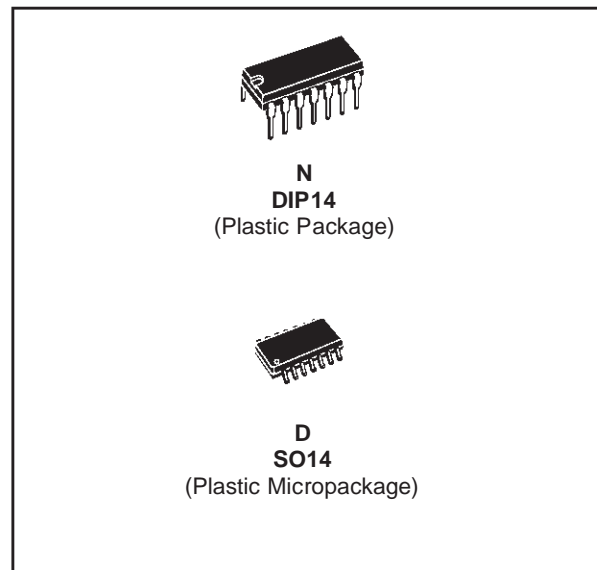




## LOW POWER J-FET QUAD OPERATIONAL AMPLIFIERS

- VERY LOW POWER CONSUMPTION : 200 $\mu$ A
- WIDE COMMON-MODE (UP TO  $V_{CC}^+$ ) AND DIFFERENTIAL VOLTAGE RANGES
- LOW INPUT BIAS AND OFFSET CURRENTS
- OUTPUT SHORT-CIRCUIT PROTECTION
- HIGH INPUT IMPEDANCE J-FET INPUT STAGE
- INTERNAL FREQUENCY COMPENSATION
- LATCH UP FREE OPERATION
- HIGH SLEW RATE : 3.5V/ $\mu$ s



### 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 device features high slew rate, low input bias and offset currents, and low offset voltage temperature coefficient.

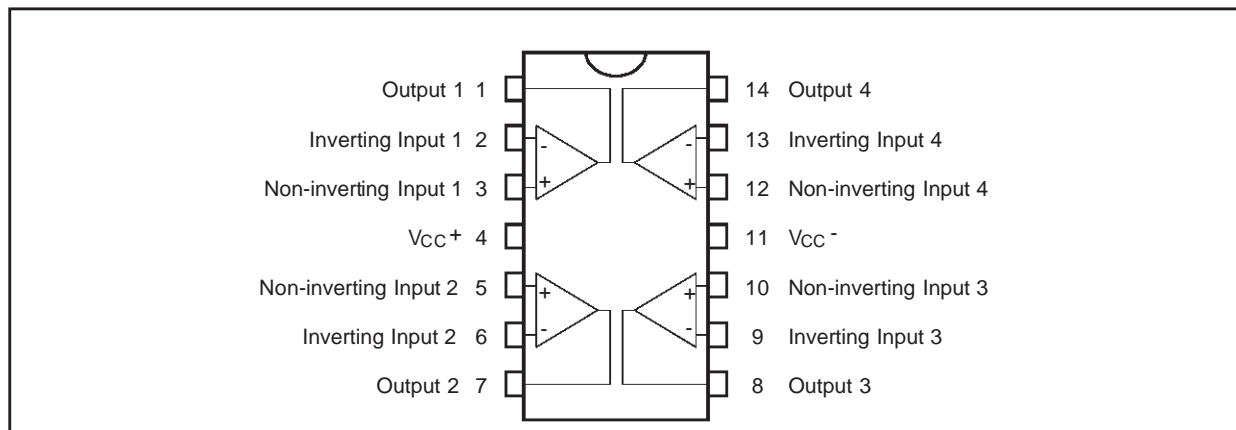
### ORDER CODE

Part Number	Temperature Range	Package	
		N	D
TL064M/AM/BM	-55°C, +125°C	•	•
TL064I/AI/BI	-40°C, +105°C	•	•
TL064C/AC/BC	0°C, +70°C	•	•

**Example** : TL064IN

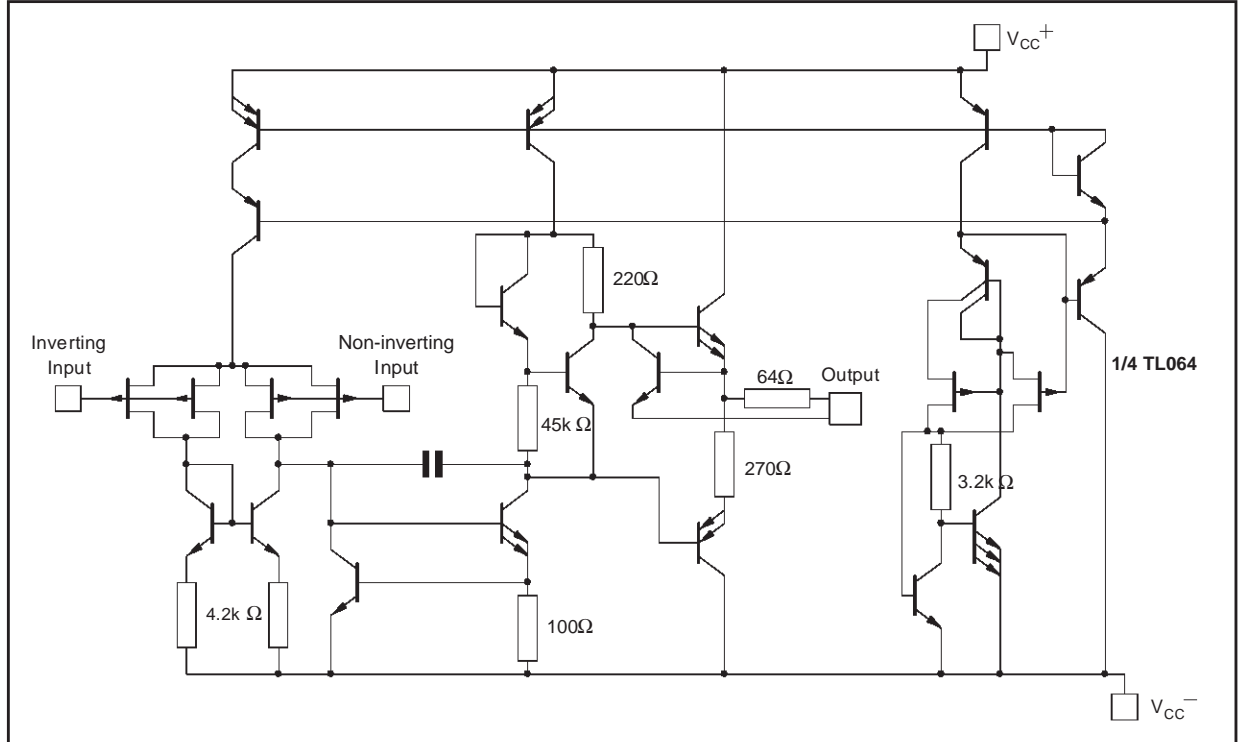
N = Dual in Line Package (DIP)  
D = Small Outline Package (SO) - also available in Tape & Reel (DT)

### PIN CONNECTIONS (top view)



# TL064 - TL064A - TL064B

## SCHEMATIC DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	TL064M, AM, BM	TL064I, AI, BI	TL064C, AC, BC	Unit
$V_{CC}$	Supply voltage - note <sup>1)</sup>	±18			V
$V_i$	Input Voltage - note <sup>2)</sup>	±15			V
$V_{id}$	Differential Input Voltage - note <sup>3)</sup>	±30			V
$P_{tot}$	Power Dissipation	680			mW
	Output Short-circuit Duration - note <sup>4)</sup>	Infinite			
$T_{oper}$	Operating Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70	°C
$T_{stg}$	Storage Temperature Range	-65 to +150			°C

1. All voltage values, except differential voltage, 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. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
3. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
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.

**ELECTRICAL CHARACTERISTICS**

$V_{CC} = \pm 15V$ ,  $T_{amb} = +25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter	TL064M			TL064I			TL064C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage ( $R_S = 50\Omega$ ) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		3	6 15		3	6 9		3	15 20	mV
$DV_{io}$	Temperature Coefficient of Input Offset Voltage ( $R_S = 50\Omega$ )		10			10			10		$\mu V/^{\circ}C$
$I_{io}$	Input Offset Current - note 1) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		5	100 20		5	100 10		5	200 5	pA nA
$I_{ib}$	Input Bias Current - note 1 $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		30	200 50		30	200 20		30	400 10	pA nA
$V_{icm}$	Input Common Mode Voltage Range	$\pm 11.5$	+15 -12		$\pm 11.5$	+15 -12		$\pm 11$	+15 -12		V
$V_{opp}$	Output Voltage Swing ( $R_L = 10k\Omega$ ) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	20 20	27		20 20	27		20 20	27		V
$A_{vd}$	Large Signal Voltage Gain $R_L = 10k\Omega$ , $V_o = \pm 10V$ , $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	4 4	6		4 4	6		3 3	6		V/mV
GBP	Gain Bandwidth Product $T_{amb} = 25^{\circ}C$ , $R_L = 10k\Omega$ , $C_L = 100pF$		1			1			1		MHz
$R_i$	Input Resistance		$10^{12}$			$10^{12}$			$10^{12}$		$\Omega$
CMR	Common Mode Rejection Ratio $R_S = 50\Omega$	80	86		80	86		70	76		dB
SVR	Supply Voltage Rejection Ratio $R_S = 50\Omega$	80	95		80	95		70	95		dB
$I_{CC}$	Supply Current, Per Amplifier $T_{amb} = 25^{\circ}C$ , no load, no signal		200	250		200	250		200	250	$\mu A$
$V_{o1}/V_{o2}$	Channel Separation $A_v = 100$ , $T_{amb} = 25^{\circ}C$		120			120			120		dB
$P_D$	Total Power Consumption $T_{amb} = 25^{\circ}C$ , no load, no signal		6	7.5		6	7.5		6	7.5	mW
SR	Slew Rate $V_i = 10V$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_v = 1$	1.5	3.5		1.5	3.5		1.5	3.5		V/ $\mu s$
$t_r$	Rise Time 5 (see figure 1) $V_i = 20mV$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_v = 1$		0.2			0.2			0.2		$\mu s$
$K_{ov}$	Overshoot Factor (see figure 1) $V_i = 20mV$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_v = 1$ (see figure 1)		10			10			10		%
$e_n$	Equivalent Input Noise Voltage $R_S = 100\Omega$ , $f = 1KHz$		42			42			42		$\frac{nV}{\sqrt{Hz}}$

1. The 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 possible.

## TL064 - TL064A - TL064B

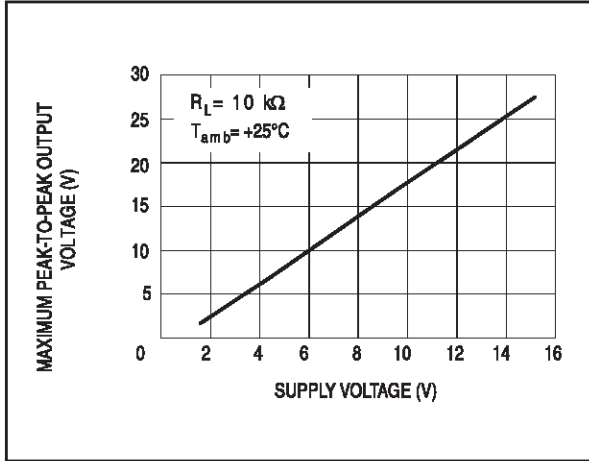
### ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15V$ ,  $T_{amb} = +25^{\circ}C$  (unless otherwise specified)

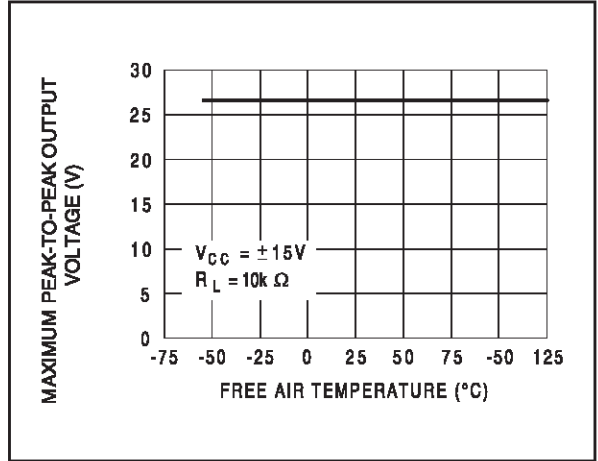
Symbol	Parameter	TL064AC, AI, AM			TL064BC, BI, BM			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage ( $R_S = 50\Omega$ ) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		3	6 7.5		2	3 5	mV
$DV_{io}$	Temperature Coefficient of Input Offset Voltage ( $R_S = 50\Omega$ )		10			10		$\mu V/^{\circ}C$
$I_{io}$	Input Offset Current - note 1) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		5	100 3		5	100 3	pA nA
$I_{ib}$	Input Bias Current - note 1 $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		30	200 7		30	200 7	pA nA
$V_{icm}$	Input Common Mode Voltage Range	$\pm 11.5$	+15 -12		$\pm 11.5$	+15 -12		V
$V_{opp}$	Output Voltage Swing ( $R_L = 10k\Omega$ ) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	20 20	27		20 20	27		V
$A_{vd}$	Large Signal Voltage Gain $R_L = 10k\Omega$ , $V_o = \pm 10V$ , $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	4 4	6		4 4	6		V/mV
GBP	Gain Bandwidth Product $T_{amb} = 25^{\circ}C$ , $R_L = 10k\Omega$ , $C_L = 100pF$		1			1		MHz
$R_i$	Input Resistance		$10^{12}$			$10^{12}$		$\Omega$
CMR	Common Mode Rejection Ratio $R_S = 50\Omega$	80	86		80	86		dB
SVR	Supply Voltage Rejection Ratio $R_S = 50\Omega$	80	95		80	95		dB
$I_{CC}$	Supply Current (Per Amplifier) $T_{amb} = +25^{\circ}C$ , no load, no signal		200	250		200	250	$\mu A$
$V_{o1}/V_{o2}$	Channel Separation $A_V = 100$ , $T_{amb} = +25^{\circ}C$		120			120		dB
$P_D$	Total Power Consumption (Each Amplifier) $T_{amb} = 25^{\circ}C$ , no load, no signal		6	7.5		6	7.5	mW
SR	Slew Rate $V_i = 10V$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_V = 1$	1.5	3.5		1.5	3.5		V/ $\mu s$
$t_r$	Rise Time $V_i = 20mV$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_V = 1$		0.2			0.2		$\mu s$
$K_{ov}$	Overshoot Factor (see figure 1) $V_i = 20mV$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $A_V = 1$		10			10		%
$e_n$	Equivalent Input Noise Voltage $R_S = 100\Omega$ , $f = 1KHz$		42			42		$\frac{nV}{\sqrt{Hz}}$

1. The 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 possible.

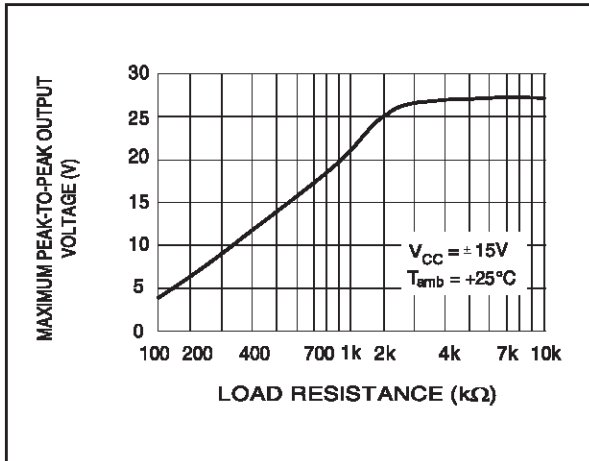
**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE versus SUPPLY VOLTAGE**



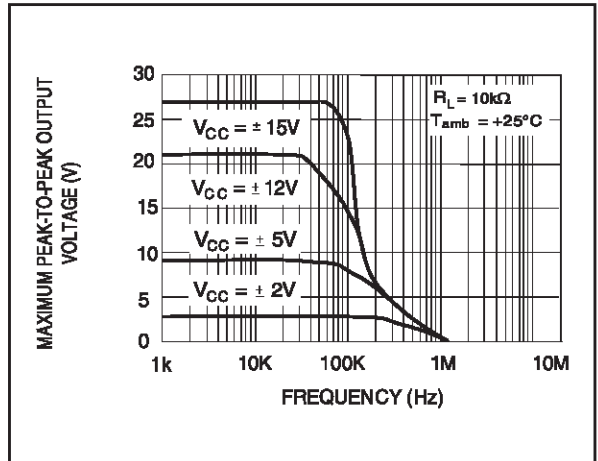
**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE versus FREE AIR TEMPERATURE**



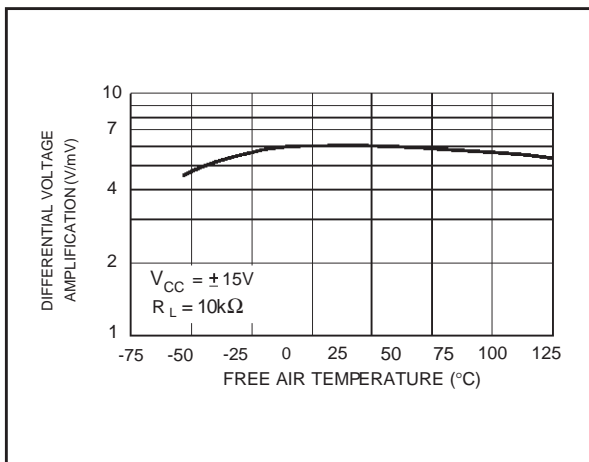
**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE versus LOAD RESISTANCE**



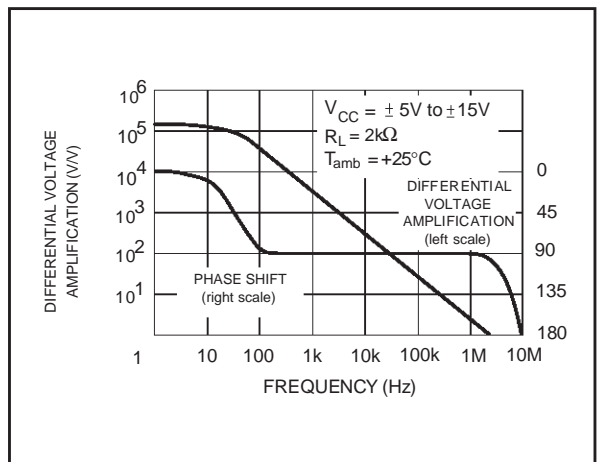
**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE versus FREQUENCY**



**DIFFERENTIAL VOLTAGE AMPLIFICATION versus FREE AIR TEMPERATURE**

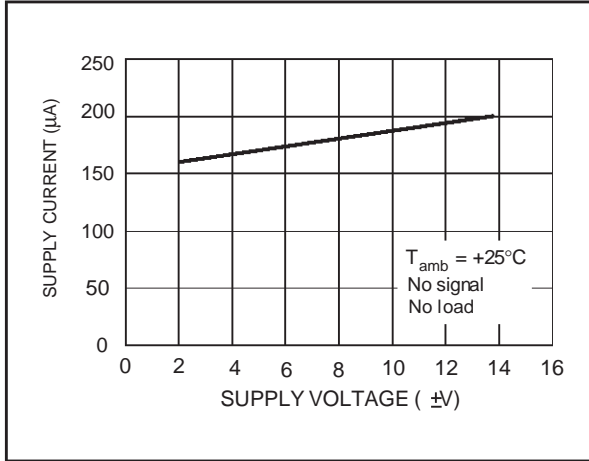


**LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT versus FREQUENCY**

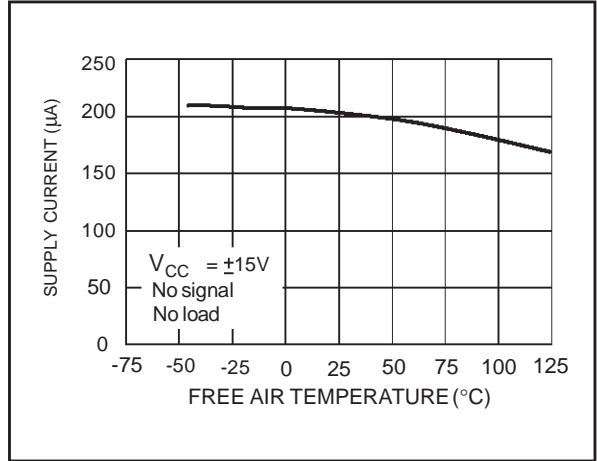


**TL064 - TL064A - TL064B**

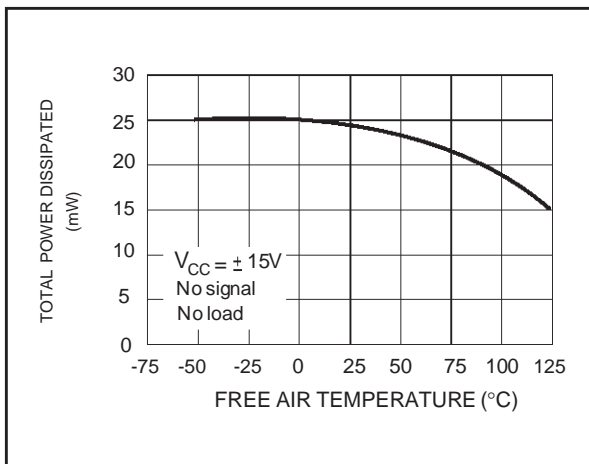
**SUPPLY CURRENT PER AMPLIFIER versus SUPPLY VOLTAGE**



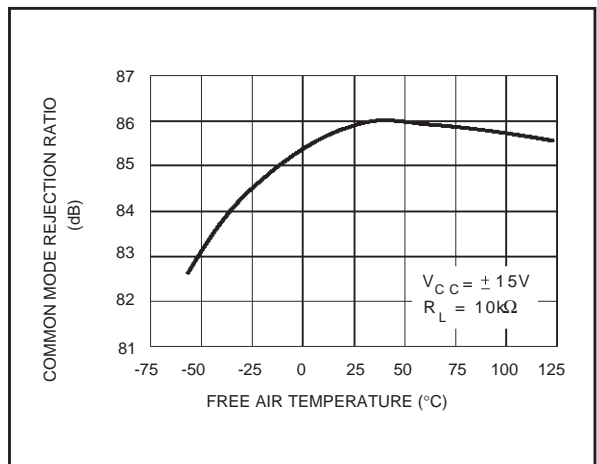
**SUPPLY CURRENT PER AMPLIFIER versus FREE AIR TEMPERATURE**



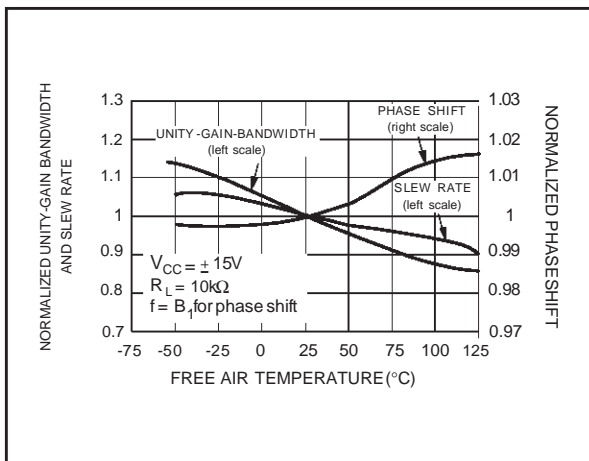
**TOTAL POWER DISSIPATED versus FREE AIR TEMPERATURE**



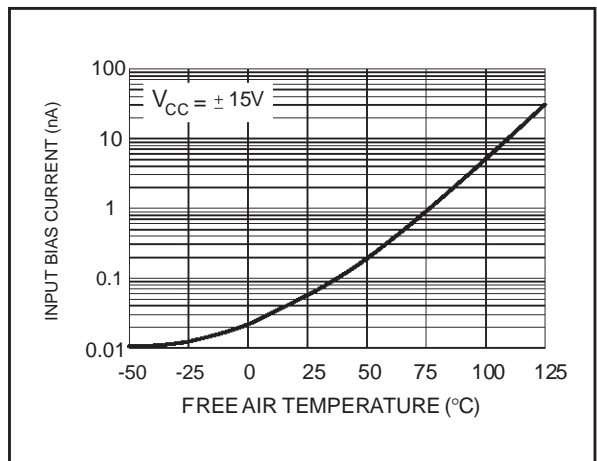
**COMMON MODE REJECTION RATIO versus FREE AIR TEMPERATURE**



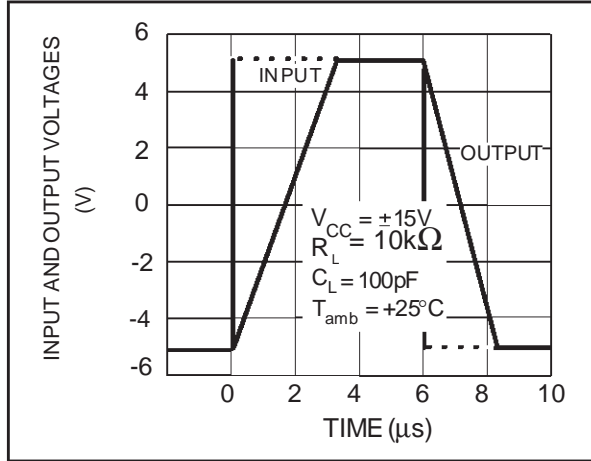
**NORMALIZED UNITY GAIN BANDWIDTH, SLEW RATE, AND PHASE SHIFT versus TEMPERATURE**



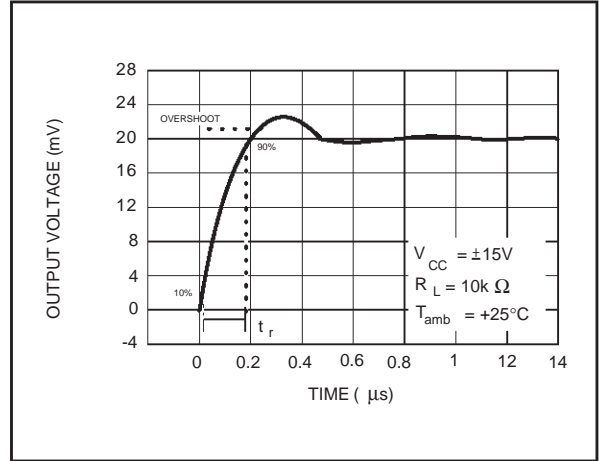
**INPUT BIAS CURRENT versus FREE AIR TEMPERATURE**



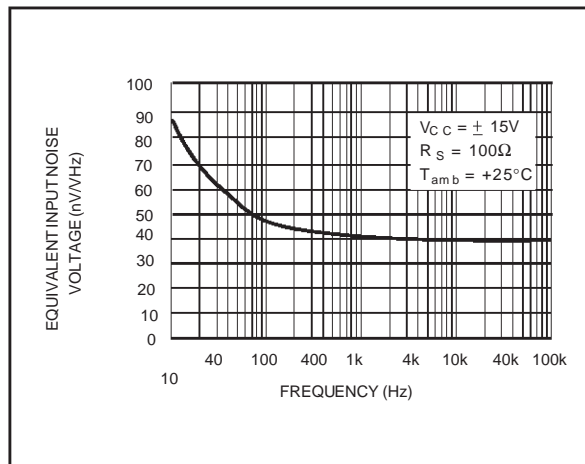
**VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE**



**OUTPUT VOLTAGE versus ELAPSED TIME**



**EQUIVALENT INPUT NOISE VOLTAGE versus FREQUENCY**



PARAMETER MEASUREMENT INFORMATION

Figure 1 : Voltage Follower

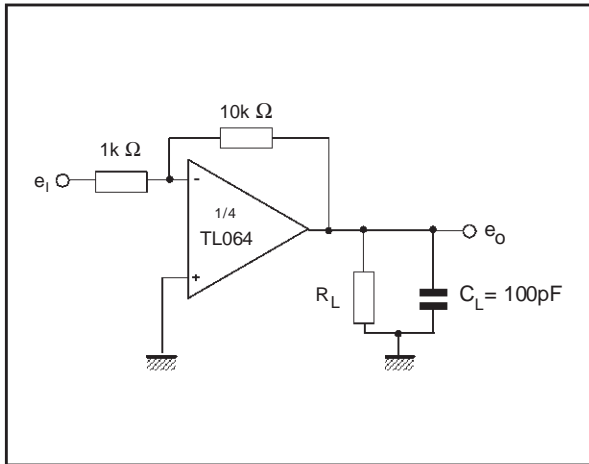
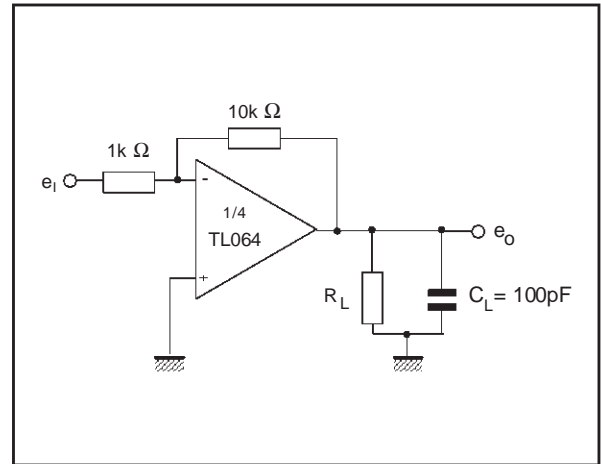
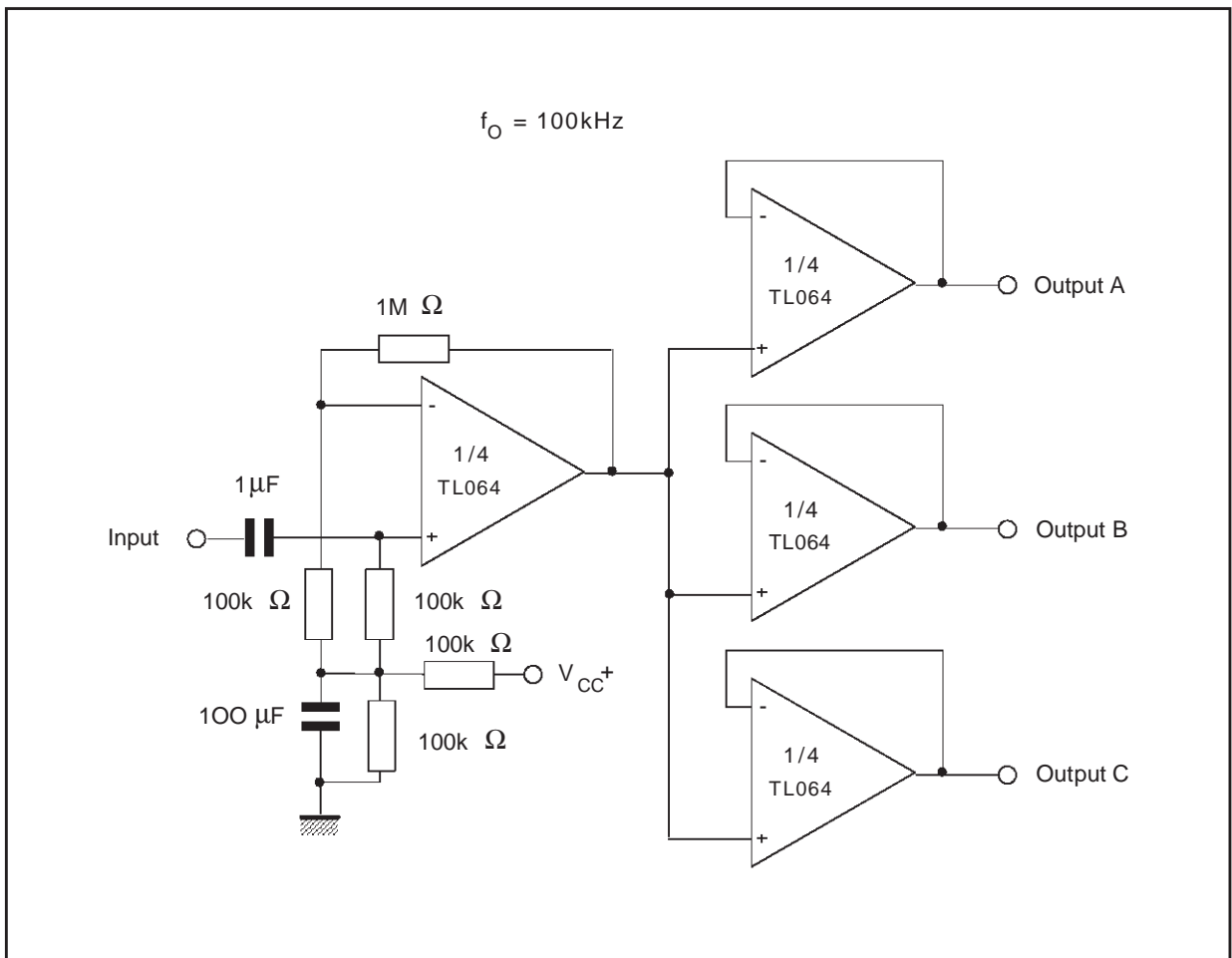


Figure 2 : Gain-of-10 Inverting Amplifier



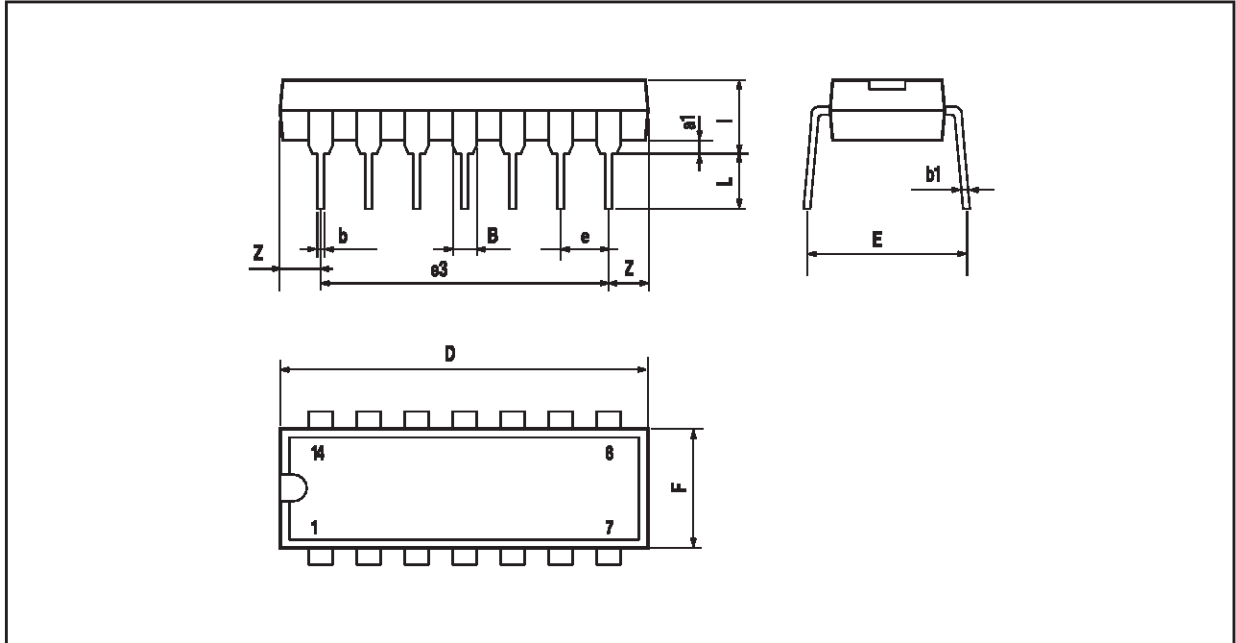
TYPICAL APPLICATIONS

AUDIO DISTRIBUTOR AMPLIFIER





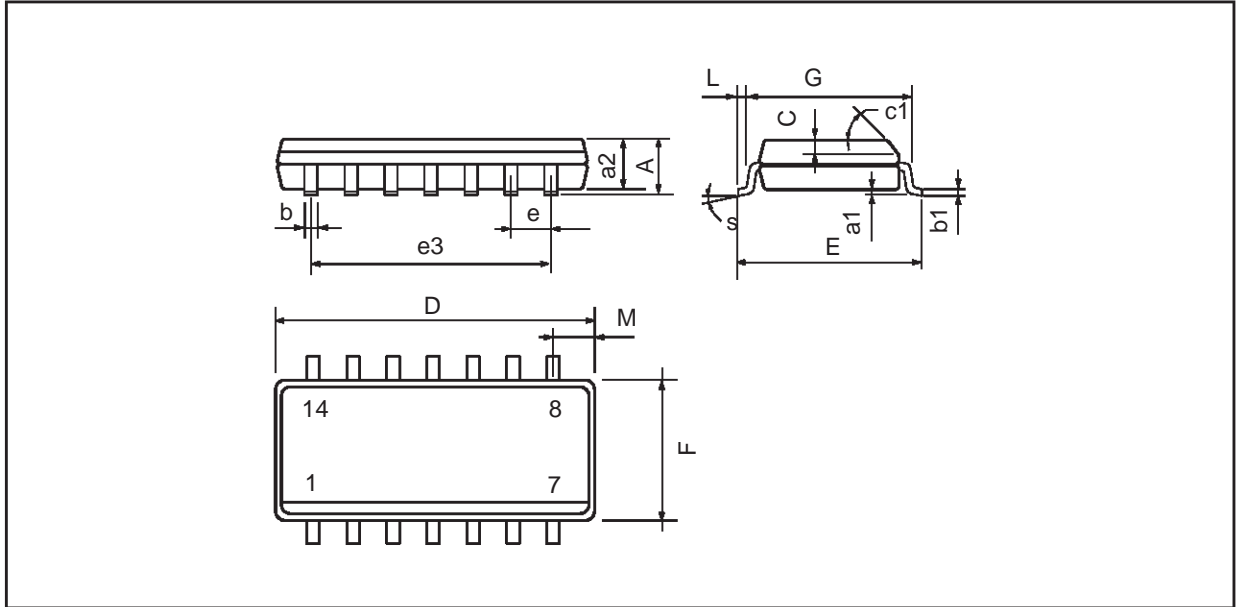
**PACKAGE MECHANICAL DATA**  
14 PINS - PLASTIC DIP



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		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		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

# TL064 - TL064A - TL064B

## PACKAGE MECHANICAL DATA 14 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 (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

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