

TL7700-SEP Radiation Hardened Supply-Voltage Supervisor in Space Enhanced Plastic

1 Features

- VID V62/19602
- Radiation hardened
 - Single event latch-up (SEL) immune to 43 MeV-cm²/mg at 125°C
 - Total ionizing dose (TID) RLAT for every wafer lot up to 20 krad(Si)
- Space enhanced plastic
 - Controlled baseline
 - Gold wire
 - NiPdAu lead finish
 - One assembly and test site
 - One fabrication site
 - Available in military (–55°C to 125°C) temperature range
 - Extended product life cycle
 - Extended product-change notification
 - Product traceability
 - Enhanced mold compound for low outgassing
- Adjustable sense voltage with two external resistors
- 1% sense voltage tolerance (25°C)
- Adjustable hysteresis of sense voltage
- Wide operating supply-voltage range: 1.8 V to 40 V
- Low power consumption: $I_{CC} = 0.6$ mA typical, $V_{CC} = 40$ V

2 Applications

- Low Earth orbit (LEO) space applications
- Power supervisor for satellites
- Supervise DPS, MCUs, FPGAs, and ASICs

3 Description

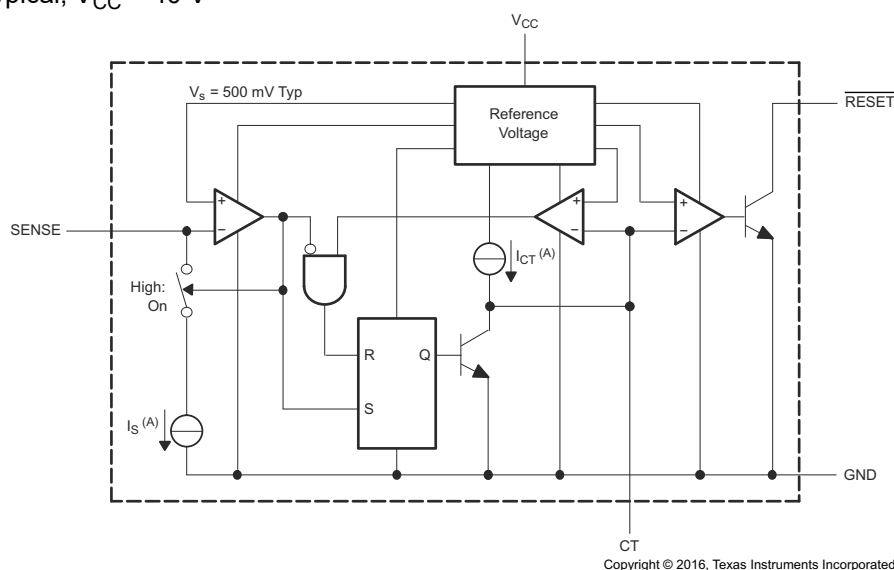
The TL7700-SEP is a bipolar integrated circuit designed for use as a reset controller in microcomputer and microprocessor systems. The SENSE voltage can be set to any value greater than 0.5 V using two external resistors.

Circuit function is very stable, with supply voltage in the 1.8-V to 40-V range. Minimum supply current allows use with AC line operation and portable battery operation. The TL7700-SEP device is designed for operation from –55°C to 125°C.

Device Information

PART NUMBER ⁽¹⁾	PACKAGE	SIZE AND MASS (NOM) ⁽²⁾
V62/19602	TSSOP (8)	3.00 mm × 4.40 mm Mass = 39.47 mg

- (1) For all available packages, see the orderable addendum at the end of the data sheet.
 (2) Mass is accurate to ±10%.



Functional Block Diagram



Table of Contents

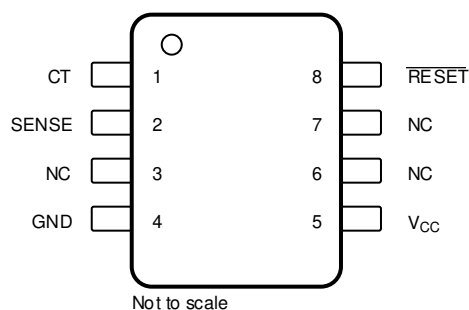
1 Features	1	8.3 Feature Description.....	11
2 Applications	1	8.4 Device Functional Modes.....	12
3 Description	1	9 Application and Implementation	13
4 Revision History	2	9.1 Application Information.....	13
5 Pin Configuration and Functions	3	9.2 Typical Application.....	13
6 Specifications	4	10 Power Supply Recommendations	15
6.1 Absolute Maximum Ratings.....	4	11 Layout	15
6.2 ESD Ratings.....	4	11.1 Layout Guidelines.....	15
6.3 Recommended Operating Conditions.....	4	11.2 Layout Example.....	15
6.4 Thermal Information.....	4	12 Device and Documentation Support	16
6.5 Electrical Characteristics.....	5	12.1 Receiving Notification of Documentation Updates.....	16
6.6 Switching Characteristics.....	5	12.2 Support Resources.....	16
6.7 Typical Characteristics.....	6	12.3 Trademarks.....	16
7 Parameter Measurement Information	8	12.4 Electrostatic Discharge Caution.....	16
8 Detailed Description	10	12.5 Glossary.....	16
8.1 Overview.....	10	13 Mechanical, Packaging, and Orderable Information	17
8.2 Functional Block Diagram.....	10		

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (March 2019) to Revision A (August 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Added package mass to Device Information table and removed automotive applications from the <i>Description</i> section.....	1
• Removed MIN and MAX values for SENSE input current [25°C] in the <i>Electrical Characteristics</i> section.....	5
• Changed MIN value for SENSE input current [–55°C to 125°C], From 1.5 µA : To 1 µA, in the <i>Electrical Characteristics</i> section.....	5
• Changed MIN value for Timing-capacitor charge current [25°C], From 11 µA : To 8 µA, in the <i>Electrical Characteristics</i> section.....	5
• Added more variables to the t_{po} equation in the <i>Output Pulse-Duration Setting</i> section.....	12
• Added equations to demonstrate an example calculation in the <i>Detailed Design Procedure</i> section.....	13

5 Pin Configuration and Functions



**Figure 5-1. PW Package
8-Pin TSSOP
Top View**

Table 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
CT	1	I/O	Timing capacitor connection This terminal sets the RESET output pulse duration (t_{po}). It is connected internally to a 15- μ A constant-current source. There is a limit on the switching speed of internal elements; even if CT is set to 0, response speeds remain at approximately 5 to 10 μ s. If CT is open, the device can be used as an adjustable-threshold noninverting comparator. If CT is low, the internal output-stage comparator is active, and the RESET output transistor is on. An external voltage must not be applied to this terminal due to the internal structure of the device. Therefore, drive the device using an open-collector transistor, FET, or tri-state buffer (in the low-level or high-impedance state).
GND	4	—	Ground Keep this terminal as low impedance as possible to reduce circuit noise.
NC	3, 6, 7	—	No internal connection.
RESET	8	O	Reset output This terminal can be connected directly to a system that resets in the active-low state. A pullup resistor usually is required because the output is an npn open-collector transistor. An additional transistor should be connected when the active-high reset or higher output current is required.
SENSE	2	I	Voltage sense This terminal has a threshold level of 500 mV. The sense voltage and hysteresis can be set at the same time when the two voltage-dividing resistors are connected. The reference voltage is temperature compensated to inhibit temperature drift in the threshold voltage within the operating temperature range.
V _{CC}	5	—	Power supply This terminal is used in an operating-voltage range of 1.8 V to 40 V.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply voltage ⁽²⁾		41	V
V _s	SENSE input voltage	−0.3	41	V
V _{OH}	Output voltage (off state)		41	V
I _{OL}	Output current (on state)		5	mA
T _J	Operating virtual-junction temperature		150	°C
T _{stg}	Storage temperature	−65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to the network ground terminal.

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	500
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	1000

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V _{CC}	Supply voltage	1.8	40	V
I _{OL}	Low-level output current		3	mA
T _A	Operating free-air temperature	−55	125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TL7700-SEP	UNIT
		PW (TSSOP)	
		8 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	172.9	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	56.6	°C/W
R _{θJB}	Junction-to-board thermal resistance	101.2	°C/W
ψ _{JT}	Junction-to-top characterization parameter	5.2	°C/W
ψ _{JB}	Junction-to-board characterization parameter	99.6	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC package thermal metrics](#) application report.

6.5 Electrical Characteristics

 $V_{CC} = 3\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_s SENSE input voltage		-55°C to 125°C	490		520	mV
I_s SENSE input current	$V_s = 0.4\text{ V}$	25°C		2.5		μA
		-55°C to 125°C	1		3.5	
I_{CC} Supply current	$V_{CC} = 40\text{ V}$, $V_s = 0.6\text{ V}$, no load	25°C		0.6	1	mA
V_{OL} Low-level output voltage	$I_{OL} = 1.5\text{ mA}$	25°C			0.4	V
	$I_{OL} = 3\text{ mA}$	25°C			0.8	
I_{OH} High-level output current	$V_{OH} = 40\text{ V}$, $V_s = 0.6\text{ V}$	-55°C to 125°C			1	μA
I_{CT} Timing-capacitor charge current	$V_s = 0.6\text{ V}$	25°C	8	15	19	μA

6.6 Switching Characteristics

 $V_{CC} = 3\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{pi} SENSE pulse duration	$C_T = 0.01\text{ }\mu\text{F}$ (see Figure 7-5)	2			μs
t_{po} Output pulse duration	$C_T = 0.01\text{ }\mu\text{F}$ (see Figure 7-5)	0.5	1	1.5	ms
t_r Output rise time	$C_T = 0.01\text{ }\mu\text{F}$, $R_L = 2.2\text{ k}\Omega$, $C_L = 100\text{ pF}$ (see Figure 7-5)			15	μs
t_f Output fall time	$C_T = 0.01\text{ }\mu\text{F}$, $R_L = 2.2\text{ k}\Omega$, $C_L = 100\text{ pF}$ (see Figure 7-5)			0.5	μs
t_{pd} Propagation delay time, SENSE to output	$C_T = 0.01\text{ }\mu\text{F}$ (see Figure 7-5)			10	μs

6.7 Typical Characteristics

Data at high and low temperatures are applicable only within the recommended operating conditions.

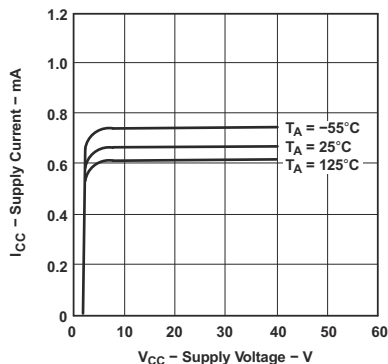


Figure 6-1. Supply Current vs Supply Voltage

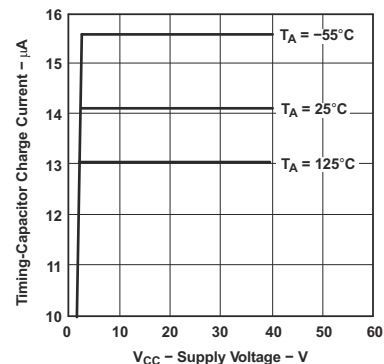


Figure 6-2. Timing Capacitor Charge Current vs Supply Voltage

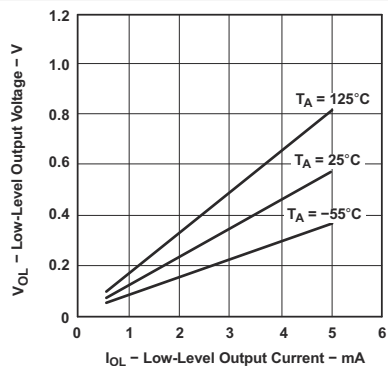


Figure 6-3. V_{OL} vs I_{OL}

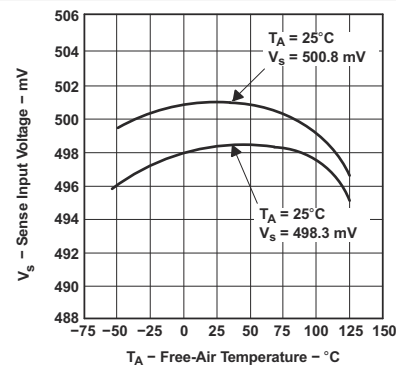


Figure 6-4. Sense Input Voltage vs Temperature

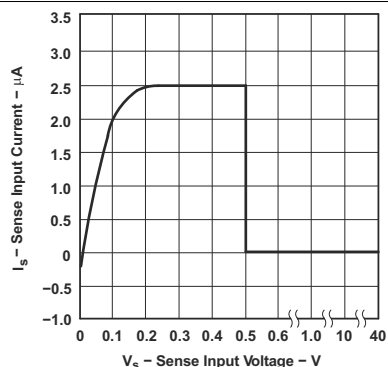


Figure 6-5. Sense Input Current vs Sense Input Voltage

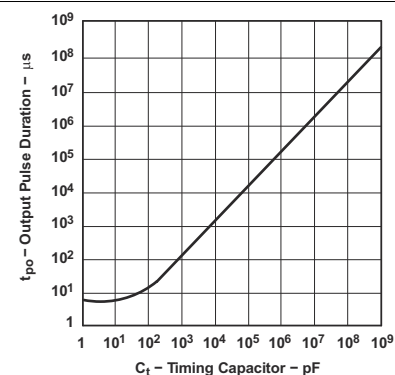


Figure 6-6. Output Pulse Duration vs Timing Capacitor

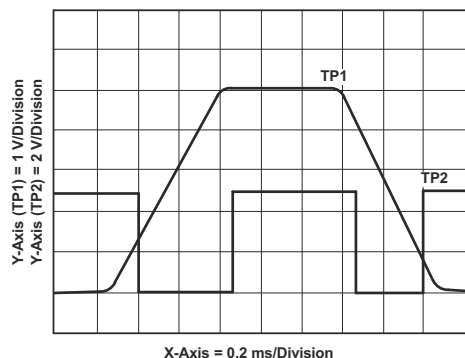


Figure 6-7. V_{CC} vs Output Waveform 1 - See Figure 6-8

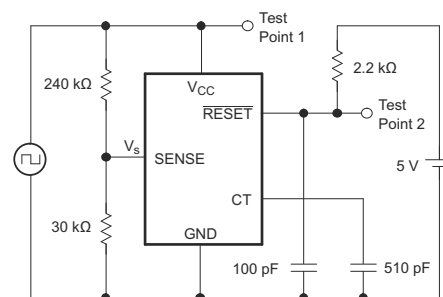


Figure 6-8. V_{CC} vs Output Test Circuit 1

6.7 Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the recommended operating conditions.

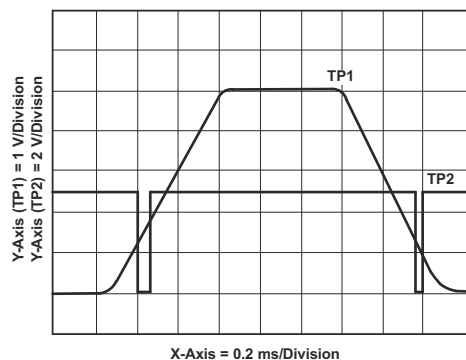


Figure 6-9. V_{CC} vs Output Waveform 2 - See [Figure 6-10](#)

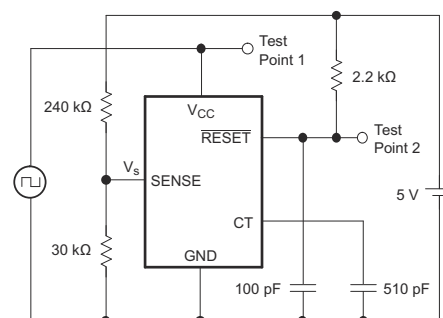


Figure 6-10. V_{CC} vs Output Test Circuit 2

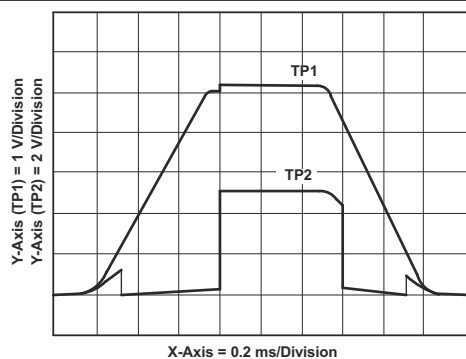


Figure 6-11. V_{CC} vs Output Waveform 3 - See [Figure 6-12](#)

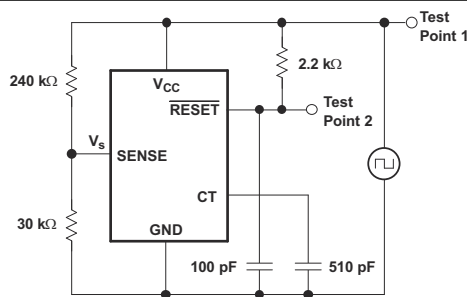


Figure 6-12. V_{CC} vs Output Test Circuit 3

7 Parameter Measurement Information

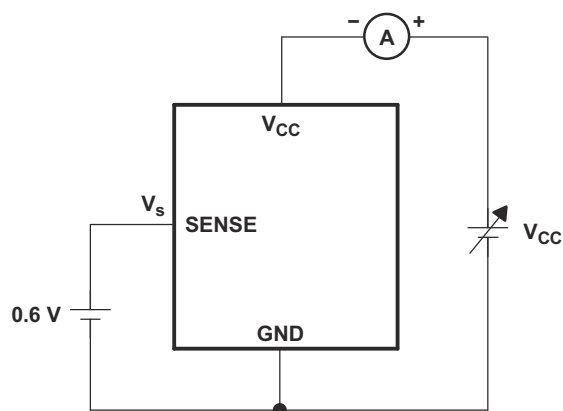


Figure 7-1. V_{CC} vs I_{CC} Measurement Circuit

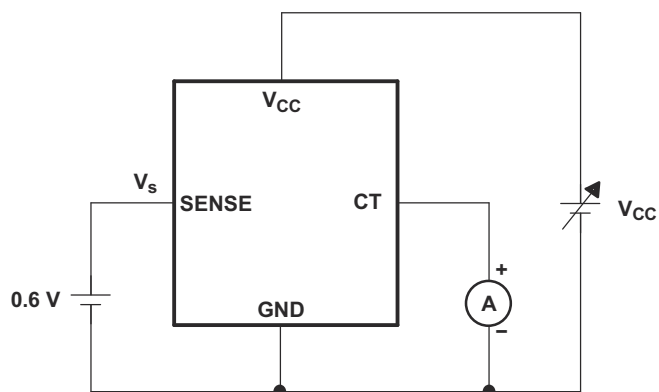


Figure 7-2. V_{CC} vs I_{CT} Measurement Circuit

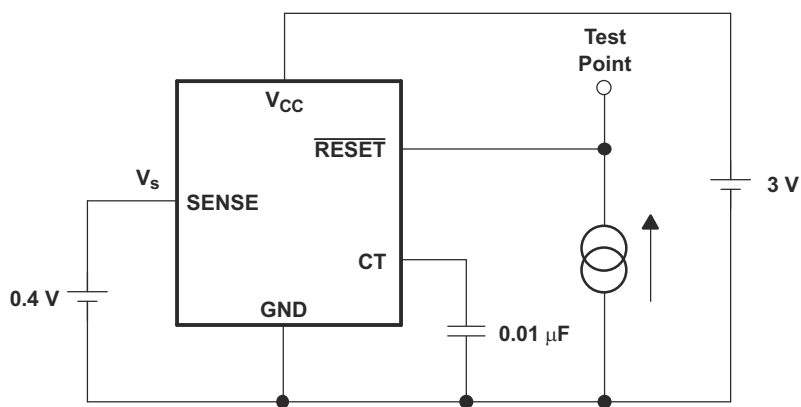


Figure 7-3. I_{OL} vs V_{OL} Measurement Circuit

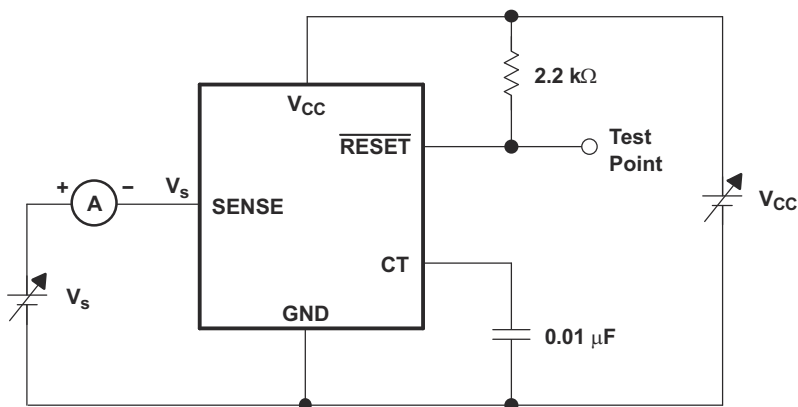


Figure 7-4. V_s and I_s Characteristics Measurement Circuit

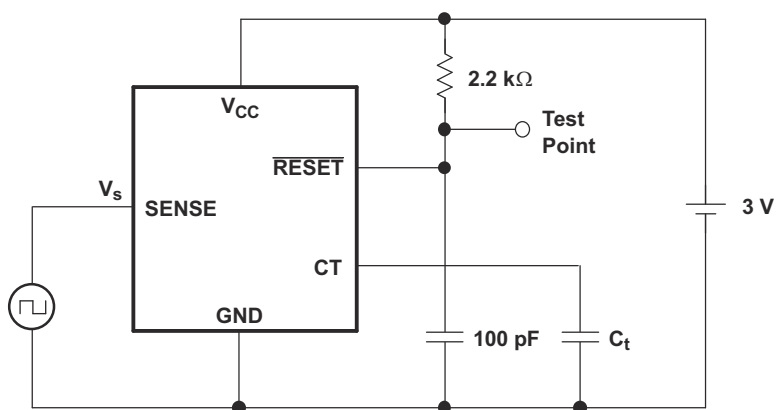


Figure 7-5. Switching Characteristics Measurement Circuit

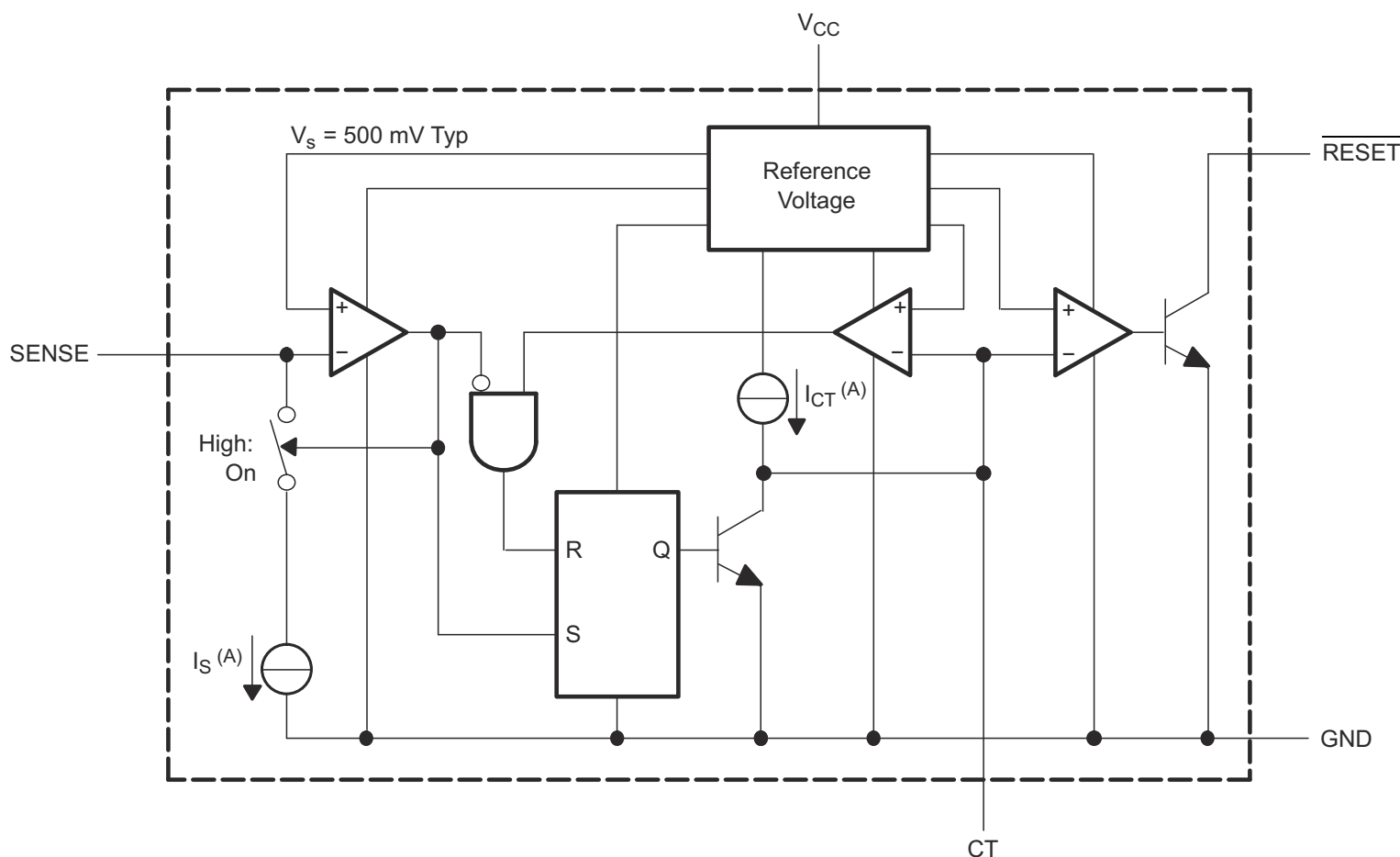
8 Detailed Description

8.1 Overview

The TL7700-SEP is a bipolar integrated circuit designed for use as a reset controller in microcomputer and microprocessor systems. The SENSE voltage can be set to any value greater than 0.5 V using two external resistors. The hysteresis value of the sense voltage also can be set by the same resistors. The device includes a precision voltage reference, fast comparator, timing generator, and output driver, so it can generate a power-on reset signal in a digital system.

The TL7700-SEP has an internal 1.5-V temperature-compensated voltage reference from which all function blocks are supplied. Circuit function is very stable, with supply voltage in the 1.8-V to 40-V range. Minimum supply current allows use with AC line operation and portable battery operation.

8.2 Functional Block Diagram



Copyright © 2016, Texas Instruments Incorporated

$I_{CT} = 15 \mu A$ (Typ), $I_S = 2.5 \mu A$ (Typ)

8.3 Feature Description

8.3.1 Sense-Voltage Setting

The typical SENSE terminal input voltage (V_s) of the TL7700-SEP is 500 mV. By using two external resistors, the circuit designer can set the desired sense voltage to any value above 500 mV. Based on the schematic shown in [Figure 8-1](#), the desired sense voltage ($V_{s'}$) is calculated as:

$$V_{s'} = V_s \times \frac{(R1 + R2)}{R2} \quad (1)$$

where:

- V_s = 490 mV to 520 mV over temperature range

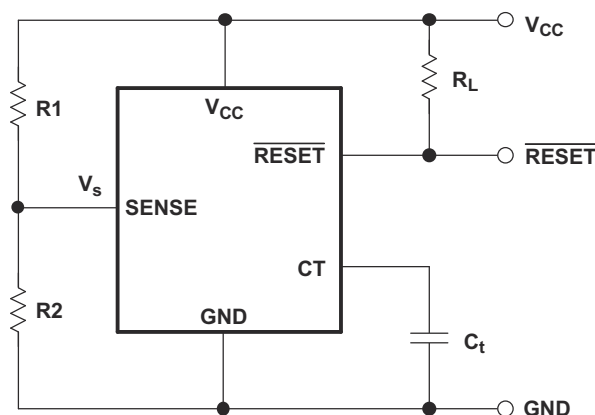


Figure 8-1. Setting the Sense Voltage

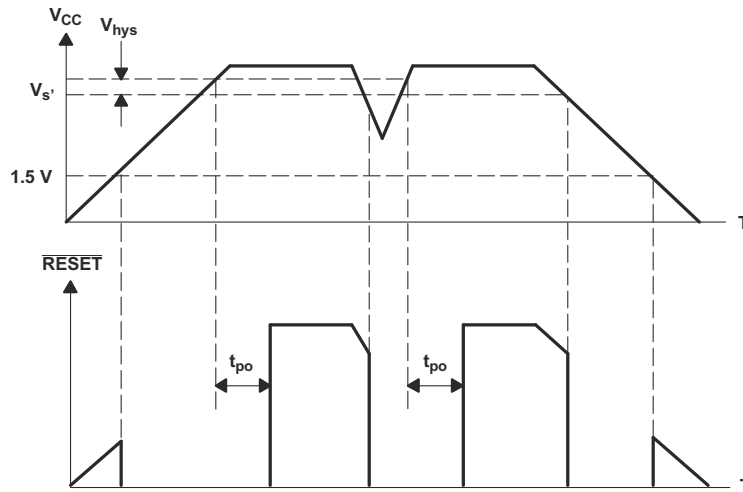
8.3.2 Sense-Voltage Hysteresis Setting

If the desired sense voltage (V_s') does not have hysteresis in it and the voltage on the sensing line contains ripples, the resetting of TL7700-SEP will be unstable. Hysteresis is added to the sense voltage to prevent such problems. As shown in Figure 8-2, the hysteresis (V_{hys}) is added and the value is determined as:

$$V_{hys} = I_s \times R1 \quad (2)$$

where

- $I_s = 1 \mu\text{A}$ to $3.5 \mu\text{A}$ over temperature range



The desired sense voltage (V_s') is different from the SENSE input voltage (V_s). V_s is typically 500 mV for triggering.

Figure 8-2. V_{CC}-RESET Response

8.3.3 Output Pulse-Duration Setting

Constant-current charging starts on the timing capacitor when the sensing-line voltage reaches the TL7700-SEP sense voltage. When the capacitor voltage exceeds the threshold level of the output drive comparator, RESET changes from a low to a high level. The output pulse duration is the time between the point when the SENSE-pin voltage exceeds the threshold level and the point when the RESET output changes from a low level to a high level. When the TL7700-SEP is used for system power-on reset, the output pulse duration, t_{po} , must be set longer than the power rise time. The value of t_{po} in seconds is:

$$t_{po} = C_T \frac{\Delta V_{CT}}{I_{CT}} \quad (3)$$

where:

- C_T is the timing capacitor in farads
- ΔV_{CT} is the change in voltage at the CT pin (1.5-V reference voltage)
- I_{CT} is the timing capacitor charge current (typically $15 \mu\text{A}$)

There is a limit on the device response speed. Even if $C_t = 0$, t_{po} is not 0, but approximately $5 \mu\text{s}$ to $10 \mu\text{s}$. Therefore, when the TL7700-SEP is used as a comparator with hysteresis without connecting C_t , switching speeds (t_r/t_f , t_{po}/t_{pd} , and so forth) must be considered.

8.4 Device Functional Modes

Figure 8-2 shows how the RESET output pin responds to a change in the voltage at the SENSE pin. When the SENSE pin drops below 500 mV, the RESET pin is pulled low.

9 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

9.1 Application Information

The TL7700-SEP supply-voltage supervisor allows for any voltage greater than 500 mV to be monitored. This flexibility allows it to be used in many applications from FPGAs and microcontrollers to supply monitoring.

9.2 Typical Application

Figure 9-1 shows an application where the TL7700-SEP device is being used to sense the voltage supply for a microcontroller that is supplied with 5 V. If the sense voltage drops below 4.5 V, the $\overline{\text{RESET}}$ pin is pulled LOW, signaling the microcontroller to reset.

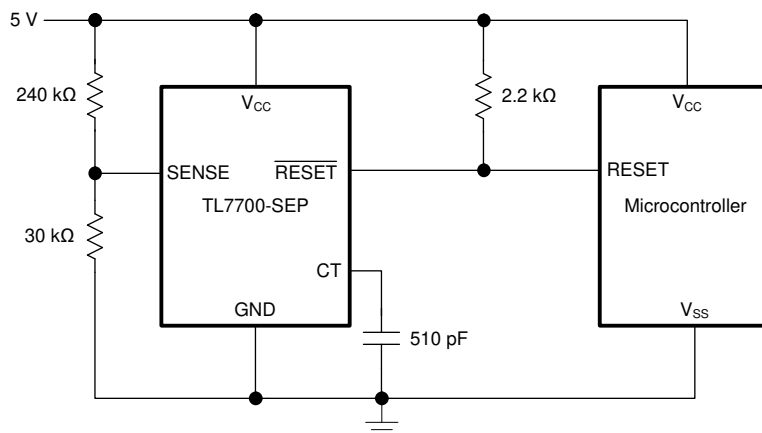


Figure 9-1. 5-V Supply Voltage Supervision

9.2.1 Design Requirements

- When the TL7700-SEP is used for system power-on reset, the output pulse duration, t_{po} , must be set longer than the power rise time.
- The RESET output is an open-collector output, so a pullup resistor is required.

9.2.2 Detailed Design Procedure

The SENSE terminal input voltage, V_s , for TL7700-SEP is typically 500 mV. By using two external resistors, any sense voltage over 500 mV can be sensed.

Resistor R1 should be selected first to set the desired hysteresis. Section 8.3.2 provides detailed information on how to set the hysteresis. For this application, a 240-kΩ resistor is selected.

$$V_{hys} = I_s \times R1 \quad (4)$$

$$V_{hys} = 2.5 \mu A \times 240 k\Omega = 0.6 V \quad (5)$$

Resistor R2 should then be selected based on the R1 value and the desired sense voltage (V_s). Section 8.3.1 describes how to set V_s , and provides an equation. In this example, V_s is set to 4.5 V by using the value of R1 selected earlier and using a 30-kΩ resistor for R2.

$$V_{s'} = V_s \times \frac{(R1 + R2)}{R2} \quad (6)$$

$$V_{s'} = 0.5 V \times \frac{(240 k\Omega + 30 k\Omega)}{30 k\Omega} = 4.5 V \quad (7)$$

Finally, the output pulse duration (t_{PO}) is set using the equation found in [Section 8.3.3](#).

$$t_{po} = C_T \frac{\Delta V_{CT}}{I_{CT}} \quad (8)$$

$$t_{po} = 510 \text{ pF} \frac{1.5 V}{15 \mu A} = 51 \mu s \quad (9)$$

9.2.3 Application Curve

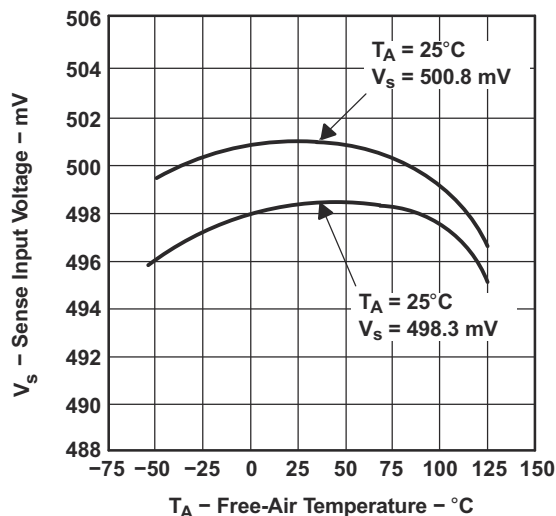


Figure 9-2. SENSE Input Voltage vs Temperature

10 Power Supply Recommendations

The TL7700-SEP device will operate within the supply range specified in [Section 6.3](#). The device risks permanent damage over the voltage specified in [Section 6.1](#).

11 Layout

11.1 Layout Guidelines

As the $\overline{\text{RESET}}$ pin is an open collector output, a pullup resistor is required to ensure the output is high when the output transistor is off. The SENSE resistors should be placed as close to the SENSE pin as possible to avoid introducing noise to the pin.

11.2 Layout Example

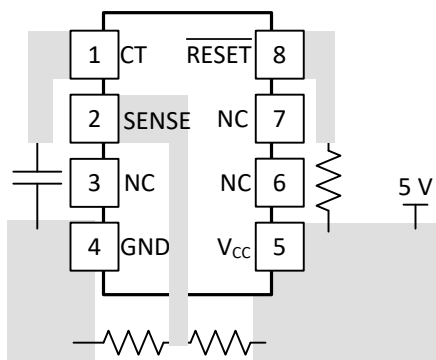


Figure 11-1. TL7700-SEP Layout

12 Device and Documentation Support

12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.2 Support Resources

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

12.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

12.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.5 Glossary

[TI Glossary](#)

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TL7700CMPWPSEP	Active	Production	TSSOP (PW) 8	150 TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	7700SP
TL7700CMPWTPSEP	Active	Production	TSSOP (PW) 8	250 SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	7700SP

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL7700CMPWTPSEP	TSSOP	PW	8	250	180.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL7700CMPWTPSEP	TSSOP	PW	8	250	210.0	185.0	35.0

TUBE



*All dimensions are nominal

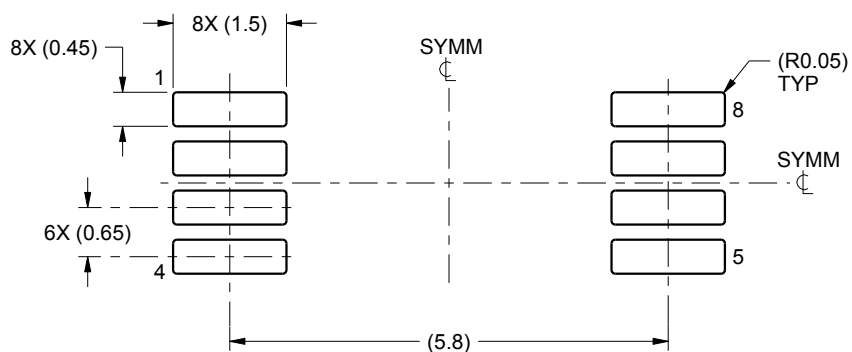
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
TL7700CMPWPSEP	PW	TSSOP	8	150	530	10.2	3600	3.5
V62/19602-01XE-T	PW	TSSOP	8	150	530	10.2	3600	3.5

EXAMPLE BOARD LAYOUT

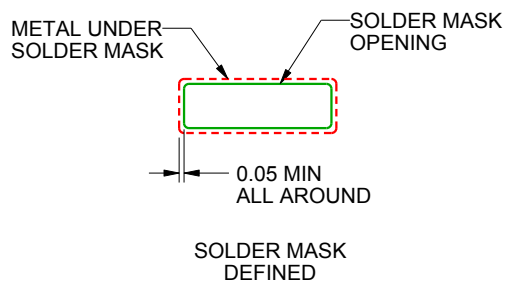
PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:10X



SOLDER MASK DETAILS
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

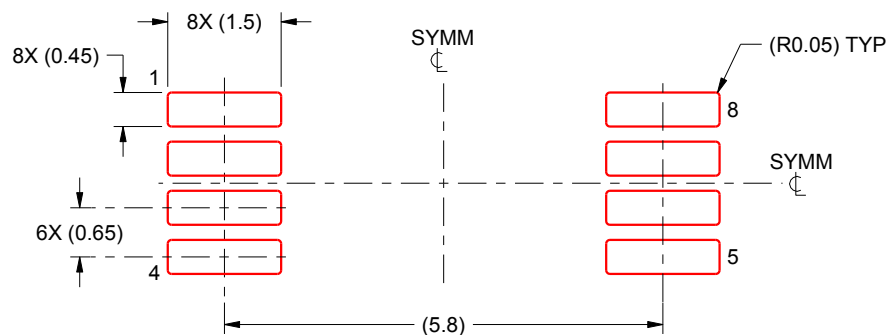
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2025, Texas Instruments Incorporated