
Micropower, Single-Supply Comparator and Precision Reference IC

Features

- Single-Supply Voltage Range: +2.5 V to +5.5 V
- Very Low Supply Current (33 μ A)
- Low Input Bias Current: 2 nA maximum
- Low Offset Voltage: ± 7 mV maximum
- 450-ns Propagation Delay
- Rail-to-Rail Inputs
- -40°C to 125°C Operation Range
- Voltage Reference Offers:
 - 20ppm/ $^{\circ}\text{C}$ (typ) Temperature Coefficient
 - $\pm 0.4\%$ (max) Initial Accuracy
 - Stable for 0 to 100-nF Capacitive Loads

Description

The comparator features rail-to-rail input and output, with a common-mode input voltage range that extends 250mV beyond the supply rails. Input bias current is typically 1.0pA, and input offset voltage is typically 0.5mV. Internal hysteresis ensures clean output switching, even with slow-moving input signals. The output stage features a unique design that limits supply current surges while switching, virtually eliminating supply glitches typical of many other comparators. This design also minimizes overall power consumption under dynamic conditions. The comparator outputs have rail-to-rail, push-pull output stages sinks and sources up to 95mA. The propagation delay is 450ns, even with the low-operating supply current. The device features an on-chip 1.23-V reference.

Applications

- Precision Battery Management
- Window Comparators
- Level Translators
- Digital Line Receivers

Typical Application Circuit

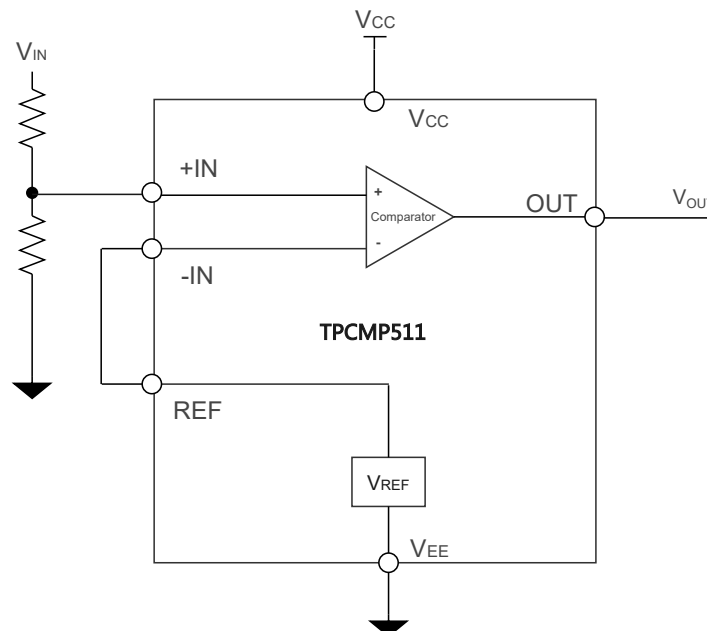


Table of Contents

Features.....	1
Applications.....	1
Description.....	1
Typical Application Circuit.....	1
Revision History.....	3
Pin Configuration and Functions.....	4
Specifications.....	5
Absolute Maximum Ratings ⁽¹⁾	5
ESD, Electrostatic Discharge Protection.....	5
Recommended Operating Conditions.....	5
Thermal Information.....	6
Electrical Characteristics.....	7
Typical Performance Characteristics.....	10
Detailed Description.....	12
Overview.....	12
Functional Block Diagram.....	13
Application and Implementation.....	14
Application and Implementation.....	14
Typical Application.....	15
Tape and Reel Information.....	16
Package Outline Dimensions.....	17
WLCSP.....	17
Order Information.....	18
IMPORTANT NOTICE AND DISCLAIMER.....	19

Revision History

Date	Revision	Notes
2025-12-10	Rev.A.0	Initial version.

Pin Configuration and Functions

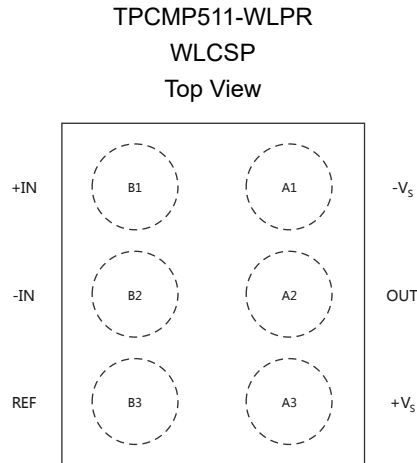


Table 1. Pin Functions: TPCMP511-WLPR

Pin No.	Name	I/O	Description
A1	$-V_S$	–	Negative power supply.
A2	OUT	O	Output.
A3	$+V_S$	–	Positive power supply.
B1	+IN	I	Non-inverting input.
B2	–IN	I	Inverting input.
B3	REF	–	Reference voltage output

Micropower, Single-Supply Comparator and Precision Reference IC

Specifications

Absolute Maximum Ratings ⁽¹⁾

Parameter		Min	Max	Unit
	Supply Voltage, (+V _S) – (–V _S)	–0.3	6	V
	Input Voltage	(–V _S) – 0.3	(+V _S) + 0.3	V
	Input Current: +IN, –IN ⁽²⁾	–10	10	mA
	Output Voltage	(–V _S) – 0.3	(+V _S) + 0.3	V
	Comparator Output Short-Circuit Duration ⁽³⁾		Indefinite	
	Reference Output Short-Circuit Duration ⁽³⁾		Indefinite	
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 positive and negative power supply. If the input extends more than 500 mV beyond the positive or 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)	2.5		5.5	V

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
WLCSP	201	24	°C/W

Micropower, Single-Supply Comparator and Precision Reference IC

Electrical Characteristics

All test conditions: $V_S = 5\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current	$V_S = 5\text{ V}$, No Load, Output High, $V_{INP} = 1\text{ V}$, $V_{INN} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C		33	100	μA
		$V_S = 5\text{ V}$, No Load, Output Low, $V_{INP} = 0\text{ V}$, $V_{INN} = 1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C		33	100	μA
		$V_S = 2.7\text{ V}$, No Load, Output High, $V_{INP} = 1\text{ V}$, $V_{INN} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C		32	100	μA
		$V_S = 2.7\text{ V}$, No Load, Output Low, $V_{INP} = 0\text{ V}$, $V_{INN} = 1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C		32	100	μA
PSRR	Power Supply Rejection Ratio	$V_S = 2.5\text{ V}$ to 5.5 V , $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	67	80		dB
Input Characteristics						
V_{OS}	Input Offset Voltage ⁽¹⁾	$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$	-5	± 0.5	5	mV
		$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-7		7	mV
$V_{OS\text{ TC}}$	Input Offset Voltage Drift ⁽²⁾	$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			30	$\mu\text{V}/^\circ\text{C}$
V_{OS}	Input Offset Voltage ⁽¹⁾	$V_S = 2.5\text{ V}$, $V_{CM} = 0\text{ V}$	-5		5	mV
		$V_S = 2.5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-7	± 1	7	mV
$V_{OS\text{ TC}}$	Input Offset Voltage Drift ⁽²⁾	$V_S = 2.5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C			30	$\mu\text{V}/^\circ\text{C}$
V_{HYST}	Input Hysteresis Voltage ⁽¹⁾	$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$		2.5		mV
V_{HYST}	Input Hysteresis Voltage ⁽¹⁾	$V_S = 2.5\text{ V}$, $V_{CM} = 0\text{ V}$		2.5		mV
I_B	Input Bias Current	$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-2000	± 1	2000	pA
		$V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-2000		2000	pA
I_{OS}	Input Offset Current	$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$	-1000	± 0.5	1000	pA
		$V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-2000	± 0.5	2000	pA
		$V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$	-1000		1000	pA
		$V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-2000	± 0.5	2000	pA
C_{IN}	Input Capacitance	Either input over v_{cm} range		2.5		pF

Micropower, Single-Supply Comparator and Precision Reference IC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CMRR	Common-mode Rejection Ratio	V _S = 5 V, V _{CM} = 0 V to 5 V, T _A = −40°C to 125°C	60	65		dB
V _{CM}	Common-mode Input Voltage Range	V _S = 5 V	−0.25		5.25	V
		V _S = 5 V, T _A = −40°C to 125°C	0		5	V
Output						
V _{OL}	Output Voltage Swing from Negative Rail	V _S = 5 V, I _{SINK} = 8 mA			300	mV
		V _S = 5 V, I _{SINK} = 8mA, T _A = −40°C to 125°C		250	350	mV
		V _S = 2.7 V, I _{SINK} = 3.5 mA			160	mV
		V _S = 2.7 V, I _{SINK} = 3.5 mA, T _A = −40°C to 125°C		150	200	mV
V _{OH}	Output Voltage Swing from Positive Rail	V _S = 5 V, I _{SOURCE} = 8 mA			150	mV
		V _S = 5 V, I _{SOURCE} = 8 mA, T _A = −40°C to 125°C		120	200	mV
		V _S = 2.7 V, I _{SOURCE} = 3.5 mA			120	mV
		V _S = 2.7 V, I _{SOURCE} = 3.5 mA, T _A = −40°C to 125°C		100	150	mV
I _{SOURCE}	Source Current	V _S = 5 V, T _A = −40°C to 125°C		95		mA
		V _S = 2.7 V, T _A = −40°C to 125°C		35		mA
I _{SINK}	Sink Current	V _S = 5 V, T _A = −40°C to 125°C		95		mA
		V _S = 2.7 V, T _A = −40°C to 125°C		35		mA
Switching Characteristics ⁽³⁾						
T _{PLH}	Propagation Delay Time, Low to High	V _S = 2.7 V, V _{CM} = V _S /2, 50mV overdrive, C _L = 15 pF		450		ns
		V _S = 2.7 V, V _{CM} = V _S /2, 100mV overdrive, C _L = 15 pF		400		ns
		V _S = 5 V, V _{CM} = V _S /2, 50mV overdrive, C _L = 15 pF		450		ns
		V _S = 5 V, V _{CM} = V _S /2, 100mV overdrive, C _L = 15 pF		400	450	ns
T _{PHL}	Propagation Delay Time, High to Low	V _S = 2.7 V, V _{CM} = V _S /2, 50mV overdrive, C _L = 15 pF		450		ns
		V _S = 2.7 V, V _{CM} = V _S /2, 100mV overdrive, C _L = 15 pF		400		ns
		V _S = 5 V, V _{CM} = V _S /2, 50mV overdrive, C _L = 15 pF		450		ns
		V _S = 5 V, V _{CM} = V _S /2, 100mV overdrive, C _L = 15 pF		400	450	ns
T _R	Rise time	V _S = 5 V, C _L = 15 pF, Output from 20% to 80%		40		ns

Micropower, Single-Supply Comparator and Precision Reference IC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_R	Rise time	$V_S = 5\text{ V}$, $C_L = 50\text{ pF}$, Output from 20% to 80%		50		ns
T_R	Rise time	$V_S = 5\text{ V}$, $C_L = 200\text{ pF}$, Output from 20% to 80%		80		ns
T_F	Fall time	$V_S = 5\text{ V}$, $C_L = 15\text{ pF}$, Output from 80% to 20%		40		ns
T_F	Fall time	$V_S = 5\text{ V}$, $C_L = 50\text{ pF}$, Output from 80% to 20%		50		ns
T_F	Fall time	$V_S = 5\text{ V}$, $C_L = 200\text{ pF}$, Output from 80% to 20%		80		ns
T_{ON}	Power-up time	$V_S = 5\text{ V}$, The time between VCC exceed 2.7V and the output is in a valid logic state.		20		μs
Reference						
V_{REF}	Reference Voltage, 0.4%	Initial at 25°C	1.225	1.23	1.235	V
V_{REFTC}	Output Voltage Temperature Coefficient	-40°C to 85°C		20	100	ppm/°C
		-40°C to 125°C		20	100	ppm/°C
$\Delta V_{REF}/\Delta V_S$	Line Regulation	$2.5\text{ V} \leq V_S \leq 5.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C		50	200	$\mu\text{V/V}$
$\Delta V_{REF}/\Delta I_{REF}$	Load Regulation	Sourcing: $0\mu\text{A} \sim 500\mu\text{A}$, $T_A = -40^\circ\text{C}$ to 125°C		2	4	$\mu\text{V}/\mu\text{A}$
		Sinking: $-500\mu\text{A} \sim 0\mu\text{A}$, $T_A = -40^\circ\text{C}$ to 125°C		3.5	6	$\mu\text{V}/\mu\text{A}$
I_{SC}	Output Short-Circuit Current	$V_{REF} = -V_S$ or V_S , $T_A = 25^\circ\text{C}$		4		mA
Noise Voltage	Peak to Peak Noise	$f = 0.1\text{ Hz}$ to 10 Hz , $T_A = 25^\circ\text{C}$		17		μV_{pp}
Noise Voltage	RMS Noise	$f = 10\text{ Hz}$ to 10 kHz , $T_A = 25^\circ\text{C}$		42		μV
Ripple Rejection	$\Delta V_{REF}/\Delta V_{CC}$	$V_{CC} = 5\text{ V} \pm 100\text{ mV}$, $f = 120\text{ Hz}$, $T_A = 25^\circ\text{C}$		86		dB
T_{HYST}	Thermal Hysteresis	$T_A = 25^\circ\text{C}$		130		ppm
C_{LOAD}	Capacitive Load	$T_A = -40^\circ\text{C}$ to 125°C			100	nF
T_{REF}	Turn-on settling time	To $V_{ref} = 1\%$ of final value, $T_A = 25^\circ\text{C}$		200		μs

- (1) The input offset voltage is the average of 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.

Typical Performance Characteristics

All test conditions: $V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, unless otherwise noted.

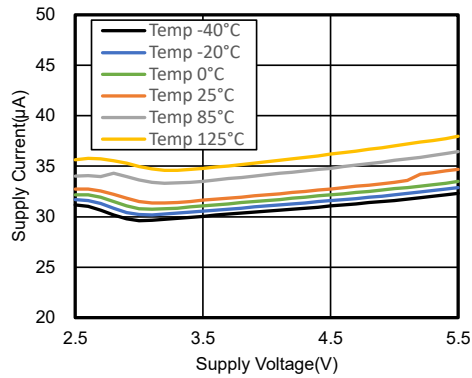


Figure 1. Supply Current vs. Supply Voltage, Output High

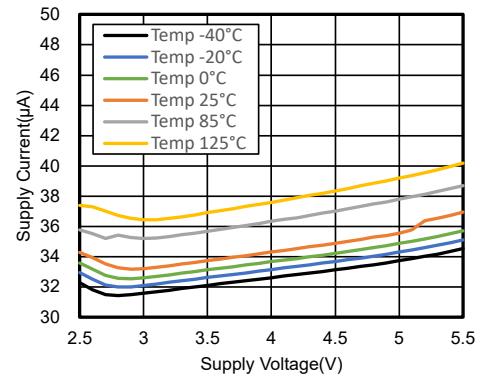


Figure 2. Supply Current vs. Temperature

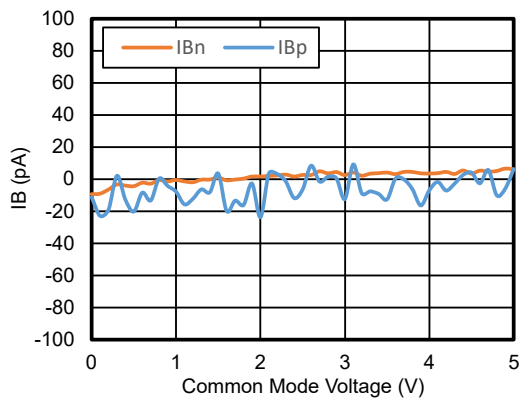


Figure 3. IB vs. Common-Mode Voltage

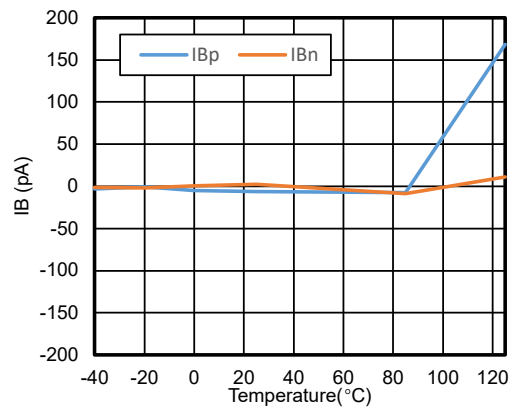


Figure 4. IB vs. Temperature

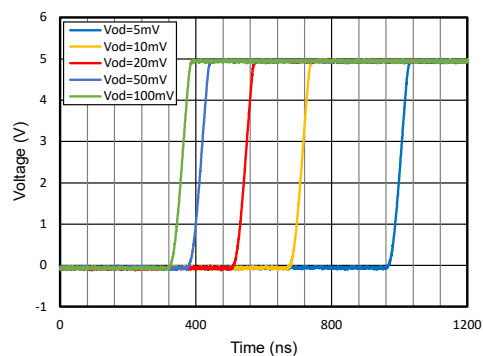


Figure 5. Propagation Delay, Low to High, 5 V

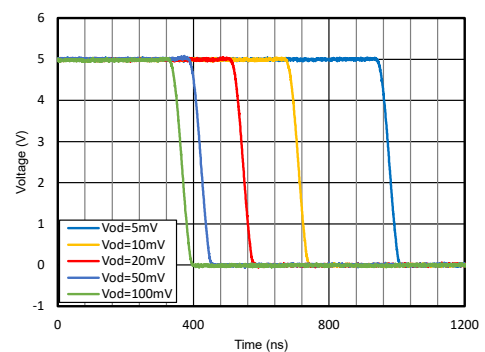
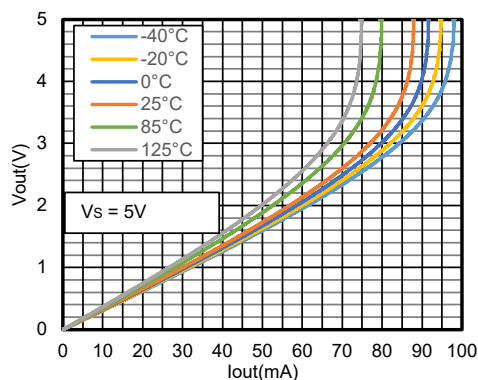
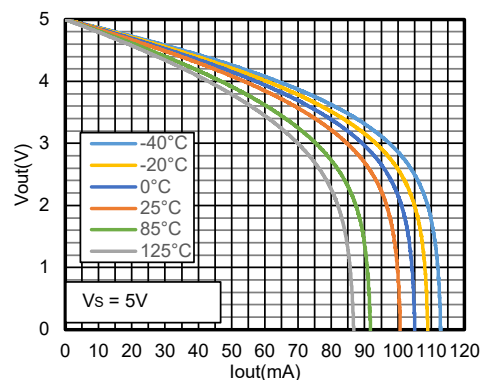


Figure 6. Propagation Delay, High to Low, 5 V


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

Figure 8. Output Voltage vs. Output Sourcing Current, 5 V

Detailed Description

Overview

The comparators feature rail-to-rail inputs and outputs, with a common-mode input voltage range that extends 250 mV beyond the supply rails. Input bias current is typically 1.0 pA, and input offset voltage is typically 0.5 mV. Internal hysteresis ensures clean output switching, even with slow-moving input signals. The output stage features a unique design that limits supply current surges while switching, virtually eliminating supply glitches typical of many other comparators. This design also minimizes overall power consumption under dynamic conditions. The comparator outputs have rail-to-rail, push-pull output stages sinks and sources up to 95mA. The propagation delay is 450 ns, even with the low-operating supply current. The device features an on-chip 1.23-V reference.

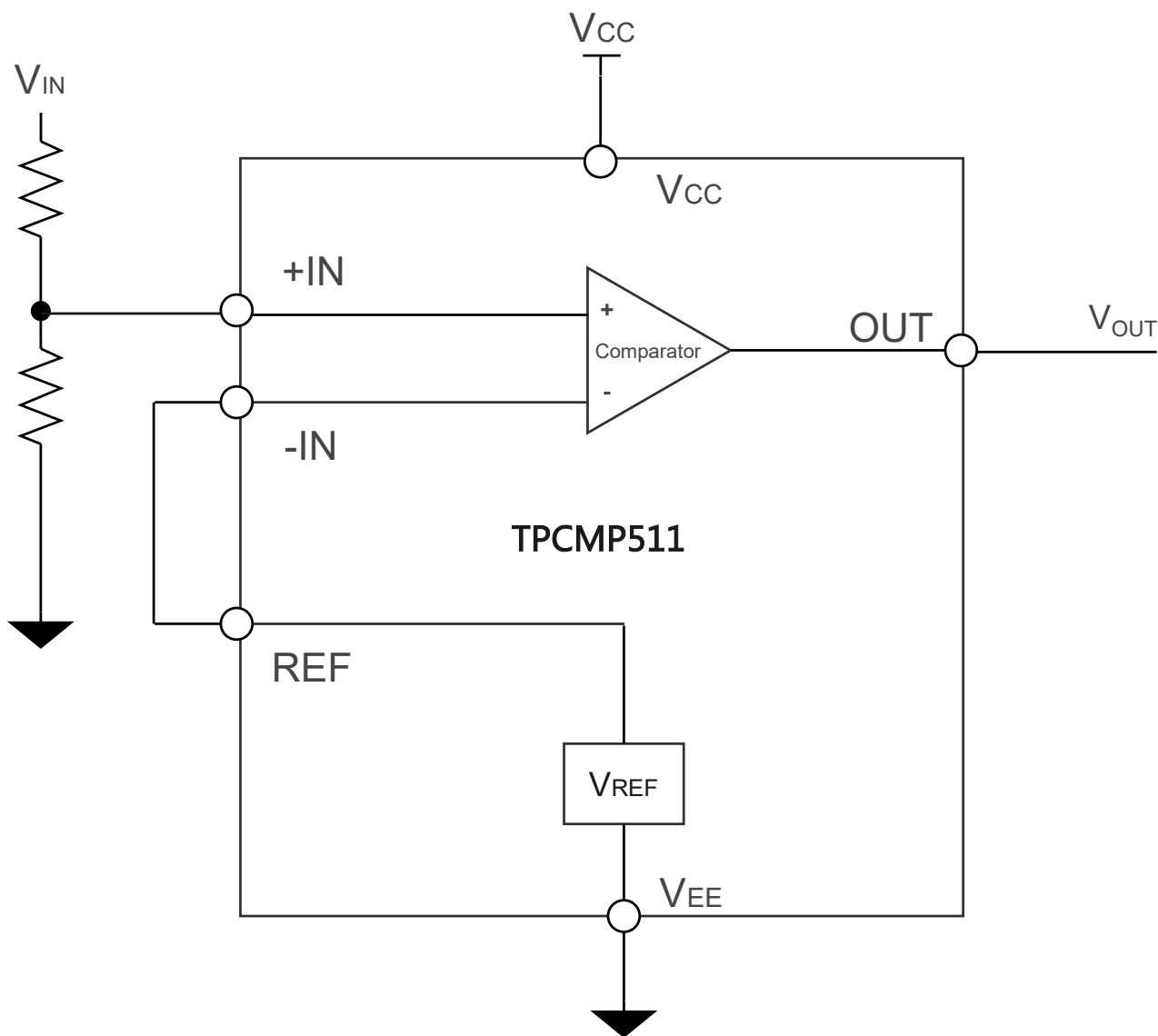
Functional Block Diagram


Figure 9. Functional Block Diagram

Application and Implementation

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

Over-voltage Detection

The device is an ideal candidate to be used as over-voltage detection shown in [Figure 10](#). The input signal is compared with the reference voltage through a resistor divider to generate a comparator logic output. When the divided input voltage exceeds the reference voltage, the comparator output goes high to indicate an over-voltage fault.

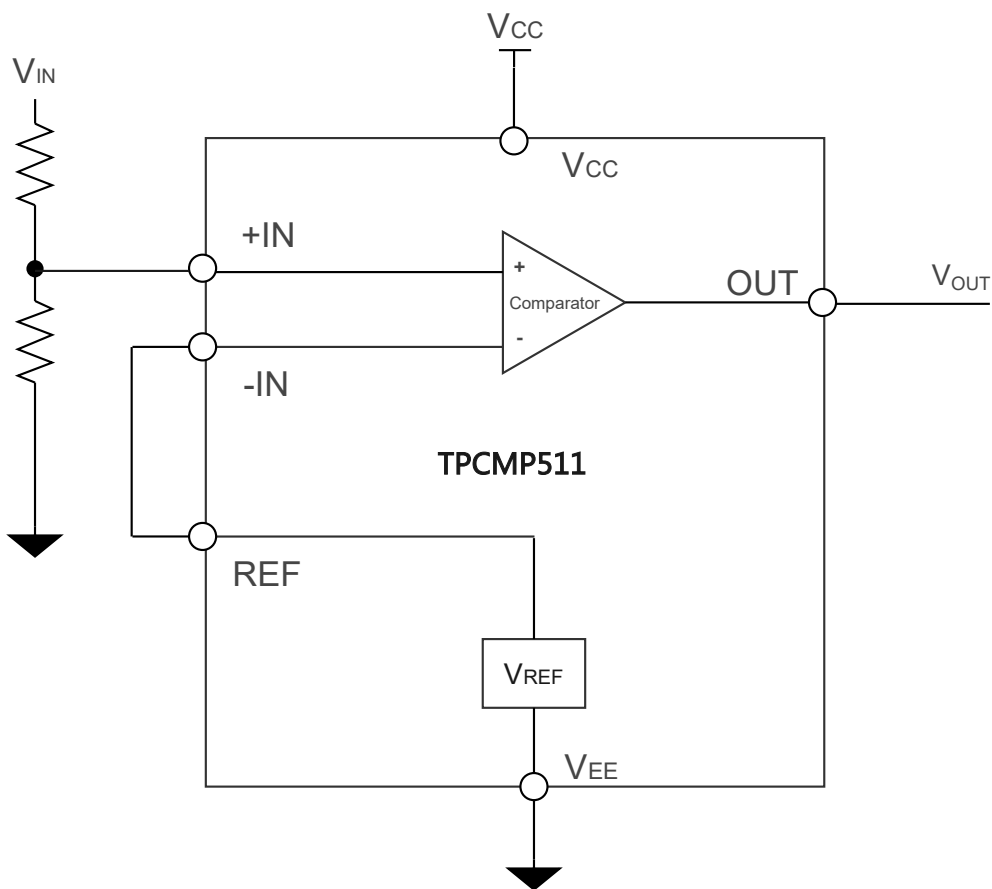
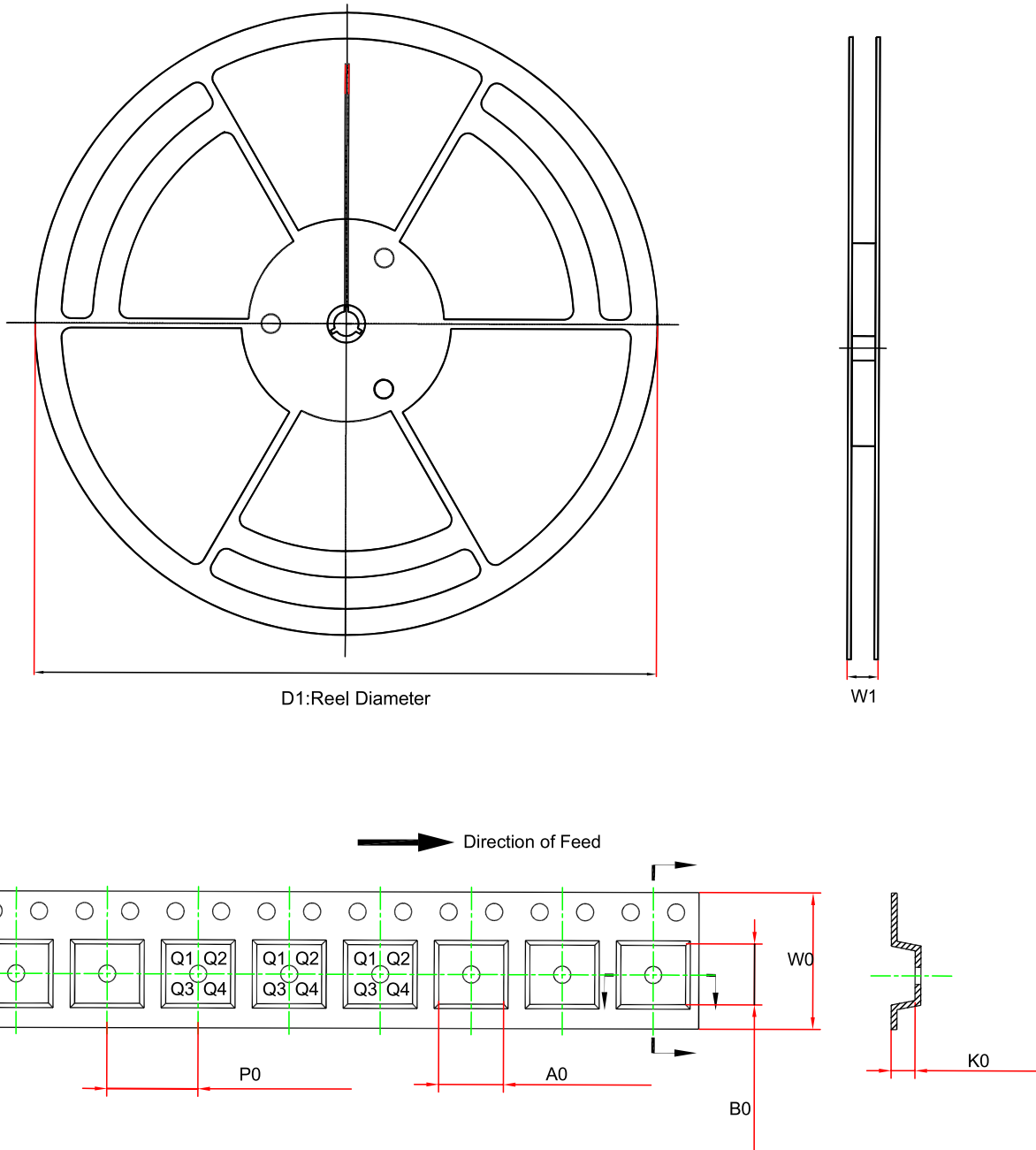


Figure 10. Typical Application Circuit

Tape and Reel Information

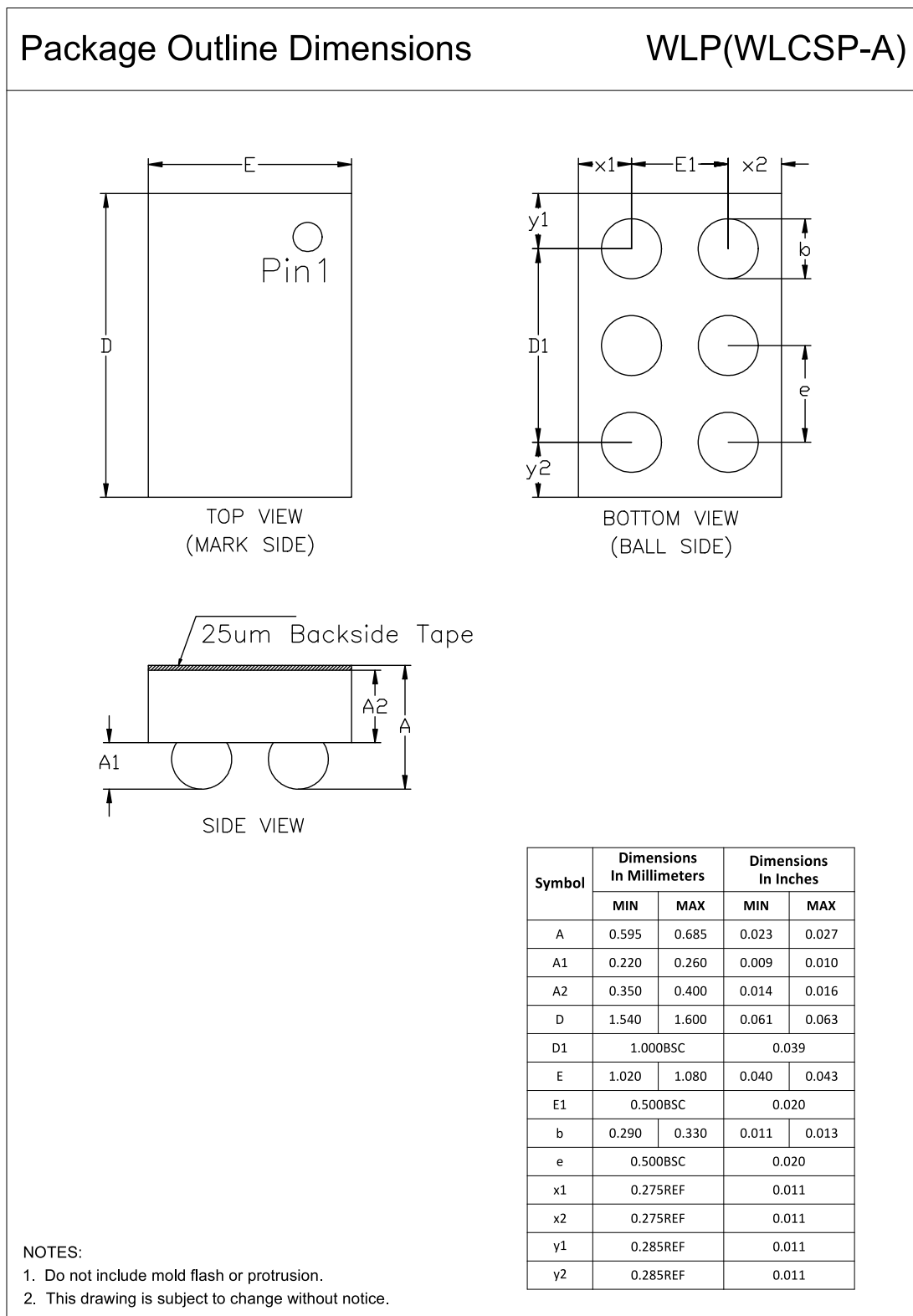


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) ⁽¹⁾	B0 (mm) ⁽¹⁾	K0 (mm) ⁽¹⁾	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPCMP511-WLPR	WLCSP	178	12.5	1.18	1.68	0.83	4	8	Q1

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

Package Outline Dimensions

WLCSP



Micropower, Single-Supply Comparator and Precision Reference IC**Order Information**

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPCMP511-WLPR	-40 to 125°C	WLCSP	C51	MSL1	Tape and Reel,3000	Green

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

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