5-V Low-Power Comparators with Open Drain Output

Features

- Power Supply Voltage: 1.5 V to 5.5 V
- Low Supply Current: 40 µA per Channel
- High-to-Low Propagation Delay: 100 ns
- Internal Hysteresis Ensures Clean Switching
- Offset Voltage: ±5 mV
- Input Bias Current: 75 pA (Typ)
- Input Common-Mode Range Extends 100 mV for + V_S and 100 mV for −V_S
- Open Drain Output
- TPCMP202-VS1R-S is Qualified for Automotive Applications with the AEC- Q100 Reliability Test

Applications

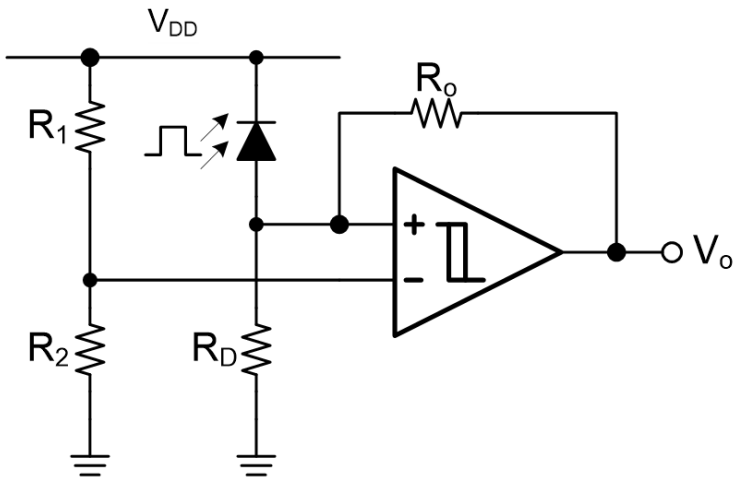
- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at the Ground or Supply Line
- Logic Level Shifting or Translation
- Window Comparators
- IR Receivers

Description

The devices are low-power comparators with internal hysteresis. The common-mode input voltage range extends 100 mV beyond the positive power rail and 100 mV beyond the negative power rail. The devices have 100-ns propagation delay which makes the devices suitable for general applications. The internal input hysteresis eliminates output switching caused by input noise voltage.

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
2025-07-30	Rev.A.0	Initial version.
2025-11-14	Rev.A.1	Added TPCMP202 Electrical Characteristics: • V_S = 5 V, I_{OL} = 4 mA, TPCMP202, V_{OL}: Typ 208 mV • V_S = 5 V, I_{OL} = 4 mA, TPCMP202, V_{OL}: Typ 310 mV • V_S = 3.3 V, I_{OL} = 1 mA, TPCMP202, V_{OL}: Typ 70 mV • V_S = 3.3 V, I_{OL} = 1 mA, T_A = −40°C to 125°C, TPCMP202, V_{OL}: Typ 105 mV • V_S = 5 V, TPCMP202, I_{SINK}: Typ 23 mA Updated Electrical Characteristics descriptions: • T_{PLH} conditions: changed from "V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100 mV overdrive, Delay time is measured from mid-point of input to mid-point of output." to "V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output." and changed from " V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20 mV overdrive, Delay time is measured from mid-point of input to mid-point of output." to " V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output." • T_{PHL} conditions: changed from "V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100 mV overdrive, Delay time is measured from mid-point of input to mid-point of output." to "V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output." and changed from " V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20 mV overdrive, Delay time is measured from mid-point of input to mid-point of output." to " V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output." • T_{on} conditions: changed from "V_S = 5 V, the time between V_S exceed 1.5 V and the output is in a correct state." to "V_S = 5 V, the time between V_S exceeds 1.5 V and the output is in a correct state." Updated Typical Performance Characteristics: • Added figure for Output Voltage vs. Output Sinking Current, 5 V, TPCMP202

Pin Configuration and Functions

TPCMP201U-SC5R
SOT353 (SC70-5)
Top View

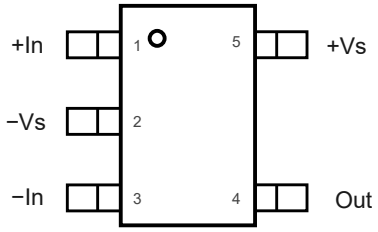
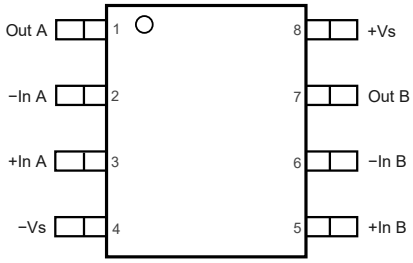


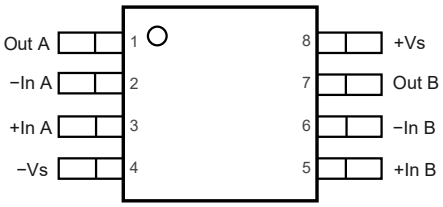
Table 1. Pin Functions: TPCMP201U-SC5R

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

TPCMP202-SO1R
SOP8
Top View



TPCMP202-VS1R-S
MSOP8
Top View



TPCMP202-DFGR
DFN2X2-8
Top View

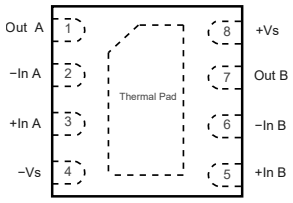


Table 2. Pin Functions: TPCMP202-SO1R/TPCMP202-VS1R-S/TPCMP202-DFGR

Pin No.			Name	I/O	Description
TPCMP202-SO1R	TPCMP202-VS1R-S	TPCMP202-DFGR			
1	1	1	Out A	O	Output
2	2	2	−In A	I	Inverting input
3	3	3	+In A	I	Non-inverting input
4	4	4	$-V_S$	−	Negative power supply
5	5	5	+In B	I	Non-inverting input
6	6	6	−In B	I	Inverting input
7	7	7	Out B	O	Output
8	8	8	$+V_S$	−	Positive power supply.
−	−	Thermal Pad	Exposed Thermal Pad	−	Exposed Thermal Pad. The exposed pad is tied to the $-V_S$.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage, $(+V_S) – (-V_S)$	0	6	V
	Input Voltage	$(-V_S) – 0.3$	$(+V_S) + 0.3$	V
	Input Current: +IN, −IN (2)	−10	10	mA
	Output Current: OUT	−10	10	mA
	Output Short-Circuit Duration (3)		Continuous	
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)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1	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, $(+V_S) – (-V_S)$	1.5		5.5	V

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT353 (SC70-5)	400	150	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
DFN2X2-8	100	60	°C/W

Electrical Characteristics

All test conditions: V_S = 5 V, $R_{PULL-UP}$ = 2.5 k, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	V_S = 5 V, No Load, Output High, V_{INP} = 1 V, V_{INN} = 0 V		38	70	μA
		V_S = 5 V, No Load, Output Low, V_{INP} = 0 V, V_{INN} = 1 V		34	70	μA
		V_S = 1.8 V, No Load, Output High, V_{INP} = 1 V, V_{INN} = 0 V		27	60	μA
		V_S = 1.8 V, No Load, Output Low, V_{INP} = 0 V, V_{INN} = 1 V		26	60	μA
PSRR	Power Supply Rejection Ratio	V_S = 1.5 V to 5.5 V, V_{CM} = 0 V	65	91		dB
		V_S = 1.5 V to 5.5 V, V_{CM} = 0 V, T_A = −40°C to 125°C	60			dB
Input Characteristics						
V_{OS}	Input Offset Voltage (1)	V_S = 5 V, V_{CM} = 0 V	−5	1.2	5	mV
		V_S = 5 V, V_{CM} = 0 V, T_A = −40°C to 125°C	−6.5		6.5	mV
$V_{OS}TC$	Input Offset Voltage Drift (2)	V_S = 5 V, V_{CM} = 0 V, T_A = −40°C to 125°C		5		uV/℃
V_{HYST}	Input Hysteresis Voltage (1)	V_S = 5 V, V_{CM} = 0 V	3	4.5	6	mV
		V_S = 5 V, V_{CM} = 0 V, T_A = −40°C to 125°C	2		8	mV
V_{OS}	Input Offset Voltage (1)	V_S = 1.8 V, V_{CM} = 0 V	−5	1.2	5	mV
		V_S = 1.8 V, V_{CM} = 0 V, T_A = −40°C to 125°C	−6.5		6.5	mV
$V_{OS}TC$	Input Offset Voltage Drift (2)	V_S = 1.8 V, V_{CM} = 0 V, T_A = −40°C to 125°C		2		μV/℃
V_{HYST}	Input Hysteresis Voltage (1)	V_S = 1.8 V, V_{CM} = 0 V	3	4.5	6	mV
		V_S = 1.8 V, V_{CM} = 0 V, T_A = −40°C to 125°C	2		8	mV
I_B	Input Bias Current	V_S = 5 V, V_{CM} = V_S/2		10		pA
		V_S = 5 V, V_{CM} = V_S/2, T_A = −40°C to 125°C			200	pA
I_{OS}	Input Offset Current	V_S = 5 V, V_{CM} = V_S/2		1		pA
		V_S = 5 V, V_{CM} = V_S/2, T_A = −40°C to 125°C	−100		100	pA
V_{CM}	Common-mode Voltage Range	V_S = 5 V, T_A = −40°C to 125°C	−0.1		5.1	V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CMRR	Common-mode Rejection Ratio	V_S = 5 V, V_{CM} = −0.1 V to 5.1 V	63	80		dB
		V_S = 5 V, V_{CM} = −0.1 V to 5.1 V, T_A = −40°C to 125°C	60			dB
Output						
V_{OL}	Output Voltage Swing from Negative Rail	V_S = 5 V, I_{OL} = 4 mA, TPCMP201		75	80	mV
		V_S = 5 V, I_{OL} = 4 mA, T_A = −40°C to 125°C, TPCMP201			110	mV
		V_S = 3.3 V, I_{OL} = 1 mA, TPCMP201		26	30	mV
		V_S = 3.3 V, I_{OL} = 1 mA, T_A = −40°C to 125°C, TPCMP201			40	mV
		V_S = 5 V, I_{OL} = 4 mA, TPCMP202		208		mV
		V_S = 5 V, I_{OL} = 4 mA, T_A = −40°C to 125°C, TPCMP202		310		mV
		V_S = 3.3 V, I_{OL} = 1 mA, TPCMP202		70		mV
		V_S = 3.3 V, I_{OL} = 1 mA, T_A = −40°C to 125°C, TPCMP202		105		mV
I_{SINK}	Sink Current	V_S = 5 V, TPCMP201	45	60		mA
		V_S = 5 V, TPCMP202		23		mA
		V_S = 3.3 V, TPCMP202		15	20	mA
Switching Characteristics (3)						
T_{PLH}	Propagation Delay Time, Low to High	V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output.		155		ns
		V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output.		260		ns
T_{PHL}	Propagation Delay Time, High to Low	V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 100-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output.		100		ns
		V_S = 5 V, ΔV_{IN} = 1 V, V_{CM} = V_S/2, 20-mV overdrive, Delay time is measured from the mid-point of the input to the mid-point of the output.		210		ns
T_F	Fall Time (4)(5)	V_S = 5 V		1.7		ns
T_{on}	Power-up Time (4)	V_S = 5 V, the time between V_S exceeds 1.5 V and the output is in a correct state.		20		µs
f_{toggle}	Toggle Frequency (4)	V_S = 5 V		5		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 20% of V_S and 80% of V_S.

Typical Performance Characteristics

All test conditions: V_S = 5 V, $R_{PULL-UP}$ = 2.5 k, T_A = 25°C, unless otherwise noted.

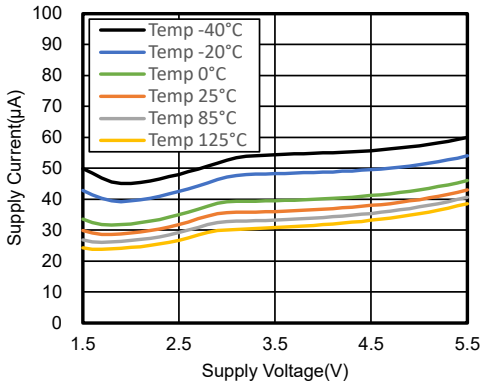


Figure 1. Supply Current vs. Supply Voltage, Output High

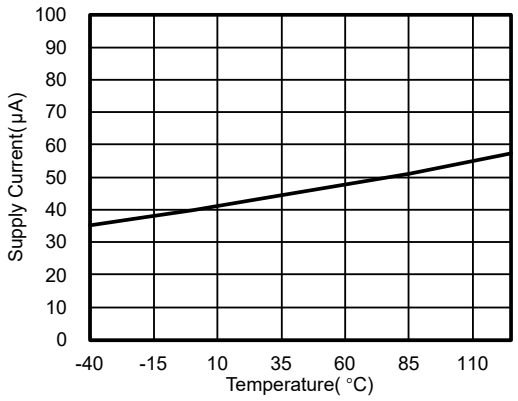


Figure 2. Supply Current vs. Temperature

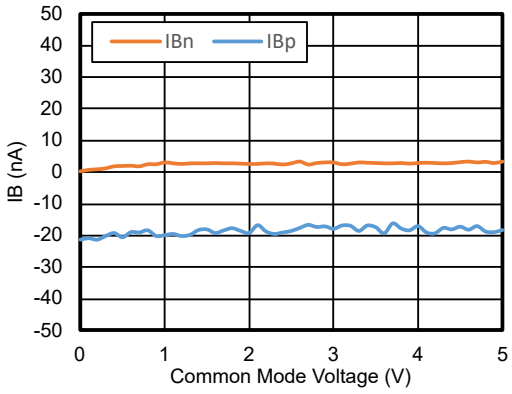


Figure 3. IB vs. Common-Mode Voltage

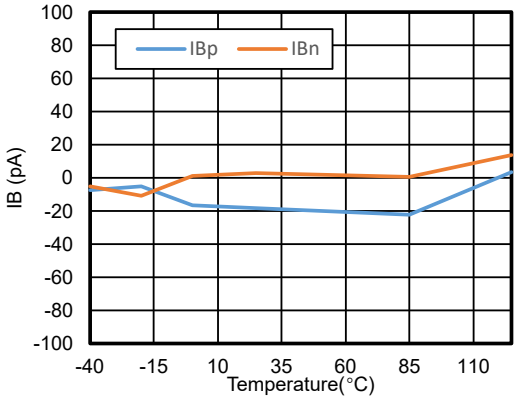


Figure 4. IB vs. Temperature

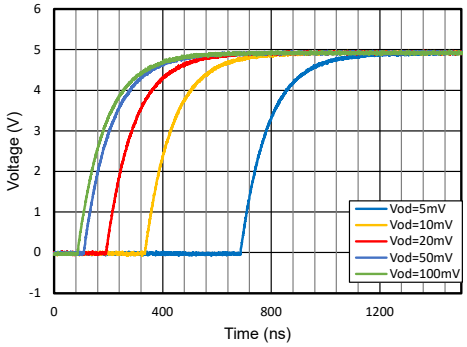


Figure 5. Propagation Delay, Low to High, 5 V

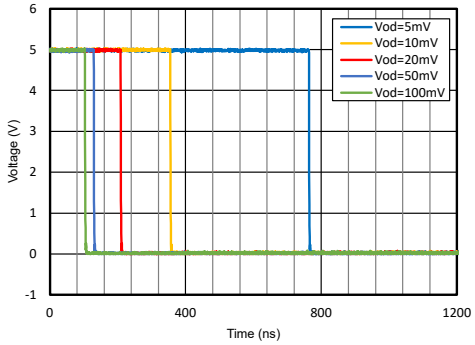


Figure 6. Propagation Delay, High to Low, 5 V

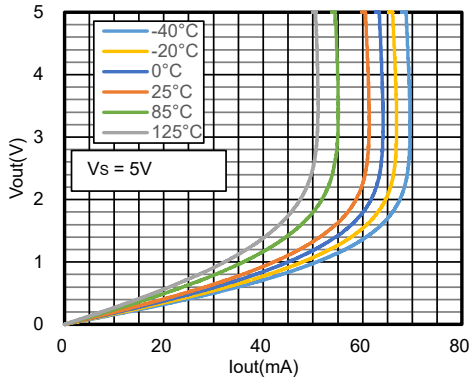


Figure 7. Output Voltage vs. Output Sinking Current, 5 V, TPCMP201

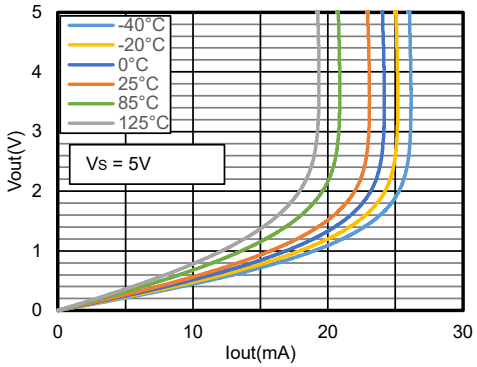


Figure 8. Output Voltage vs. Output Sinking Current, 5 V, TPCMP202

Detailed Description

Overview

The devices feature 100-ns response time and include 5 mV of internal hysteresis for improved noise immunity with an input common-mode range that extends 0.1 V beyond the positive power supply rail and 0.1 V beyond the negative power supply rail, having the ability to operate from 1.5 V to 5.5 V on the supply pin.

Functional Block Diagram

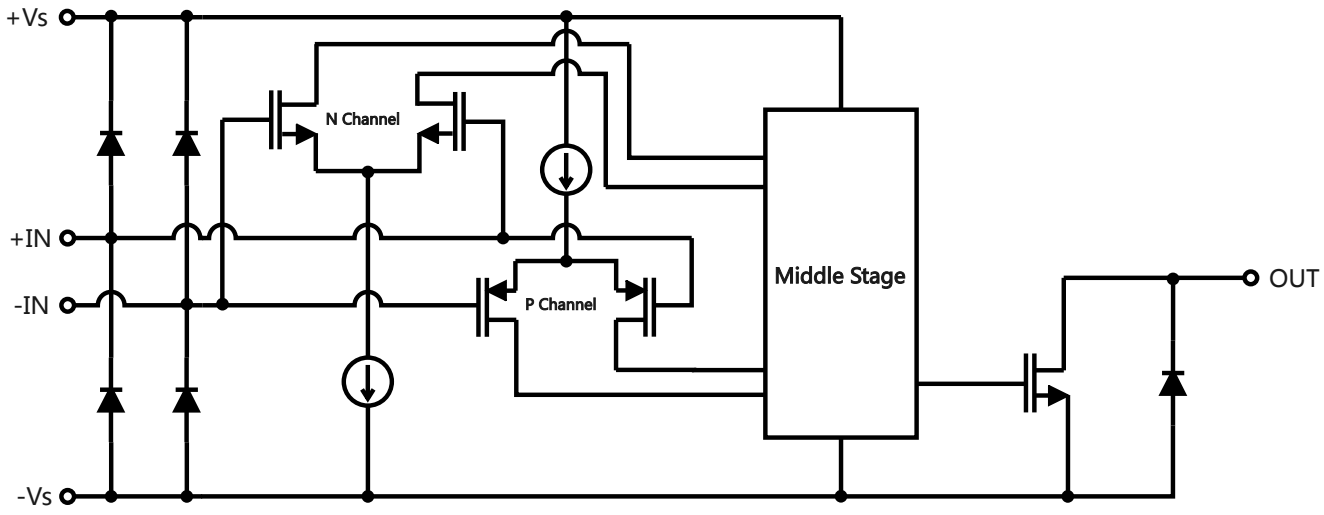


Figure 9. Functional Block Diagram

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 pins of the TPCMP201 and the TPCMP202 should have local bypass capacitors (i.e., 0.01 μF to 0.1 μF) within 2 mm for high-frequency performance. They can also use a bulk capacitor (i.e., 1 μF or larger) within 100 mm to provide large and slow currents. This bulk capacitor can be shared with other analog parts.

A 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 pins of the comparator as close as possible.

Operation Outside of the Common Input Voltage Range

A list of input voltage situations and the corresponding outcomes are as follows:

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 impedance.
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 10. The infrared photo diode produces 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.

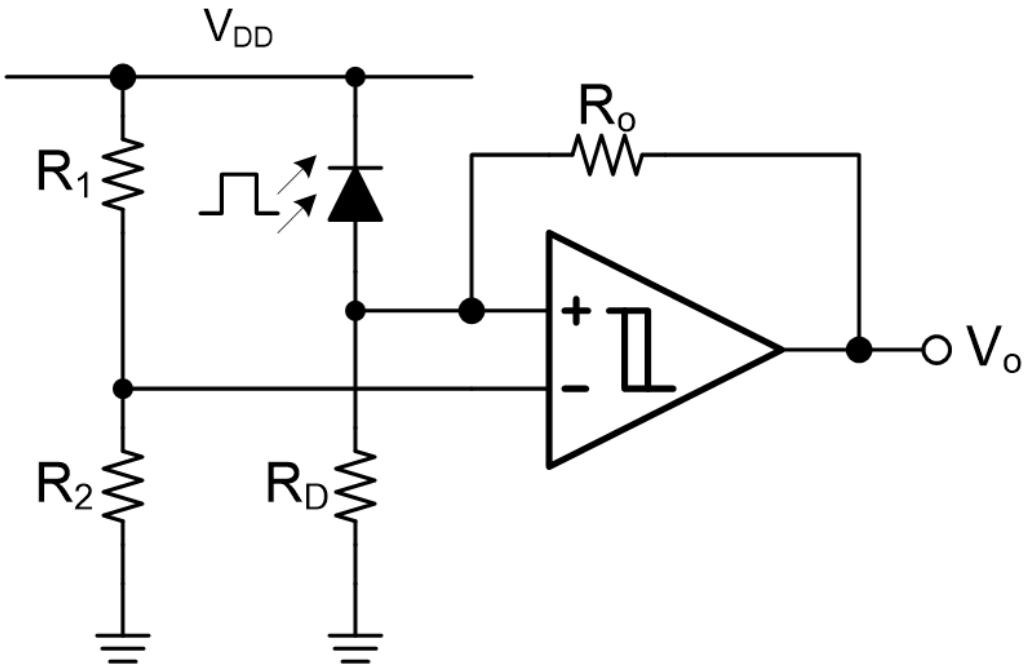
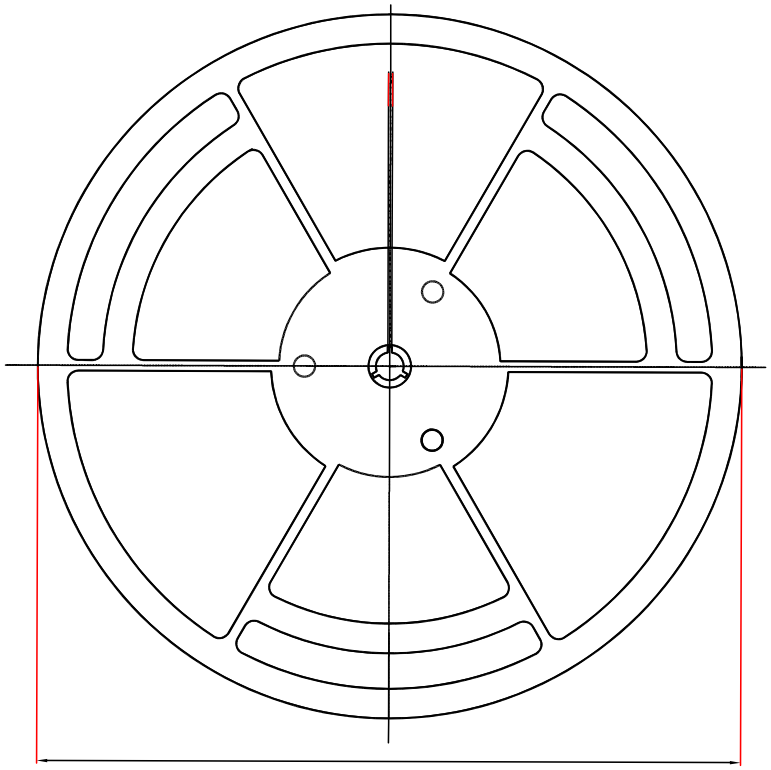
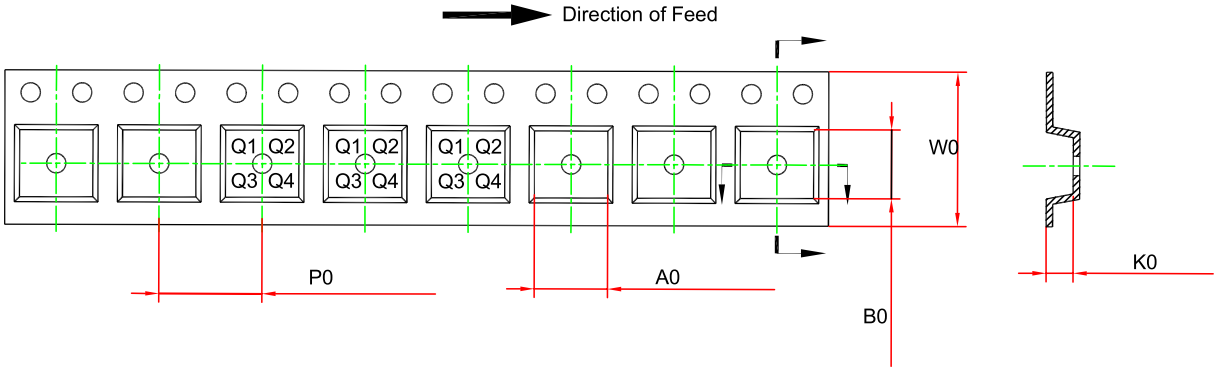


Figure 10. Typical Application Circuit

Tape and Reel Information





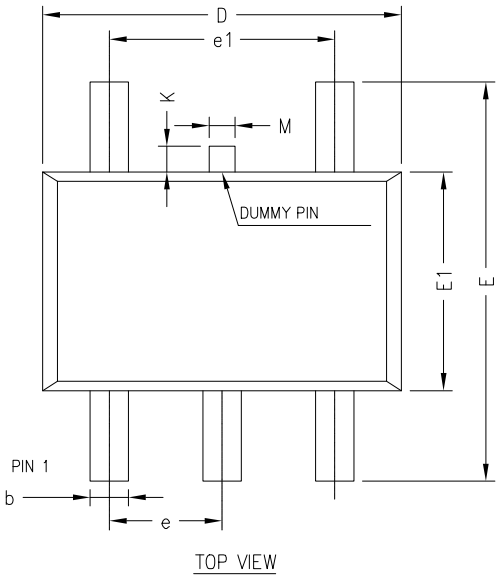
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPCMP201U-SC5R	SOT353 (SC70-5)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPCMP202-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPCMP202-VS1R-S	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1
TPCMP202-DFGR	DFN2X2-8	180	12.5	2.3	2.3	1.1	4	8	Q2

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

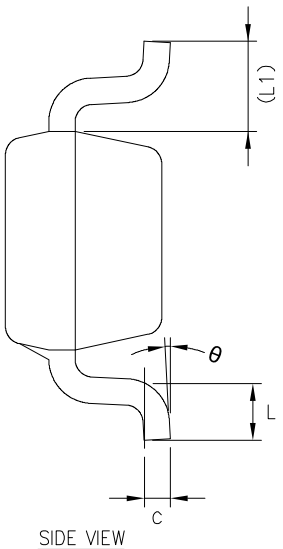
Package Outline Dimensions

SOT353 (SC70-5)

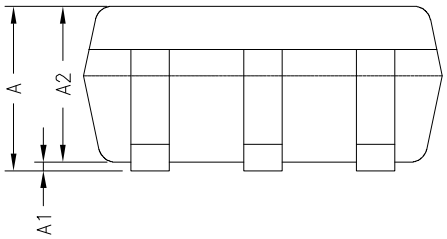
Package Outline Dimensions SC5(SOT353-5-B)



TOP VIEW



SIDE VIEW



SIDE VIEW

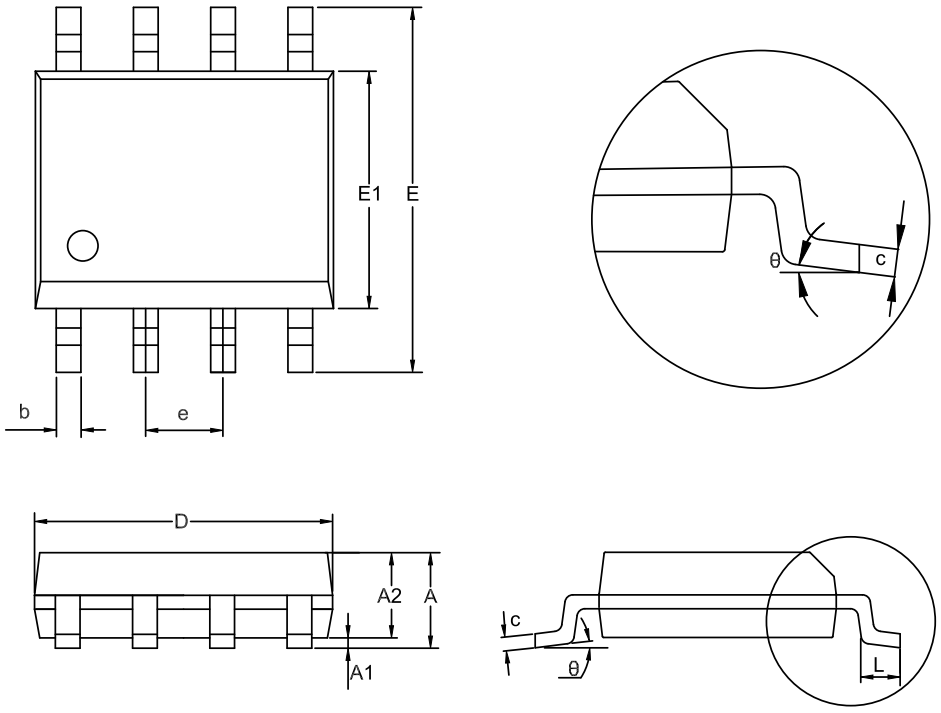
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.230	0.004	0.009
D	2.020	2.120	0.080	0.083
E	2.150	2.450	0.085	0.096
E1	1.210	1.310	0.048	0.052
e	0.650 BSC		0.026 BSC	
e1	1.200	1.400	0.047	0.055
L	0.260	0.460	0.010	0.018
L1	0.520 REF		0.020 REF	
K	0.000	0.200	0.000	0.008
M	0.100	0.200	0.004	0.008
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)



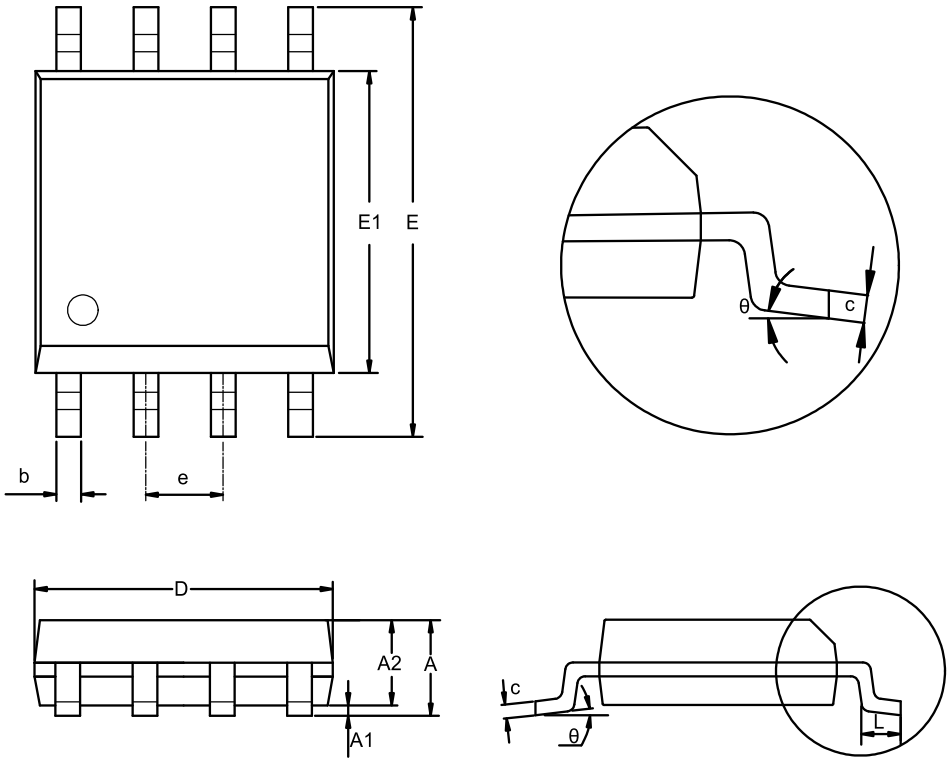
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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



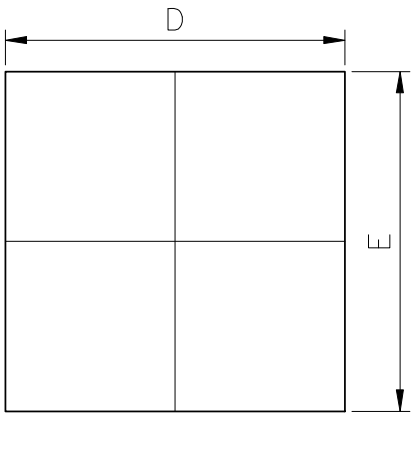
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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

NOTES

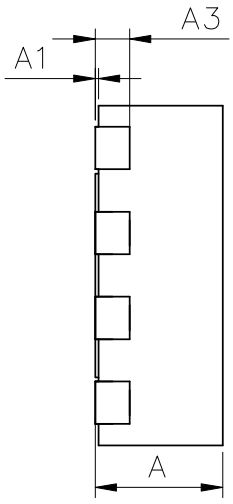
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

DFN2X2-8

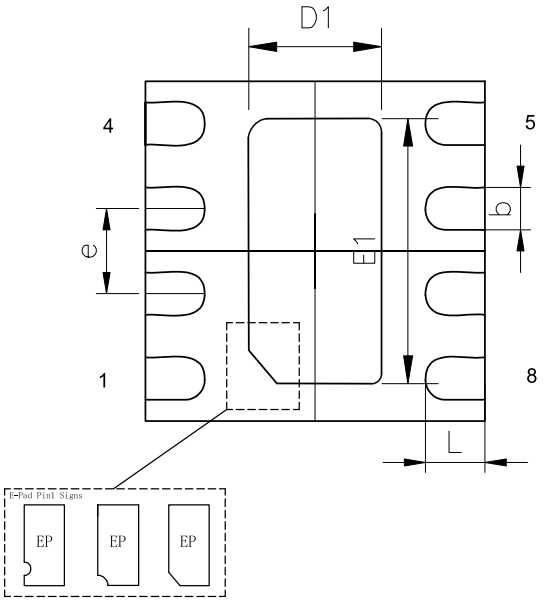
Package Outline Dimensions DFG(DFN2X2-8-E)



Top View



Side View



Bottom View

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
b	0.150	0.300	0.006	0.012
A3	0.100	0.200	0.004	0.008
D	1.900	2.100	0.075	0.083
D1	0.800	1.000	0.031	0.039
E	1.900	2.100	0.075	0.083
E1	1.600	1.800	0.063	0.071
e	0.500 BSC		0.020BSC	
L	0.224	0.376	0.009	0.015

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPCMP201U-SC5R	−40 to 125°C	SOT353 (SC70-5)	A9T	1	Tape and Reel, 3000	Green
TPCMP202-VS1R-S (1)	−40 to 125°C	MSOP8	MP202	1	Tape and Reel, 3000	Green
TPCMP202-SO1R (2)	−40 to 125°C	SOP8		1	Tape and Reel, 3000	Green
TPCMP202-DFGR (2)	−40 to 125°C	DFN2X2-8		1	Tape and Reel, 3000	Green

(1) Passed AEC-Q100 Reliability Test.
(2) 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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