5-V, 10-ns Comparators with Push-Pull Output

Features

- Power Supply Voltage: 2.5 V to 5.5 V
- Low Supply Current: 650 µA per Channel
- Propagation Delay: 10 ns
- Internal Hysteresis Ensures Clean Switching
- Offset Voltage: ±10 mV
- Input Bias Current: 30 pA Typical
- Input Common-Mode Range Extends 100 mV
- Push-Pull Output

Applications

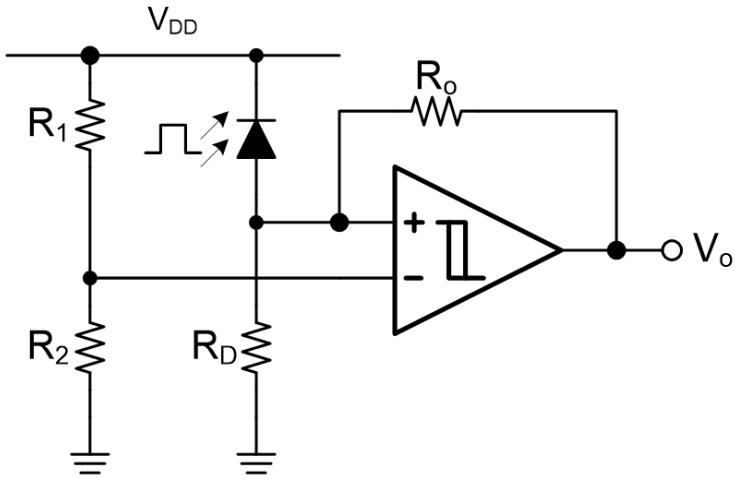
- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at the Ground or Supply Line
- Logic Level Shifting or Translation
- Power Supply

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 10-ns propagation delay which makes the devices suitable for high-speed applications. The internal input hysteresis eliminates output switching caused by input noise voltage. The devices have push-pull output to support rail-to-rail output swing.

The operating temperature range of the devices is from −40°C to +125°C.

Typical Application Circuit



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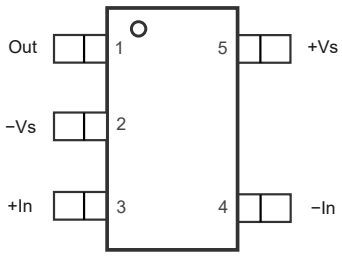
Revision History

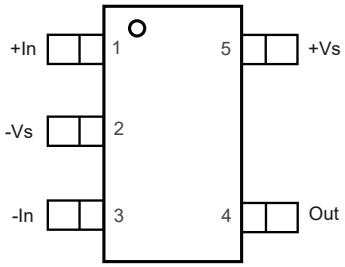
Date	Revision	Notes
2023-08-23	Rev.A.0	Initial version.
2023-09-12	Rev.A.1	Added the minimum spec of ISC.
2024-12-19	Rev.A.2	Changed the status of the TPCMP272-SO1R to production in the Order Information. The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated the Tape and Reel Information. • Updated the Order Information.

Pin Configuration and Functions

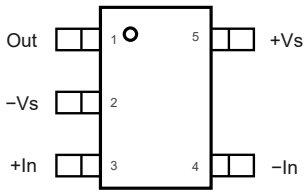
TPCMP271
SOT23-5 Package
Top View



TPCMP271U
SOT23-5 Package
Top View



TPCMP271
SOT353 (SC70-5) Package
Top View



TPCMP271U
SOT353 (SC70-5) Package
Top View

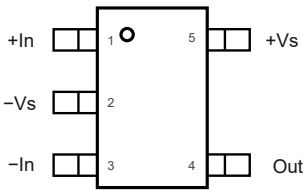
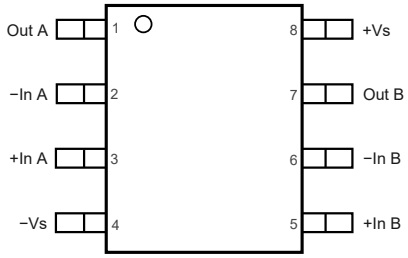


Table 1. Pin Functions: TPCMP271, TPCMP271U

Pin No.		Name	I/O	Description
TPCMP271	TPCMP271U			
1	4	Out	O	Output
2	2	−V_S	-	Negative power supply
3	1	+In	I	Non-inverting input
4	3	−In	I	Inverting input
5	5	+V_S	-	Positive power supply

TPCMP272
SOP8 Package
Top View



TPCMP272
MSOP8 Package
Top View

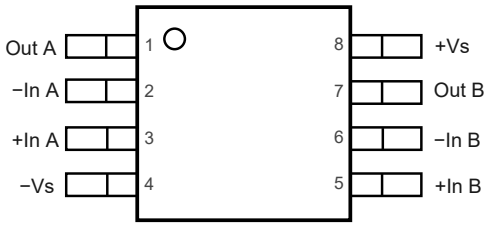


Table 2. Pin Functions: TPCMP272

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	−In A	I	Inverting input
3	+In A	I	Non-inverting input
4	$-V_S$	-	Negative power supply
5	+In B	I	Non-inverting input
6	−In B	I	Inverting input
7	Out B	O	Output
8	$+V_S$		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
SOT23-5	250	81	°C/W

Electrical Characteristics

All test conditions: V_S = 5 V, T_A = 25°C, unless otherwise noted.

Parameter		Conditions		Min	Typ	Max	Unit
Power Supply							
I_Q	Quiescent Current per Comparator	V_{CM} = 0 V			650		μA
		V_{CM} = 0 V, T_A = −40°C to 125°C				800	μA
PSRR	Power Supply Rejection Ratio	V_S = 2.5 V to 5 V, V_{CM} = 0 V		60	75		dB
		V_S = 2.5 V to 5 V, V_{CM} = 0 V, T_A = −40°C to 125°C		50			dB
Input Characteristics							
V_{OS}	Input Offset Voltage (1)	V_{CM} = 0 V to 5 V		−10	1	10	mV
		V_{CM} = 0 V to 5 V, T_A = −40°C to 125°C		−15		15	mV
	Input Offset Voltage Drift (2)	T_A = −40°C to 125°C			2		μV/°C
V_{HYST}	Input Hysteresis Voltage (1)	V_{CM} = 0 V to 5 V			7	10	mV
		V_{CM} = 0 V to 5 V, T_A = −40°C to 125°C				15	mV
	Input Hysteresis Voltage Drift (2)	T_A = −40°C to 125°C			20		μV/°C
I_B	Input Bias Current (2)	V_{CM} = 2.5 V			30		pA
		V_{CM} = 2.5 V, T_A = −40°C to 125°C			300	240,000	pA
I_{OS}	Input Offset Current (2)	V_{CM} = 2.5 V			2		pA
		V_{CM} = 2.5 V, T_A = −40°C to 125°C			20	240,000	pA
C_{IN}	Input Capacitance (4)	T_A = 25°C	Differential		2		pF
			Common Mode		3		
V_{CM}	Common-Mode Input Voltage Range	T_A = −40°C to 125°C		($-V_S$) − 0.1		($+V_S$) + 0.1	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0 V to 5 V		49	70		dB
		V_{CM} = 0 V to 5 V, T_A = −40°C to 125°C		46			dB
Output Characteristics							
I_{SC}	Output Short-Circuit Current	Sink or source current		70	120		mA
		Sink or source current, T_A = −40°C to 125°C		50			mA
V_{OH}	Output Voltage Swing from Positive Rail	I_{OL} = 4 mA, V_{ID} = −1 V			55	80	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				100	mV
		I_{OL} = 1 mA, V_{ID} = −1 V			15	26	mV
		I_{OL} = 1 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				35	mV
V_{OL}	Output Voltage Swing from Negative Rail	I_{OL} = 4 mA, V_{ID} = −1 V			33	55	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				75	mV

Parameter		Conditions	Min	Typ	Max	Unit
		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, 100-mV overdrive (2)		10	16	ns
		ΔV_{IN} = 1 V, V_{CM} = 0 V, 20-mV overdrive (2)		12	25	ns
T_{PHL}	Propagation Delay Time, High to Low	ΔV_{IN} = 1 V, V_{CM} = 0 V, 100-mV overdrive (2)		10	16	ns
		ΔV_{IN} = 1 V, V_{CM} = 0 V, 20-mV overdrive (2)		13	25	ns
T_R	Rise Time	(2)(5)		0.9		ns
T_F	Fall Time	(2)(5)		0.9		ns
Ts_{SKEW}	$\lvert T_{PLH} - T_{PHL} \rvert$	(2)		1		ns
f_{Max}	Maximum Toggle Frequency	100-mV overdrive (4)		50		MHz

(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 tests and design simulation.
(3) Delay time is measured from the mid-point of the input to the mid-point of the output.
(4) Provided by design simulation.
(5) Measured between 10% of V_S and 90% of V_S.

Electrical Characteristics (Continued)

All test conditions: V_S = 2.5 V, T_A = 25°C, unless otherwise noted.

Parameter		Conditions		Min	Typ	Max	Unit
Power Supply							
I_Q	Quiescent Current per Comparator	V_{CM} = 0 V			650		µA
		V_{CM} = 0 V, T_A = −40°C to 125°C				800	µA
Input Characteristics							
V_{OS}	Input Offset Voltage (1)	V_{CM} = 0 V to 2.5 V		−10	1	10	mV
		V_{CM} = 0 V to 2.5 V, T_A = −40°C to 125°C		−15		15	mV
	Input Offset Voltage Drift (2)	T_A = −40°C to 125°C			2		µV/°C
V_{HYST}	Input Hysteresis Voltage (1)	V_{CM} = 0 V to 2.5 V			7	10	mV
		V_{CM} = 0 V to 2.5 V, T_A = −40°C to 125°C				15	mV
	Input Hysteresis Voltage Drift (2)	T_A = −40°C to 125°C			20		µV/°C
I_B	Input Bias Current (2)	V_{CM} = 1.25 V			30		pA
		V_{CM} = 1.25 V, T_A = −40°C to 125°C			300	240,000	pA
I_{OS}	Input Offset Current (2)	V_{CM} = 1.25 V			2		pA
		V_{CM} = 1.25 V, T_A = −40°C to 125°C			20	240,000	pA
C_{IN}	Input Capacitance (4)	T_A = 25°C	Differential		2		pF
			Common Mode		3		
V_{CM}	Common-Mode Input Voltage Range	T_A = −40°C to 125°C		(−V_S) − 0.1		(+V_S) + 0.1	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0 V to 2.5 V		49	63		dB
		V_{CM} = 0 V to 2.5 V, T_A = −40°C to 125°C		46			dB
Output Characteristics							
I_{SC}	Output Short-Circuit Current (2)	Sink or source current		26	34		mA
		Sink or source current, T_A = −40°C to 125°C		20			mA
V_{OH}	Output Voltage Swing from Positive Rail	I_{OL} = 4 mA, V_{ID} = −1 V			90	135	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				170	mV
		I_{OL} = 1 mA, V_{ID} = −1 V			22	35	mV
		I_{OL} = 1 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				45	mV
V_{OL}	Output Voltage Swing from Negative Rail	I_{OL} = 4 mA, V_{ID} = −1 V			51	85	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				115	mV
		I_{OL} = 1 mA, V_{ID} = −1 V			13	25	mV
		I_{OL} = 1 mA, V_{ID} = −1 V,				35	mV

Parameter		Conditions	Min	Typ	Max	Unit
		T_A = −40°C to 125°C				
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, 100-mV overdrive (4)		8.2	14	ns
		ΔV_{IN} = 1 V, V_{CM} = 0 V, 20-mV overdrive (4)		15	24	ns
T_{PHL}	Propagation Delay time, High to Low	ΔV_{IN} = 1 V, V_{CM} = 0 V, 100-mV overdrive (4)		9	15	ns
		ΔV_{IN} = 1 V, V_{CM} = 0 V, 20-mV overdrive (4)		16	25	ns
T_R	Rise Time	(2)(5)		1.8		ns
T_F	Fall Time	(2)(5)		1.55		ns
T_{SKEW}	$\lvert T_{PLH} - T_{PHL} \rvert$	(2)		1		ns
f_{Max}	Maximum Toggle Frequency	100-mV overdrive (4)		50		MHz

(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 tests and design simulation.
(3) Delay time is measured from the mid-point of the input to the mid-point of the 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 V, V_{CM} = 0 V, $V_{overdrive}$ = 100 mV, R_L = open, unless otherwise noted.

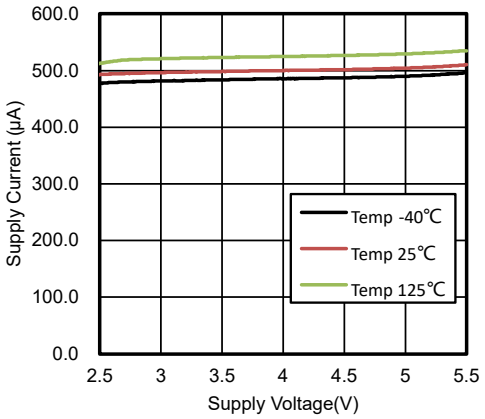


Figure 1. Supply Current vs. Supply Voltage, Output High

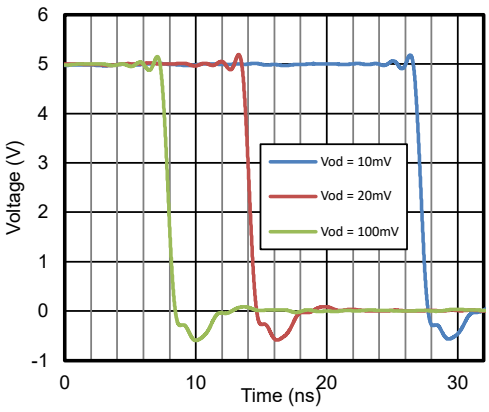


Figure 2. Propagation Delay, High to Low

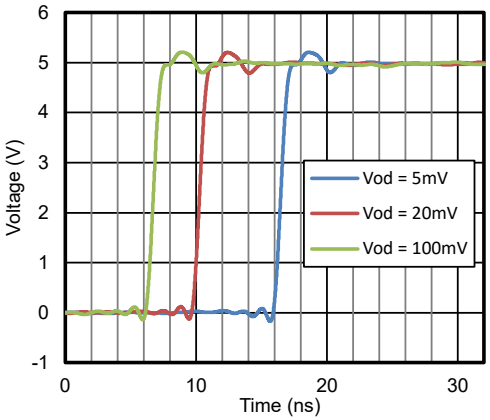


Figure 3. Propagation Delay, Low to High

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 TPCMP27x family has a local bypass capacitor (i.e., 0.01 μF to 0.1 μF) within 2 mm for 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, and place external components to the comparator pins as close 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 RD. 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.

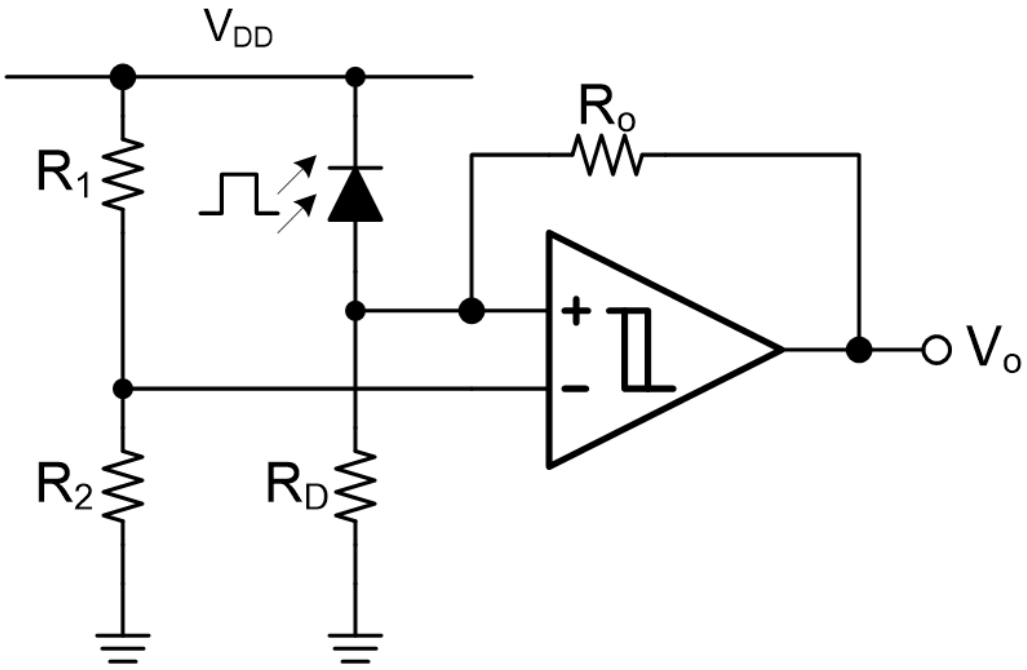
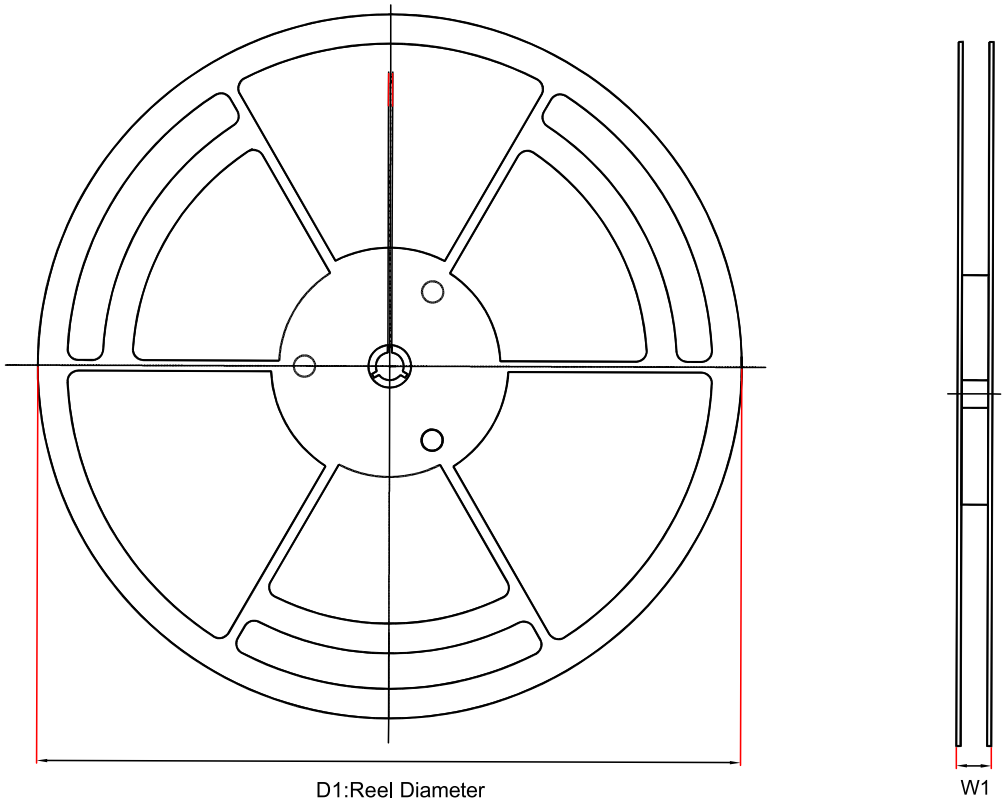
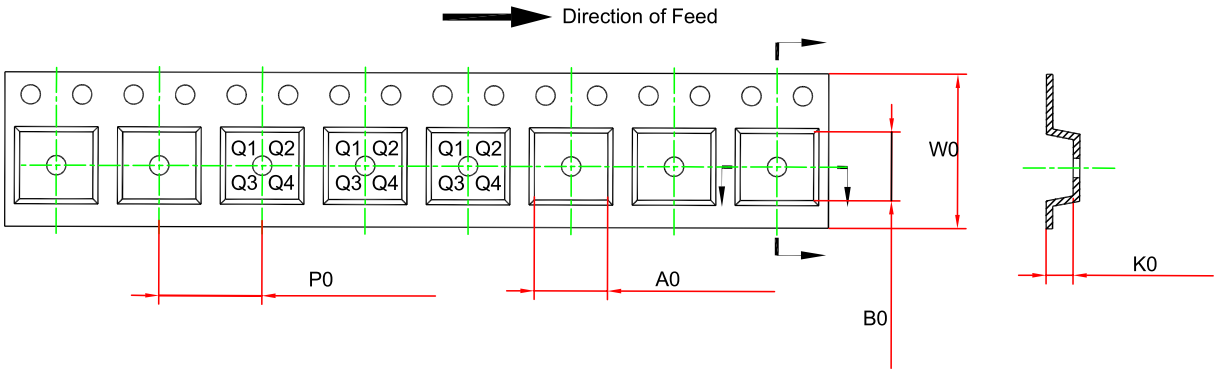


Figure 4. Typical Application Circuit

Tape and Reel Information





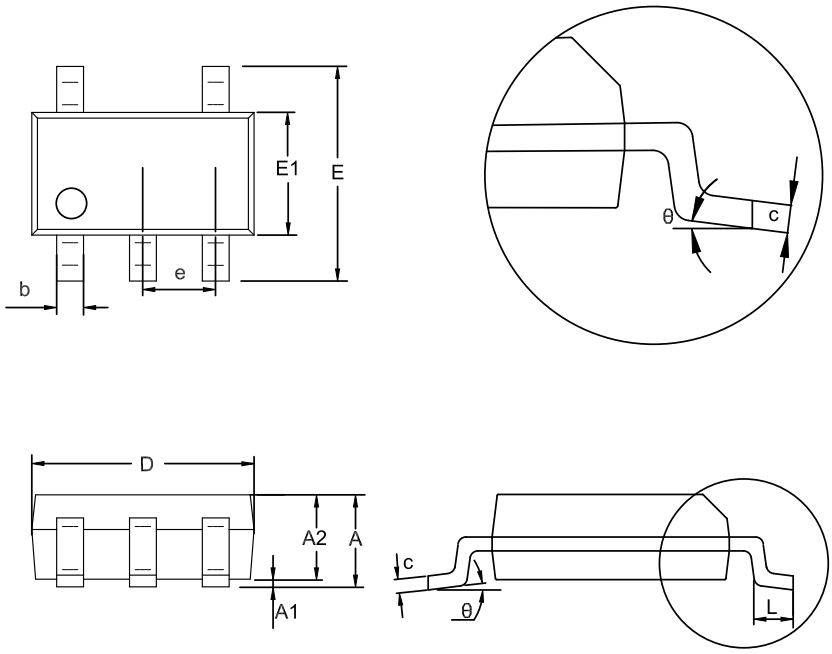
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPCMP271-S5TR	SOT23-5	180	12	3.3	3.25	1.4	4	8	Q3
TPCMP271U-S5TR	SOT23-5	180	12	3.3	3.25	1.4	4	8	Q3
TPCMP271-SC5R	SOT353 (SC70-5)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPCMP271U-SC5R	SOT353 (SC70-5)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPCMP272-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPCMP272-VS1R	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOT23-5

Package Outline Dimensions S5T(SOT23-5-A)



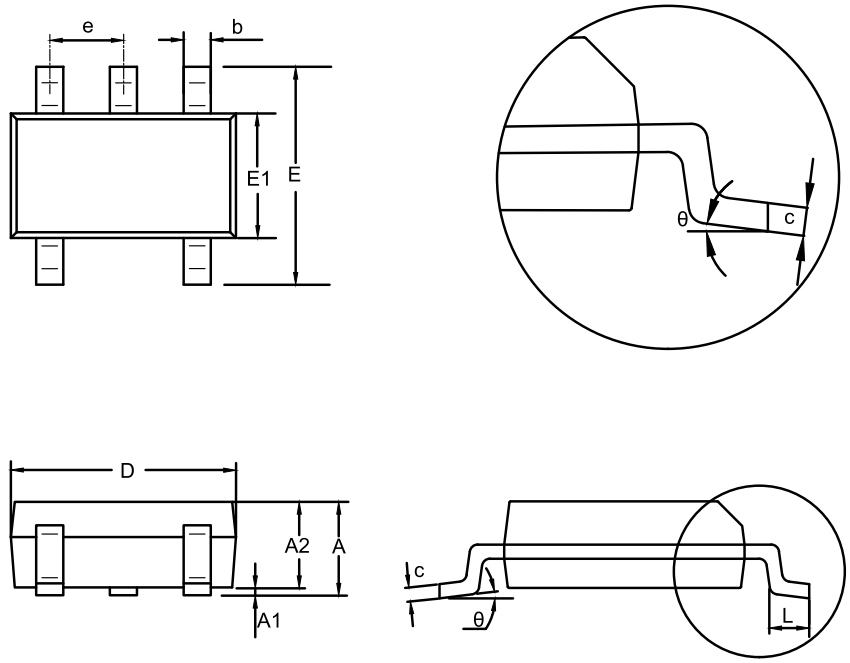
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

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

SOT353 (SC70-5)

Package Outline Dimensions SC5(SOT353-5-A)



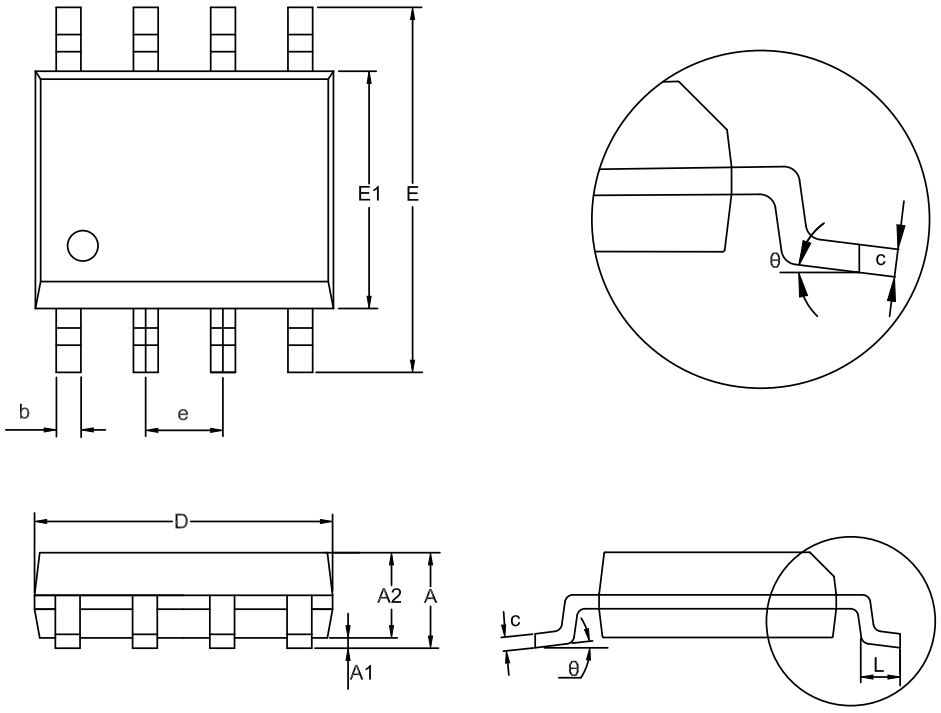
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.850	1.100	0.033	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.230	0.004	0.009
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 BSC		0.026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



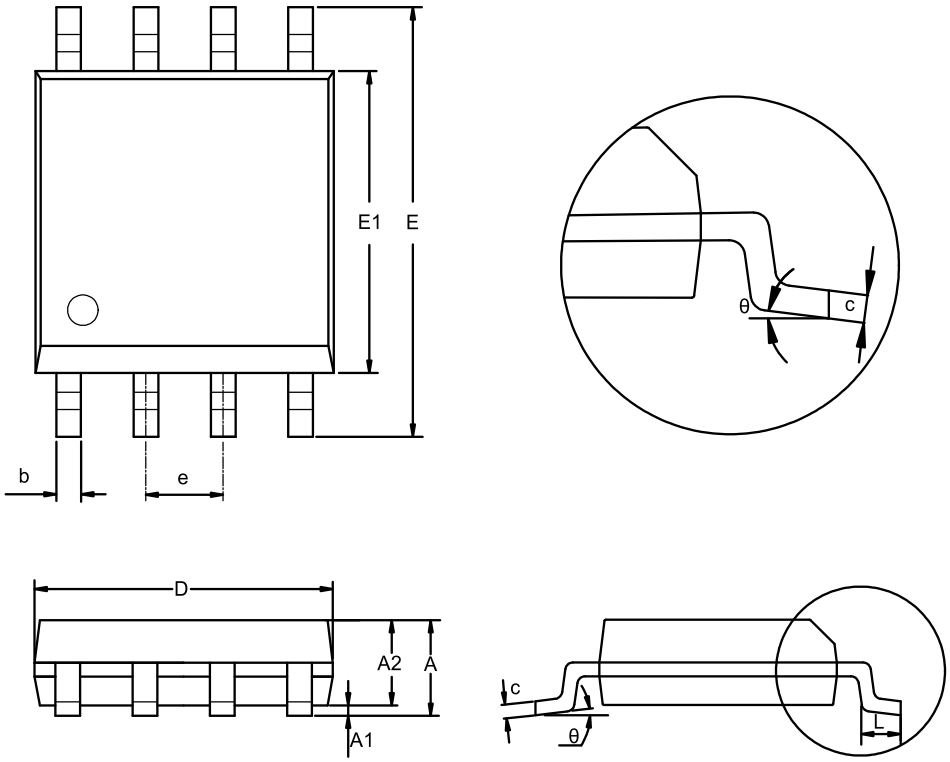
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	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
TPCMP271-S5TR	−40 to 125°C	SOT23-5	A17	2	Tape and Reel, 3000	Green
TPCMP271U-S5TR (1)	−40 to 125°C	SOT23-5	A18	2	Tape and Reel, 3000	Green
TPCMP271-SC5R (1)	−40 to 125°C	SOT353 (SC70-5)	A17	2	Tape and Reel, 3000	Green
TPCMP271U-SC5R (1)	−40 to 125°C	SOT353 (SC70-5)	A18	2	Tape and Reel, 3000	Green
TPCMP272-SO1R	−40 to 125°C	SOP8	CM272	2	Tape and Reel, 4000	Green
TPCMP272-VS1R	−40 to 125°C	MSOP8	CM272	2	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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