

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

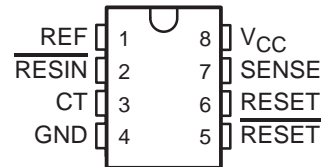
description

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).

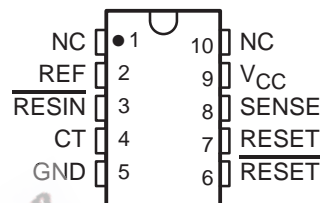
An external capacitor (typically 0.1 μF) must be connected to REF to reduce the influence of fast transients in the supply voltage.

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)

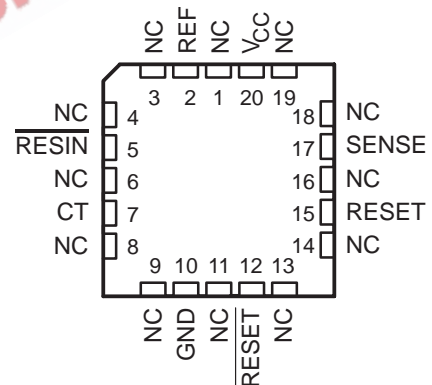


TL7705BM . . . U PACKAGE
(TOP VIEW)



NC – No internal connection

TL7705BM . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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.

**TEXAS
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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AVAILABLE OPTIONS

| T _A | 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.

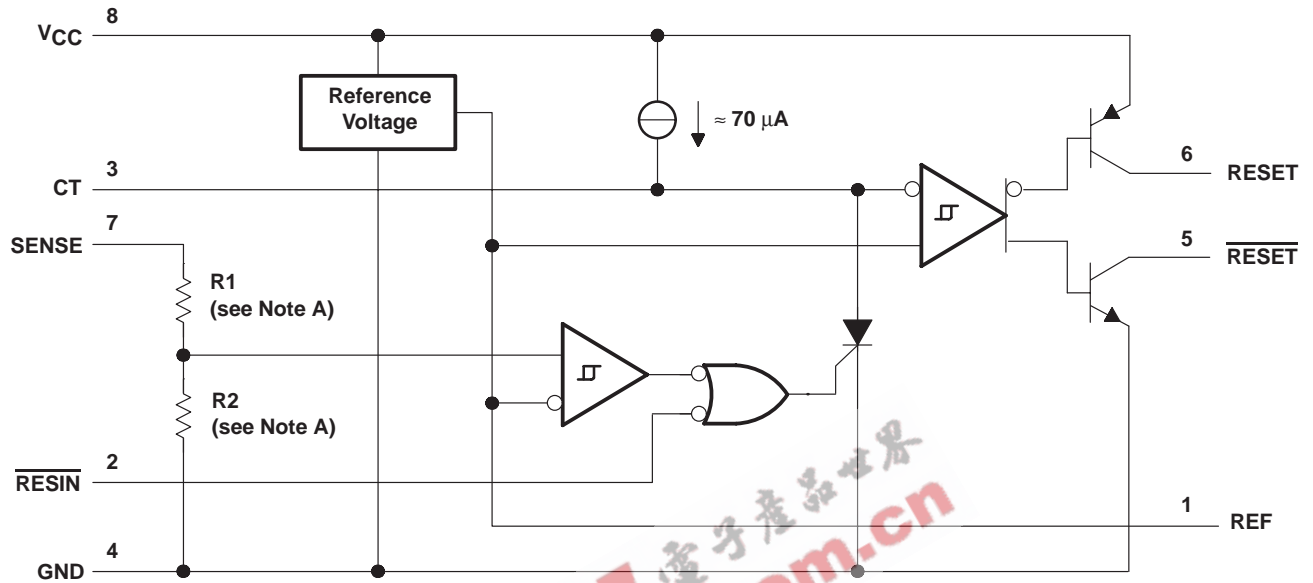
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functional block diagram

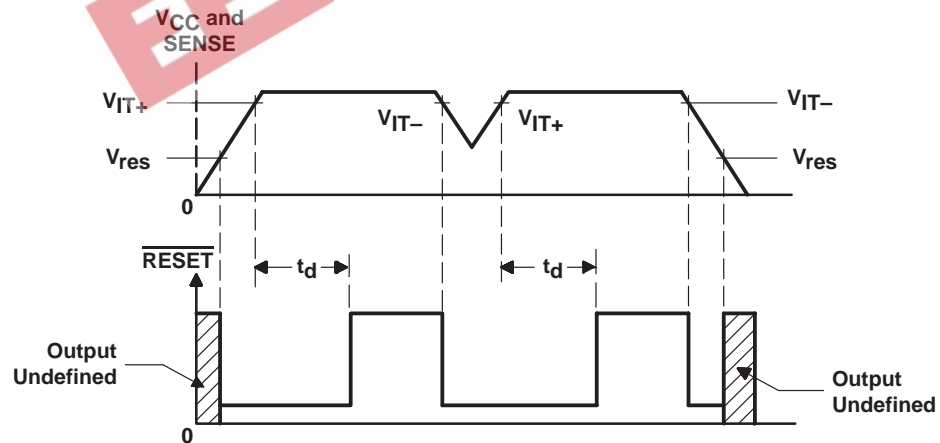
The functional block diagram is shown for illustrative purposes only; the actual circuit includes a trimming network to adjust the reference voltage and sense-comparator trip point.



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



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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, θ_{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: 1. All voltage values are with respect to the network ground terminal.
 2. Maximum power dissipation is a function of $T_J(\text{max})$, θ_{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.
 3. 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 | |

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electrical characteristics over recommended operating conditions (unless otherwise noted)

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

[†] All electrical characteristics are measured with 0.1-μF capacitors connected at REF, CT, and V_{CC} to GND.

[‡] 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.

[§] This is the lowest voltage at which RESET becomes active.

switching characteristics, V_{CC} = 5 V, CT open, T_A = 25°C

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | TL77xxBC TL77xxBI TL7705BQ | | | UNIT |
|------------------|--------------|-------------|-------------------------|----------------------------------|-----|-----|------|
| | | | | MIN | TYP | MAX | |
| t _{PLH} | RESIN | RESET | See Figures 1, 2, and 3 | 270 | 500 | ns | |
| t _{PHL} | RESIN | RESET | | 270 | 500 | | |
| t _w | RESIN | | See Figure 2 | 150 | | ns | |
| | SENSE | | | 100 | | | |
| t _r | | RESET | See Figures 1 and 3 | 75 | | ns | |
| t _f | | | | 150 200 | | | |
| t _r | | RESET | | 75 150 | | ns | |
| t _f | | | | 50 | | | |

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electrical characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | TL7705BM | | | UNIT | |
|--------------------|--|--|--|--|------|-------|---------|----|
| | | | | MIN | TYP | MAX | UNIT | |
| V _{OH} | High-level output voltage, $\overline{\text{RESET}}$ | I _{OH} = -16 mA | | V _{CC} -1.5 | | | V | |
| V _{OL} | Low-level output voltage, $\overline{\text{RESET}}$ | I _{OL} = 16 mA | | 0.4 | | | V | |
| V _{ref} | Reference voltage | I _{ref} = 500 μA, T _A = 25°C | | 2.48 | 2.53 | 2.58 | V | |
| V _{IT-} | Negative-going input threshold voltage at SENSE input | TL7702B | T _A = 25°C | 2.505 | 2.53 | 2.555 | V | |
| | | TL7705B | | 4.5 | 4.55 | 4.6 | | |
| | | TL7702B | T _A = -55°C to 125°C | 2.48 | 2.53 | 2.58 | | |
| | | TL7705B | | 4.45 | 4.55 | 4.65 | | |
| V _{hys} | Hysteresis, SENSE (V _{IT+} - V _{IT-}) | TL7702B | V _{CC} = 3.6 V to 18 V, T _A = 25°C | 10 | | | mV | |
| TL7705B | 30 | | | | | | | |
| V _{res} ‡ | Power-up reset voltage | I _{OL} at $\overline{\text{RESET}}$ = 2 mA, T _A = 25°C | | 1 | | | V | |
| I _I | Input current | $\overline{\text{RESIN}}$ | | V _I = 0.4 V to V _{CC} | | | -10 | μA |
| | | SENSE | TL7702B | V _I = V _{ref} to V _{CC} - 1.5 V | | | -0.1 -2 | |
| I _{OH} | High-level output current, $\overline{\text{RESET}}$ | V _O = 18 V | | 50 | | | μA | |
| I _{OL} | Low-level output current, $\overline{\text{RESET}}$ | V _O = 0 | | -50 | | | μA | |
| I _{CC} | Supply current | V _{SENSE} = 15 V, $\overline{\text{RESIN}} \geq 2$ V | | 1.8 | | | mA | |
| | | V _{CC} = 18 V, T _A = -55°C to 125°C | | 4 | | | | |

† All electrical characteristics are measured with 0.1-μF capacitors connected at REF, CT, and V_{CC} to GND.

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

switching characteristics, V_{CC} = 5 V, CT open, T_A = 25°C

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | TL7705BM | | | 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* | |
| 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* | | |

* 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 [†] | | 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 | | | μA |
| | | SENSE | TL7702BY $V_I = V_{ref}$ to 18 V | -0.1 -2 | | | |
| I_{OH} | High-level output current, $\overline{\text{RESET}}$ | $V_O = 18\text{ V}$, See Figure 1 | | 50 | | | μA |
| I_{OL} | Low-level output current, $\overline{\text{RESET}}$ | $V_O = 0\text{ V}$, See Figure 1 | | -50 | | | μA |
| I_{CC} | Supply current | $V_{SENSE} = 15\text{ V}$, $\text{RESIN} \geq 2\text{ V}$ | | 1.8 | 3 | | mA |

[†] All electrical characteristics are measured with 0.1- μF capacitors connected at REF, CT, and V_{CC} to GND.

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

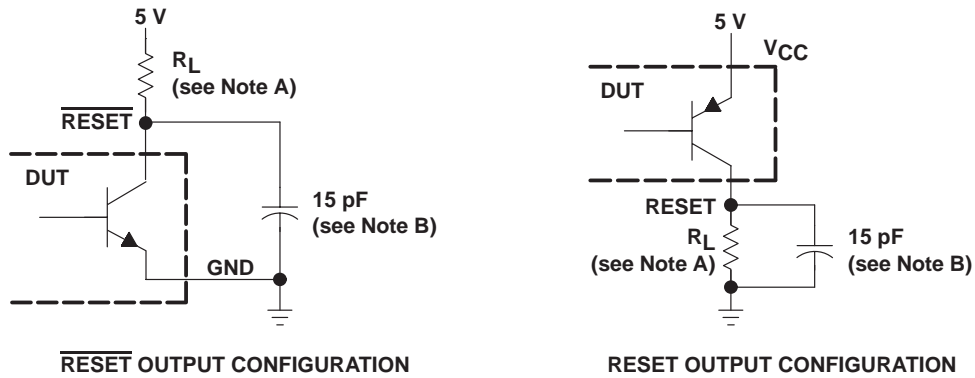
switching characteristics, $V_{CC} = 5\text{ V}$, CT open, $T_A = 25^\circ\text{C}$

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | TL7702BY TL7705BY | | | UNIT |
|-----------|---------------------------|---------------------------|-------------------------|----------------------|-----|-----|------|
| | | | | MIN | TYP | MAX | |
| t_{PLH} | $\overline{\text{RESIN}}$ | RESET | See Figures 1, 2, and 3 | 270 | 500 | ns | |
| t_{PHL} | $\overline{\text{RESIN}}$ | $\overline{\text{RESET}}$ | | 270 | 500 | | |
| t_w | $\overline{\text{RESIN}}$ | | See Figure 2 | 150 | | | ns |
| | SENSE | | | 100 | | | |
| t_r | | RESET | See Figures 1 and 3 | 75 | | | ns |
| t_f | | | | 150 | 200 | | |
| t_r | | $\overline{\text{RESET}}$ | | 75 | 150 | | ns |
| t_f | | | | 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

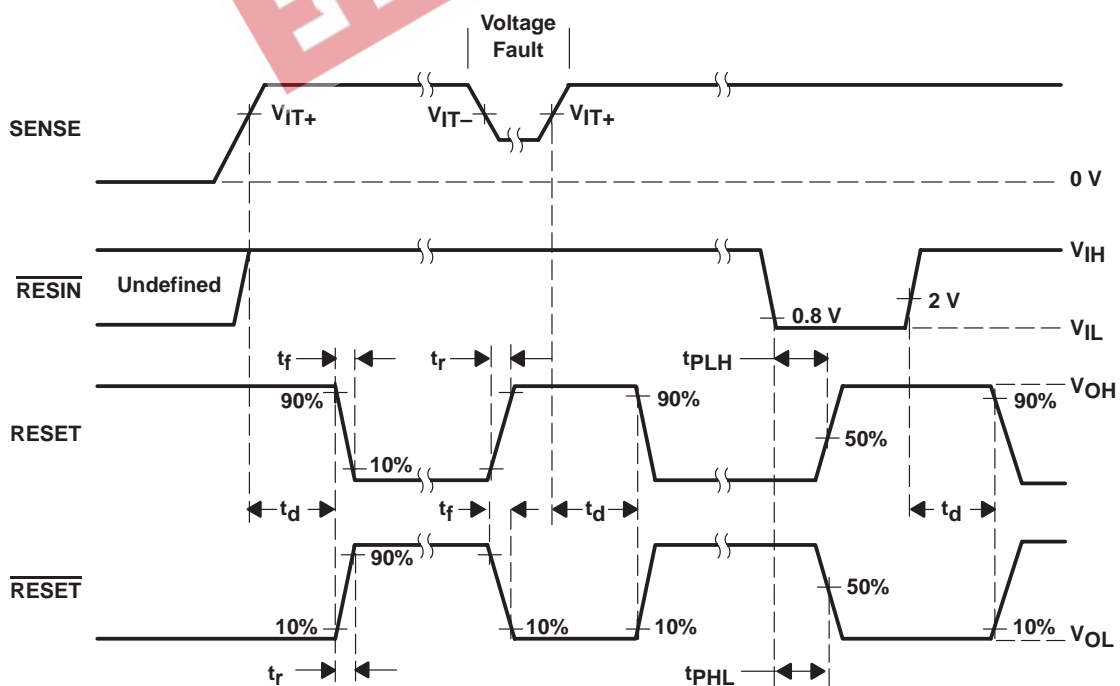
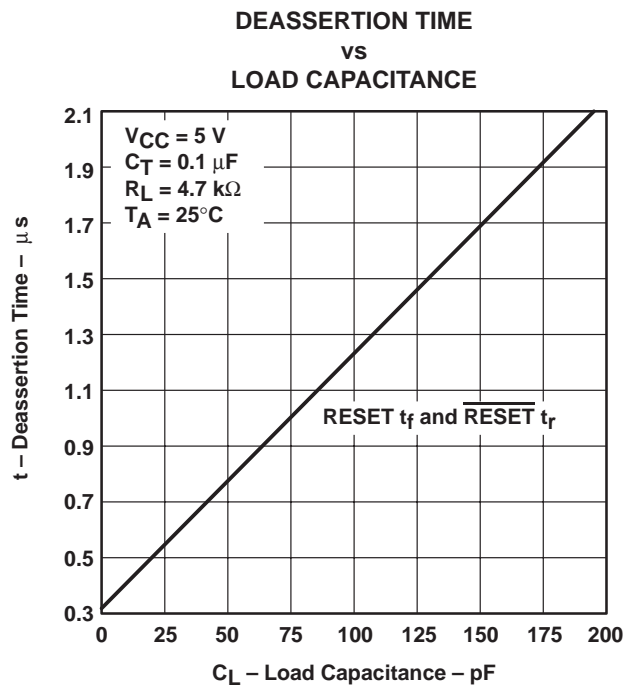
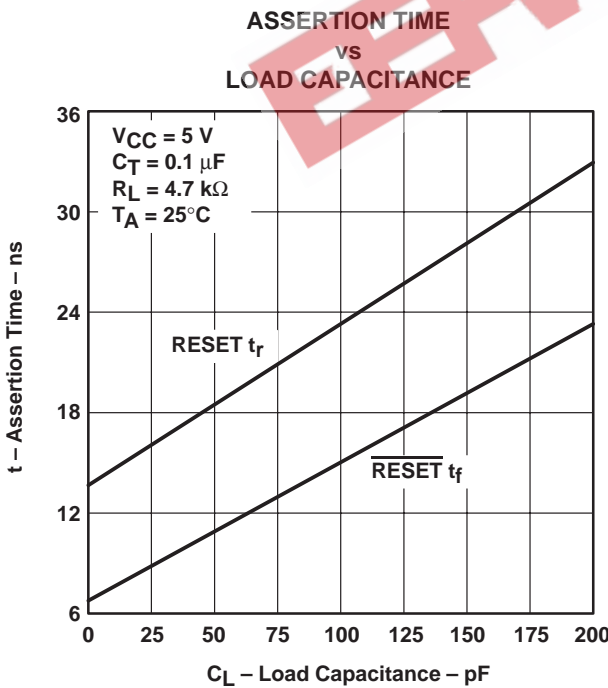
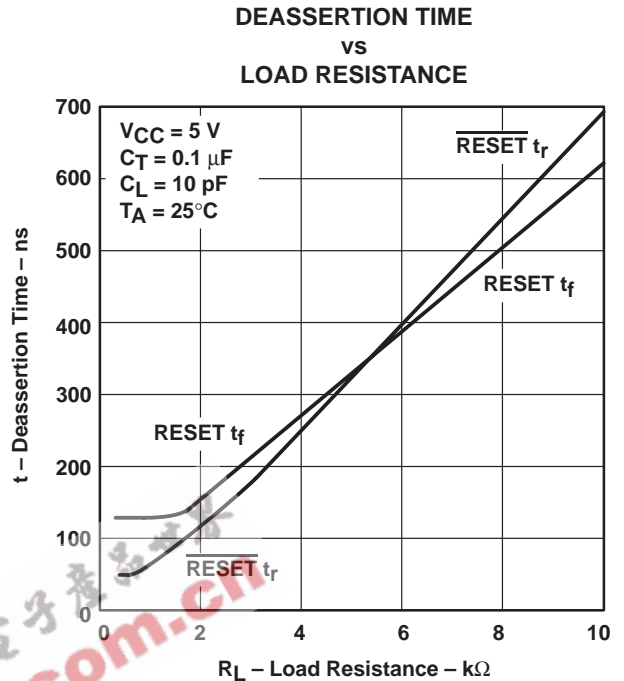
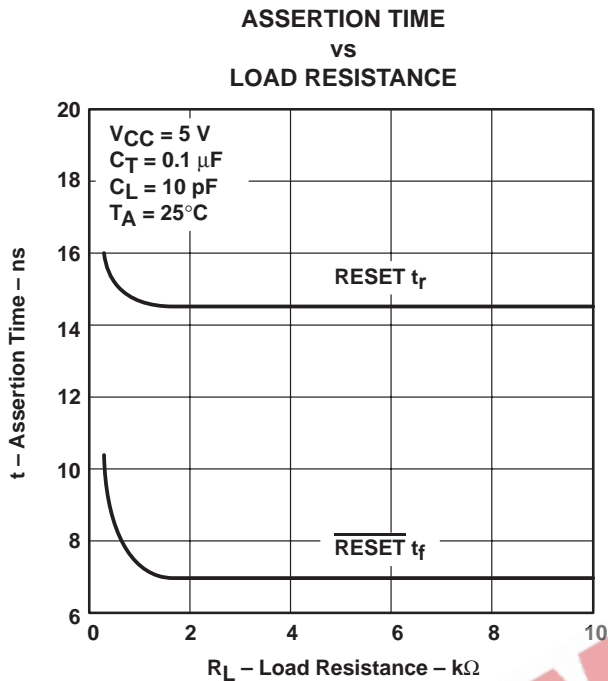


Figure 3. Voltage Waveforms

TYPICAL CHARACTERISTICS†



† 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

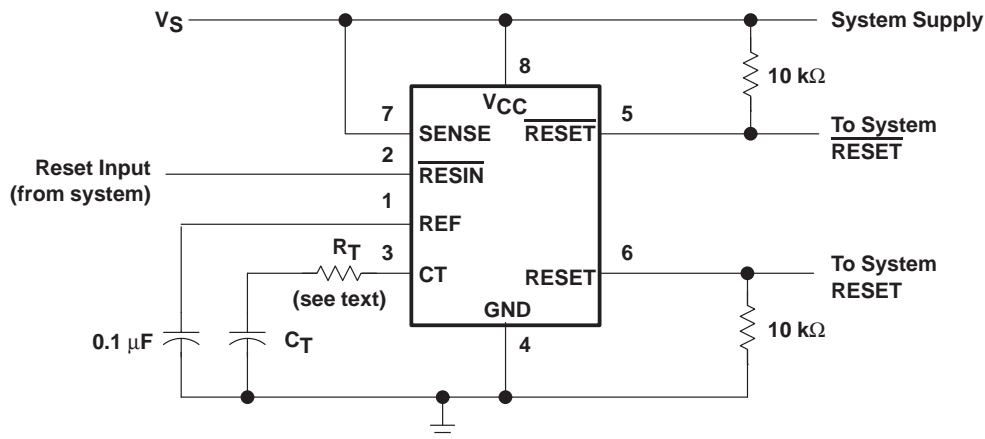


Figure 8. System Reset Controller With Undervoltage Sensing

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 (≈ 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 Ω .

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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