5-V, 35-ns, Low-Offset, Low-Overdrive Comparators

Features

- Power Supply Voltage: 2.7 V to 5.5 V
- Low Supply Current: 1.1 mA per Channel
- Propagation Delay:
  - 35 ns with 100-mV Overdrive
  - 45 ns with 0.5-mV Overdrive
- Low-Offset Voltage: ±0.3-mV Maximum at Room Temperature
- Input Rail to $-V_S$

Applications

- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at 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 negative power rail.

The devices have 35-ns propagation delay which makes the devices suitable for high-speed applications. Besides, there is only 45-ns propagation delay with very low overdrive voltage to 0.5 mV which benefits applications with high-precision requirements. The internal input hysteresis eliminates output switching due to the input noise voltage. The devices have a push-pull output to support rail-to-rail output swing.

The devices are specified for the temperature range from −40°C to +125°C.

Typical Application Circuit

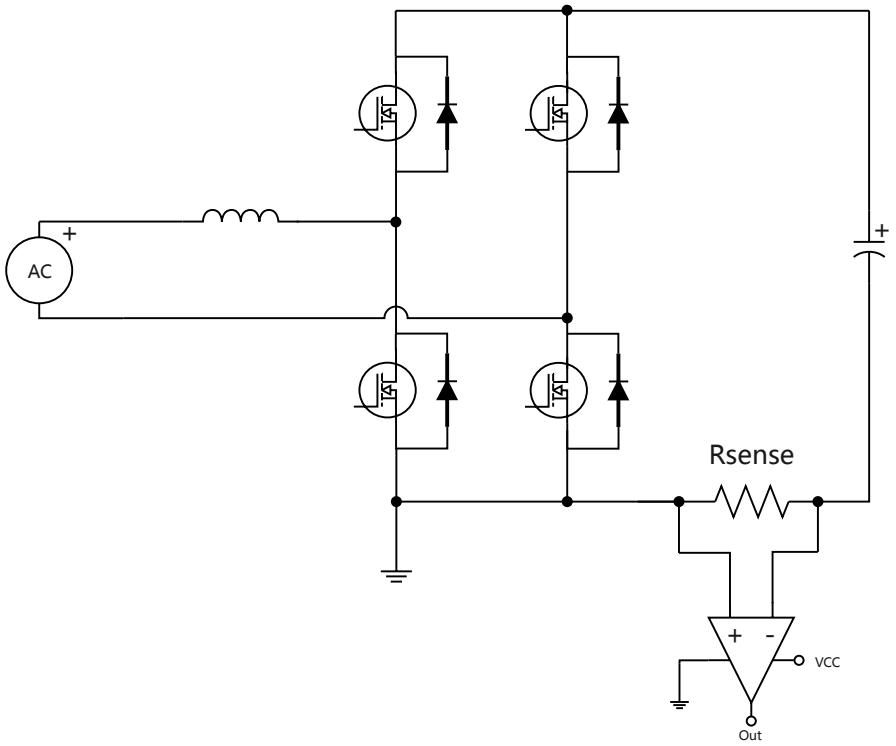


Table of Contents

Revision History

Date	Revision	Notes
2024-10-07	Rev.A.0	Initial release.
2024-12-30	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated to a new format of Package Outline Dimensions. • Updated the Tape and Reel Information.

Pin Configuration and Functions

TPCMP211
SOT23-5
Top View

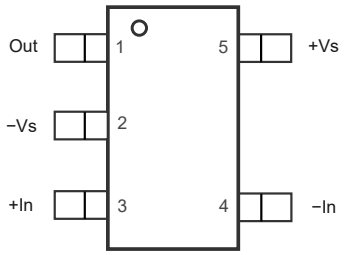
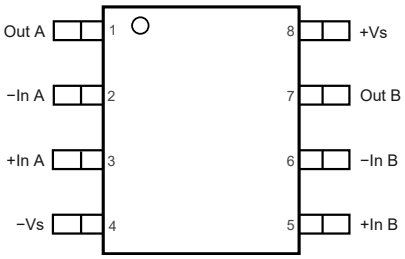


Table 1. Pin Functions: TPCMP211

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

TPCMP212
SOP8
Top View



TPCMP212
MSOP8
Top View

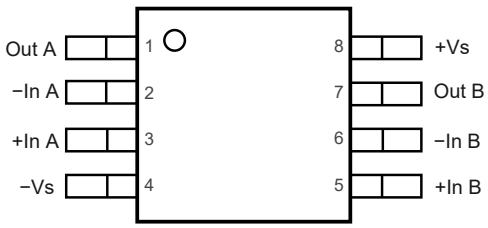


Table 2. Pin Functions: TPCMP212

Pin	Name	I/O	Description
1	Out A	Output	Output
2	−In A	Input	Inverting input
3	+In A	Input	Non-inverting input
4	$-V_S$		Negative power supply
5	+In B	Input	Non-inverting input
6	−In B	Input	Inverting input
7	Out B	Output	Output
8	$+V_S$		Positive power supply

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage: $(+V_S) - (-V_S)$		6	V
	Input Voltage	$(-V_S) - 0.3$	6	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 the negtive power supply. If the input extends more than 300 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 amplifiers 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

Symbol	Parameter	Condition	Minimum 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, $(+V_S) - (-V_S)$	2.7		5.5	V

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT23-5	170	81	°C/W
SOP8	158	43	°C/W

Package Type	θ_{JA}	θ_{JC}	Unit
MSOP8	210	45	°C/W

Electrical Characteristics

All test conditions: V_S = 5 V, C_L = 15 pF, T_A = +25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	V_{CM} = 0 V, output low		1100	1700	µA
		V_{CM} = 0 V, output low, T_A = −40°C to 125°C			1850	µA
		V_{CM} = 0 V, output high		1100	1700	µA
		V_{CM} = 0 V, output high, T_A = −40°C to 125°C			1850	µA
PSRR	Power Supply Rejection Ratio	V_S = 2.7 V to 5.5 V	68	100		dB
		V_S = 2.7 V to 5.5 V, T_A = −40°C to 125°C	65			dB
Input Characteristics						
V_{OS}	Input Offset Voltage (1)	V_{CM} = 0 V	−0.3	±0.02	0.3	mV
		V_{CM} = 0 V, T_A = −40°C to 125°C	−0.5		0.5	mV
		V_{CM} = 3.5 V	−1	±0.14	1	mV
		V_{CM} = 3.5 V, T_A = −40°C to 125°C	−1.2		1.2	mV
	Input Offset Voltage Drift	T_A = −40°C to 125°C		2		µV/°C
V_{HYST}	Input Hysteresis Voltage (2)	V_{CM} = −0.1 V to 3.5 V	2	11	18	mV
		V_{CM} = −0.1 V to 3.5 V, T_A = −40°C to 125°C			25	mV
	Input Hysteresis Voltage Drift	T_A = −40°C to 125°C		10		µV/°C
I_B	Input Bias Current (3)	V_{CM} = 0 V	−20	0.1	20	nA
		T_A = −40°C to 125°C	−50		50	nA
I_{OS}	Input Offset Current (3)	V_{CM} = 0 V	−20	0.1	20	nA
		T_A = −40°C to 125°C	−50		50	nA
V_{CM}	Common-Mode Input Voltage Range	T_A = −40°C to 125°C	($-V_S$) − 0.1		($+V_S$) – 1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 0 V to 3.5 V	70	90		dB
		V_{CM} = 0 V to 3.5 V, T_A = −40°C to 125°C	67			dB
Output Characteristics						
I_{SC}	Output Short-Circuit Current	Source current	45	55		mA
		Source current, T_A = −40°C to 125°C	40			mA
		Sink current	50	60		mA

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		Sink current, T_A = −40°C to 125°C	40			mA
V_{OH}	Output Voltage Swing from Positive Rail	I_{OL} = 4 mA, V_{ID} = −1 V		130	250	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C			300	mV
V_{OL}	Output Voltage Swing from Negative Rail	I_{OL} = 4 mA, V_{ID} = −1 V		80	120	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C			150	mV
Switching Characteristics, T_A = −40°C to 125°C (4)						
T_{PLH}	Propagation Delay Time, Low to High	V_{CM} = 0 V, 100-mV overdrive		35	60	ns
		V_{CM} = 0 V, 0.5-mV overdrive (3)		45	70	ns
T_{PHL}	Propagation Delay Time, High to Low	V_{CM} = 0 V, 100-mV overdrive		40	60	ns
		V_{CM} = 0 V, 0.5-mV overdrive (3)		45	70	ns
T_R	Rise time	(3)(5)		2		ns
T_F	Fall time	(3)(5)		1.5		ns

(1) The input offset voltage is the input-referred trip point when the output is from low to high.
(2) The input hysteresis is the difference between the input-referred trip points.
(3) Provided by bench tests and design simulation.
(4) Delay time is measured from the mid-point of the input to the mid-point of the output.
(5) Measured between 10% of V_S and 90% of V_S.

All test conditions: V_S = 3.3 V, C_L = 15 pF, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	V_{CM} = 0 V, output low		1100	1600	µA
		V_{CM} = 0 V, output low, T_A = −40°C to 125°C			1700	µA
		V_{CM} = 0 V, output high		1100	1600	µA
		V_{CM} = 0 V, output high, T_A = −40°C to 125°C			1700	µA
Input Characteristics						
V_{OS}	Input Offset Voltage (1)	V_{CM} = 0 V	−0.6	±0.07	0.6	mV
		V_{CM} = 0 V, T_A = −40°C to 125°C	−0.8		0.8	mV
		V_{CM} = 1.8 V	−1	±0.13	1	mV
		V_{CM} = 1.8 V, T_A = −40°C to 125°C	−1.2		1.2	mV
	Input Offset Voltage Drift	T_A = −40°C to 125°C		2		µV/°C
V_{HYST}	Input Hysteresis Voltage (2)	V_{CM} = 0 V to 1.8 V	2	11	18	mV
		V_{CM} = 0 V to 1.8 V, T_A = −40°C to 125°C			24	mV
	Input Hysteresis Voltage Drift	T_A = −40°C to 125°C		10		µV/°C
I_B	Input Bias Current (3)	V_{CM} = 0 V	−20	0.1	20	nA
		V_{CM} = 0 V, T_A = −40°C to 125°C	−50		50	nA
I_{OS}	Input Offset Current (3)	V_{CM} = 0 V	−20	0.1	20	nA
		V_{CM} = 0 V, T_A = −40°C to 125°C	−50		50	nA
V_{CM}	Common-Mode Input Voltage Range	T_A = −40°C to 125°C	($-V_S$) − 0.1		($+V_S$) − 1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 0 V to 1.8 V	68	90		dB
		V_{CM} = 0 V to 1.8 V, T_A = −40°C to 125°C	65			dB
Output Characteristics						
I_{SC}	Output Short-Circuit Current	Source current	23	25		mA
		Source current, T_A = −40°C to 125°C	20			mA
		Sink current	28	35		mA
		Sink current, T_A = −40°C to 125°C	22			mA
V_{OH}	Output Voltage Swing from Positive Rail	I_{OL} = 4 mA, V_{ID} = −1 V		150	250	mV

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C			300	mV
V_{OL}	Output Voltage Swing from Negative Rail	I_{OL} = 4 mA, V_{ID} = −1 V		100	150	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C			190	mV
Switching Characteristics, T_A = −40°C to 125°C (2)(4)						
T_{PLH}	Propagation Delay Time, Low to High	V_{CM} = 0 V, 100-mV overdrive		35	60	ns
		V_{CM} = 0 V, 0.5-mV overdrive (3)		45	70	ns
T_{PHL}	Propagation Delay Time, High to Low	V_{CM} = 0 V, 100-mV overdrive		35	60	ns
		V_{CM} = 0 V, 0.5-mV overdrive (3)		45	70	ns
T_R	Rise time	(3)(5)		2		ns
T_F	Fall time	(3)(5)		1.5		ns

(1) The input offset voltage is the input-referred trip point when the output is from low to high.
(2) The input hysteresis is the difference between the input-referred trip points.
(3) Provided by bench tests and design simulation.
(4) Delay time is measured from the mid-point of the input to the mid-point of the output.
(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, R_L = Open, unless otherwise noted.

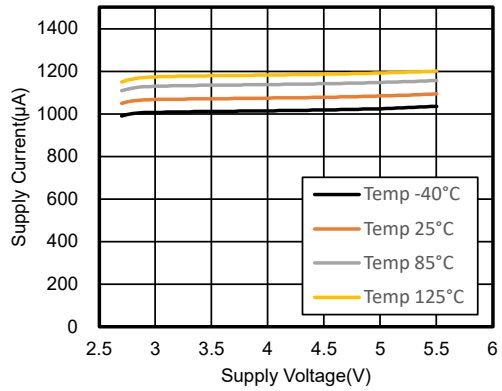


Figure 1. Supply Current vs. Supply Voltage, Output High

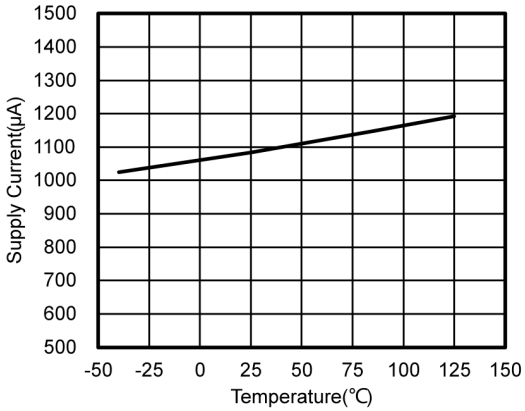


Figure 2. Supply Current vs. Temperature

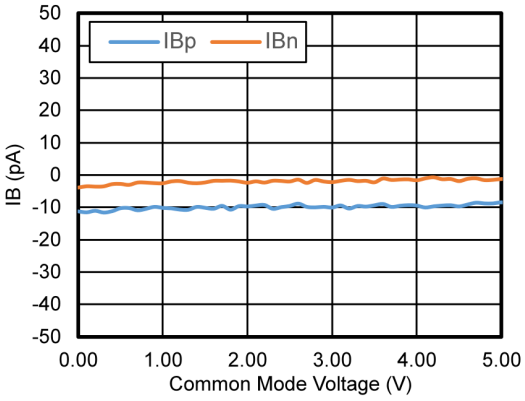


Figure 3. I_B vs. Common-Mode Voltage

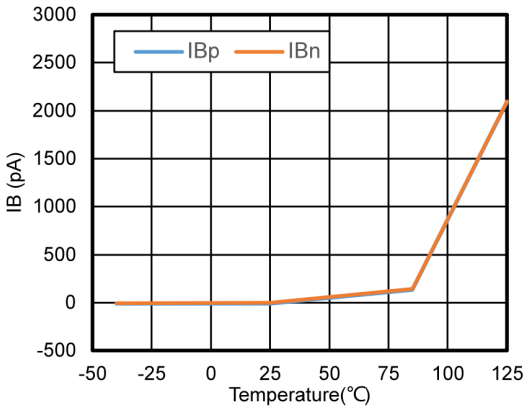


Figure 4. I_B vs. Temperature

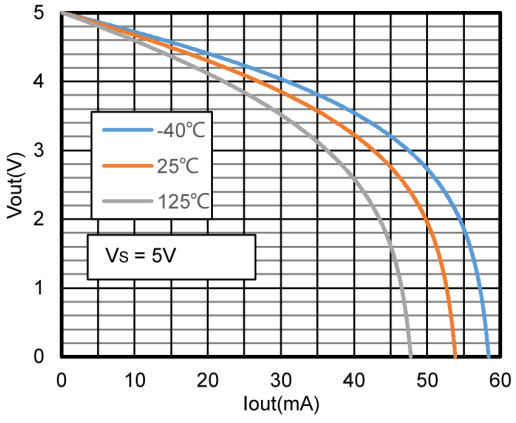


Figure 5. Output Voltage vs. Output Sourcing Current, 5 V

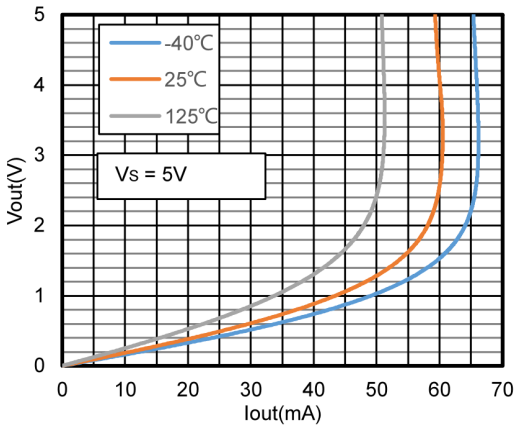


Figure 6. Output Voltage vs. Output Sinking Current, 5 V

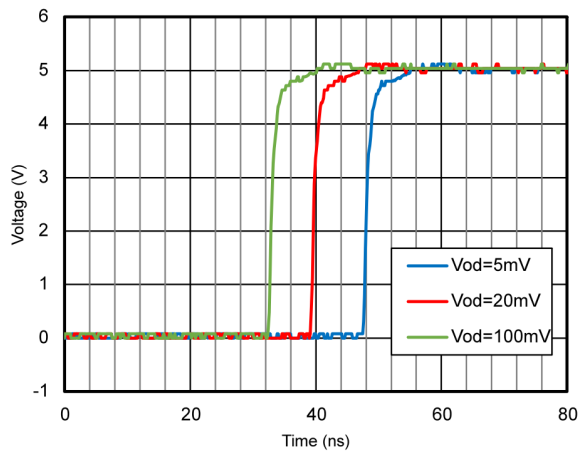


Figure 7. Propagation Delay, Low to High, 5 V

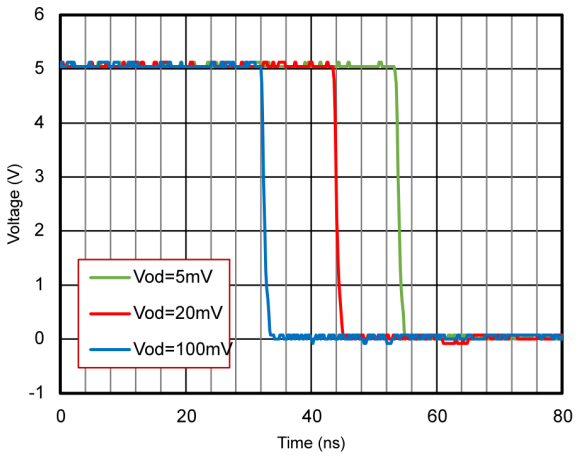


Figure 8. Propagation Delay, High to Low, 5 V

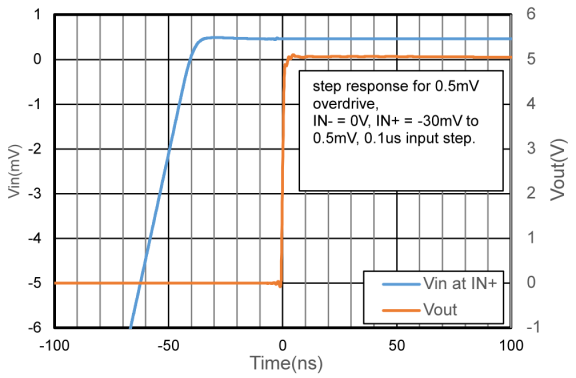


Figure 9. Propagation Delay for 0.5-mV Overdrive and 0.1-µs Rise Time Step Response

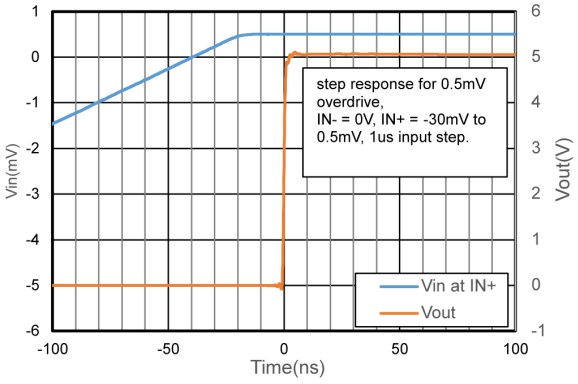


Figure 10. Propagation Delay for 0.5-mV Overdrive and 1-µs Rise Time Step Response

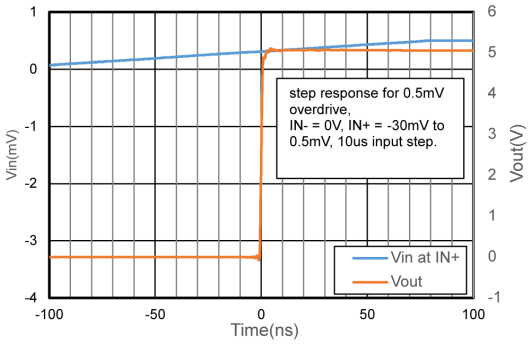


Figure 11. Propagation Delay for 0.5-mV Overdrive and 10-µs Rise Time Step Response

Detailed Description

Overview

The TPCMP21x devices are low-power, high-speed comparators with low input offset voltage and internal hysteresis, ideally suited for industrial applications.

Functional Block Diagram

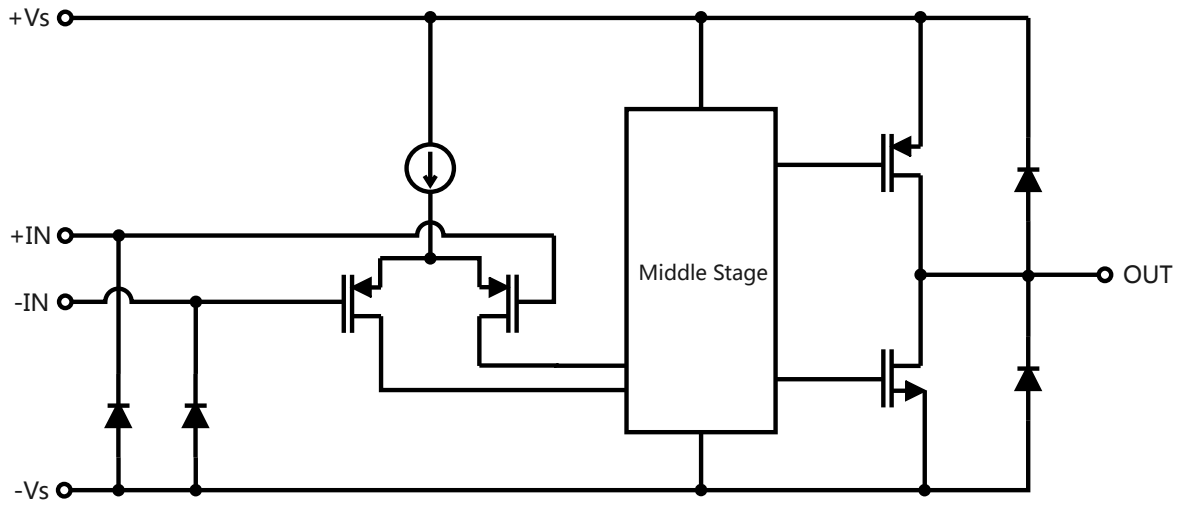


Figure 12. Functional Block Diagram

Feature Description

The Input Hysteresis Voltage and Input Offset Voltage

Most high-speed comparators oscillate in the linear region because of noise or undesired parasitic feedback. This tends to occur when the voltage on one input is at or equal to the voltage on the other input. To counter the parasitic effects and noise, the TPCMP21x devices implement internal hysteresis.

The input offset voltage (V_{OS}) is the input-referred trip point when the output is from low to high. The input hysteresis voltage (V_{HYST}) is the difference between the input-referred trip points.

Figure 13 illustrates the case that the output is from low to high when the input differential voltage is higher than Vos, and the output is from high to low when the input differential voltage is lower than V_{HYST}.

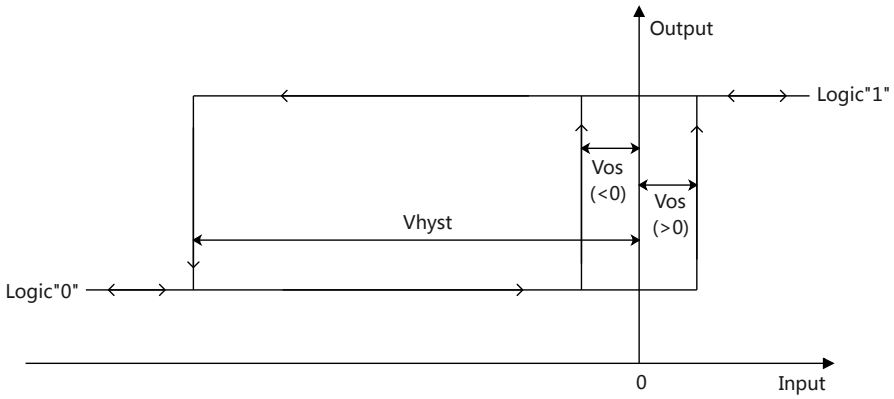


Figure 13. Hysteresis and Offset Voltage of the Comparator

The Overdrive Voltage

The difference between the voltage to be compared and the reference voltage is referred to as the overdrive voltage (V_{OD}).

The propagation delay in comparators decreases slightly as the input overdrive is increased. This variation in propagation delay as a function of overdrive is called dispersion as shown in Figure 14.

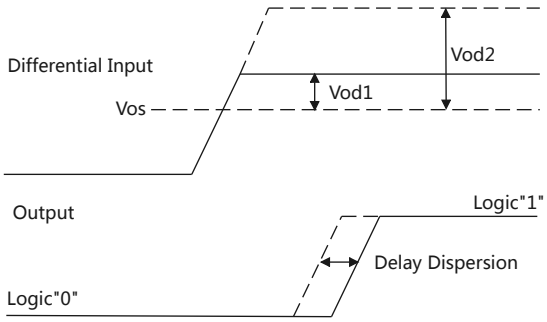


Figure 14. Comparator Delay Dispersion

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.

Typical Application

Figure 15 shows the typical application schematic.

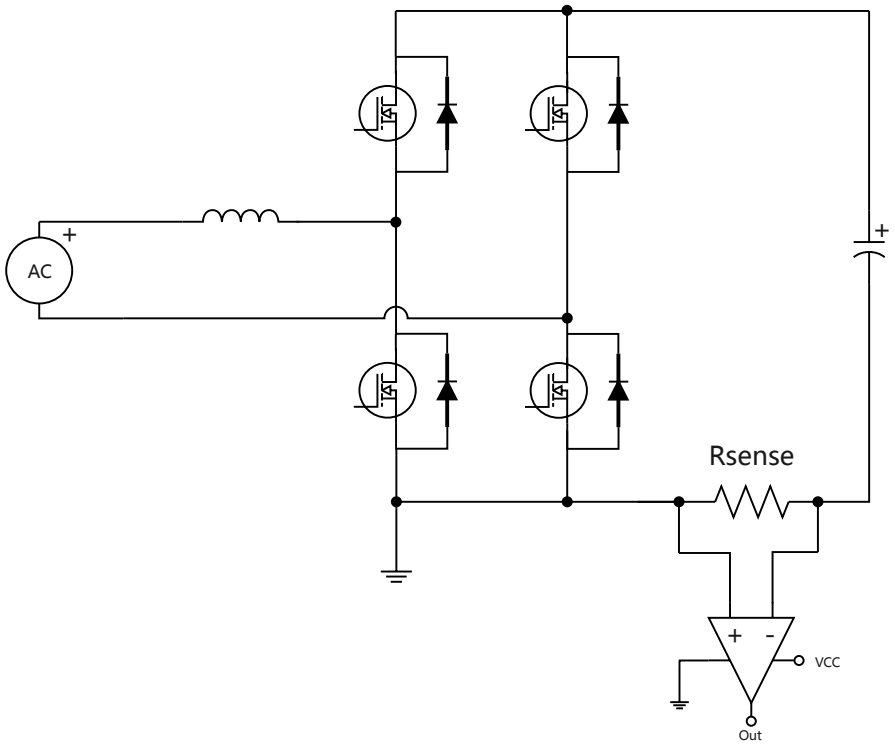
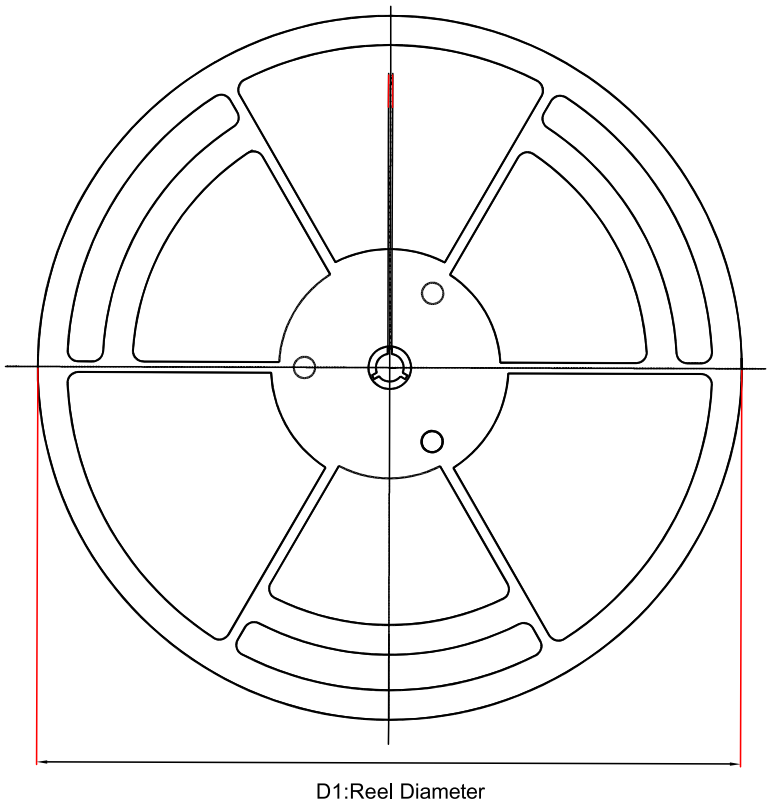


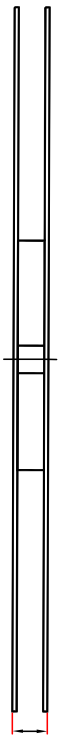
Figure 15. Typical Application Circuit

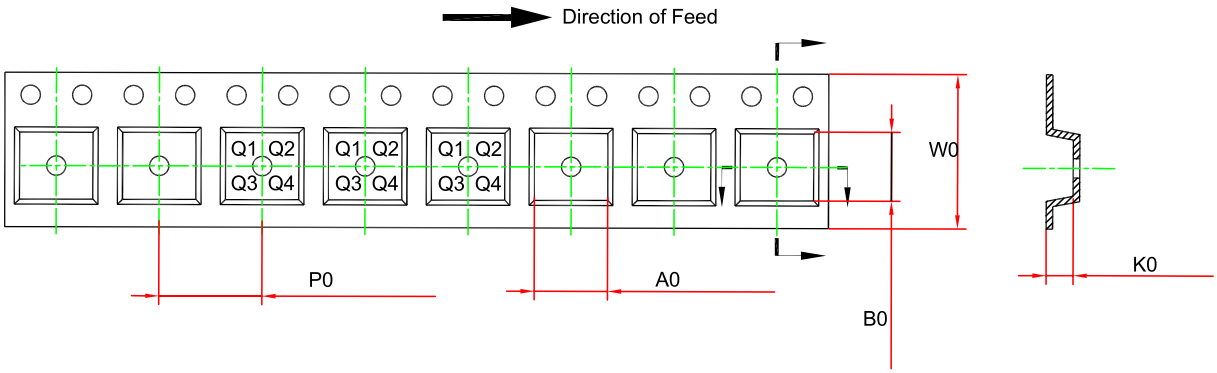
PFC Zero-Crossing Detection

The TPCMP21x devices are mainly used in PFC zero-crossing detection in Figure 15. They have low input offset voltage and fast response time for a low-overdrive voltage which provides accurate input-referred trip points when the output is from low to high.

Tape and Reel Information







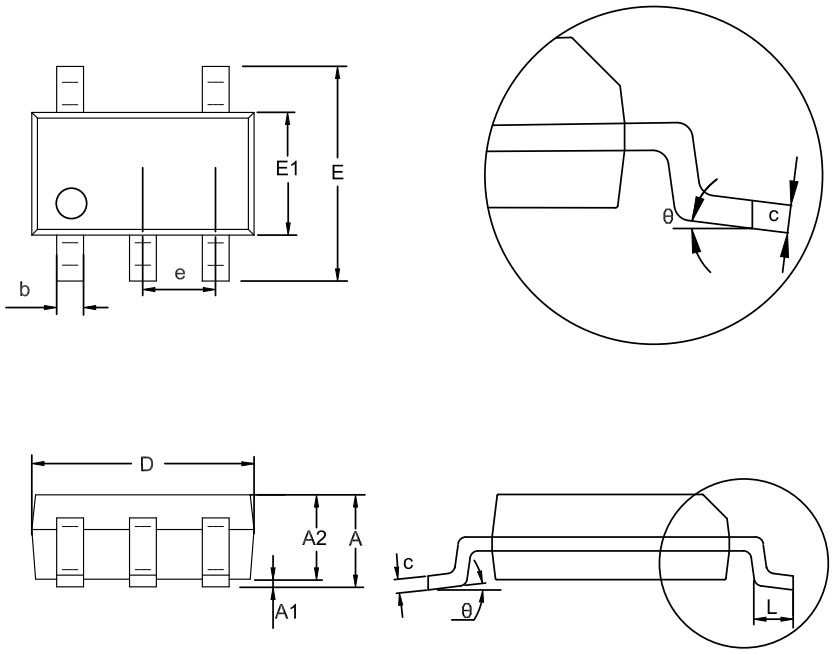
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPCMP211-S5TR	SOT23-5	180.0	12.0	3.3	3.3	1.4	4.0	8.0	Q3

(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)



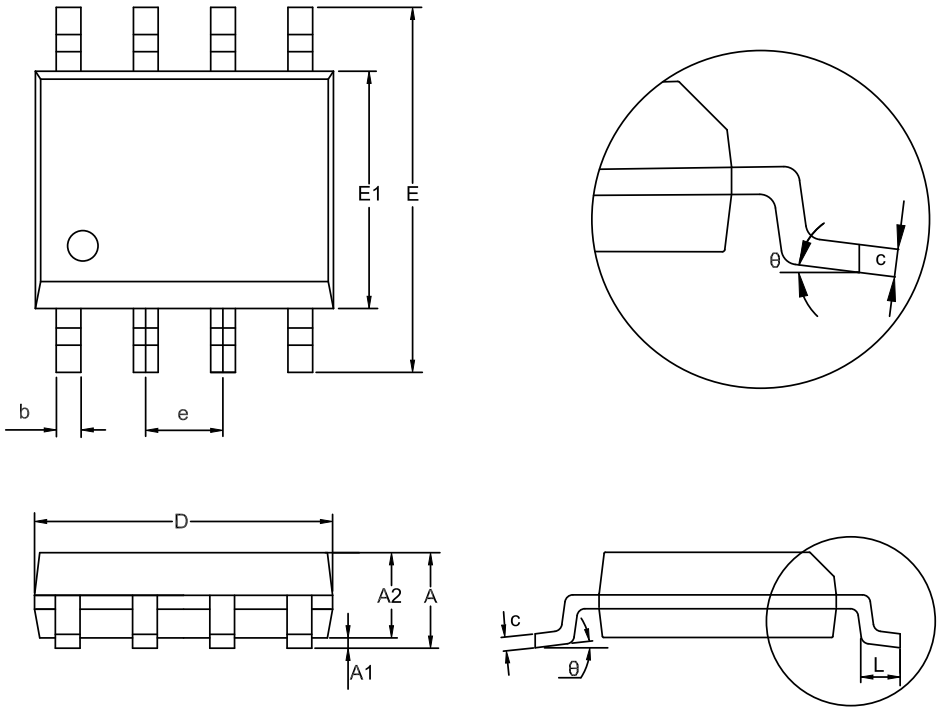
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037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

SOP8

Package Outline Dimensions SO1(SOP-8-A)



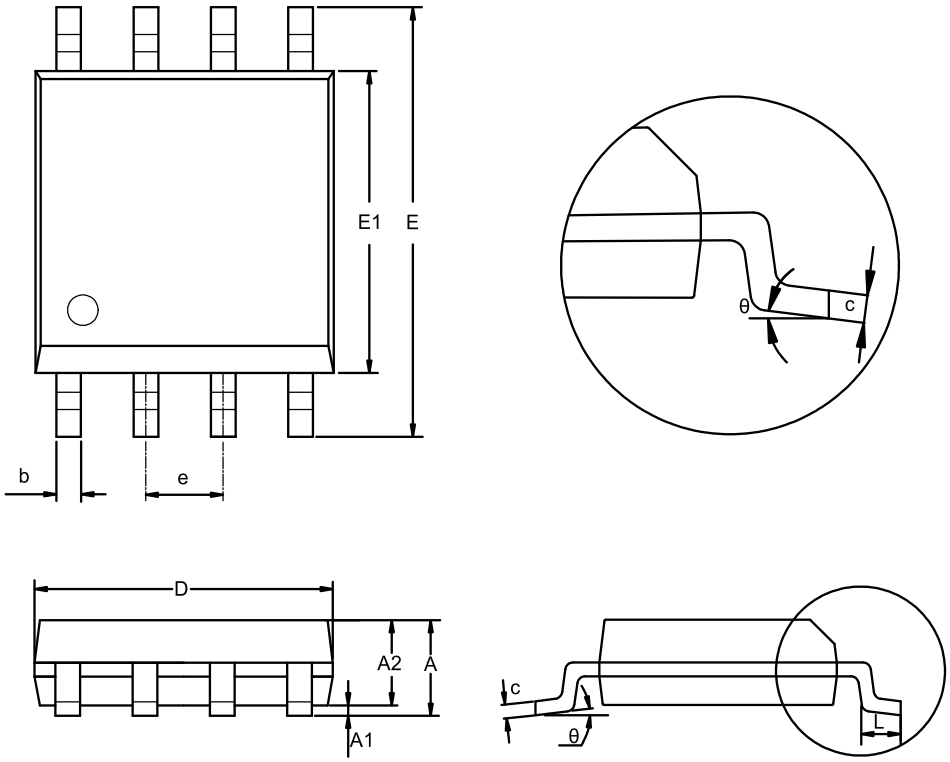
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 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
TPCMP211-S5TR	−40 to 125°C	SOT23-5	A42	1	Tape and Reel, 3000	Green
TPCMP212-SO1R (1)	−40 to 125°C	SOP8	CM212	1	Tape and Reel, 4000	Green
TPCMP212-VS1R (1)	−40 to 125°C	MSOP8	CM212	1	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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