

Features

- Power Supply Voltage: 2.5 V to 5.5 V
- Low Supply Current: 50 μ A per channel
- Propagation Delay: 120 ns
- Internal Hysteresis Ensures Clean Switching
- Offset Voltage: ± 4 mV
- Input Bias Current: 30 pA Typical
- Input Common-Mode Range Extends 100 mV
- Push-Pull Output

Applications

- Peak and Zero-crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at the Ground or Supply Line
- Logic Level Shifting or Translation
- Power Supply

Description

The devices are low-power, high-speed comparators with internal hysteresis. The common-mode input voltage range extends 100 mV beyond the power rail. The devices have 120-ns propagation delay with only 50- μ A quiescent current each comparator, which makes the devices suitable for low-power applications. The internal input hysteresis eliminates output switching due to input noise voltage. The devices have push-pull output to support rail-to-rail output swing.

The devices are specified for the temperature range from -40°C to $+125^{\circ}\text{C}$.

Typical Application Circuit

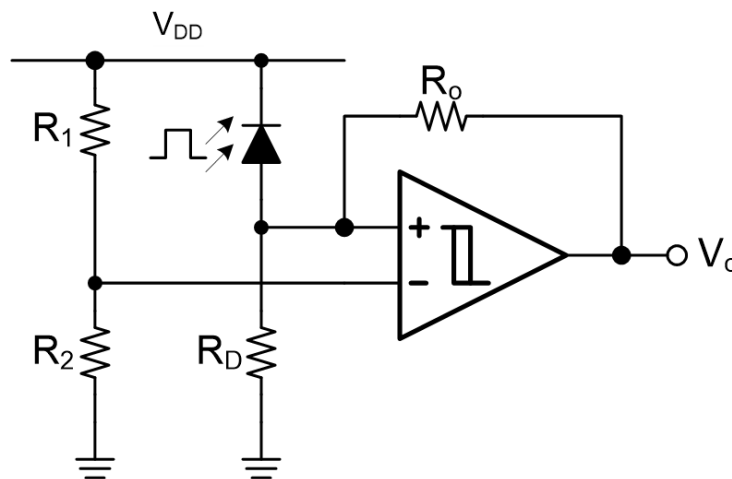


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Revision History

Date	Revision	Notes
2023-09-05	Rev.A.0	Initial version.
2023-04-26	Rev.A.1	Modified the product status of TPCMP252-SO1R, TPCMP251-SC5R and TPCMP251U-SC5R to future product in order information.

Pin Configuration and Functions

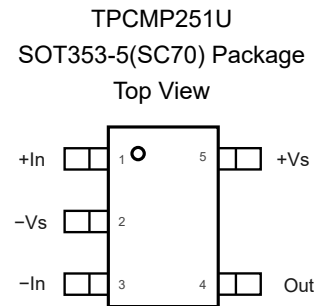
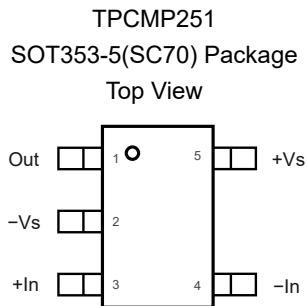
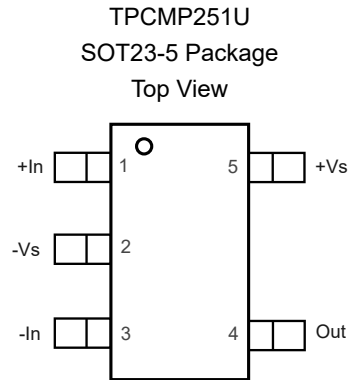
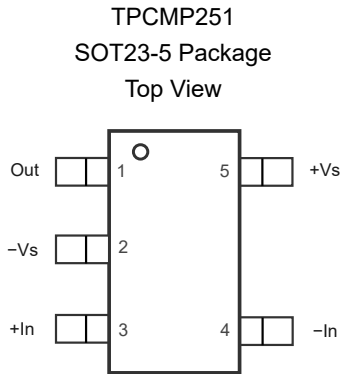


Table 1. Pin Functions: TPCMP251, TPCMP251U

Pin No.		Name	I/O	Description
TPCMP251	TPCMP251U			
1	4	Out	O	Output
2	2	-Vs	-	Negative power supply
3	1	+In	I	Noninverting input
4	3	-In	I	Inverting input
5	5	+Vs	-	Positive power supply

5-V, 120-ns Low-power Comparators with Push-Pull Output

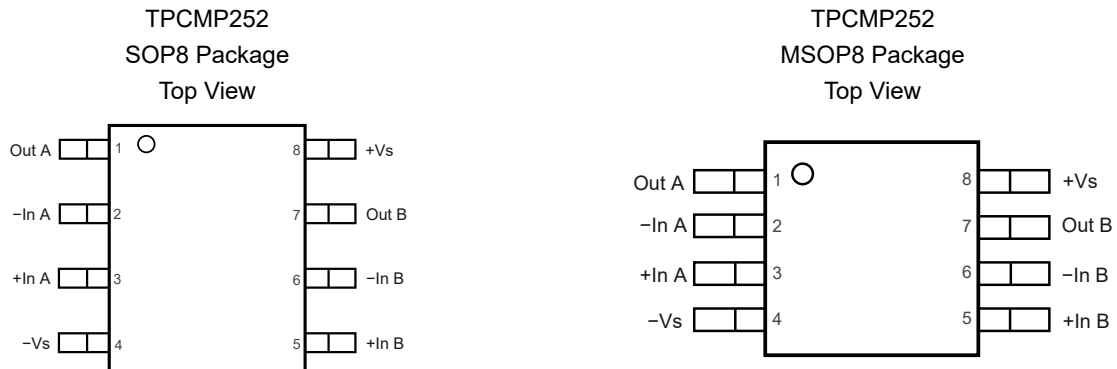


Table 2. Pin Functions: TPCMP252

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Noninverting input
4	-Vs	-	Negative power supply
5	+In B	I	Noninverting input
6	-In B	I	Inverting input
7	Out B	O	Output
8	+Vs		Positive power supply

Specifications

Absolute Maximum Ratings ⁽¹⁾

Parameter		Min	Max	Unit
	Supply Voltage, (+V _S) – (–V _S)		6.5	V
	Input Voltage	(–V _S) – 0.3	6.5	V
	Input Current: +IN, –IN ⁽²⁾	–10	+10	mA
	Output Current: OUT	–10	+10	mA
	Output Short-Circuit Duration ⁽³⁾		Thermal protection	
T _J	Maximum Junction Temperature		150	°C
T _A	Operating Temperature Range	–40	125	°C
T _{STG}	Storage Temperature Range	–65	150	°C
T _L	Lead Temperature (Soldering 10 sec)		260	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

(2) The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 500 mV beyond the negative power supply, the input current should be limited to less than 10 mA.

(3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many comparators are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 ⁽²⁾	1.5	kV

(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.

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V _S	Supply Voltage, (+V _S) – (–V _S)	2.5		5.5	V

Thermal Information

Package Type	θ _{JA}	θ _{Jc}	Unit
SOT353 (SC70-5)	400	150	°C/W
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W

5-V, 120-ns Low-power Comparators with Push-Pull Output
Electrical Characteristics

 All test conditions: $V_S = 5.5\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	$V_{CM} = 5.5\text{ V}$		53	83	μA
		$V_{CM} = 5.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			100	μA
PSRR	Power Supply Rejection Ratio	$V_S = 2.5\text{ V}$ to 5.5 V , $V_{CM} = 0\text{ V}$	60	80		dB
		$V_S = 2.5\text{ V}$ to 5.5 V , $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	50			dB
Input Characteristics						
V_{OS}	Input Offset Voltage ⁽¹⁾	$V_{CM} = 0\text{ V}$ to 5.5 V	-4	-0.5	4	mV
		$V_{CM} = 0\text{ V}$ to 5.5 V , $T_A = -40^\circ\text{C}$ to 125°C	-5		5	mV
	Input Offset Voltage Drift ⁽²⁾	$T_A = -40^\circ\text{C}$ to 125°C		2		$\mu\text{V}/^\circ\text{C}$
V_{HYST}	Input Hysteresis Voltage ⁽¹⁾	$V_{CM} = 0\text{ V}$ to 5.5 V	1	6	12	mV
		$V_{CM} = 0\text{ V}$ to 5.5 V , $T_A = -40^\circ\text{C}$ to 125°C			15	mV
	Input Hysteresis Voltage Drift ⁽²⁾	$T_A = -40^\circ\text{C}$ to 125°C		10		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current ⁽²⁾	$V_{CM} = 2.75\text{ V}$		30		pA
		$V_{CM} = 2.75\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			240000	pA
I_{OS}	Input Offset Current ⁽²⁾	$V_{CM} = 2.75\text{ V}$		30		pA
		$V_{CM} = 2.75\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			240000	pA
C_{IN}	Input Capacitance ⁽⁴⁾	$T_A = 25^\circ\text{C}$	Differential		2	pF
			Common Mode		3	
V_{CM}	Common-mode Input Voltage Range	$T_A = -40^\circ\text{C}$ to 125°C	$(-V_S) - 0.1$		$(+V_S) + 0.1$	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0\text{ V}$ to 5.5 V	60	80		dB
		$V_{CM} = 0\text{ V}$ to 5.5 V , $T_A = -40^\circ\text{C}$ to 125°C	50			dB
Output Characteristics						
I_{SC}	Output Short-Circuit Current ⁽²⁾	Sink or source current	110	120		mA
		Sink or source current, $T_A = -40^\circ\text{C}$ to 125°C	90			mA
V_{OH}	Output Voltage Swing from Positive Rail	$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$		50	80	mV
		$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			100	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$		15	25	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			35	mV

5-V, 120-ns Low-power Comparators with Push-Pull Output

Parameter		Conditions	Min	Typ	Max	Unit
V _{OL}	Output Voltage Swing from Negative Rail	I _{OL} = 4 mA, V _{ID} = -1 V		30	55	mV
		I _{OL} = 4 mA, V _{ID} = -1 V, T _A = -40°C to 125°C			75	mV
		I _{OL} = 1 mA, V _{ID} = -1 V		10	15	mV
		I _{OL} = 1 mA, V _{ID} = -1 V, T _A = -40°C to 125°C			25	mV
Switching Characteristics, T_A = -40°C to 125°C ⁽³⁾						
T _{PLH}	Propagation delay time, low-to-high	ΔV _{IN} = 1 V, V _{CM} = 0 V, 100mV overdrive ⁽²⁾		120	180	ns
		ΔV _{IN} = 1 V, V _{CM} = 0 V, 20mV overdrive ⁽⁴⁾		220		ns
T _{PHL}	Propagation delay time, high-to-low	ΔV _{IN} = 1 V, V _{CM} = 0 V, 100mV overdrive ⁽²⁾		110	170	ns
		ΔV _{IN} = 1 V, V _{CM} = 0 V, 20mV overdrive ⁽⁴⁾		222		ns
T _R	Rise time	⁽²⁾ ⁽⁵⁾		0.9		ns
T _F	Fall time	⁽²⁾ ⁽⁵⁾		0.9		ns

(1) The input offset voltage is the average of the input-referred trip points. The input hysteresis is the difference between the input-referred trip points.

(2) Provided by bench test and design simulation.

(3) Delay time is measured from mid-point of input to mid-point of output.

(4) Provided by design simulation.

(5) Measured between 10% of V_S and 90% of V_S.

5-V, 120-ns Low-power Comparators with Push-Pull Output
Electrical Characteristics (continued)

 All test conditions: $V_S = 2.5\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	$V_{CM} = 2.5\text{ V}$		45	80	μA
		$V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			100	μA
Input Characteristics						
V_{OS}	Input Offset Voltage ⁽¹⁾	$V_{CM} = 0\text{ V}$ to 2.5 V	-4	-0.5	4	mV
		$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C	-5		5	mV
	Input Offset Voltage Drift ⁽²⁾	$T_A = -40^\circ\text{C}$ to 125°C		2		$\mu\text{V}/^\circ\text{C}$
V_{HYST}	Input Hysteresis Voltage ⁽¹⁾	$V_{CM} = 0\text{ V}$ to 2.5 V	1	6	10	mV
		$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C			15	mV
	Input Hysteresis Voltage Drift ⁽²⁾	$T_A = -40^\circ\text{C}$ to 125°C		20		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current ⁽²⁾	$V_{CM} = 1.25\text{ V}$		30		pA
		$V_{CM} = 1.25\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			240000	pA
I_{OS}	Input Offset Current ⁽²⁾	$V_{CM} = 1.25\text{ V}$		2		pA
		$V_{CM} = 1.25\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			240000	pA
C_{IN}	Input Capacitance ⁽⁴⁾	$T_A = 25^\circ\text{C}$	Differential		2	pF
			Common Mode		3	
V_{CM}	Common-mode Input Voltage Range	$T_A = -40^\circ\text{C}$ to 125°C	$(-V_S)$ - 0.1		$(+V_S)$ + 0.1	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0\text{ V}$ to 2.5 V	60	80		dB
		$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C	50			dB
Output Characteristics						
I_{SC}	Output Short-Circuit Current ⁽²⁾	Sink or source current	24	34		mA
		Sink or source current, $T_A = -40^\circ\text{C}$ to 125°C	20			mA
V_{OH}	Output Voltage Swing from Positive Rail	$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$		90	135	mV
		$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			170	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$		20	35	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			45	mV
V_{OL}	Output Voltage Swing from Negative Rail	$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$		50	85	mV
		$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			115	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$		12	25	mV
		$I_{OL} = 1\text{ mA}$, $V_{ID} = -1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			35	mV
Switching Characteristics, $T_A = -40^\circ\text{C}$ to 125°C ⁽³⁾						
T_{PLH}	Propagation delay time, low-to-high	$\Delta V_{IN} = 1\text{ V}$, $V_{CM} = 0\text{ V}$, 100mV overdrive ⁽⁴⁾		150	250	ns
		$\Delta V_{IN} = 1\text{ V}$, $V_{CM} = 0\text{ V}$, 20mV overdrive ⁽⁴⁾		223		ns

5-V, 120-ns Low-power Comparators with Push-Pull Output

Parameter		Conditions	Min	Typ	Max	Unit
T _{PHL}	Propagation delay time, high-to-low	$\Delta V_{IN} = 1\text{ V}$, $V_{CM} = 0\text{ V}$, 100mV overdrive ⁽⁴⁾		110	170	ns
		$\Delta V_{IN} = 1\text{ V}$, $V_{CM} = 0\text{ V}$, 20mV overdrive ⁽⁴⁾		225		ns
T _R	Rise time	(2) (5)		1.8		ns
T _F	Fall time	(2) (5)		1.5		ns

(1) The input offset voltage is the average of the input-referred trip points. The input hysteresis is the difference between the input-referred trip points.

(2) Provided by bench test and design simulation.

(3) Delay time is measured from mid-point of input to mid-point of output.

(4) Provided by design simulation.

(5) Measured between 10% of V_S and 90% of V_S .

Typical Performance Characteristics

All test conditions: $V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$, $R_L = \text{Open}$, unless otherwise noted.

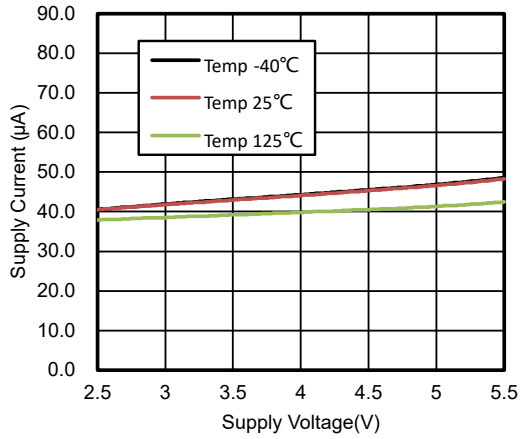


Figure 1. Supply Current vs. Supply Voltage, Output High

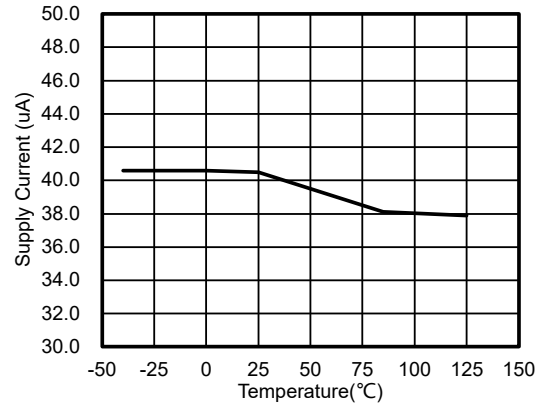


Figure 2. Supply Current vs. Temperature, Output High

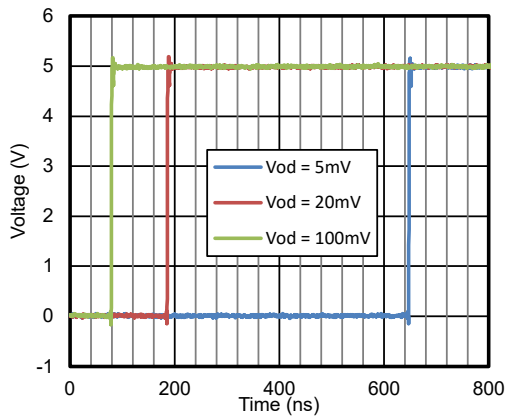


Figure 3. Propagation Delay, Low to High

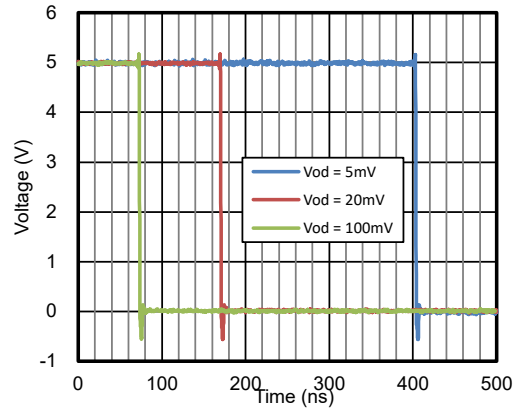


Figure 4. Propagation Delay, High to Low

Application and Implementation

Note

Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

Power Supply Layout and Bypass

The power supply pin of the TPCMP25x family is supposed to have a local bypass capacitor (i.e., 0.01 μF to 0.1 μF) within 2 mm for good high-frequency performance. It can also use a bulk capacitor (i.e., 1 μF or larger) within 100 mm to provide large, slow currents. This bulk capacitor can be shared with other analog parts.

Good ground layout improves performance by decreasing the amount of stray capacitance and noise at the inputs and outputs of the comparator. To decrease stray capacitance, minimize PCB lengths and resistor leads, place external components as close to the comparator pins as possible.

Operation Outside of the Common Input Voltage Range

The following is a list of input voltage situation and their outcomes:

1. When both $-IN$ and $+IN$ are within the common-mode range:
 - a. If the voltage at the $-IN$ pin is higher than the voltage at the $+IN$ pin and the offset voltage, the output is low and the output MOSFET is sinking current.
 - b. If the voltage at the $-IN$ pin is lower than the voltage at the $+IN$ pin and the offset voltage, the output is high and output MOSFET is sourcing current.
2. When the voltage at the $-IN$ pin is higher than the common-mode voltage range and the voltage at the $+IN$ pin is within the common-mode voltage range, the output is low and the output MOSFET is sinking current.
3. When the voltage at the $+IN$ pin is higher than the common-mode voltage range and the voltage at the $-IN$ pin is within the common-mode voltage range, the output is high impedance.
4. When the voltage at the $-IN$ and $+IN$ pins are both higher than the common-mode voltage range, the output is in an uncertain state.

Typical Application

IR Receiver

The device is an ideal candidate to be used as an infrared receiver shown in Figure 4. The infrared photo diode creates a current relative to the amount of infrared light present. The current creates a voltage across R_D . When this voltage level crosses the voltage applied by the voltage divider to the inverting input, the output transitions. Optional R_o provides additional hysteresis for noise immunity.

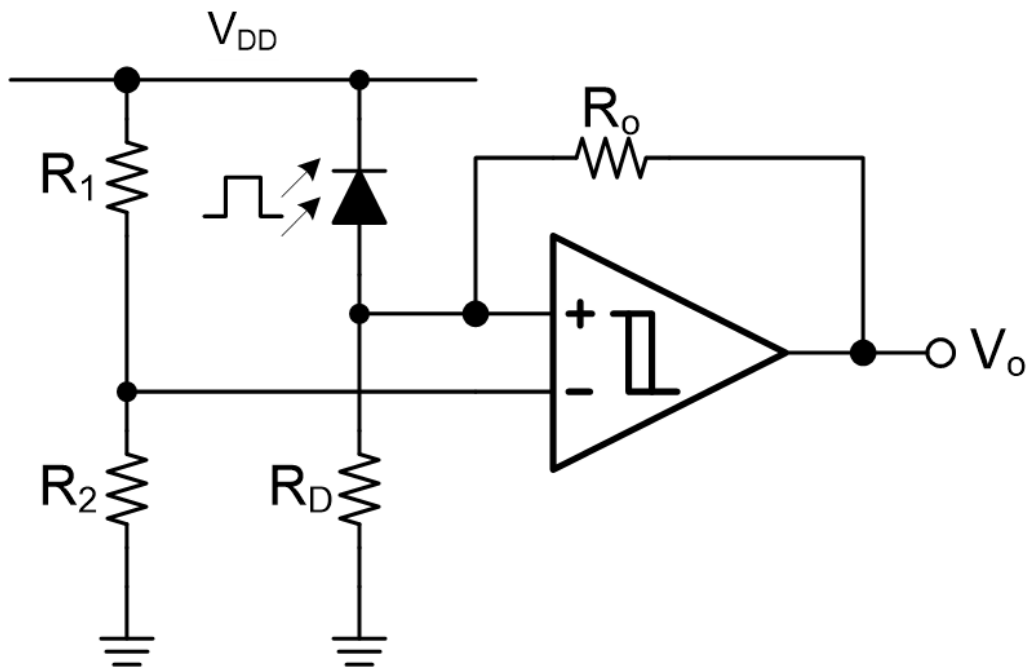
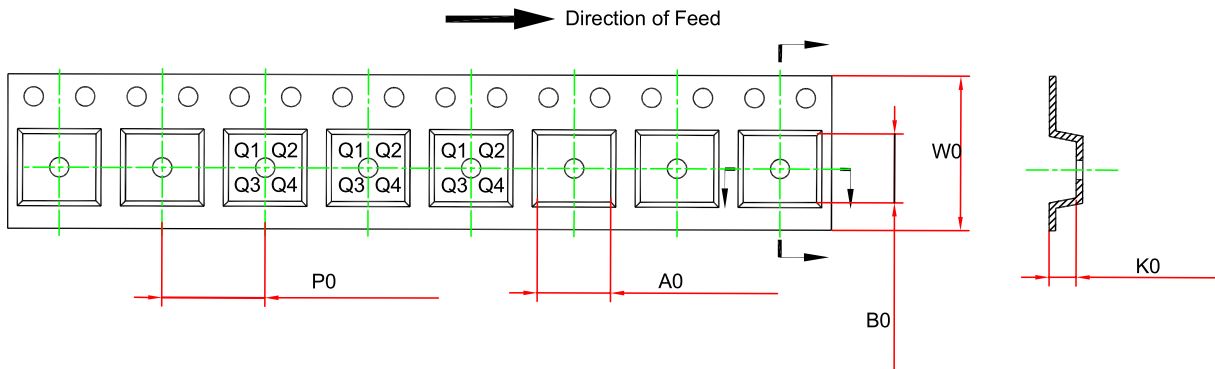
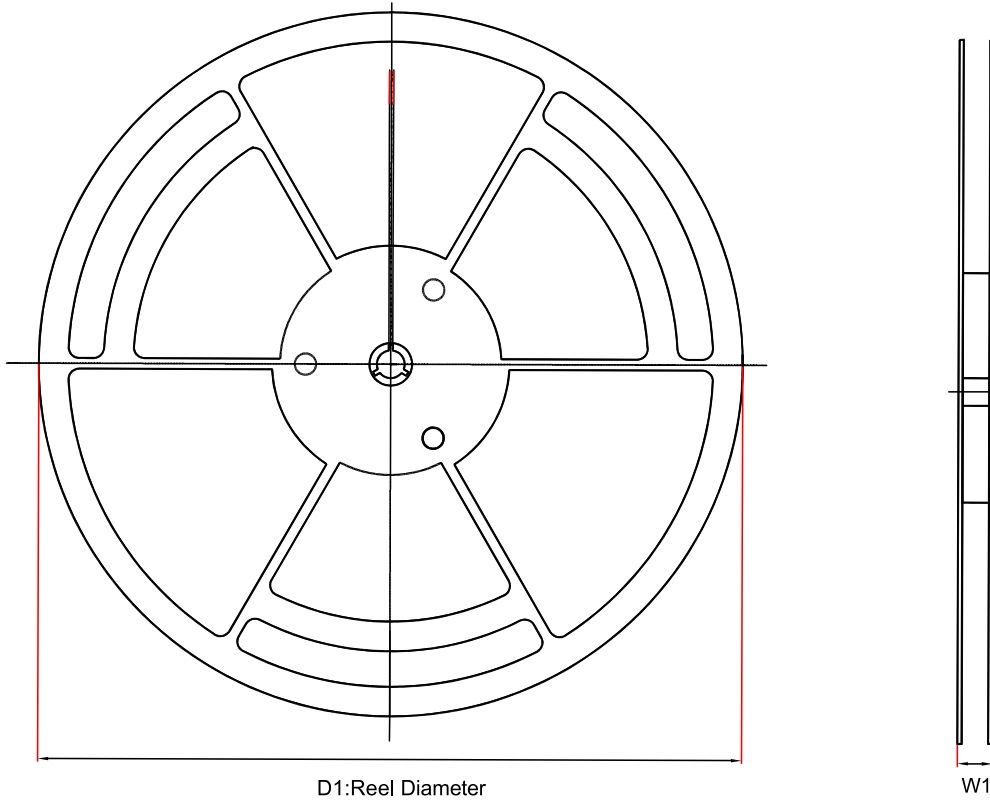


Figure 5. Typical Application Circuit

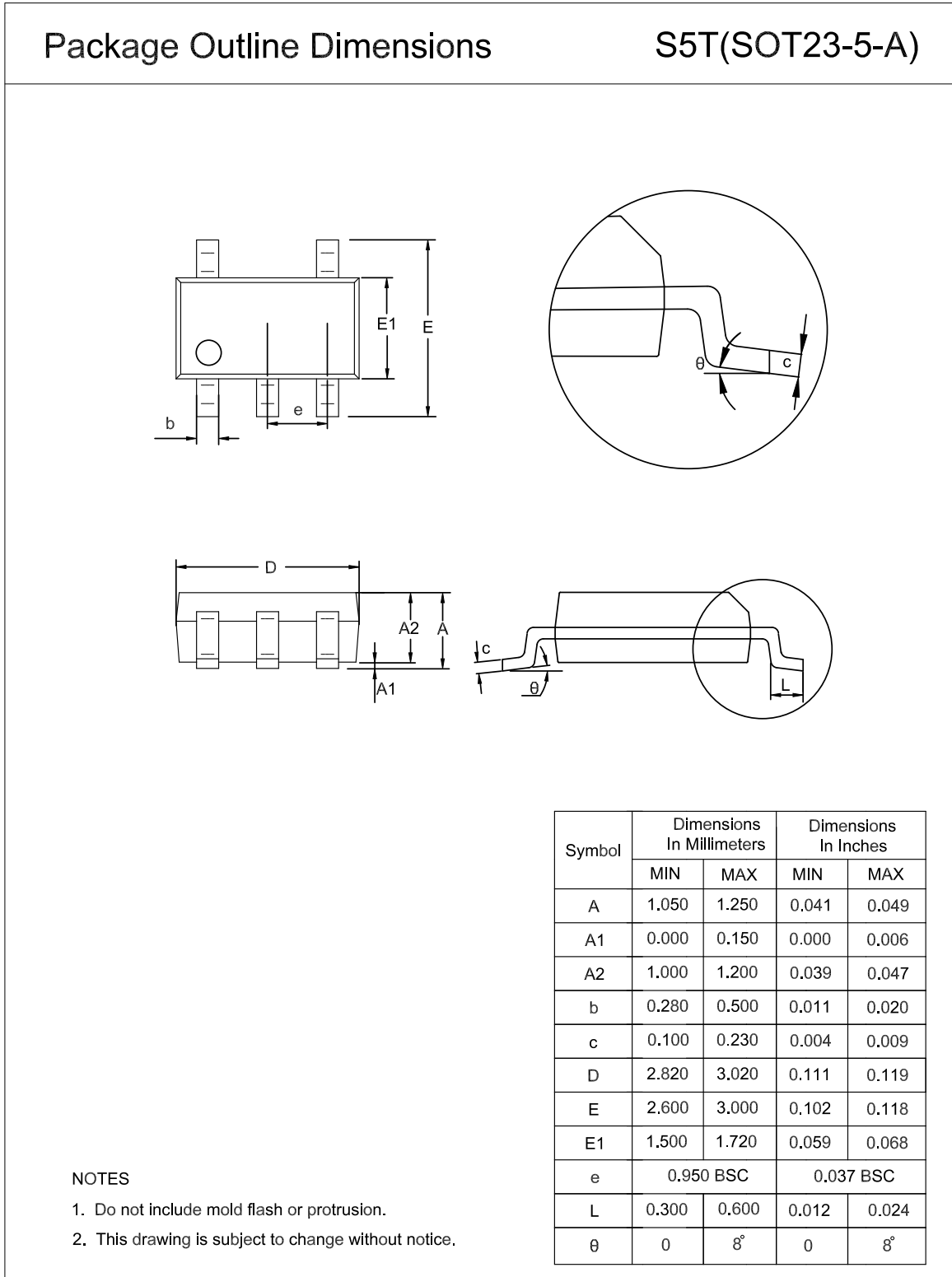
Tape and Reel Information

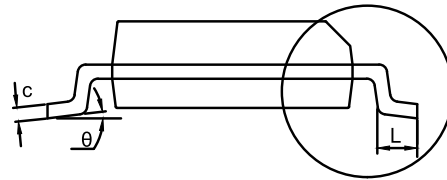
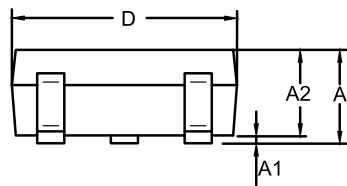
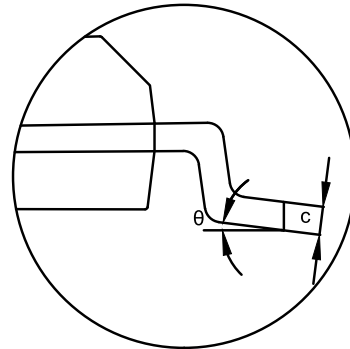
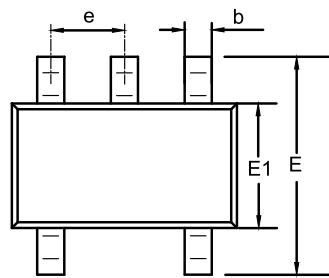


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPCMP251-S5TR	SOT23-5	179	12	3.3	3.25	1.4	4	8	Q3
TPCMP251U-S5TR	SOT23-5	179	12	3.3	3.25	1.4	4	8	Q3
TPCMP251-SC5R	SOT353 (SC70-5)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPCMP251U-SC5R	SOT353 (SC70-5)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPCMP252-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPCMP252-VS1R	MSOP8	330	17.6	5.2	3.3	1.3	8	12	Q1

Package Outline Dimensions

SOT23-5



SOT353-5
Package Outline Dimensions
SC5(SOT353-5-A)


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.850	1.100	0.033	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.230	0.004	0.009
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 BSC		0.026 BSC	
L	0.260	0.460	0.010	0.018
θ	0	8°	0	8°

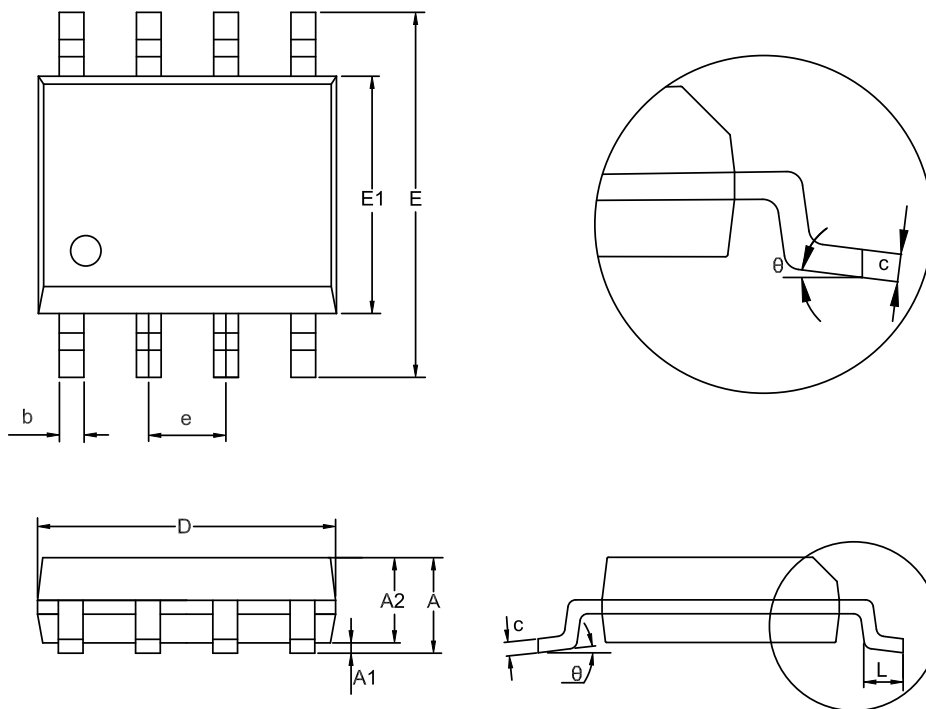
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOP8

Package Outline Dimensions

SO1(SOP-8-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
theta	0	8°	0	8°

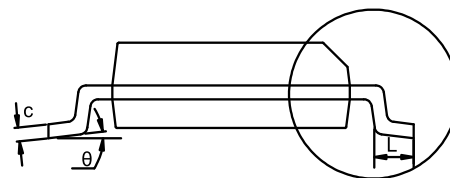
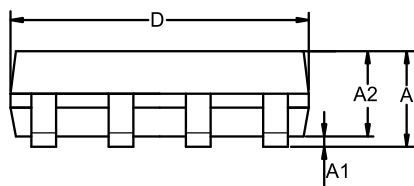
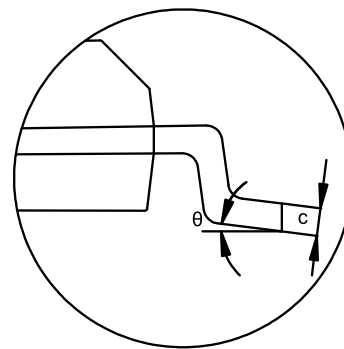
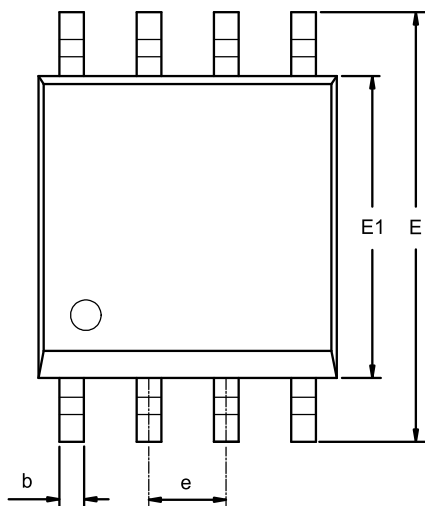
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

MSOP8

Package Outline Dimensions

VS1(MSOP-8-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPCMP251-S5TR	-40 to 125°C	SOT23-5	A20	MSL2	Tape and Reel,3000	Green
TPCMP251U-S5TR	-40 to 125°C	SOT23-5	A21	MSL2	Tape and Reel,3000	Green
TPCMP251-SC5R ⁽¹⁾	-40 to 125°C	SOT353(SC70-5)	A20	MSL2	Tape and Reel,3000	Green
TPCMP251U-SC5R ⁽¹⁾	-40 to 125°C	SOT353(SC70-5)	A21	MSL2	Tape and Reel,3000	Green
TPCMP252-SO1R ⁽¹⁾	-40 to 125°C	SOP8	CM252	MSL2	Tape and Reel,4000	Green
TPCMP252-VS1R	-40 to 125°C	MSOP8	CM252	MSL2	Tape and Reel,3000	Green

(1) For future products, contact the 3PEAK factory for more information and samples.

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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