

## TC44 Series

### VOLTAGE DETECTOR

#### FEATURES

- Precise Detection Thresholds ..... Standard  $\pm 2.5\%$
- Small Packages ..... SMT: SOT-23-5  
SMT: SOT-89-3  
Thru-hole: TO-92
- Low Current Drain ..... Typ.  $1\mu\text{A}$
- Voltage Detection Range ..... 0.9V to 6.0V
- Operating Voltage Range ..... 0.7V to 10.0V

#### APPLICATIONS

- Microprocessor Reset
- Battery Status Indicator
- Level Discriminator
- Power-failure Detector
- Switching Circuit in Battery Backup
- Waveform Shaping Circuit

#### GENERAL DESCRIPTION

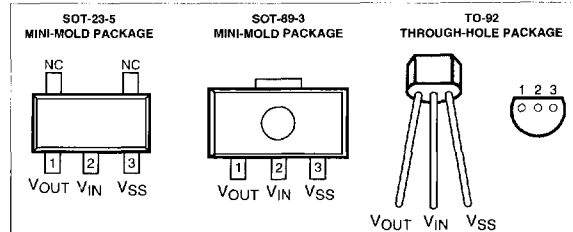
The TC44 Series are CMOS voltage detectors, suited especially for battery-powered applications because of their extremely low  $1\mu\text{A}$  operating current and small surface-mount packaging. Each part is laser trimmed to the desired threshold voltage which can be ordered in the range of 0.9V to 6.0V, in 0.1V steps.

The design includes a comparator, low-current high-precision reference, laser-trimmed divider, hysteresis circuit and output driver. The latter is available in either an open-drain or complementary ("CMOS") configuration.

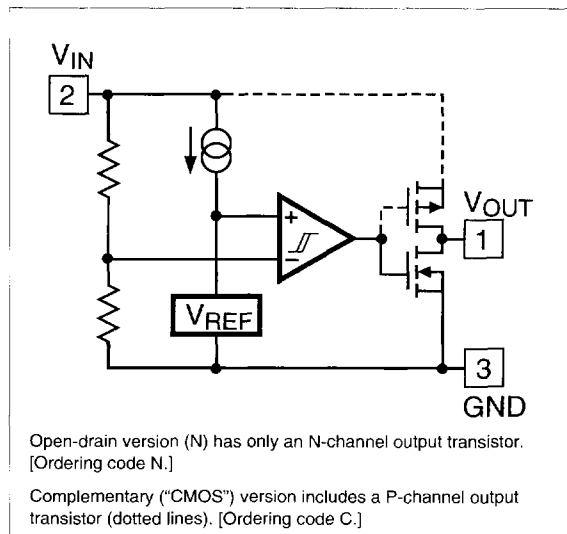
In operation, the TC44 output ( $V_{\text{OUT}}$ ) remains in the logic HIGH state as long as  $V_{\text{IN}}$  is greater than the specified threshold voltage ( $-V_{\text{DET}}$ ). When  $V_{\text{IN}}$  falls below  $-V_{\text{DET}}$ , the output is driven to a logic LOW.  $V_{\text{OUT}}$  remains LOW until  $V_{\text{IN}}$  rises above  $-V_{\text{DET}}$  by an amount  $V_{\text{Hyst}}$ , whereupon it resets to a logic HIGH.

3

#### PIN CONFIGURATIONS



#### FUNCTIONAL BLOCK DIAGRAM



#### ORDERING INFORMATION

**PART CODE TC44 V X XX X X X XX XXX**

- Output form:** \_\_\_\_\_  
 N = Nch Open Drain  
 C = CMOS Output
- Detected Voltage:** \_\_\_\_\_  
 Ex: 09 = 0.9V; 60 = 6.0V
- Extra Feature Code:** Fixed: 0 \_\_\_\_\_
- Tolerance:** 3:  $\pm 2.5\%$  \_\_\_\_\_
- Temperature:** E:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  \_\_\_\_\_
- Package Type and Pin Count:** \_\_\_\_\_  
 CT: SOT-23-5, MB: SOT-89-3, ZB: TO-92-3
- Taping Direction:** \_\_\_\_\_  
 723: Left Taping, 713: Right Taping  
 no suffix: TO-92 Bulk

**TC44 Series**

**ABSOLUTE MAXIMUM RATINGS**

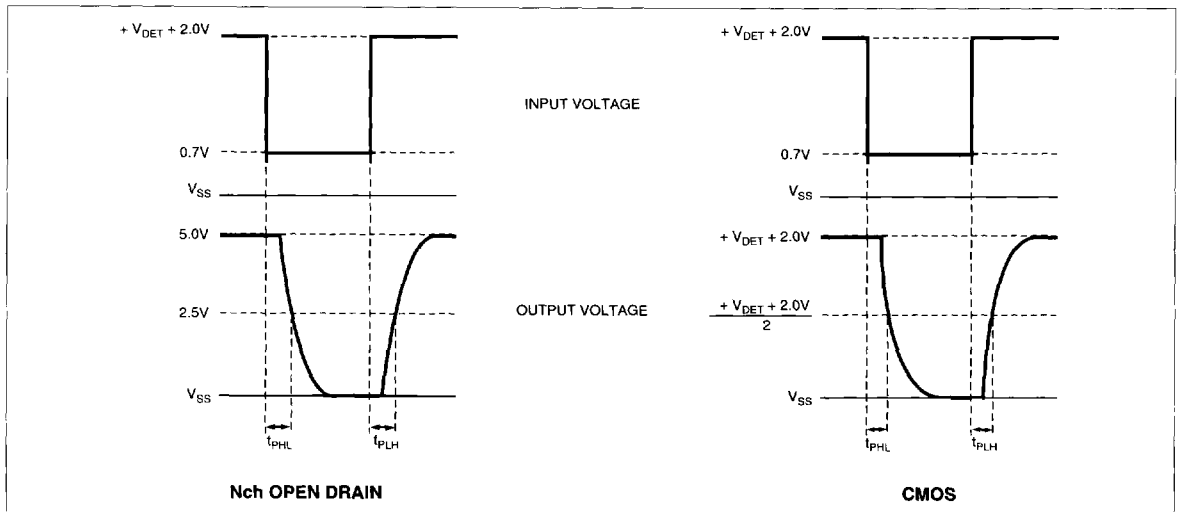
Supply Voltage $V_{IN}$ .....	12V	Power Dissipation: SOT-23-5 .....	150mW
Output Voltage: CMOS .....	$(V_{SS} - 0.3)$ to $(V_{IN} + 0.3)$	SOT-89-3 .....	300mW
Open Drain .....	12V	TO-92 .....	300mW
Output Current .....	70mA	Storage Temperature .....	- 65°C to +150°C
Operating Temperature .....	- 40°C to +85°C	Soldering Temperature .....	260°C, 10 seconds

**ELECTRICAL CHARACTERISTICS: ( $T_A = 25^\circ\text{C}$ , unless otherwise specified)**

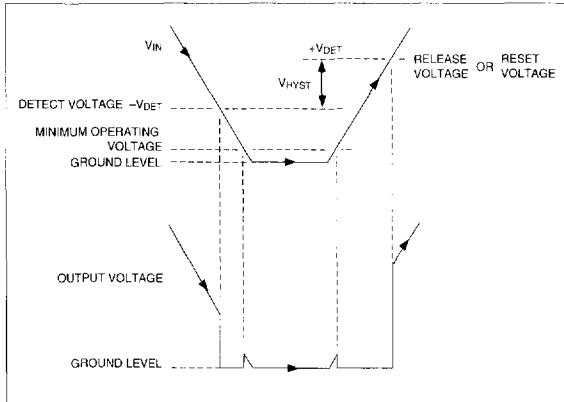
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$-V_{DET}$	Threshold Voltage		$(-V_{DET})$ $\times 0.975$		$(-V_{DET})$ $\times 1.025$	V
$V_{HYST}$	Hysteresis Range		$(-V_{DET})$ $\times 0.03$	$(-V_{DET})$ $\times 0.05$	$(-V_{DET})$ $\times 0.07$	V
$I_{SS}$	Quiescent Current	$V_{IN} = 1V$ (Output = ON)		1.0	(note 1)	$\mu\text{A}$
$V_{IN}$	Operating Voltage		0.7		10.0	V
$I_{OUT}$ (Note 2)	Output Current	N-channel $-V_{DET} = 4.5V$ 2.7V 0.9V  P-channel $-V_{DET} = 4.5V$ 2.7V 0.9V	$V_{DS} = 0.5V$ $V_{IN} = 4.0V$ 2.5V 0.8V  $V_{DS} = 0.5V$ $V_{IN} = 5.0V$ 3.0V 1.0V		12.0 7.2 0.45  0.6 0.4 0.05	mA  mA
$\frac{\Delta(-V_{DET})}{\Delta T_A}$	Tempco of $(-V_{DET})$			$\pm 100$		ppm/ $^\circ\text{C}$

- NOTE 1:** When  $V_{IN}$  drops to 1.5 volts or less,  $I_{SS}$  is approximately 0.5 – 1.0 $\mu\text{A}$ . At  $(-V_{DET}) \pm 1V$ , it is approximately 1.5 $\mu\text{A}$ . For  $I_{SS}$  at higher values of  $V_{IN}$  or over temperature, see the appropriate curves.
- NOTE 2:** These are average values for devices in the "ON" condition ( $V_{IN}$  lower than  $-V_{DET}$  for the N-channel output, and  $V_{IN}$  higher than  $-V_{DET}$  for the P-channel output).

**DEFINITION OF OUTPUT DELAY TIME**



TIMING CHART

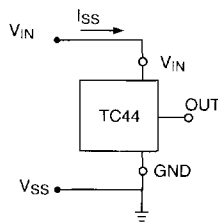


DESCRIPTION OF OPERATION

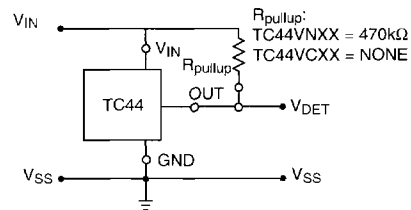
- When an input voltage ( $V_{IN}$ ) is larger than the detected voltage ( $-V_{DET}$ ),  $V_{IN}$  will equal  $V_{OUT}$  (OFF mode in Nch open drain).
- When  $V_{IN}$  is lower than  $-V_{DET}$ ,  $V_{OUT}$  will equal  $V_{SS}$ .
- When  $V_{IN}$  drops below the minimum operating voltage ( $V_{MIN}$ ),  $V_{OUT}$  will be undefined.
- When  $V_{IN}$  rises from ground potential (GND), the output will be undefined when  $V_{IN}$  is between GND and  $V_{MIN}$ .  $V_{OUT}$  will be equal to  $V_{SS}$  when  $V_{IN}$  is between  $V_{MIN}$  and the release voltage ( $+V_{DET}$ ).
- The difference between  $+V_{DET}$  and  $-V_{DET}$  is  $V_{HYST}$ .

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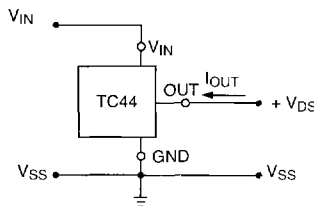
TEST CIRCUITS



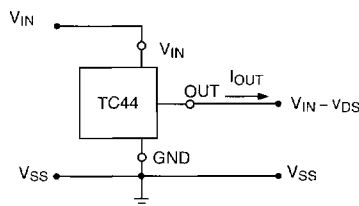
**QUIESCENT CURRENT**  
(See Typical Characteristics #1, page 4)



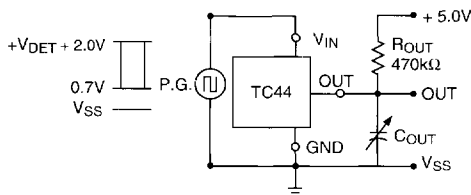
**DETECTOR THRESHOLD**  
(See Typical Characteristics #2 & 7, pages 4 & 6)



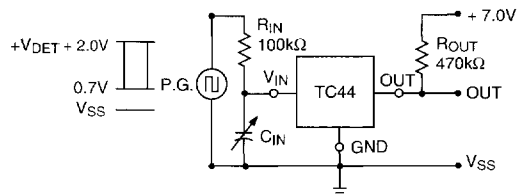
**Nch DRIVER OUTPUT CURRENT**  
(See Typical Characteristics #3 & 8, pages 4 & 7)



**Pch DRIVER OUTPUT CURRENT**  
(See Typical Characteristics #4, page 5)



**OUTPUT DELAY (1)**  
(See Typical Characteristics #5, page 5)

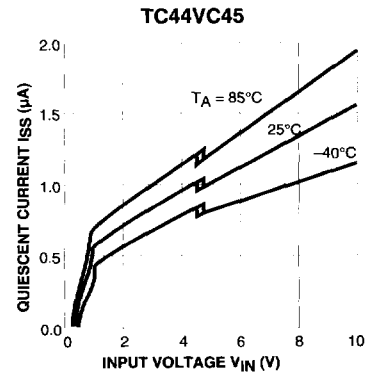
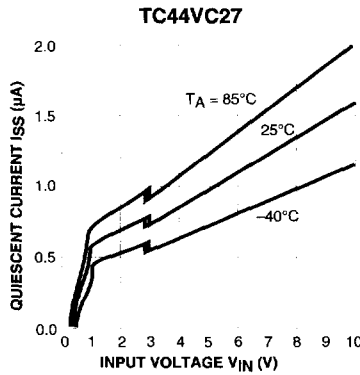
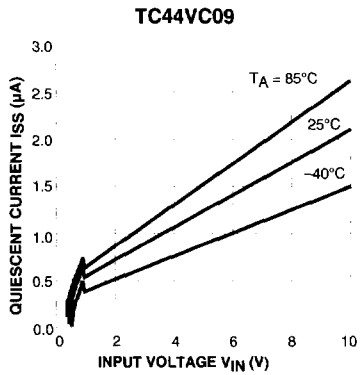


**OUTPUT DELAY (2)**  
(See Typical Characteristics #6, page 5)

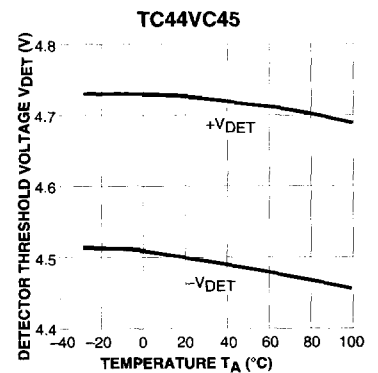
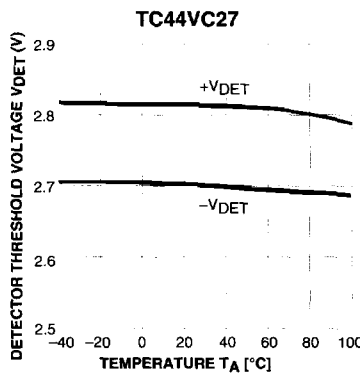
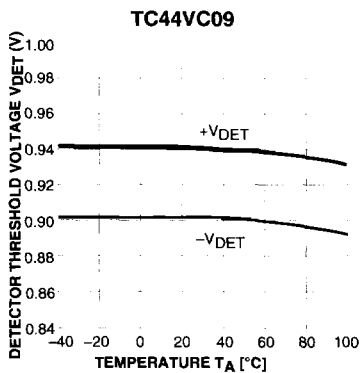
TC44 Series

TYPICAL CHARACTERISTICS

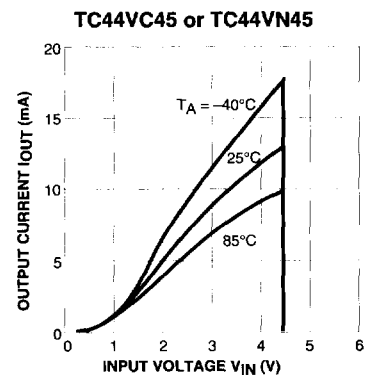
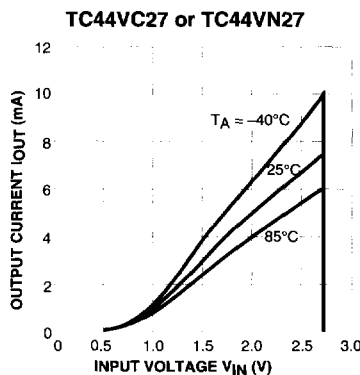
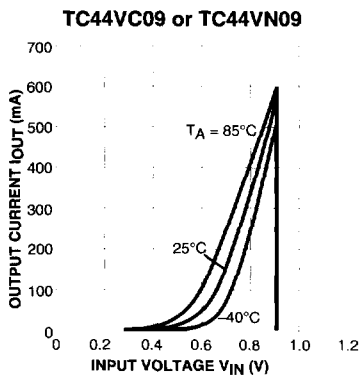
1) Quiescent Current vs. Input Voltage



2) Detector Threshold vs. Temperature

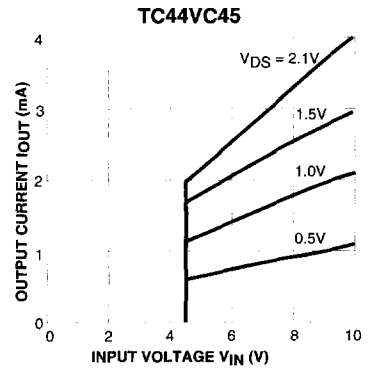
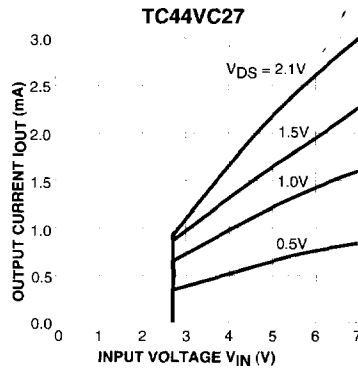
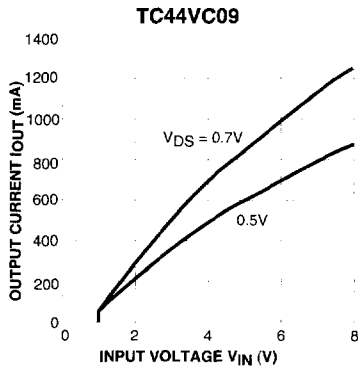


3) Nch Driver Output Current vs. Input Voltage



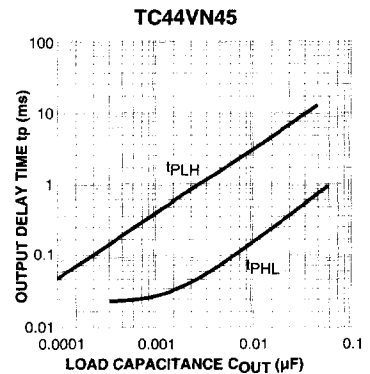
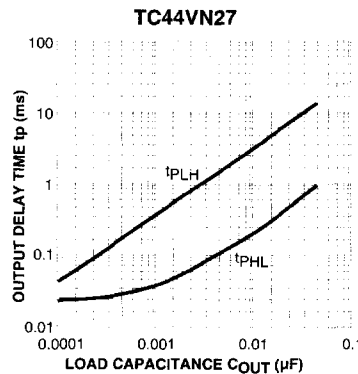
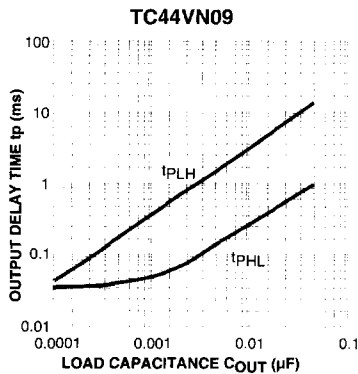
TYPICAL CHARACTERISTICS (continued)

4) Pch Driver Output Current vs. Input Voltage ( $T_A = 25^\circ\text{C}$ )

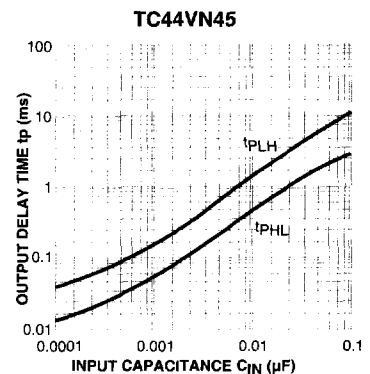
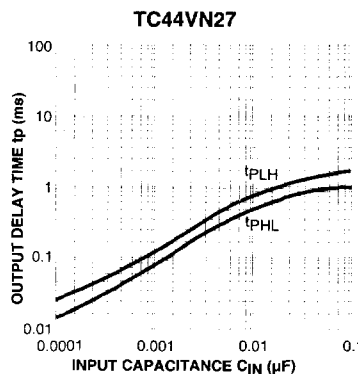
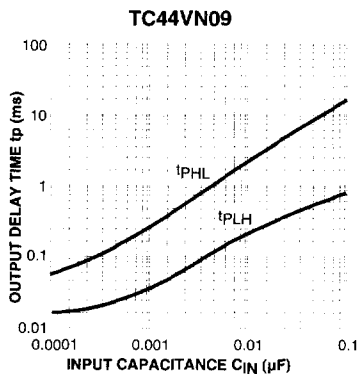


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5) Output Delay vs. Load Capacitance ( $T_A = 25^\circ\text{C}$ )



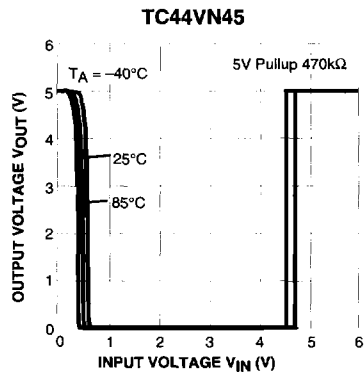
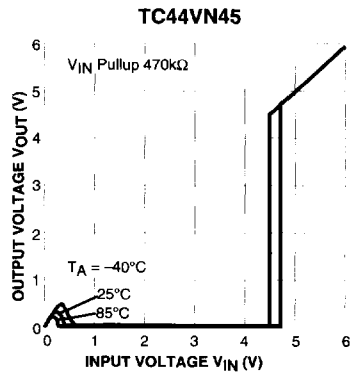
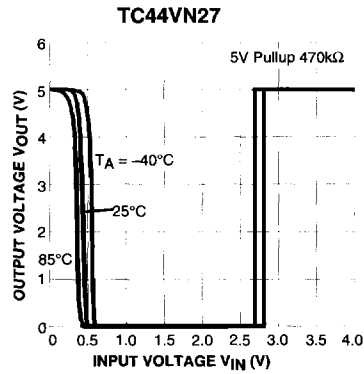
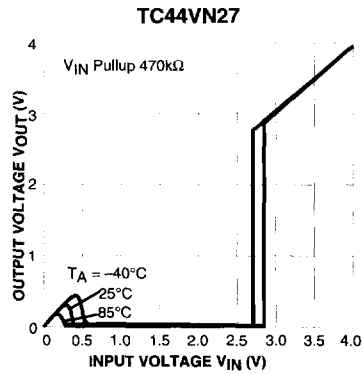
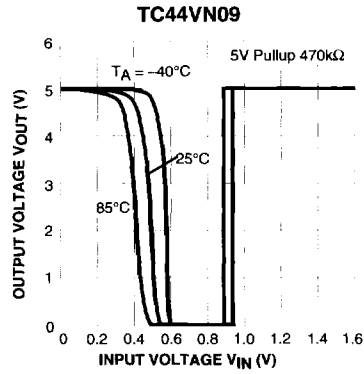
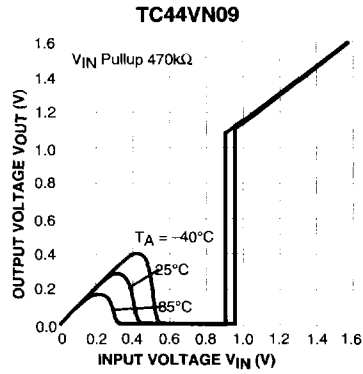
6) Output Delay vs. Input Capacitance (External)



TC44 Series

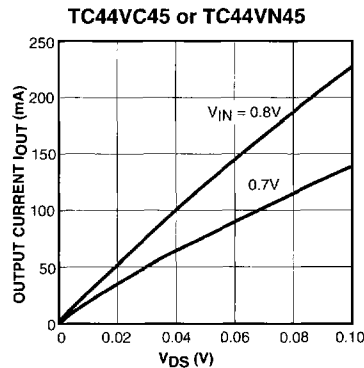
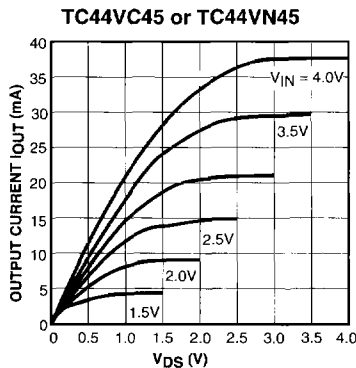
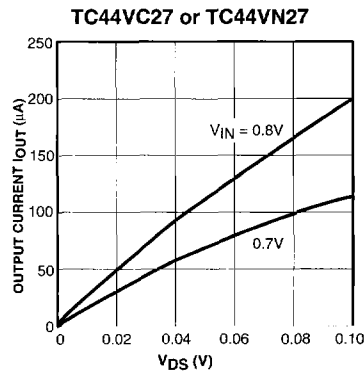
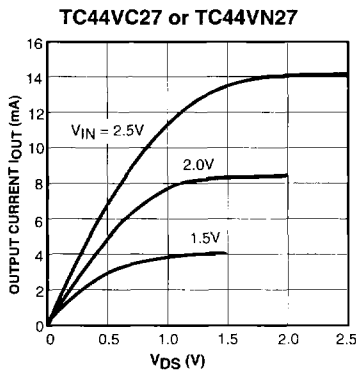
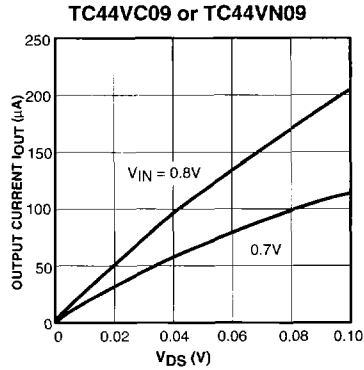
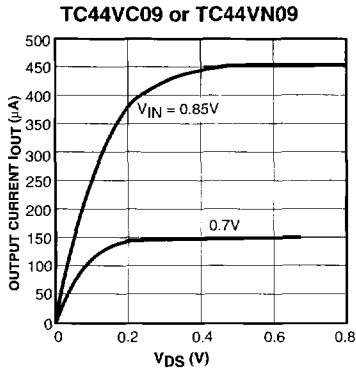
TYPICAL CHARACTERISTICS (continued)

7) Output Voltage vs. Input Voltage



TYPICAL CHARACTERISTICS (continued)

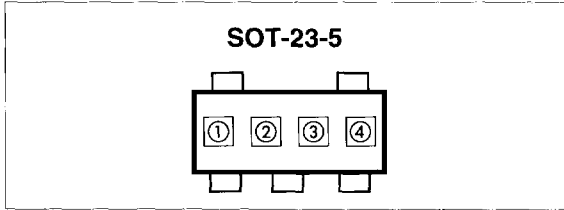
8) Nch Driver Output Current vs.  $V_{DS}$  ( $T_A = 25^\circ\text{C}$ )



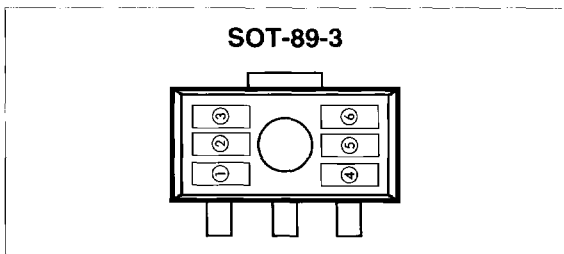
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**TC44 Series**

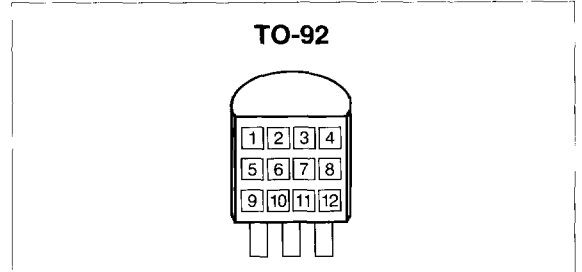
**MARKING**



- ② = output (Nch or CMOS) plus first voltage digit  
0 1 2 3 4 5 6  
Nch N P R S T U V ex: CMOS3.X=○○○K  
CMOS G H J K L M N
- ① = first voltage decimal: CMOS3.4=④K○○○
- ③ & ④ = assembly lot number



- ① = T (fixed)
- ② = first voltage digit (0-6)
- ③ = first voltage decimal (0-9)
- ④ = output (Nch = A, CMOS = C)
- ⑤ and ⑥ = lot assembly number



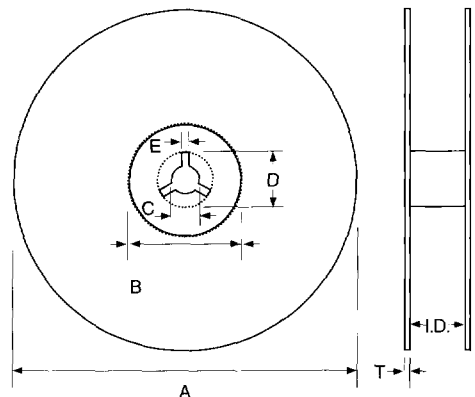
- ①, ② & ③ = 44V (fixed)
- ④ = output (C = CMOS, N = Nch)
- ⑤ = first voltage digit (0-6)
- ⑥ = first voltage decimal (0-9)
- ⑦ = fixed: 0
- ⑧ =  $-V_{DET} \pm \text{tolerance}$ : 3 =  $\pm 2.5\%$
- ⑨, ⑩, ⑪ & ⑫ = assembly lot number

**TAPING REEL**

	SOT-23-5	SOT-89	TO-92
A	178 ±1.0	178 ±2.0	360
B	60 ±2.0	80 ±1.0	80
C	13 ±0.2	13 ±0.05	30
D	22 ±0.5	21 ±0.5	45
E	2 ±0.2	2 ±0.2	2
I.D.	8.5 ±1.5	14.0 +1/-1.5	43
T	1.5 ±0.3	2.0 ±0.5	5

(unit = mm)

Reel Materials: SOT-23-5/SOT-89: Plastic  
TO-92: Cardboard + Plastic Hub



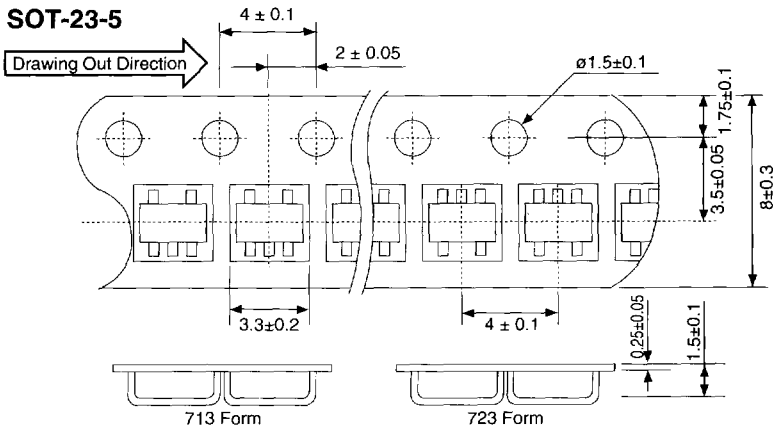
SOT-89-3: 1,000 pcs/Reel  
TO-92: 2,000 pcs/Reel  
SOT-23-5: 3,000 pcs/Reel



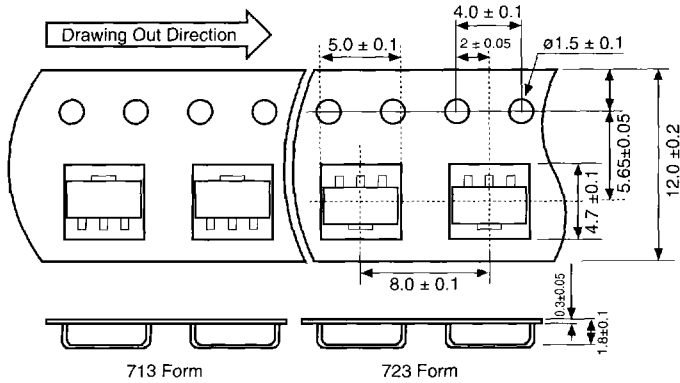
TAPING FORM

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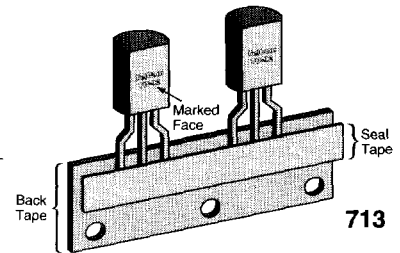
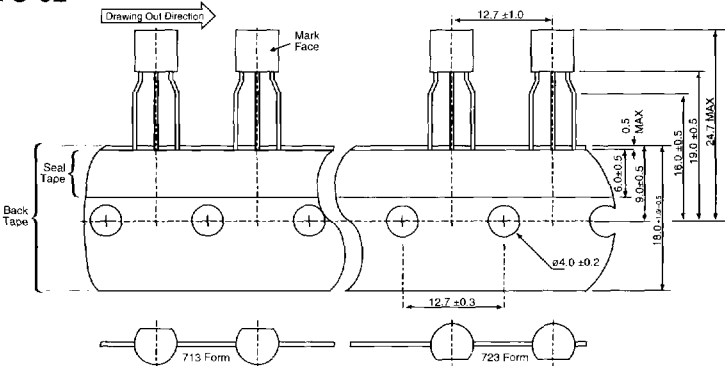
SOT-23-5



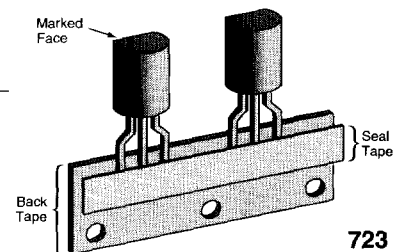
SOT-89-3



TO-92



713



723