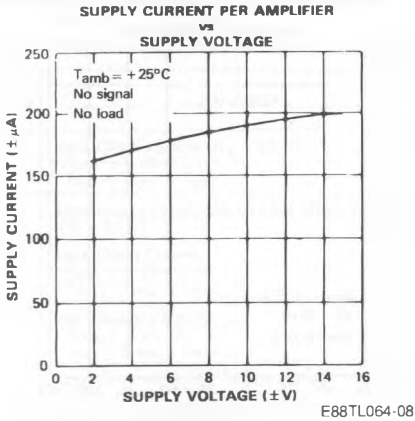
Symbol	Parameter	TL064C			TL064AC			TL064BC			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_{\text{S}} = 50\ \Omega$) $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		3	15 20		3	6 7.5		2	3 5	mV
αV_{IO}	Temperature Coefficient of Input Offset Voltage ($R_{\text{S}} = 50\ \Omega$)		10			10			10		$\mu\text{V}/^{\circ}\text{C}$
I_{IO}	Input Offset Current * $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		5	200 5		5	100 3		5	100 3	pA 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	400 10		30	200 7		30	200 7	pA nA
V_{I}	Input Common-mode Voltage Range ($T_{\text{amb}} = +25^{\circ}\text{C}$)	± 10	± 11		± 11.5	± 12		± 11.5	± 12		V
V_{OPP}	Output Voltage Swing : $R_{\text{L}} = 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$ $R_{\text{L}} \geq 10\ \text{k}\Omega$, $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	20 20	27		20 20	27		20 20	27		V
A_{VD}	Large Signal Voltage Gain ($R_{\text{L}} \geq 10\ \text{k}\Omega$, $V_{\text{O}} = \pm 10\ \text{V}$) $T_{\text{amb}} = +25^{\circ}\text{C}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	3 3	6		4 4	6		4 4	6		V/mV
GWR	Small Signal Bandwidth ($T_{\text{amb}} = +25^{\circ}\text{C}$, $R_{\text{L}} = 10\ \text{k}\Omega$)		1			1			1		MHz
R_{I}	Input Resistance ($T_{\text{amb}} = +25^{\circ}\text{C}$)		10^{12}			10^{12}			10^{12}		Ω
CMR	Common-mode Rejection Ratio ($R_{\text{S}} \leq 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$)	70	76		80	86		80	86		dB
SVR	Supply Voltage Rejection Ratio ($\Delta V_{\text{CC}}/\Delta V_{\text{IO}}$) $R_{\text{S}} \leq 10\ \text{k}\Omega$, $T_{\text{amb}} = +25^{\circ}\text{C}$	70	95		80	95		80	95		dB
I_{CC}	Supply Current (per amplifier) $T_{\text{amb}} = +25^{\circ}\text{C}$, no Load, no Signal		200	250		200	250		200	250	μA
$V_{\text{O1}}/V_{\text{O2}}$	Channel Separation ($A_{\text{VD}} = 100$, $T_{\text{amb}} = +25^{\circ}\text{C}$)		120			120			120		dB
P_{D}	Total Power Consumption (each amplifier) $T_{\text{amb}} = +25^{\circ}\text{C}$, no Load, no Signal		6	7.5		6	7.5		6	7.5	mW

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

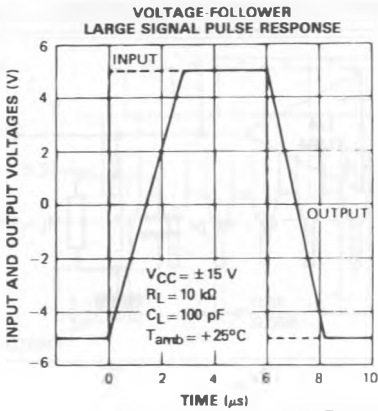
TYPICAL CHARACTERISTICS



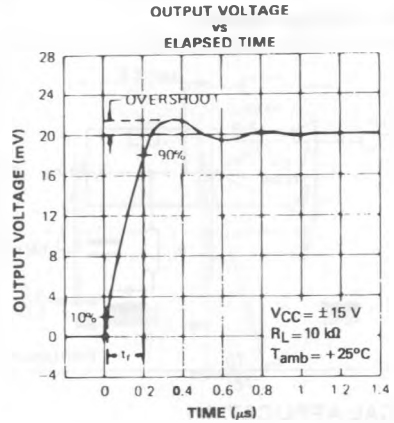
TYPICAL CHARACTERISTICS (continued)



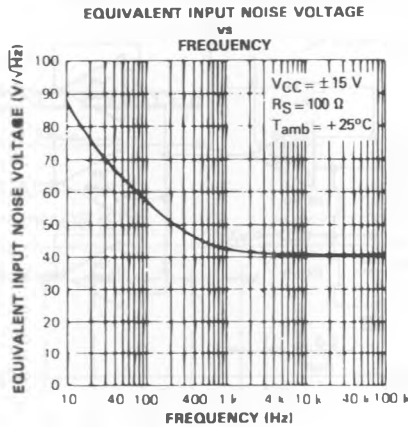
TYPICAL CHARACTERISTICS (continued)



E88TL064-14



E88TL064-15



E88TL064-16

PARAMETER MEASUREMENT INFORMATION

Figure 1 : Voltage follower.

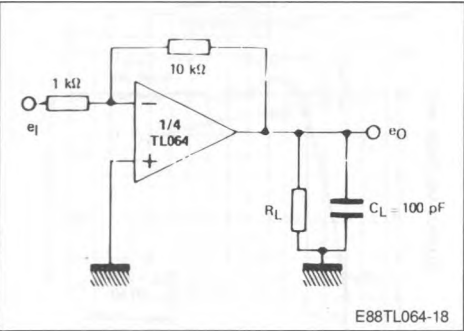
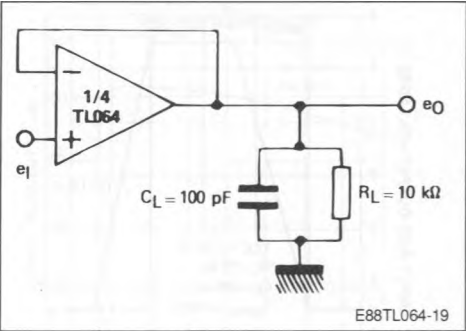
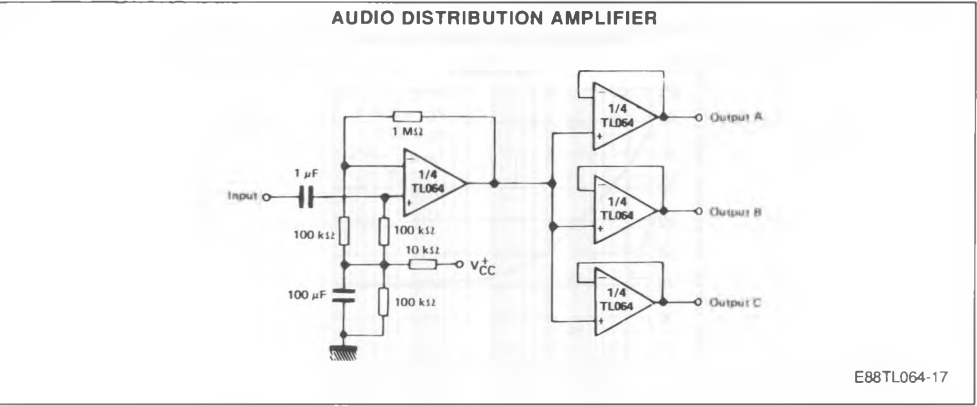


Figure 2 : Gain-of-10 inverting amplifier.



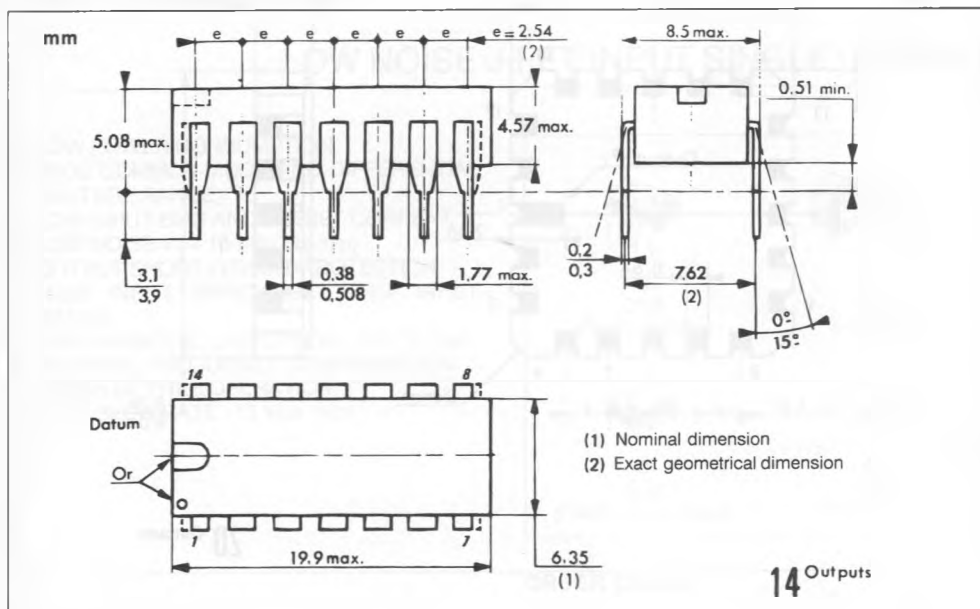
TYPICAL APPLICATION

AUDIO DISTRIBUTION AMPLIFIER

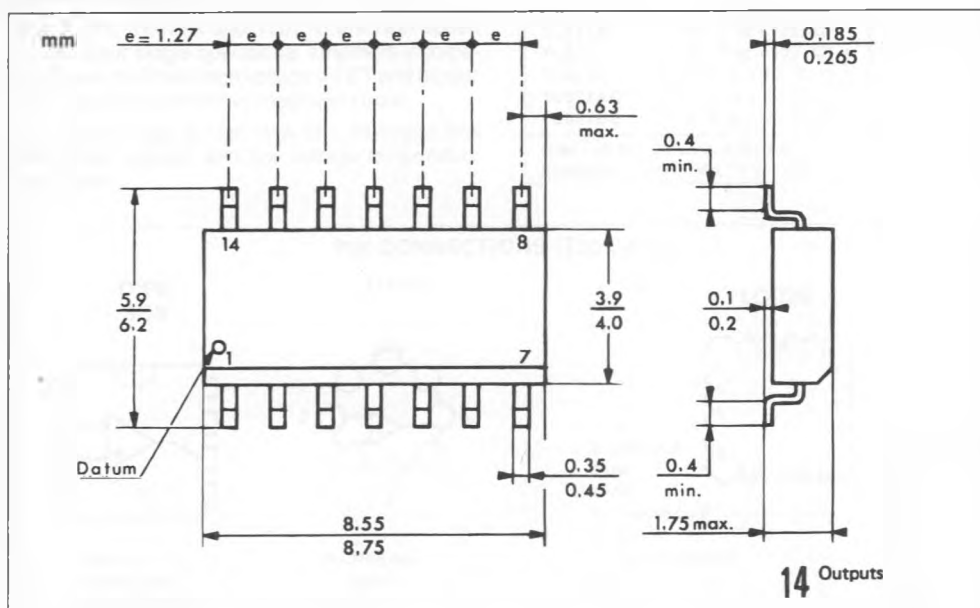


PACKAGE MECHANICAL DATA

14 PINS – PLASTIC DIP OR CerdIP



14 PINS – PLASTIC MICROPACKAGE (SO)



20 PINS – TRICECOP (LCC)

