

# TL044M, TL044C QUAD LOW-POWER OPERATIONAL AMPLIFIERS

D1862, SEPTEMBER 1973—REVISED JUNE 1988

- Very Low Power Consumption
- Typical Power Dissipation with  $\pm 2$ -V Supplies . . . 340  $\mu$ W
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Input Offset Voltage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- Power Applied in Pairs

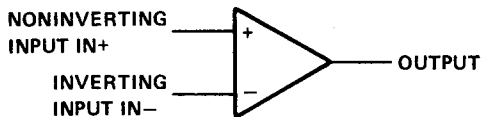
**TL044M IS NOT RECOMMENDED FOR NEW DESIGNS.**

### description

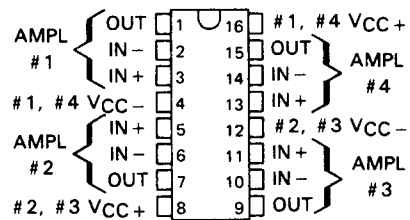
The TL044 is a quad low-power operational amplifier designed to replace higher-power devices in many applications without sacrificing system performance. High input impedance, low supply currents, and low equivalent input noise voltage over a wide range of operating supply voltages result in an extremely versatile operational amplifier for use in a variety of analog applications including battery-operated circuits. Internal frequency compensation, absence of latch-up, high slew rate, and output short-circuit protection assure ease of use. Power may be applied separately to Section A (amplifiers 1 and 4) or Section B (amplifiers 2 and 3) while the other pair remains unpowered.

The TL044M is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ; the TL044C is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

### symbol (each amplifier)

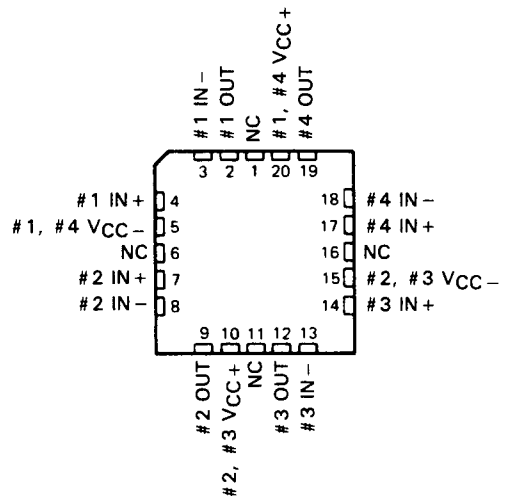


**TL044M . . . J OR W DUAL-IN-LINE PACKAGE  
TL044C . . . J OR N PACKAGE  
(TOP VIEW)**



Pins 4 and 12 are internally connected together in the N package only.

**TL044M . . . FK PACKAGE  
(TOP VIEW)**



NC—No internal connection

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## AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> MAX AT 25°C	PACKAGE			
		CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	FLAT PACK (W)
0°C to 70°C	5 mV	—	TL044CJ	TL044CN	—
-55°C to 125°C	5 mV	TL044MFK	TL044MJ	—	TL044MW

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	TL044M	TL044C	UNIT
Supply voltage V <sub>CC+</sub> (see Note 1)	22	18	V
Supply voltage V <sub>CC-</sub> (see Note 1)	-22	-18	V
Differential input voltage (see Note 2)	±30	±30	V
Input voltage (any input, see Notes 1 and 3)	±15	±15	V
Duration of output short-circuit (see Note 4)	unlimited	unlimited	
Continuous total dissipation	See Dissipation Rating Table		
Operating free-air temperature range	-55 to 125	0 to 70	°C
Storage temperature range	-65 to 150	-65 to 150	°C
Case temperature for 60 seconds	FK package	260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J or W package	300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	N package	260	°C

- NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between V<sub>CC+</sub> and V<sub>CC-</sub>.  
 2. Differential voltages are at the noninverting 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 V, whichever is less.  
 4. The output may be shorted to ground or either power supply. For the TL044M only, the unlimited duration of the short-circuit applies at (or below) 125°C case temperature or 85°C free-air temperature.

## DISSIPATION RATING TABLE

PACKAGE	T <sub>A</sub> ≤ 25°C	DERATING FACTOR	DERATE ABOVE T <sub>A</sub>	T <sub>A</sub> = 70°C	T <sub>A</sub> = 125°C
	POWER RATING			POWER RATING	POWER RATING
FK	680 mW	11.0 mW/°C	88°C	680 mW	275 mW
J (TL044M)	680 mW	11.0 mW/°C	88°C	680 mW	275 mW
J (TL044C)	680 mW	8.2 mW/°C	67°C	656 mW	—
N	680 mW	N/A	N/A	680 mW	—
W	680 mW	8.0 mW/°C	65°C	640 mW	200 mW

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electrical characteristics at specified free-air temperature,  $V_{CC+} = 15\text{ V}$ ,  $V_{CC-} = -15\text{ V}$

PARAMETER	TEST CONDITIONS†	TL044M			TL044C			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 0$ , $R_S = 50\ \Omega$	25°C	1	5	1	5	mV	
		Full range		6		7.5		
$I_{IO}$ Input offset current	$V_O = 0$	25°C	5	40	15	80	nA	
		Full range		100		200		
$I_{IB}$ Input bias current	$V_O = 0$	25°C	50	100	100	250	nA	
		Full range		250		400		
$V_{ICR}$ Common-mode input voltage range		25°C	±12	±13	±12	±13	V	
		Full range	±12		±12			
$V_{OPP}$ Maximum peak-to-peak output voltage swing	$R_L = 10\text{ k}\Omega$	25°C	20	26	20	26	V	
	$R_L \geq 10\text{ k}\Omega$	Full range	20		20			
$A_{VD}$ Large-signal differential voltage amplification	$R_L \geq 10\text{ k}\Omega$ , $V_O = \pm 10\text{ V}$	25°C	72	86	60	80	dB	
		Full range	66		60			
$B_1$ Unity-gain bandwidth		25°C		0.5		0.5	MHz	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\ min}$ , $V_O = 0$ , $R_S = 50\ \Omega$	25°C	60	72	60	72	dB	
		Full range	60		60			
$k_{SVS}$ Supply voltage sensitivity ( $\Delta V_{IO}/\Delta V_{CC}$ )	$V_{CC} = \pm 9\text{ V to } \pm 15\text{ V}$ , $V_O = 0$ , $R_S = 50\ \Omega$	25°C		30	150	30	200	$\mu\text{V/V}$
		Full range		150		200		
$V_n$ Equivalent input noise voltage	$A_{VD} = 20\text{ dB}$ , $B = 1\text{ Hz}$ , $f = 1\text{ kHz}$	25°C		50		50	$\text{nV}/\sqrt{\text{Hz}}$	
$I_{OS}$ Short-circuit output current		25°C		±6		±6	mA	
$I_{CC}$ Supply current (four amplifiers)	No load, $V_O = 0\text{ V}$	25°C		250	400	250	500	$\mu\text{A}$
		Full range		400		500		
$P_D$ Total dissipation (four amplifiers)	No load, $V_O = 0\text{ V}$	25°C		7.5	12	7.5	15	mW
		Full range		12		15		

† All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. Full range for TL044M is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  and for TL044C is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

operating characteristics,  $V_{CC+} = 15\text{ V}$ ,  $V_{CC-} = -15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TL044M			TL044C			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$t_r$ Rise time	$V_I = 20\text{ mV}$ , $C_L = 100\text{ pF}$ , See Figure 1		0.3			0.3	$\mu\text{s}$	
			5%			5%		
SR Slew rate at unity gain	$V_I = 10\text{ V}$ , $C_L = 100\text{ pF}$ , See Figure 1		0.5			0.5	$\text{V}/\mu\text{s}$	