

# TL7702B, TL7705B SUPPLY-VOLTAGE SUPERVISORS

SLVS037H – SEPTEMBER 1989 – REVISED JULY 1999

- Power-On Reset Generator
- Automatic Reset Generation After Voltage Drop
- $\overline{\text{RESET}}$  Output Defined From  $V_{CC} \geq 1 \text{ V}$
- Precision Voltage Sensor
- Temperature-Compensated Voltage Reference
- True and Complement Reset Outputs
- Externally Adjustable Pulse Duration

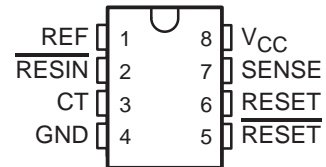
## description

The TL7702B and TL7705B are integrated-circuit supply-voltage supervisors designed for use as reset controllers in microcomputer and microprocessor systems. The supply-voltage supervisor monitors the supply for undervoltage conditions at the SENSE input. During power up, the  $\overline{\text{RESET}}$  output becomes active (low) when  $V_{CC}$  attains a value approaching 1 V. As  $V_{CC}$  approaches 3 V (assuming that SENSE is above  $V_{T+}$ ), the delay timer function activates a time delay, after which outputs  $\overline{\text{RESET}}$  and RESET go inactive (high and low, respectively). When an undervoltage condition occurs during normal operation, outputs  $\overline{\text{RESET}}$  and RESET go active. To ensure that a complete reset occurs, the reset outputs remain active for a time delay after the voltage at the SENSE input exceeds the positive-going threshold value. The time delay is determined by the value of the external capacitor  $C_T$ :  $t_d \approx 2.6 \times 10^4 \times C_T$ , where  $C_T$  is in farads (F) and  $t_d$  is in seconds (s).

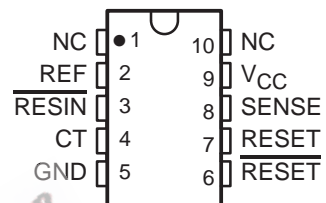
An external capacitor (typically 0.1  $\mu\text{F}$ ) must be connected to REF to reduce the influence of fast transients in the supply voltage.

The TL7702BC and TL7705BC are characterized for operation from 0°C to 70°C. The TL7702BI and TL7705BI are characterized for operation from -40°C to 85°C. The TL7705BQ is characterized for operation from -40°C to 125°C. The TL7705BM is characterized for operation from -55°C to 125°C.

TL77xxBC . . . D OR P PACKAGE  
TL7705BM . . . JG PACKAGE  
TL7705BQ . . . D PACKAGE  
(TOP VIEW)

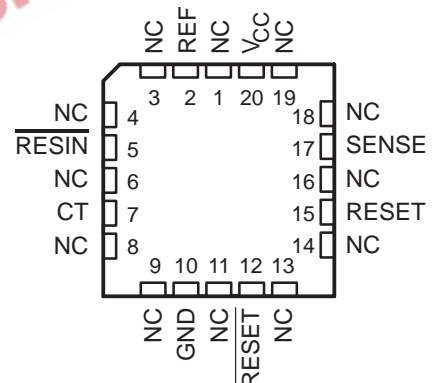


TL7705BM . . . U PACKAGE  
(TOP VIEW)



NC – No internal connection

TL7705BM . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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## AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGED DEVICES					CHIP FORM (Y)
	SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	CERAMIC FLATPACK (U)	
0°C to 70°C	TL7702BCD	—	—	TL7702BCP	—	TL7702BY, TL7705BY
	TL7705BCD	—	—	TL7705BCP	—	
-40°C to 85°C	TL7702BID	—	—	TL7702BIP	—	
	TL7705BID	—	—	TL7705BIP	—	
-40°C to 125°C	TL7705BQD	—	—	—	—	
-55°C to 125°C	—	TL7702BMFK	TL7702BMJG	—	TL7702BMU	
	—	TL7705BMFK	TL7705BMJG	—	TL7705BMU	

The D package is available taped and reeled. Add the suffix R to device type (e.g., TL7702BCDR). Chip forms are tested at 25°C.

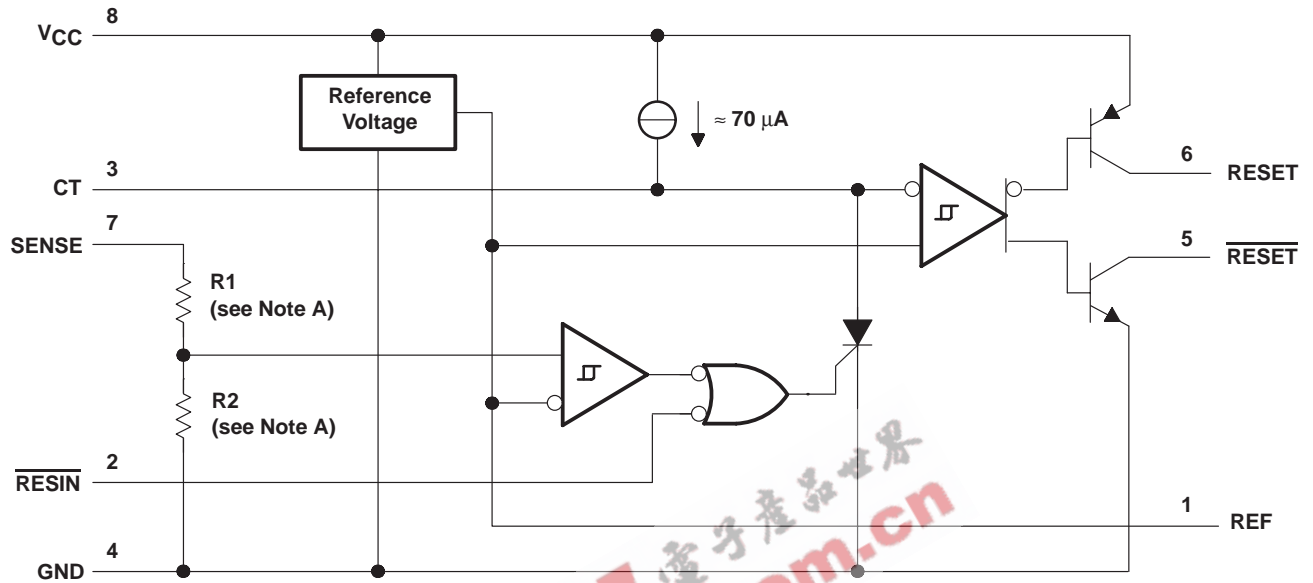
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## functional block diagram

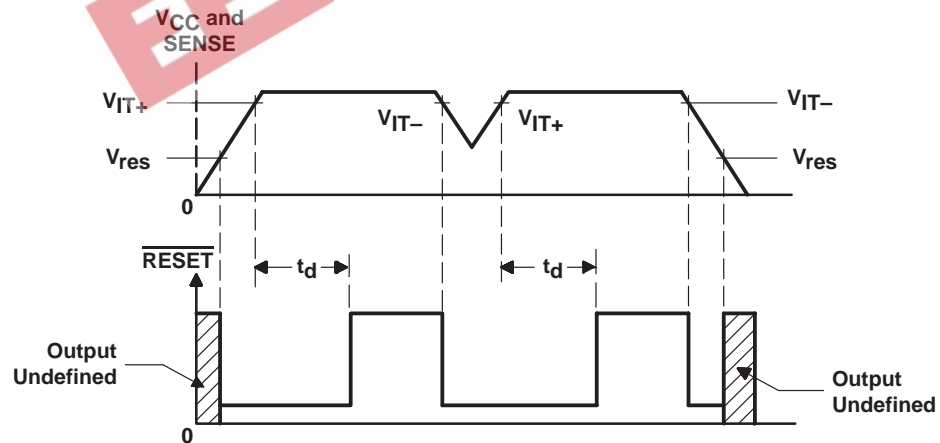
The functional block diagram is shown for illustrative purposes only; the actual circuit includes a trimming network to adjust the reference voltage and sense-comparator trip point.



Pin numbers shown are for the D, JG, and P packages.

NOTE A: TL7702B: R1 = 0 Ω, R2 = open  
TL7705B: R1 = 23 kΩ, R2 = 10 kΩ, nominal

## typical timing diagram



# TL7702B, TL7705B SUPPLY-VOLTAGE SUPERVISORS

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

Supply voltage, $V_{CC}$ (see Note 1)	20 V
Input voltage range, $V_I$ : $\overline{\text{RESIN}}$	-0.3 V to 20 V
SENSE	-0.3 V to 20 V
High-level output current, $I_{OH}$ (RESET)	-30 mA
Low-level output current, $I_{OL}$ (RESET)	30 mA
Package thermal impedance, $\theta_{JA}$ (see Notes 2 and 3): D package	97°C/W
P package	127°C/W
Case temperature for 60 seconds, $T_C$ : FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG or U packages	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P packages	260°C
Storage temperature range, $T_{stg}$	-65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
- All voltage values are with respect to the network ground terminal.
  - Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.
  - The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

## recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{CC}$		3.6	18	V
High-level input voltage, $V_{IH}$	$\overline{\text{RESIN}}$	2	18	V
Low-level input voltage, $V_{IL}$	$\overline{\text{RESIN}}$	0	0.8	V
Input voltage, $V_I$	SENSE	0	18	V
High-level output current, $I_{OH}$	RESET		-16	mA
Low-level output current, $I_{OL}$	$\overline{\text{RESET}}$		16	mA
Operating free-air temperature range, $T_A$	TL770xBC	0	70	°C
	TL770xBI	-40	85	
	TL7705BQ	-40	125	
	TL7705BM	-55	125	

# TL7702B, TL7705B SUPPLY-VOLTAGE SUPERVISORS

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## electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITION <sup>†</sup>		TL77xxBC TL77xxBI TL7705BQ			UNIT
				MIN	TYP	MAX	
V <sub>OH</sub>	High-level output voltage, RESET	I <sub>OH</sub> = -16 mA		V <sub>CC</sub> -1.5			V
V <sub>OL</sub>	Low-level output voltage, RESET	I <sub>OL</sub> = 16 mA		0.4			V
V <sub>ref</sub>	Reference voltage	I <sub>ref</sub> = 500 μA, T <sub>A</sub> = 25°C		2.48	2.53	2.58	V
V <sub>IT-</sub>	Negative-going input threshold voltage at SENSE input	TL7702B	T <sub>A</sub> = 25°C	2.505	2.53	2.555	V
		TL7705B		4.5	4.55	4.6	
		TL7702B	T <sub>A</sub> = full range <sup>‡</sup>	2.48	2.53	2.58	
		TL7705B		4.45	4.55	4.65	
V <sub>hys</sub>	Hysteresis, SENSE (V <sub>IT+</sub> - V <sub>IT-</sub> )	TL7702B	V <sub>CC</sub> = 3.6 V to 18 V, T <sub>A</sub> = 25°C	10			mV
		TL7705B		30			
V <sub>res</sub> <sup>§</sup>	Power-up reset voltage	I <sub>OL</sub> at RESET = 2 mA, T <sub>A</sub> = 25°C		1			V
I <sub>I</sub>	Input current	RESIN	V <sub>I</sub> = 0.4 V to V <sub>CC</sub>	-10			μA
		SENSE	TL7702B V <sub>I</sub> = V <sub>ref</sub> to 18 V	-0.1 -2			
I <sub>OH</sub>	High-level output current, RESET	V <sub>O</sub> = 18 V, See Figure 1		50			μA
I <sub>OL</sub>	Low-level output current, RESET	V <sub>O</sub> = 0 V, See Figure 1		-50			μA
I <sub>CC</sub>	Supply current	V <sub>SENSE</sub> = 15 V, RESIN ≥ 2 V		1.8	3		mA
		V <sub>CC</sub> = 18 V, T <sub>A</sub> = full range <sup>‡</sup>		3.5			mA

<sup>†</sup> All electrical characteristics are measured with 0.1-μF capacitors connected at REF, CT, and V<sub>CC</sub> to GND.

<sup>‡</sup> Full range is 0°C to 70°C for the C-suffix devices, -40°C to 85°C for the I-suffix devices, and -40°C to 125°C for the Q-suffix device.

<sup>§</sup> This is the lowest voltage at which RESET becomes active.

## switching characteristics, V<sub>CC</sub> = 5 V, CT open, T<sub>A</sub> = 25°C

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	TL77xxBC TL77xxBI TL7705BQ			UNIT
				MIN	TYP	MAX	
t <sub>PLH</sub>	RESIN	RESET	See Figures 1, 2, and 3	270	500		ns
t <sub>PHL</sub>	RESIN	RESET		270	500		ns
t <sub>w</sub>	RESIN		See Figure 2	150			ns
	SENSE			100			
t <sub>r</sub>		RESET	See Figures 1 and 3	75			ns
t <sub>f</sub>				150 200			
t <sub>r</sub>		RESET		75 150			ns
t <sub>f</sub>				50			

# TL7702B, TL7705B SUPPLY-VOLTAGE SUPERVISORS

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## electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		TL7705BM			UNIT
				MIN	TYP	MAX	UNIT
V <sub>OH</sub>	High-level output voltage, $\overline{\text{RESET}}$	I <sub>OH</sub> = -16 mA		V <sub>CC</sub> -1.5			V
V <sub>OL</sub>	Low-level output voltage, $\overline{\text{RESET}}$	I <sub>OL</sub> = 16 mA		0.4			V
V <sub>ref</sub>	Reference voltage	I <sub>ref</sub> = 500 μA,	T <sub>A</sub> = 25°C	2.48	2.53	2.58	V
V <sub>IT-</sub>	Negative-going input threshold voltage at SENSE input	TL7702B	T <sub>A</sub> = 25°C	2.505	2.53	2.555	V
		TL7705B		4.5	4.55	4.6	
		TL7702B	T <sub>A</sub> = -55°C to 125°C	2.48	2.53	2.58	
		TL7705B		4.45	4.55	4.65	
V <sub>hys</sub>	Hysteresis, SENSE (V <sub>IT+</sub> - V <sub>IT-</sub> )	TL7702B	V <sub>CC</sub> = 3.6 V to 18 V, T <sub>A</sub> = 25°C	10			mV
TL7705B	30						
V <sub>res</sub> ‡	Power-up reset voltage	I <sub>OL</sub> at $\overline{\text{RESET}}$ = 2 mA, T <sub>A</sub> = 25°C		1			V
I <sub>I</sub>	Input current	$\overline{\text{RESIN}}$		V <sub>I</sub> = 0.4 V to V <sub>CC</sub>			μA
		SENSE	TL7702B	V <sub>I</sub> = V <sub>ref</sub> to V <sub>CC</sub> - 1.5 V			
I <sub>OH</sub>	High-level output current, $\overline{\text{RESET}}$	V <sub>O</sub> = 18 V		50			μA
I <sub>OL</sub>	Low-level output current, $\overline{\text{RESET}}$	V <sub>O</sub> = 0		-50			μA
I <sub>CC</sub>	Supply current	V <sub>SENSE</sub> = 15 V, $\overline{\text{RESIN}} \geq 2$ V		1.8			mA
		V <sub>CC</sub> = 18 V, T <sub>A</sub> = -55°C to 125°C		4			

† All electrical characteristics are measured with 0.1-μF capacitors connected at REF, CT, and V<sub>CC</sub> to GND.

‡ This is the lowest value at which  $\overline{\text{RESET}}$  becomes active.

## switching characteristics, V<sub>CC</sub> = 5 V, CT open, T<sub>A</sub> = 25°C

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	TL7705BM			UNIT
				MIN	TYP	MAX	
t <sub>PLH</sub>	Propogation delay time from low- to high-level output	$\overline{\text{RESIN}}$	RESET	See Figures 1, 2, and 3	270	500*	ns
t <sub>PHL</sub>	Propogation delay time from high- to low-level output	$\overline{\text{RESIN}}$	$\overline{\text{RESET}}$		270	500*	
t <sub>w</sub>	Effective pulse duration	$\overline{\text{RESIN}}$		See Figure 2	150		ns
		SENSE			100		
t <sub>r</sub>	Rise time		RESET	See Figures 1 and 3	75*		ns
t <sub>f</sub>	Fall time				150		
t <sub>r</sub>	Rise time		$\overline{\text{RESET}}$		75		ns
t <sub>f</sub>	Fall time				50*		

\* On products compliant to MIL-PRF-38535, these parameters are not production tested.

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electrical characteristics over recommended operating conditions,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITION <sup>†</sup>		TL7702BY TL7705BY			UNIT
				MIN	TYP	MAX	
$V_{OH}$	High-level output voltage, $\overline{\text{RESET}}$	$I_{OH} = -16\text{ mA}$		$V_{CC} - 1.5$			V
$V_{OL}$	Low-level output voltage, $\overline{\text{RESET}}$	$I_{OL} = 16\text{ mA}$		0.4			V
$V_{ref}$	Reference voltage	$I_{ref} = 500\ \mu\text{A}$		2.48	2.53	2.58	V
$V_{IT-}$	Negative-going input threshold voltage at SENSE input	TL7702BY		2.505	2.53	2.555	V
		TL7705BY		4.5	4.55	4.6	
$V_{hys}$	Hysteresis, SENSE ( $V_{IT+} - V_{IT-}$ )	TL7702BY	$V_{CC} = 3.6\text{ V to }18\text{ V}$	10			mV
		TL7705BY		30			
$V_{res}^\ddagger$	Power-up reset voltage	$I_{OL}$ at $\overline{\text{RESET}} = 2\text{ mA}$		1			V
$I_I$	Input current	RESIN	$V_I = 0.4\text{ V to }V_{CC}$	-10			$\mu\text{A}$
		SENSE	TL7702BY $V_I = V_{ref}$ to $18\text{ V}$	-0.1 -2			
$I_{OH}$	High-level output current, $\overline{\text{RESET}}$	$V_O = 18\text{ V}$ , See Figure 1		50			$\mu\text{A}$
$I_{OL}$	Low-level output current, $\overline{\text{RESET}}$	$V_O = 0\text{ V}$ , See Figure 1		-50			$\mu\text{A}$
$I_{CC}$	Supply current	$V_{SENSE} = 15\text{ V}$ , $\overline{\text{RESIN}} \geq 2\text{ V}$		1.8	3		mA

<sup>†</sup> All electrical characteristics are measured with 0.1- $\mu\text{F}$  capacitors connected at REF, CT, and  $V_{CC}$  to GND.

<sup>‡</sup> This is the lowest voltage at which  $\overline{\text{RESET}}$  becomes active.

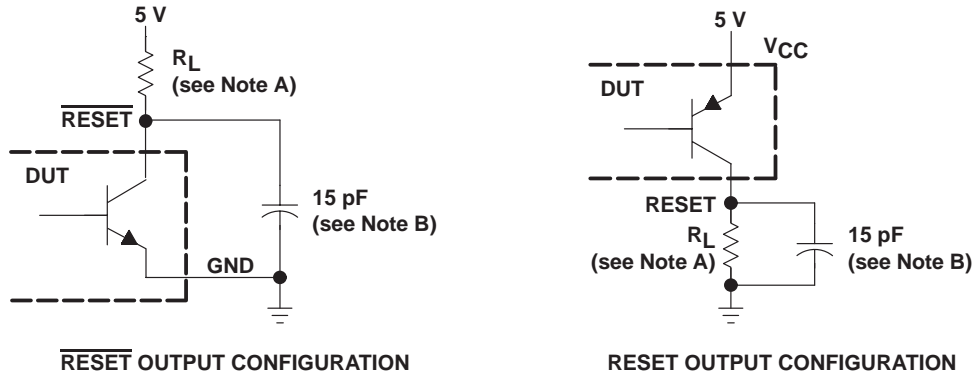
switching characteristics,  $V_{CC} = 5\text{ V}$ , CT open,  $T_A = 25^\circ\text{C}$

PARAMETER		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	TL7702BY TL7705BY			UNIT
					MIN	TYP	MAX	
$t_{PLH}$	Propagation delay time from low- to high-level output	$\overline{\text{RESIN}}$	RESET	See Figures 1, 2, and 3	270	500	ns	
$t_{PHL}$	Propagation delay time from high- to low-level output	$\overline{\text{RESIN}}$	$\overline{\text{RESET}}$		270	500		ns
$t_w$	Effective pulse duration	$\overline{\text{RESIN}}$		See Figure 2	150		ns	
		SENSE			100			
$t_r$	Rise time		RESET	See Figures 1 and 3	75		ns	
$t_f$	Fall time				150 200			
$t_r$	Rise time		$\overline{\text{RESET}}$		75 150		ns	
$t_f$	Fall time				50			

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## PARAMETER MEASUREMENT INFORMATION



NOTES: A. For  $I_{OL}$  and  $I_{OH}$ ,  $R_L = 10\text{ k}\Omega$ . For all switching characteristics,  $R_L = 511\ \Omega$ .  
B. This figure includes jig and probe capacitance.

Figure 1. RESET and RESETE Output Configurations



Figure 2. Input Pulse Definition

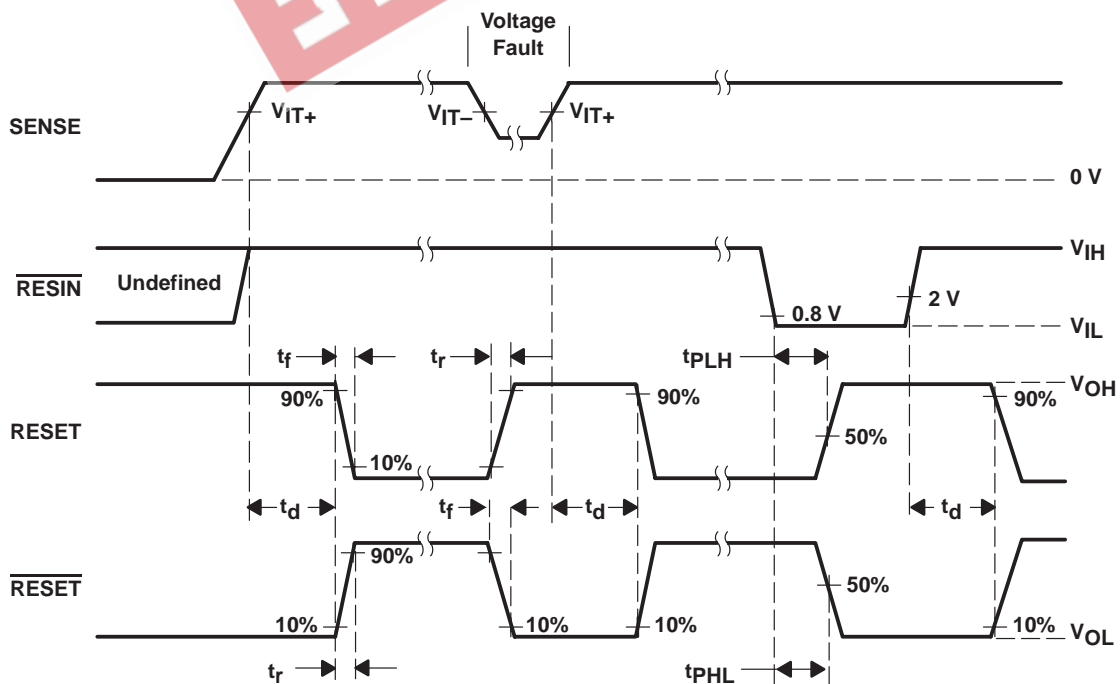


Figure 3. Voltage Waveforms



TYPICAL CHARACTERISTICS†

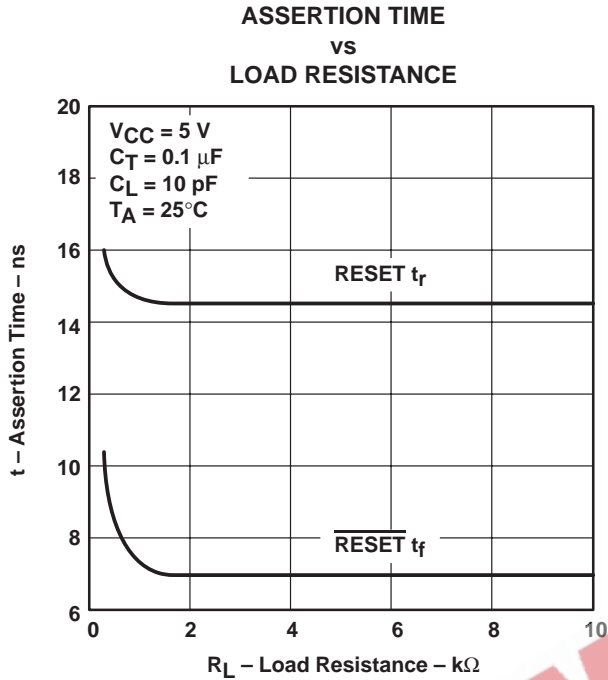


Figure 4

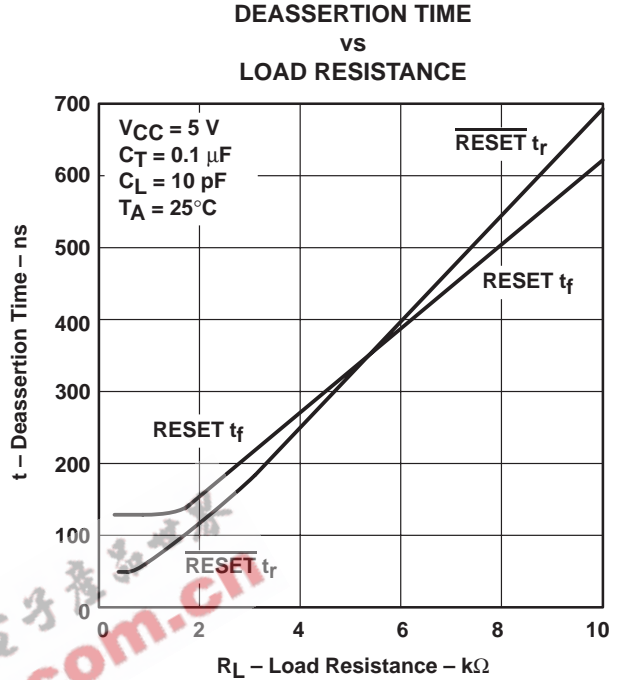


Figure 5

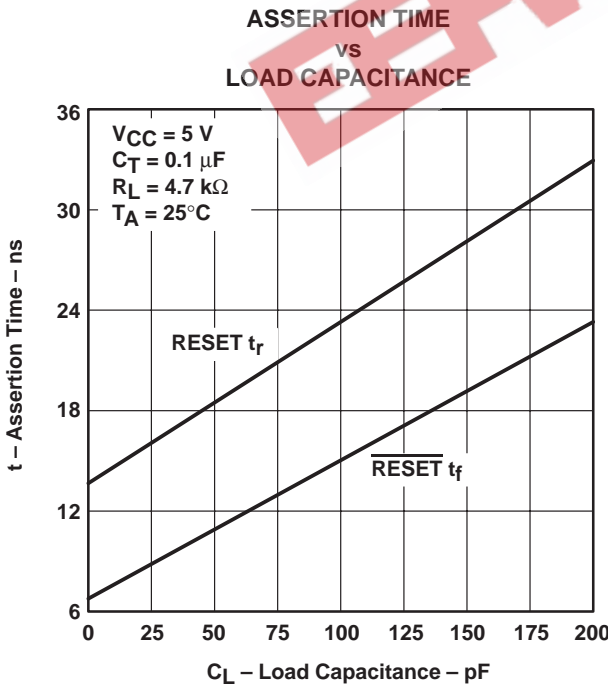


Figure 6

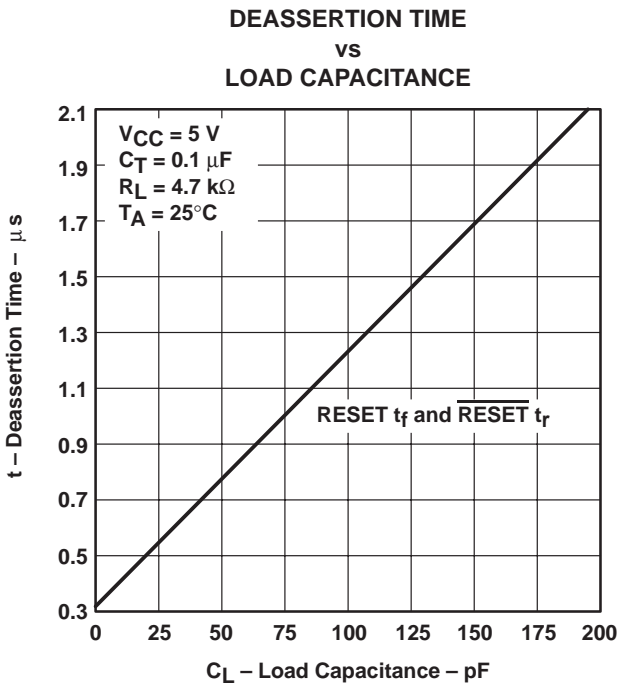


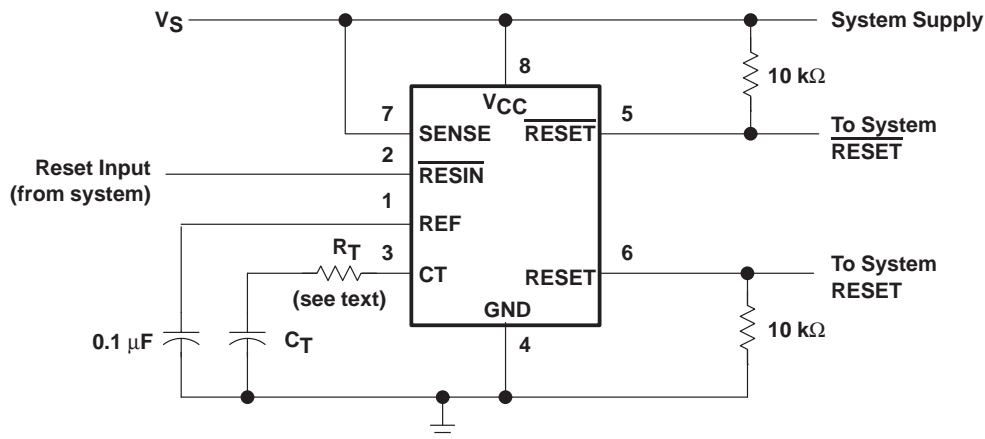
Figure 7

† For proper operation, both RESET and  $\overline{\text{RESET}}$  should be terminated with resistors of similar value. Failure to do so may cause unwanted plateauing in either output waveform during switching.

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## APPLICATION INFORMATION



**Figure 8. System Reset Controller With Undervoltage Sensing**

When the TL770xB SENSE terminal is used to monitor  $V_{CC}$ , a current-limiting resistor in series with  $C_T$  is recommended. During normal operation, the timing capacitor is charged by the onboard current source to approximately  $V_{CC}$  or an internal voltage clamp ( $\approx 7.1$ -V zener), whichever is less. When the circuit is then subjected to an undervoltage condition during which  $V_{CC}$  is rapidly slewed down, the voltage on  $C_T$  exceeds that on  $V_{CC}$ . This forward biases a secondary path internally, which falsely activates the outputs. A fault is indicated when  $V_{CC}$  drops below  $V_{(CT)}$ , not when  $V_{SENSE}$  falls below  $V_{T-}$ .

Texas Instruments performs a 100% electrical screen to verify that the outputs do not switch with 1 mA forced into the  $C_T$  terminal. Adding the external resistor,  $R_T$ , prevents false triggering. Its value is calculated as follows:

$$\frac{V_{(CT)} - V_{T-}}{R_T}$$

Where:

$$\begin{aligned} V_{(CT)} &= V_{CC} \text{ or } 7.1 \text{ V, whichever is less} \\ V_{T-} &= 4.55 \text{ V (nom)} \\ R_T &= \text{value of series resistor required} \end{aligned}$$

For  $V_{CC} = 5 \text{ V}$ :

$$\frac{5 - 4.55}{R_T} < 1 \text{ mA}$$

Therefore,

$$R_T > 450 \ \Omega$$

Using a 20% tolerance resistor,  $R_T$  should be greater than 560  $\Omega$ .

Adding this series resistor changes the duration of the reset pulse by no more than 10%.  $R_T$  extends the discharge of  $C_T$ , but also skews the  $V_{(CT)}$  threshold. These effects tend to cancel one another. The precise percentage change can be derived theoretically, but the equation is complicated by this interaction and is dependent upon the duration of the supply-voltage fault condition.

Both outputs of the TL770xB should be terminated with similar value resistors, even when only one is being used. This prevents unwanted plateauing in either output waveform during switching, which may be interpreted as an undefined state or delay system reset.

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