

# Multifunction Very Low Dropout Voltage Regulator

## FEATURES

- Operating DC Supply Voltage Range 5.0V to 28V
- Transient Supply Voltage up to 40V
- Extremely Low Quiescent Current in Standby Mode
- High Precision Standby Output Voltage 5.0V ±1%
- Output Current Capability up to 100mA
- Very Low Dropout Voltage less than 0.4V
- Reset Circuit Sensing the Output Voltage
- Programmable Reset Pulse Delay with External Capacitor
- Voltage Sense Comparator
- Thermal Shutdown and Short Circuit Protections

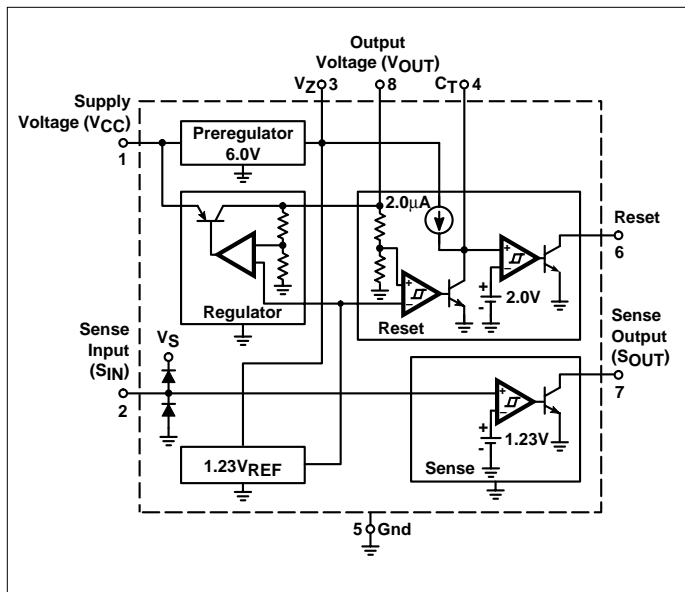
## GENERAL DESCRIPTION

The TC4949 is a monolithic integrated 5.0V voltage regulator with a very low dropout and additional functions such as power-on reset and input voltage sense. It is designed for supplying the micro-computer controlled systems especially in automotive applications.

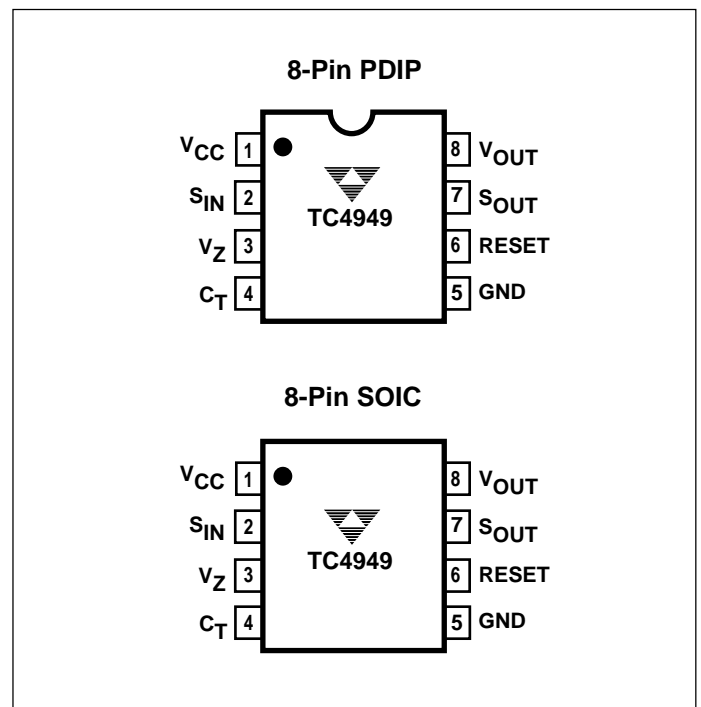
## ORDERING INFORMATION

Part Number	Package	Temperature Range
TC4949VPA	8-Pin PDIP (Narrow)	-40 to +125°C
TC4949VOA	8-Pin SOIC (Narrow)	-40 to +125°C

## REPRESENTATIVE BLOCK DIAGRAM



## PIN CONFIGURATIONS



# Multifunction Very Low Dropout Voltage Regulator

## TC4949

### ABSOLUTE MAXIMUM RATINGS\*

DC Operating Supply Voltage	$V_{CC} = 28V$
Transient Supply Voltage ( $T < 1.0$ s)	$V_{CC\ TR} = 40V$
Output Current	$I_{OUT}$ (Internally Limited)
Output Voltage	$V_{OUT} = 20V$
Sense Input Current	$I_{SI} = \pm 1.0mA$
Sense Input Voltage	$V_{SI} = V_{CC}$
Output Voltages	
Reset Output	$V_{RESET} = 20V$
Sense Output	$V_{SO} = 20V$
Output Currents	
Reset Output	$I_{RESET} = 5.0mA$
Sense Output	$I_{SO} = 5.0mA$
Preregulator Output Voltage	$V_Z = 7.0V$
Preregulator Output Current	$I_Z = 5.0mA$

ESD Protection at any pin

Human Body Model ..... 2000V

Machine Model ..... 400V

Thermal Resistance, Junction-to-Air

P Suffix, DIP-8 Plastic Package,

Case 626 .....  $\Theta_{JA} = 100^{\circ}C/W$

D Suffix, SO-8 Plastic Package,

Case 751 .....  $\Theta_{JA} = 200^{\circ}C/W$

Maximum Junction Temperature .....  $T_J = 150^{\circ}C$

Storage Temperature Range .....  $T_{STG} = -65$  to  $+150^{\circ}C$

\*This is a stress rating only, and functional operation of the device at these or any other conditions beyond those indicated in the operation section of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods of time may affect device reliability.

### ELECTRICAL CHARACTERISTICS: ( $V_{CC} = 14V$ , $-40^{\circ}C < T_J < 125^{\circ}C$ , unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$V_{OUT}$	Output Voltage	$T_J = 25^{\circ}C$ , $I_{OUT} = 1.0mA$ $6.0V < V_{CC} < 28V$ , $1.0mA < I_{OUT} < 50mA$ $V_{CC} = 35V$ , $t < 1.0$ s, $1.0mA < I_{OUT} < 50mA$	4.95 4.9 4.9	5.0 5.0 5.0	5.05 5.1 5.1	V
$V_{DROP}$	Dropout Voltage	$I_{OUT} = 10mA$ $I_{OUT} = 50mA$ $I_{OUT} = 100mA$	– – –	0.1 0.2 0.3	0.25 0.40 0.50	V
$V_{IO}$	Input to Output Voltage Difference in Undervoltage Condition	$V_{CC} = 4.0V$ , $I_{OUT} = 35mA$	–	0.2	0.4	V
$REG_{LINE}$	Line Regulation	$6.0V < V_{CC} < 28V$ , $I_{OUT} = 1.0mA$	–	1.0	20	mV
$REG_{LOAD}$	Load Regulation	$1.0mA < I_{OUT} < 100mA$	–	8.0	30	mV
$I_{LIM}$	Current Limit	$V_{OUT} = 4.5V$ $V_{OUT} = 0V$	105 –	200 100	400 –	mA
$I_{QSE}$	Quiescent Current	$I_{OUT} = 0.3mA$ , $T_J < 100^{\circ}C$	–	150	260	$\mu A$
$I_Q$		$I_{OUT} = 100mA$	–	–	5.0	mA
<b>RESET</b>						
$V_{RETH}$	Reset Threshold Voltage		–	$V_{OUT} - 0.5$	–	V
$V_{RETH,HYS}$	Reset Threshold Hysteresis	@ $T_J = 25^{\circ}C$ @ $T_J = -40$ to $+125^{\circ}C$	50 50	100 –	200 300	mV
$T_{RESD}$	Reset Pulse Delay	$C_T = 100nF$ , $T_R \geq 100\mu s$	55	100	180	ms
$T_{RESR}$	Reset Reaction Time	$C_T = 100nF$	–	5.0	30	$\mu s$
$V_{RESL}$	Reset Output Low Voltage	$R_{RESET} = 10k\Omega$ to $V_{OUT}$ , $V_{CC} \geq 3.0V$	–	–	0.4	V
$I_{RESH}$	Reset Output High Leakage Current	$V_{RESET} = 5.0V$	–	–	1.0	$\mu A$
$V_{CTTH}$	Delay Comparator Threshold		–	2.0	–	V
$V_{CTTH,HYS}$	Delay Comparator Threshold Hysteresis		–	100	–	mV

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TC4949

## ELECTRICAL CHARACTERISTICS: ( $V_{CC} = 14V$ , $-40^{\circ}C < T_J < 125^{\circ}C$ , unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>SENSE</b>						
$V_{SO\text{TH}}$	Sense Low Threshold	$V_{SI}$ Decreasing = 1.5V to 1.0V)	1.16	1.23	1.35	V
$V_{SO\text{TH,HYS}}$	Sense Threshold Hysteresis		20	100	200	mV
$V_{SO\text{L}}$	Sense Output Low Voltage	$V_{SI} \leq 1.16V$ , $V_{CC} \geq 3.0V$ , $R_{SO} = 10k\Omega$ to $V_{OUT}$	–	–	0.4	V
$I_{SO\text{H}}$	Sense Output Leakage	$V_{SO} = 5.0V$ , $V_{SI} \geq 1.5V$	–	–	1.0	$\mu A$
$I_{SI}$	Sense Input Current		1.0	0.1	1.0	$\mu A$
<b>PREREGULATOR</b>						
$V_Z$	Preregulator Output Voltage	$I_Z = 10\mu A$	–	6.3	–	V

## PIN DESCRIPTION

Pin	Symbol	Description
1	$V_{CC}$	Supply Voltage
2	$S_{IN}$	Input of Sense Comparator
3	$V_Z$	Output of Preregulator
4	$C_T$	Reset Delay Capacitor
5	GND	Ground
6	RESET	Output of Reset Comparator
7	$S_{OUT}$	Output of Sense Comparator
8	$V_{OUT}$	Main Regulator Output

## TYPICAL CHARACTERISTICS

Figure 1. Output Voltage versus Junction Temperature

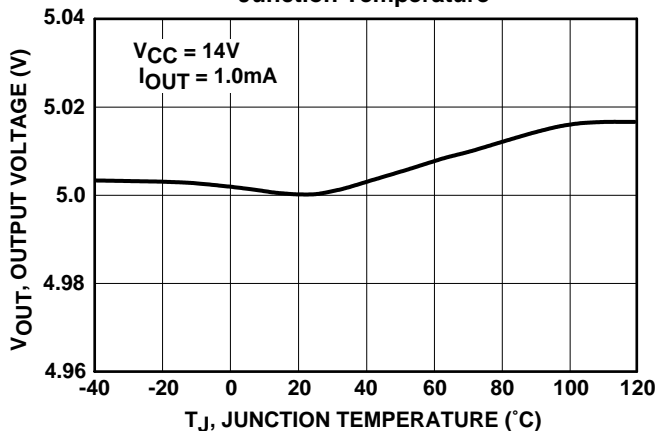
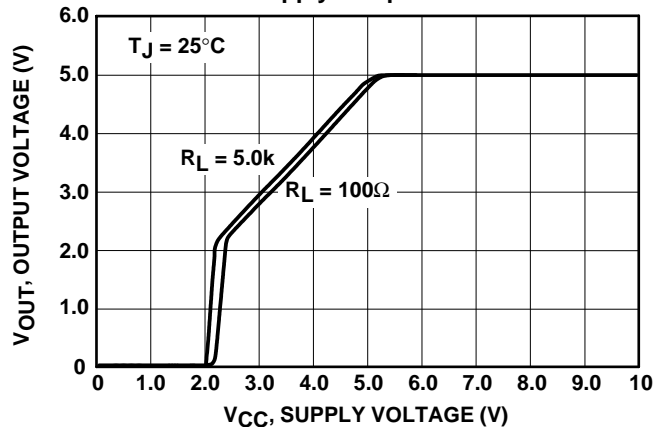


Figure 2. Output Voltage versus Supply Temperature



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TC4949

## TYPICAL CHARACTERISTICS

Figure 3. Dropout Voltage versus Output Current

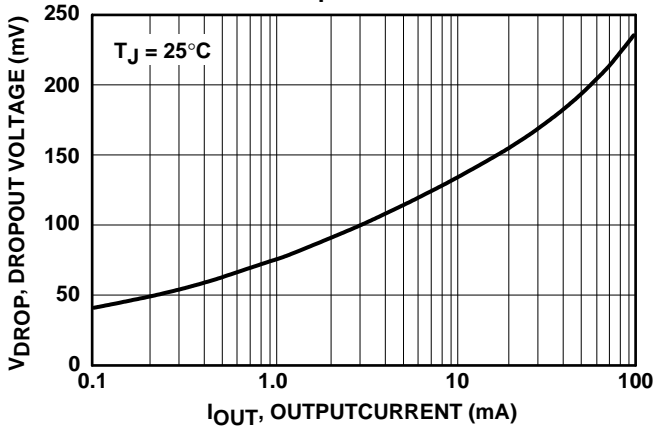


Figure 4. Dropout Voltage versus Junction Temperature

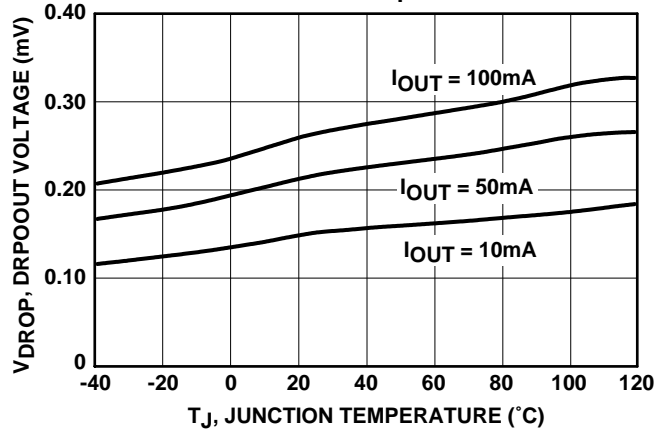


Figure 5. Quiescent Current versus Output Current

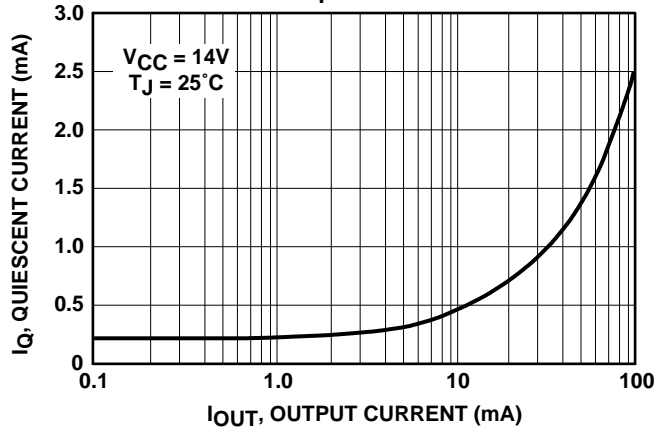


Figure 6. Quiescent Current versus Supply Voltage

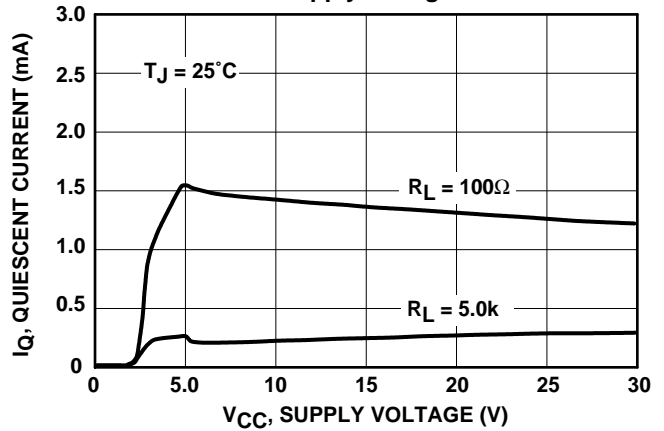


Figure 7. Reset Output versus Regulator Output Voltage

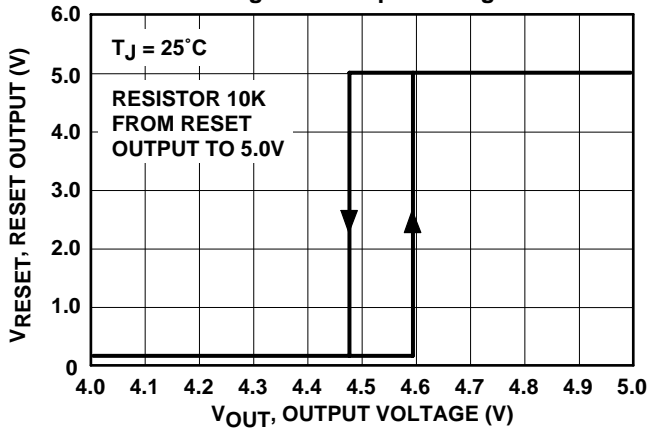
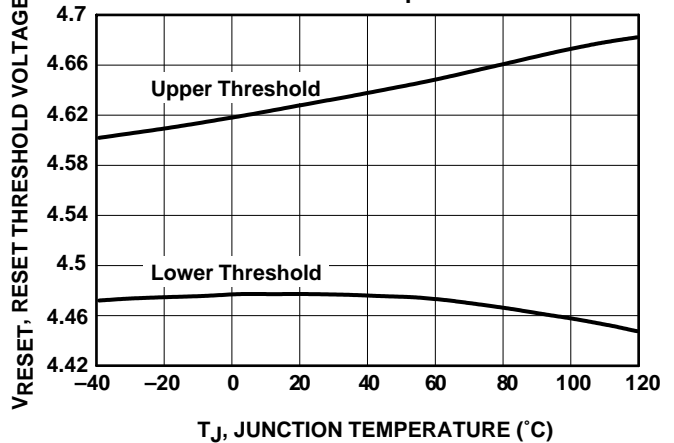


Figure 8. Reset Thresholds versus Junction Temperature



## TYPICAL CHARACTERISTICS

Figure 9. Sense Output versus Sense Input Voltage

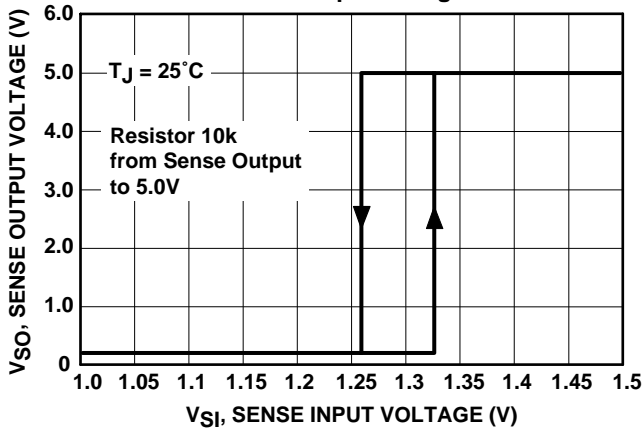
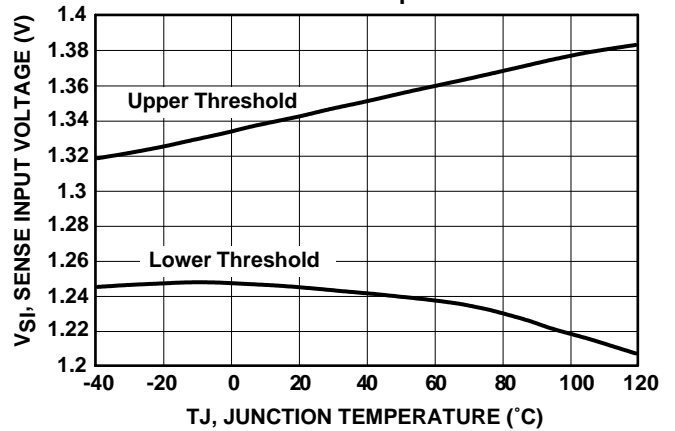


Figure 10. Sense Thresholds versus Junction Temperature



## APPLICATION INFORMATION

### Supply Voltage Transient

High supply voltage transients can cause a reset output signal perturbation. For supply voltages greater than 8.0V the circuit shows a high immunity of the reset output against supply transients of more than 100V/ $\mu\text{sec}$ . For supply volt-

ages less than 8.0V supply transients of more than 0.4V/ $\mu\text{sec}$  can cause a reset signal perturbation. To improve the transient behavior for supply voltages less than 8.0V a capacitor at Pin 3 can be used. A capacitor at Pin 3 ( $C_3 \leq 1.0\mu\text{F}$ ) reduces also the output noise.

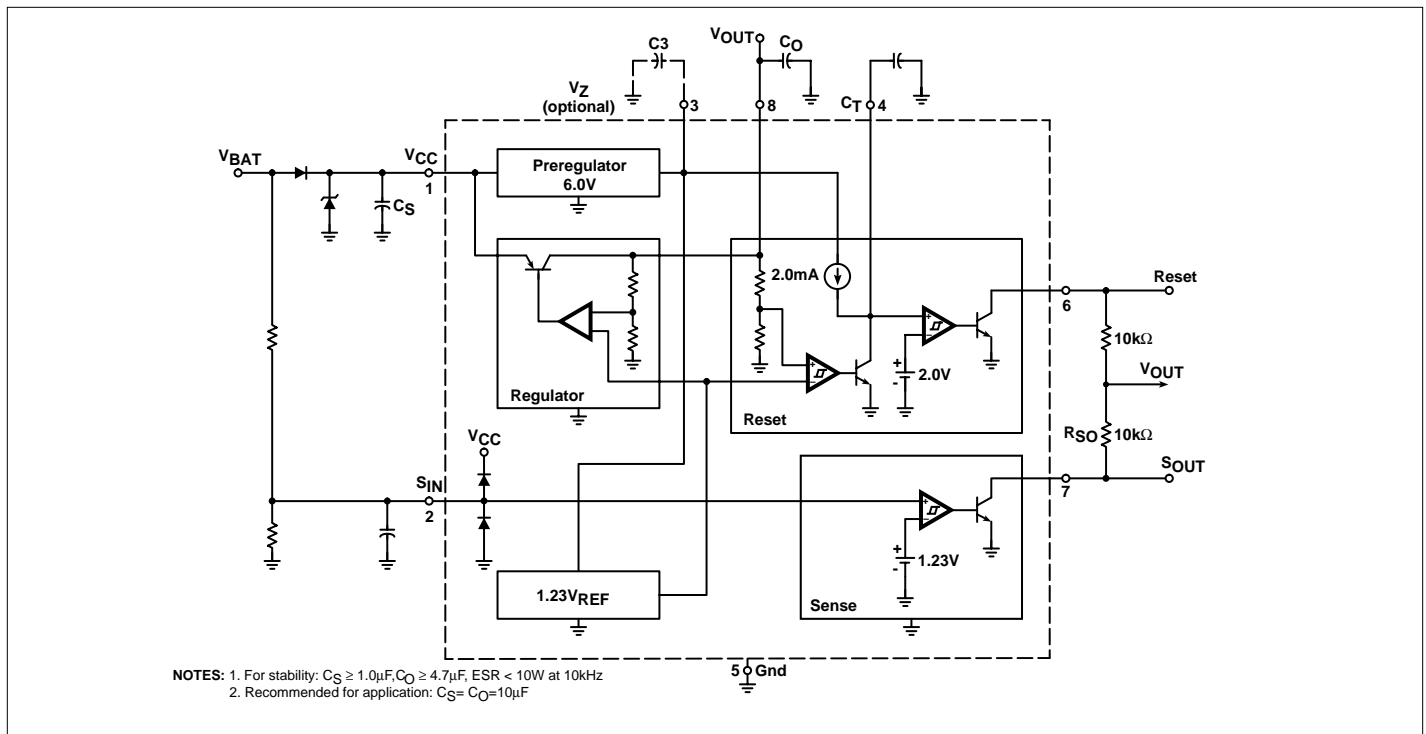


Figure 11. Application Schematic

# Multifunction Very Low Dropout Voltage Regulator

## TC4949

### OPERATING DESCRIPTION

The TC4949 is a monolithic integrated low dropout voltage regulator. Several outstanding features and auxiliary functions are implemented to meet the requirements of supplying microprocessor systems in automotive applications. Nevertheless, it is suitable also in other applications where the present functions are required. The modular approach of this device allows the use of other features and functions independently when required.

### Voltage Regulator

The voltage regulator uses an isolated Collector Vertical PNP transistor as a regulating element. With this structure, very low dropout voltage at currents up to 100mA is obtained. The dropout operation of the standby regulator is maintained down to 3.0V input supply voltage. The output voltage is regulated up to the transient input supply voltage of 35V. With this feature no functional interruption due to overvoltage pulses is generated.

The typical curve showing the standby output voltage as a function of the input supply voltage is shown in Figure 13.

The current consumption of the device (quiescent current) is less than 200 $\mu$ A.

To reduce the quiescent current peak in the undervoltage region and to improve the transient response in this region, the dropout voltage is controlled. The quiescent current as a function of the supply input voltage is shown in Figure 14.

### Short Circuit Protection:

The maximum output current is internally limited. In case of short circuit, the output current is foldback current limited as described in Figure 12.

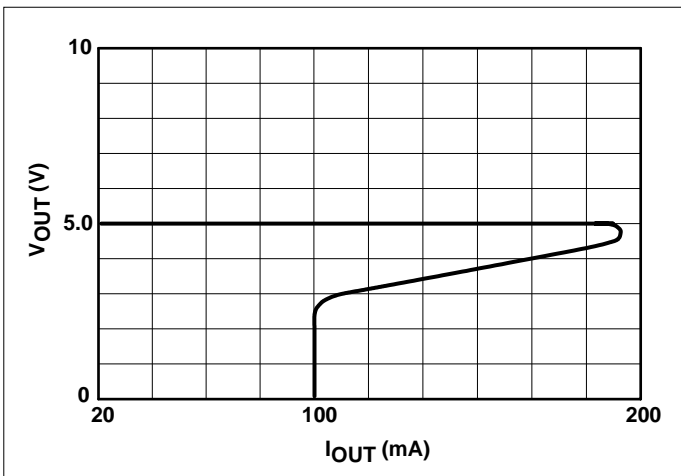


Figure 12. Foldback Characteristic of V<sub>OUT</sub>

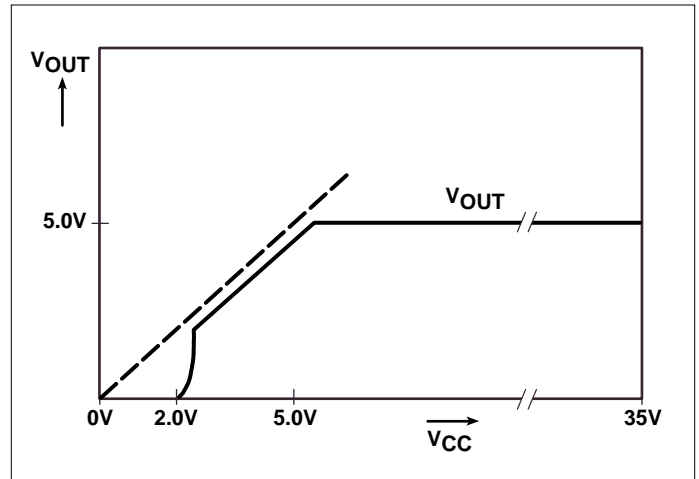


Figure 13. Output Voltage versus Supply Voltage

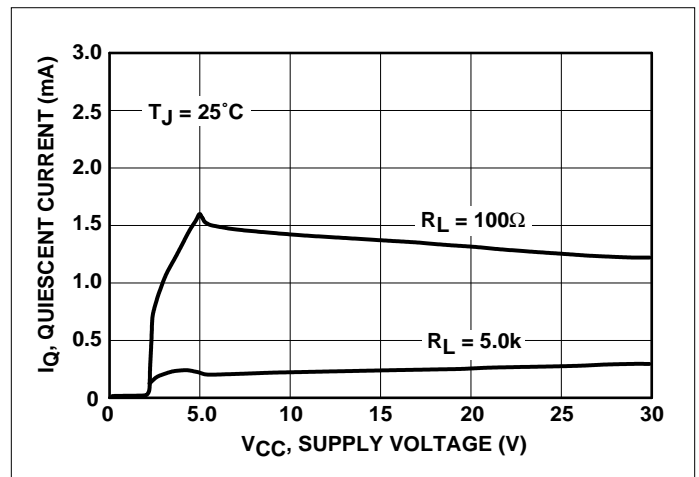


Figure 14. Quiescent Current versus Supply Voltage

### Preregulator

To improve the transient immunity a preregulator stabilizes the internal supply voltage to 6.0V. This internal voltage is present at Pin 3 (V<sub>Z</sub>). This voltage should not be used as an output because the output capability is very small ( $\leq 100\mu$ A).

This output may be used as an option when better transient behavior for supply voltages less than 8.0V is required. In this case a capacitor (100nF – 1.0 $\mu$ F) must be connected between Pin 3 and Gnd. If this feature is not used Pin 3 must be left open.

### Reset Circuit

The block circuit diagram of the reset circuit is shown in Figure 15.

The reset circuit supervises the output voltage. The reset threshold of 4.5V is defined with the internal reference voltage and standby output divider.

The reset pulse delay time  $T_{RD}$ , is defined with the charge time of an external capacitor  $C_T$ :

$$T_{RD} = \frac{C_T \times 2.0V}{2.0\mu A}$$

The reaction time of the reset circuit originates from the discharge time limitation of the reset capacitor  $C_T$  and is proportional to the value of  $C_T$ . The reaction time of the reset circuit increases the noise immunity.

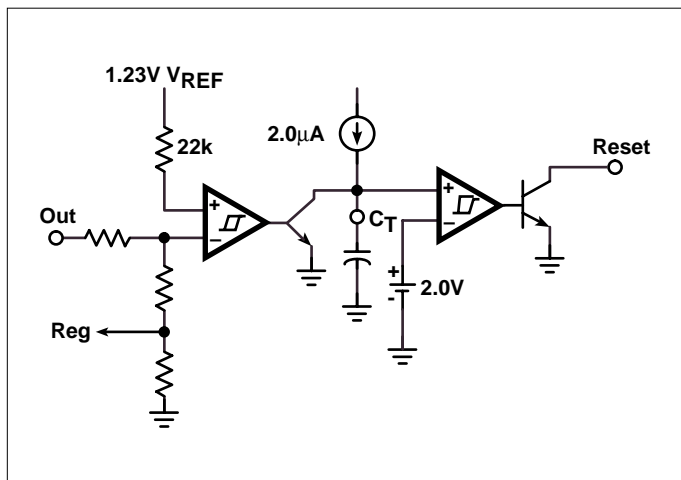


Figure 15. Reset Circuit

Standby output voltage drops below the reset threshold only a bit longer than the reaction time results in a shorter reset delay time.

The nominal reset delay time will be generated for standby output voltage drops longer than approximately 50μsec. The typical reset output waveforms are shown in Figure 16.

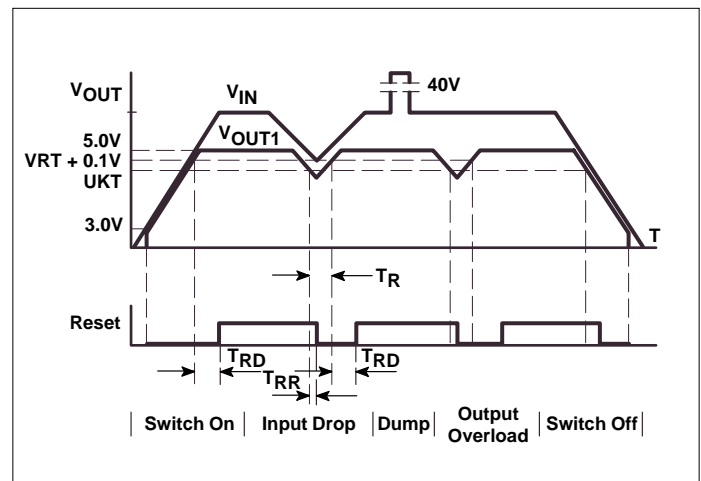


Figure 16. Typical Reset Output Waveforms

### Sense Comparator

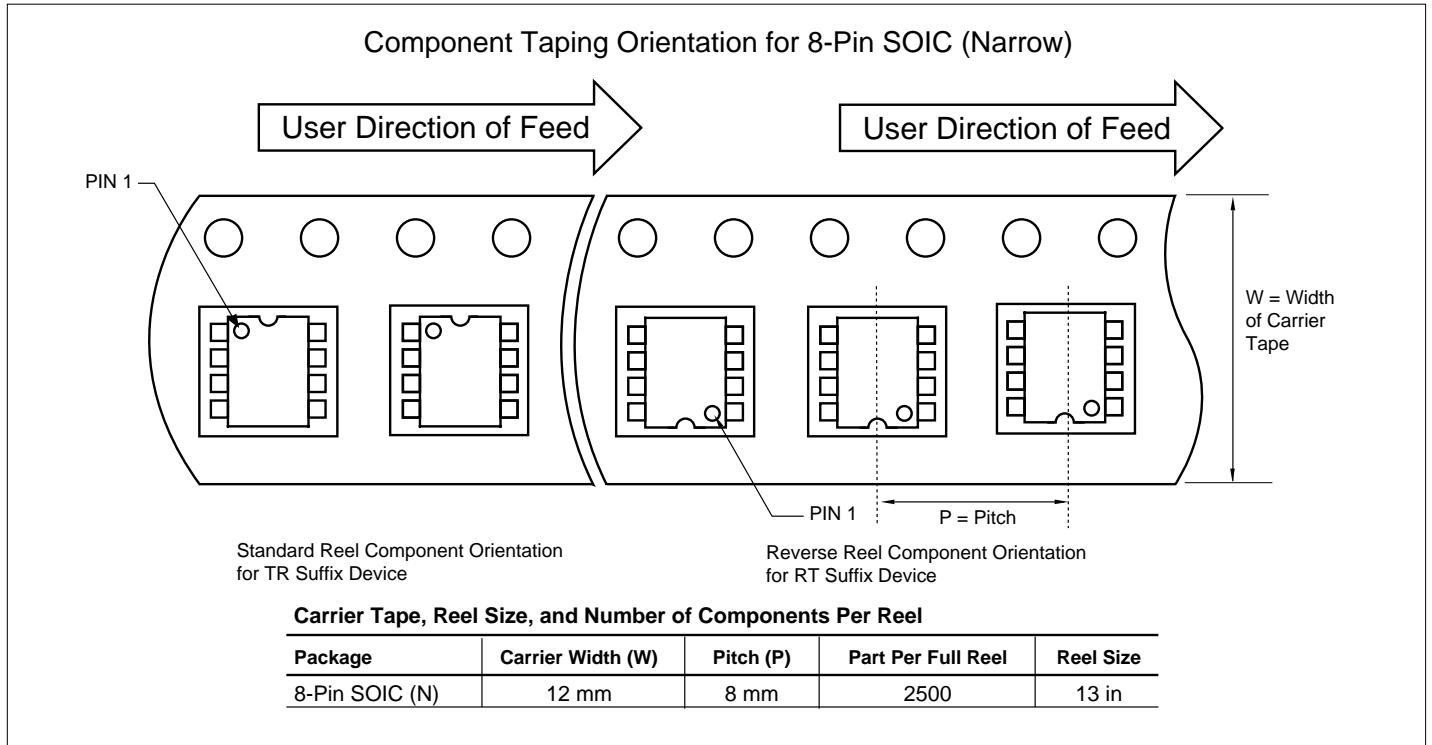
The sense comparator compares an input signal with an internal voltage reference of typical 1.23V. The use of an external voltage divider makes this comparator very flexible in the application.

It can be used to supervise the input voltage either before or after the protection diode and to give additional information to the microprocessor like low voltage warnings.

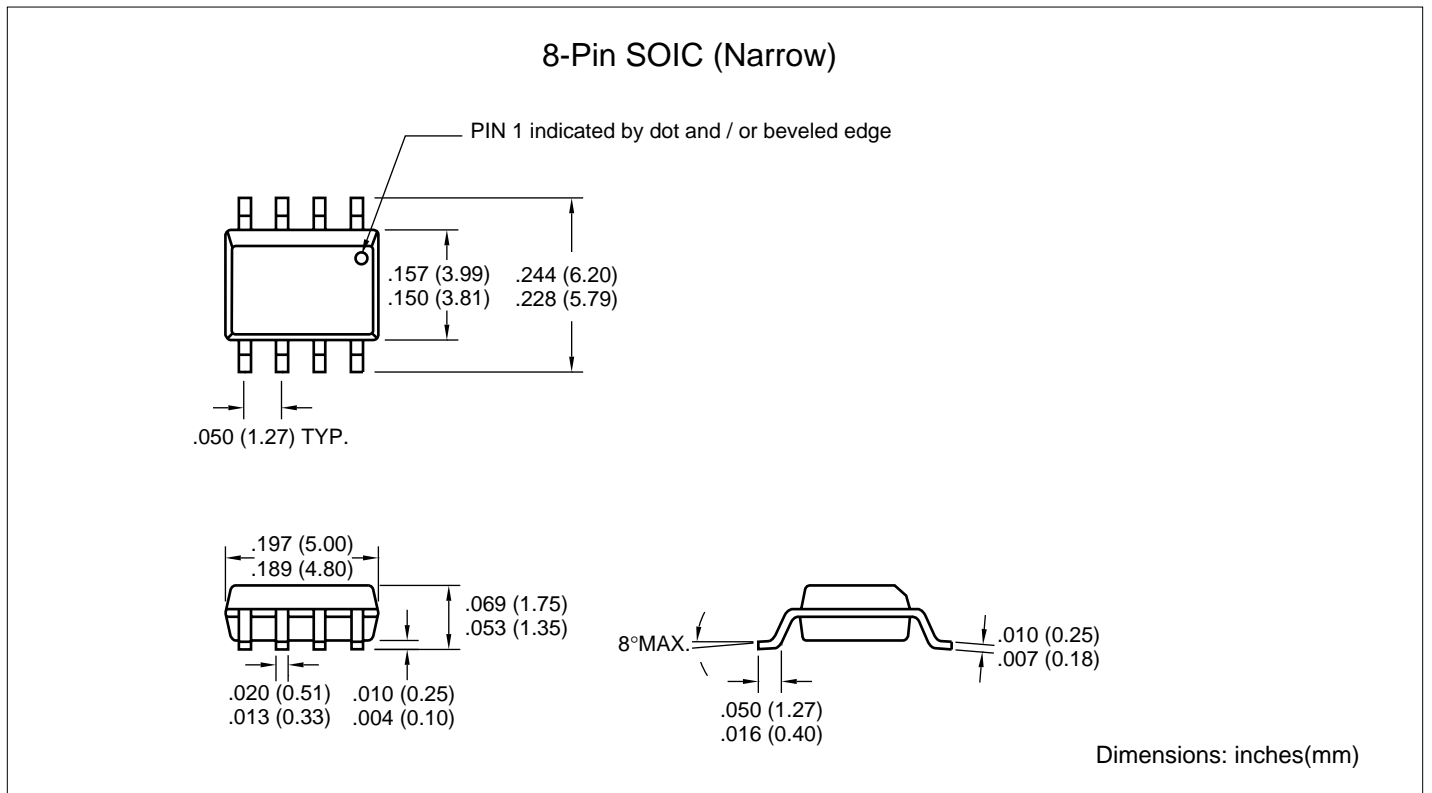
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TC4949

## TAPING FORM



## PACKAGE DIMENSIONS

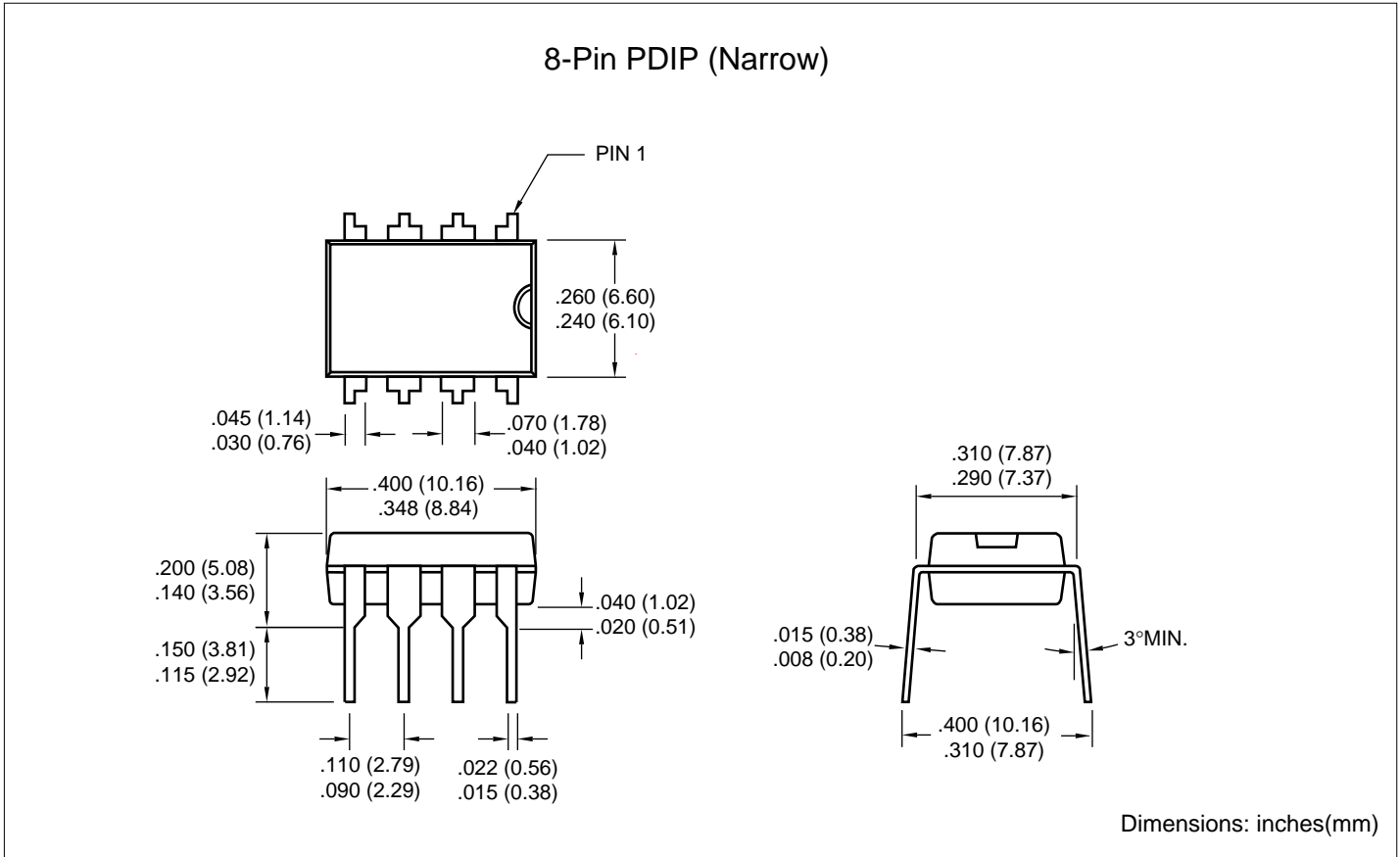




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## PACKAGE DIMENSIONS (CONT.)



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