Low-Noise, Low-Drift, Precision Voltage Reference

Features

- Wide Input Voltage Range:
  - 3 V to 15 V
- Fixed Output Voltage:
  - 1.25 V, 2.048 V, 2.5 V, 3 V, 3.3 V, 4.096 V, 4.5 V, and 5 V
- Low Temperature Coefficient:
  - 2 ppm/°C Typical from 0°C to 70°C
  - 4 ppm/°C Typical from −40°C to 125°C
  - 10 ppm/°C Maximum from −40°C to 125°C
- High Initial Accuracy:
  - 0.05% Maximum
- Low Noise:
  - 3 μVpp/V
- Temperature Range: −40°C to 125°C
- Package Options:
  - SOT23-5

Applications

- Battery Test Equipment
- Industry Control
- Precision Instrumentation
- Medical Equipment

Description

The TPR31 seires is a family of high-precision and low-temperature-drift voltage references with the initial accuracy of 0.05% and the maximum temperature coefficient of 10 ppm/°C. All products of the TPR31 series are able to support both sinking and souring current of ±10 mA and have a low dropout voltage.

The high precision and excellent temperature stability performance make the TPR31 series an ideal reference in the system with high resolution requirement.

The TPR31 series provides a SOT23-5 package with a wide range of output voltages. All the products are qualified to operate with the temperature range from –40°C to +125°C.

Typical Application Circuit

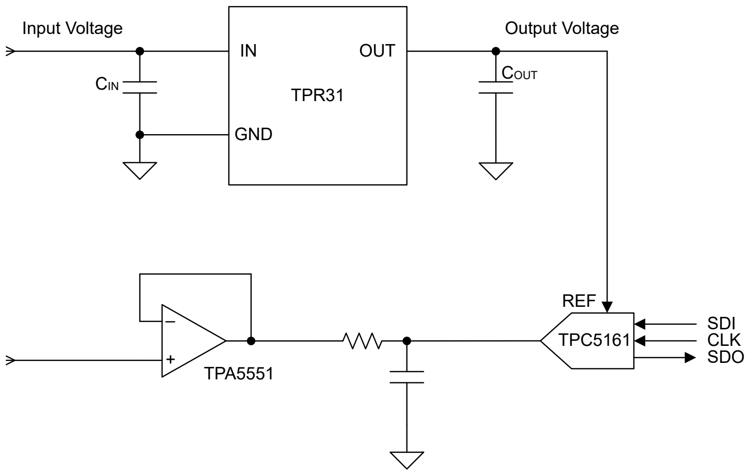


Table of Contents

Product Family Table

Order Number	Output Voltage	Package
TPR3112-S5TR-S (1)	1.25V	SOT23-5
TPR3120-S5TR-S (1)	2.048V	SOT23-5
TPR3125-S5TR-S	2.5V	SOT23-5
TPR3130-S5TR-S	3.0V	SOT23-5
TPR3133-S5TR-S	3.3V	SOT23-5
TPR3140-S5TR-S (1)	4.096V	SOT23-5
TPR3145-S5TR-S (1)	4.5V	SOT23-5
TPR3150-S5TR-S (1)	5.0V	SOT23-5

(1) Preview

Revision History

Revision	Notes
Rev.Pre.0	Preliminary revision.
Rev.A.0	Initial released.

Pin Configuration and Functions

TPR31 Series
SOT23-5 Package
Top View

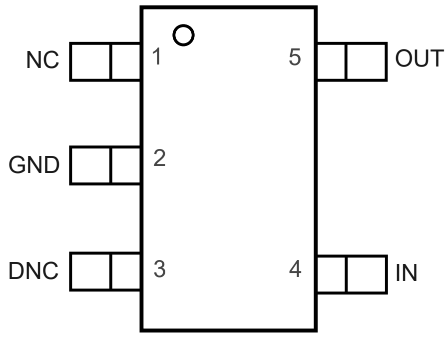


Table 1. Pin Functions: TPR31

Pin Number	Pin Name	I/O	Description
3	DNC	–	Do not connect. Left this pin open or connected to the ground.
2	GND	–	Ground.
4	IN	I	Supply voltage input pin.
1	NC	–	No internal connection.
5	OUT	O	Reference voltage output pin.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V_{IN}	Supply Voltage	−0.3	20	V
T_J	Maximum Junction Temperature	−40	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) All voltage values are with respect to ground.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Value	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_{IN}		3		15	V
I_{OUT}		−10		10	mA
C_{OUT}		0.1	10	100	μF
T_J	Junction Temperature Range	−40		125	°C

Thermal Information

Package Type	θ_{JA}	$\theta_{JC,top}$	θ_{JB}	$\theta_{JC,bottom}$	Unit
SOT23-5	150	110	60	–	°C/W

Electrical Characteristics

All test condition is at T_A = 25°C. V_{IN} = $V_{OUT(NOM)}$ + 0.5 V or 3 V, whichever is grater, I_{OUT} = 0 mA, C_{IN} = C_{OUT} = 1 μF, unless otherwise noted.

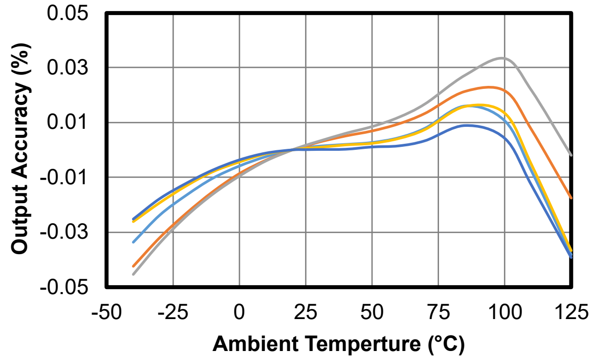
Parameter		Conditions	Min	Typ	Max	Unit
Output Voltage						
V_{OUT}	Output Voltage	TPR3112		1.25		V
		TPR3120		2.048		V
		TPR3125		2.5		V
		TPR3130		3		V
		TPR3133		3.3		V
		TPR3140		4.096		V
		TPR3145		4.5		V
		TPR3150		5		V
	Initial Accuracy		−0.05%		+0.05%	
	Output Noise	f = 0.1 Hz to 10 Hz		3		$\mu V_{PP}/V$
Input Voltage and Current						
V_{IN}	Input Voltage		$V_{IN,MIN}$ (1)		15	V
I_Q	Quiescent Current	T_A= –40°C to 125°C		0.6	1	mA
Dropout Voltage						
V_{DO}	Dropout Voltage (2)	I_{OUT} = ±5 mA, T_A = −40°C to 125°C			200	mV
		I_{OUT} = ±10 mA, T_A = −40°C to 125°C			400	mV
Output Voltage Temperature Drift						
TC	Temperature Coefficient	T_A = 0 to 70°C		2		ppm/°C
		T_A = −40°C to 125°C		4	10	ppm/°C
Outout Regulation						
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	V_{IN} = $V_{IN,MIN}$ to 15 V, T_A = −40°C to 125°C		0.1		ppm/V
		V_{IN} = 6 V to 15 V, T_A = −40°C to 125°C		0.1		ppm/V
		V_{IN} = $V_{IN,MIN}$ to 6 V, V_{OUT} = 1.25 V, 2.048 V, 2.5 V and 3 V, T_A = −40°C to 125°C			20	ppm/V
		V_{IN} = $V_{IN,MIN}$ to 6 V, V_{OUT} = 3.3 V and 4.096 V, T_A = −40°C to 125°C			25	ppm/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN} = $V_{IN,MIN}$, −10 mA < I_{OUT} < 10 mA		2.5	20	ppm/mA
		V_{IN} = $V_{IN,MIN}$, −10 mA < I_{OUT} < 10 mA, T_A = −40°C to 125°C		2.5	20	ppm/mA
Thermal Hysteresis						

Parameter		Conditions	Min	Typ	Max	Unit
THYS	Thermal Hysteresis	Cycle 1 (+25°C to −40°C to +125°C to 25 °C)		100		ppm
		Cycle 2 (+25°C to −40°C to +125°C to 25 °C)		42		ppm
		Cycle 1 (+25°C to +70°C to 0°C to 25 °C)		12		ppm
		Cycle 2 (+25°C to +70°C to 0°C to 25 °C)		8		ppm
Long-Term Stability						
LTS	Long-Term Stability	1000 hours, SOP8 Package				ppm
		2000 hours, SOP8 Package				ppm
Turn-On Settling Time						
t_{ON}	Turn-on Settling Time	To 0.1% with CL = 1 μF		150		μs
Short-Circuit Current						
I_{SC}	Short-Circuit Current	V_{OUT} = 0 V		121		mA
Capacitive Load						
C_L			0.1		100	μF

(1) $V_{IN,MIN} = V_{OUT(NOM)}$ + 0.4 V or 3 V, whichever is greater.
(2) Dropout voltage is not tested for the output voltage below 3 V.

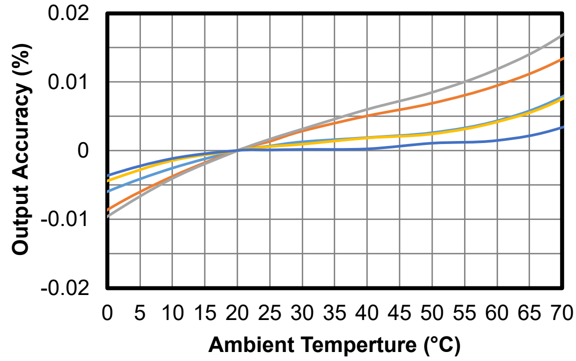
Typical Performance Characteristics

All test conditions: T_A = 25°C. V_{IN} = $V_{OUT(NOM)}$ + 0.5 V or 3 V, whichever is greater; I_{OUT} = 0 mA, C_{IN} = C_{OUT} = 1 μF, unless otherwise noted.



V_{OUT} = 2.5 V

Figure 1. V_{OUT} vs. Temperature



V_{OUT} = 2.5 V

Figure 2. V_{OUT} vs. Temperature

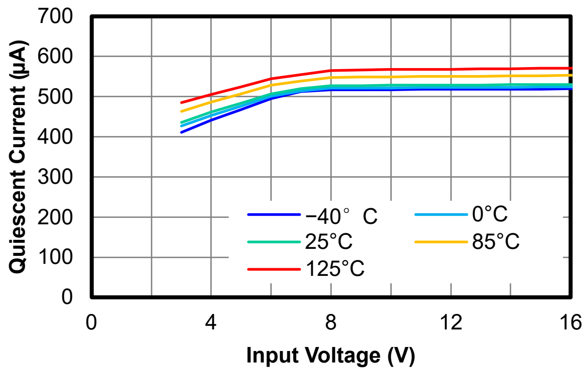


Figure 3. Quiescent Current vs. V_{IN}

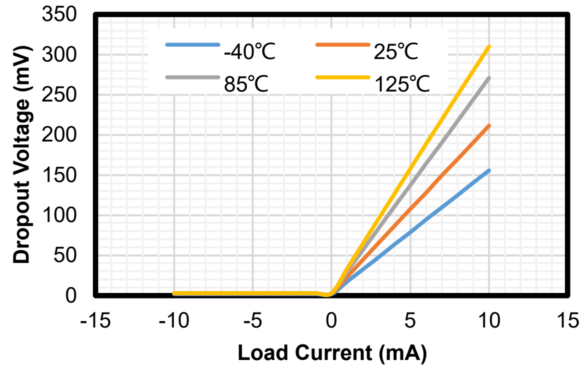
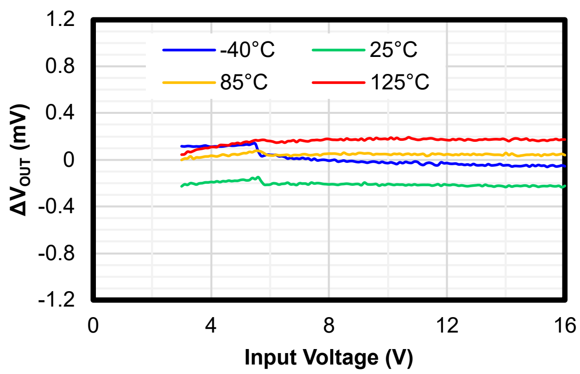
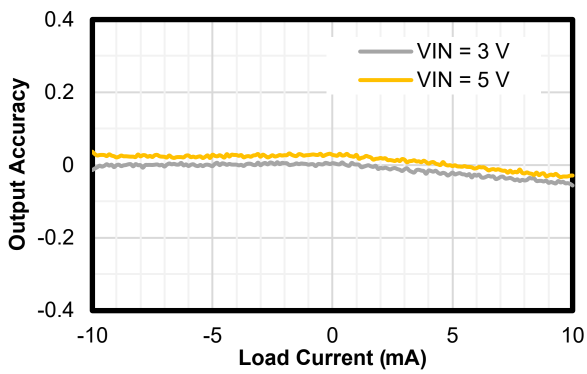


Figure 4. Dropout Voltage



V_{OUT} = 2.5 V

Figure 5. Line Regulation



V_{OUT} = 2.5 V

Figure 6. Load Regulation

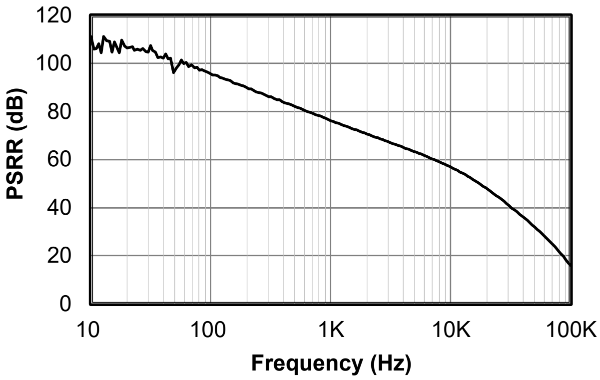


Figure 7. PSRR

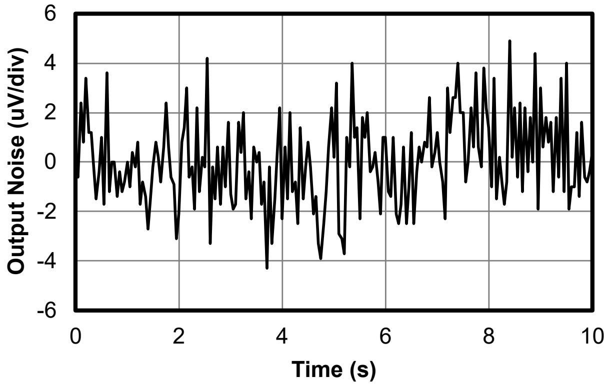
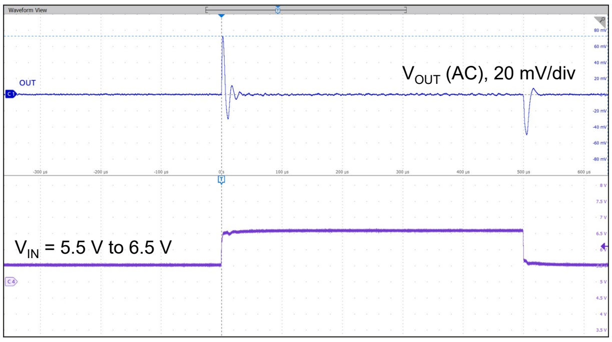
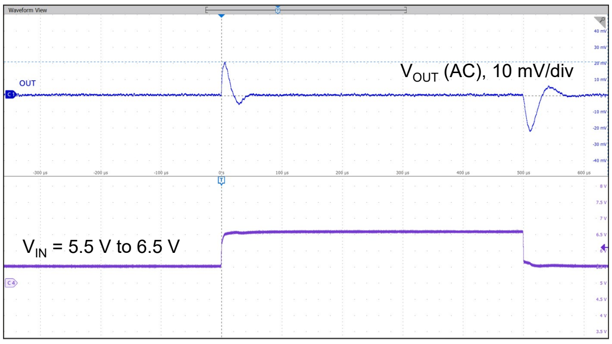


Figure 8. Noise



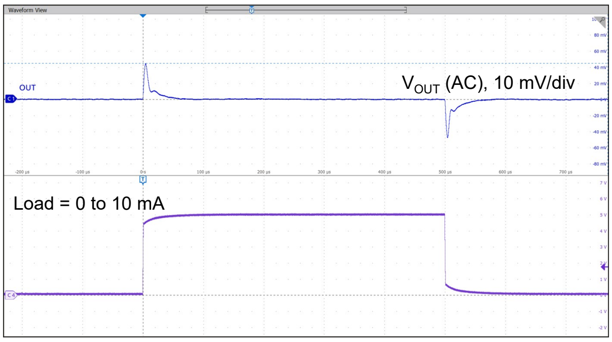
V_{IN} = 5.5 V to 6.5 V, C_{OUT} = 1 µF

Figure 9. Line Transient



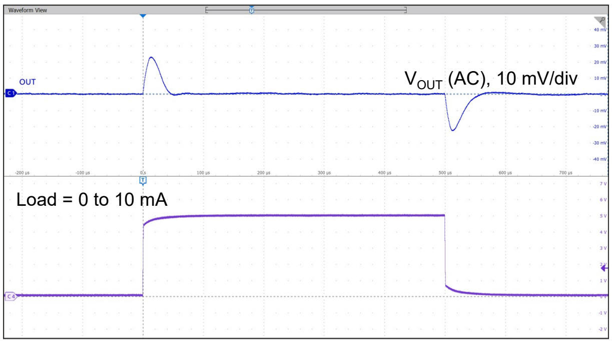
V_{IN} = 5.5 V to 6.5 V, C_{OUT} = 10 µF

Figure 10. Line Transient



Load = 0 to 10 mA, C_{OUT} = 1 µF

Figure 11. Load Transient



Load = 0 to 10 mA, C_{OUT} = 10 µF

Figure 12. Load Transient

Detailed Description

Overview

The TPR31 seires is a family of high-precision and low-temperature-drift voltage references with 0.05% initial accuracy and maximum 10-ppm/°C temperature coefficient. All products of the TPR31 series are able to support both sinking and souring current of ±10 mA and have a low dropout voltage.

The high precision and excellent temperature stability performance make the TPR31 series an ideal reference in the system with high resolution requirement.

Functional Block Diagram

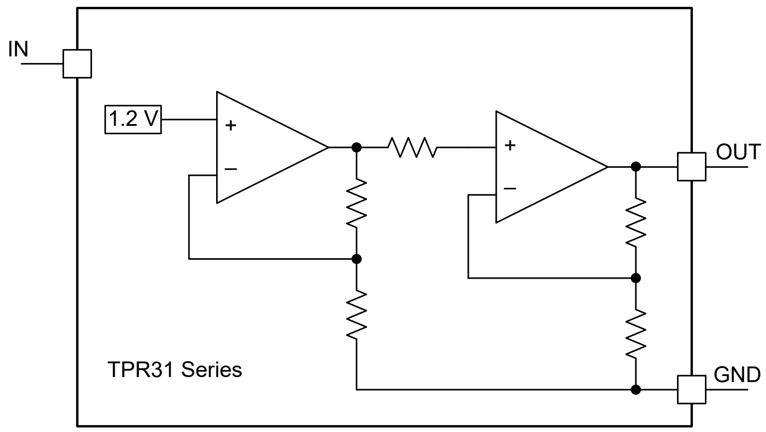


Figure 13. Functional Block Diagram

Feature Description

Temperature Drift

The TPR31 is one of the low-temperature-drift voltage references. Temperature drift is defined as the voltage variation over the operating temperature change, which can be calculated as Equation 1.

$$\text{Temperature Drift} = \left(\frac{V_{OUT,\,max} - V_{OUT,\,min}}{V_{OUT}}\right) / (T_{max} - T_{min}) \times 10^6 \ (\text{ppm/°C}) \quad (1)$$

Where, $V_{OUT,max}$ and $V_{OUT,min}$ are the maximum and minimum voltage values during the temperature change, T_{max} and T_{min} are the temperature range, V_{OUT} is the nominal output voltage.

The maximum temperature drift of TPR31 is 10 ppm/°C maximum from −40°C to 125°C.

Thermal Hysteresis

Thermal hysteresis is defined as the voltage change after the operating temperature cycling, which can be calculated as Equation 2.

$$\text{Thermal Hysteresis} = \frac{|V_{PRE} - V_{POST}|}{V_{OUT}} \times 10^6 \ (\text{ppm}) \quad (2)$$

Where, V_{PRE} is the output voltage before the temperature cycling and V_{POST} is the output voltage after the temperature cycling, V_{OUT} is the nominal output voltage.

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

The TPR31 seires is a family of high-precision and low-temperature-drift voltage references with 0.05% initial accuracy and maximum 10-ppm/°C temperature coefficient. All products of the TPR31 series are able to support both sinking and souring current of ±10 mA and have a low dropout voltage.

Typical Application

Figure 14 shows the typical application schematic.

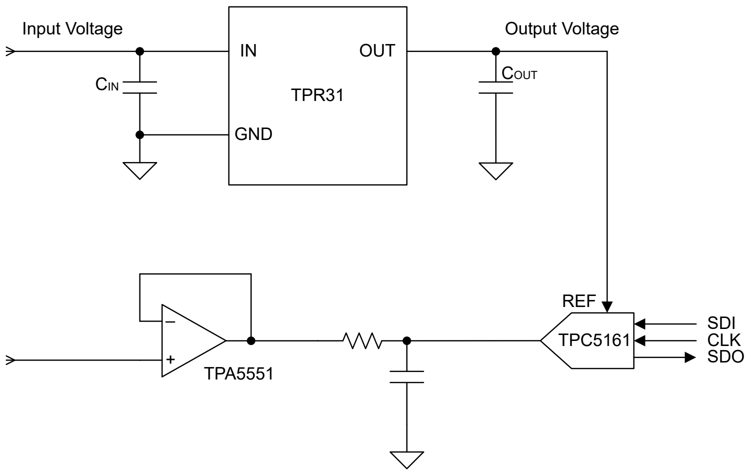


Figure 14. Typical Application Circuit

Power Dissipation and Thermal Consideration

During normal operation, the device junction temperature should meet the requirement in the Recommended Operating Conditions table. Use below equations to calculate the power dissipation and estimate the junction temperature.

The power dissipation can be calculated using Equation 3.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q \quad (3)$$

The junction temperature can be estimated using Equation 4. θ_{JA} is the junction-to-ambient thermal resistance.

$$T_J = T_A + P_D \times \theta_{JA} \quad (4)$$

Layout

Layout Guideline

- Both input capacitors and output capacitors must be placed as close to the device pins as possible.
- It is recommended to bypass the IN pin to ground with a 1-μF to 10-μF capacitor in parallel with a 0.1-μF small ceramic capacitor. The loop area formed by the bypass capacitor connection, the IN pin, and the GND pin of the system must be as small as possible.
- It is required to place a decoupling 1-μF to 50-μF capacitor at the output. A small 1-μF ceramic capacitor in parallel is recommended to filter the noise and improve the output transient performance.

Layout Example

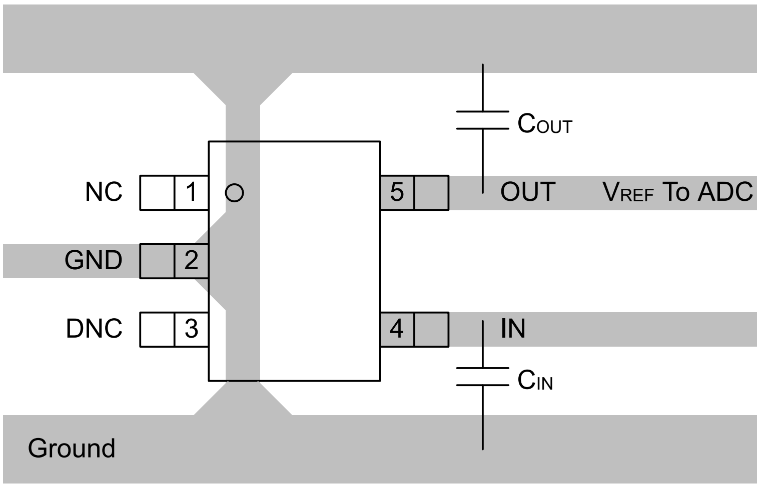
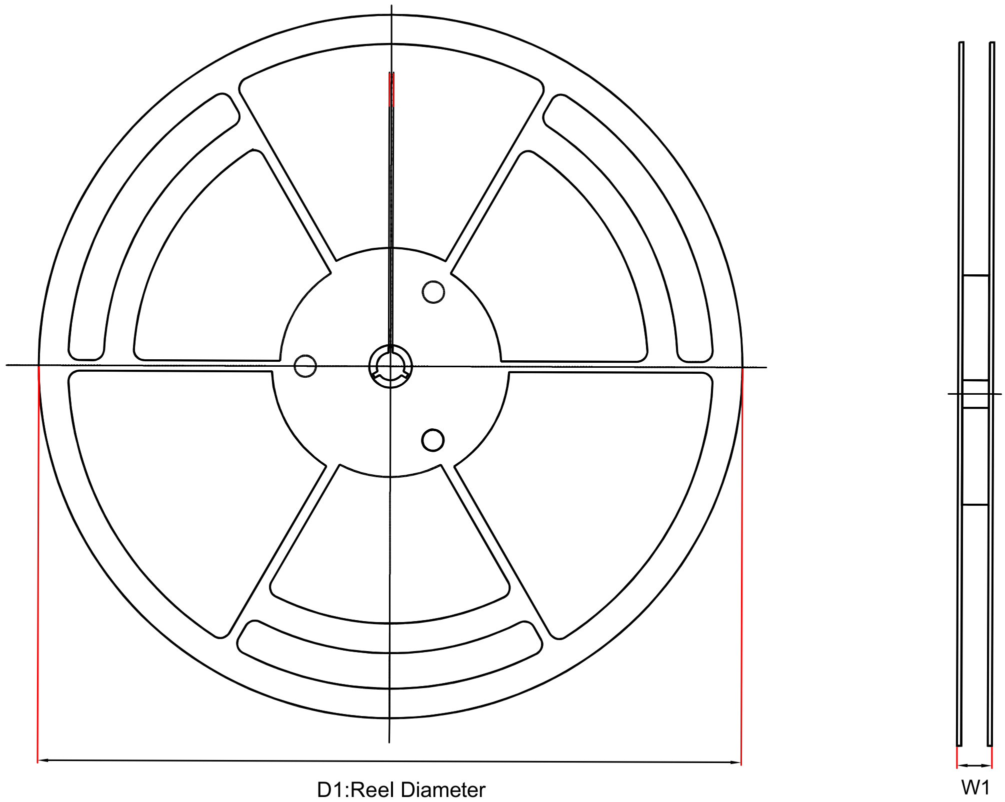
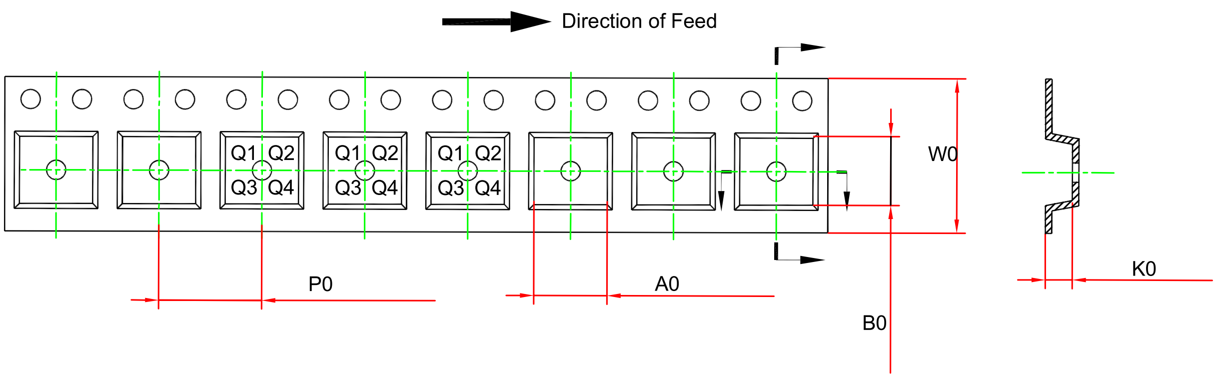


Figure 15. Layout Example

Tape and Reel Information





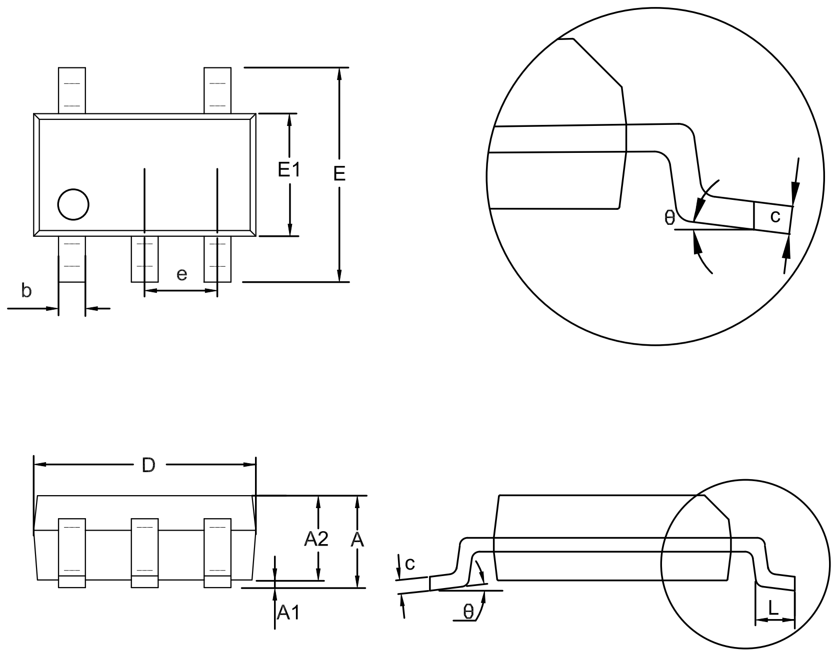
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPR31xx-SO1R (1)	SOT23-5	180	13.1	3.2	3.2	1.4	4	8	Q3

(1) Output voltage value, xx = 12 to 50. For example, 25 means output voltage of 2.5 V.

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.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPR3112-S5TR-S (1)	−40°C to +125°C	SOT23-5	R5A	MSL3	Tape and Reel, 3,000	Green
TPR3120-S5TR-S (1)	−40°C to +125°C	SOT23-5	R5B	MSL3	Tape and Reel, 3,000	Green
TPR3125-S5TR-S	−40°C to +125°C	SOT23-5	R5C	MSL3	Tape and Reel, 3,000	Green
TPR3130-S5TR-S	−40°C to +125°C	SOT23-5	R5D	MSL3	Tape and Reel, 3,000	Green
TPR3133-S5TR-S	−40°C to +125°C	SOT23-5	R5E	MSL3	Tape and Reel, 3,000	Green
TPR3140-S5TR-S (1)	−40°C to +125°C	SOT23-5	R5F	MSL3	Tape and Reel, 3,000	Green
TPR3145-S5TR-S (1)	−40°C to +125°C	SOT23-5	R5H	MSL3	Tape and Reel, 3,000	Green
TPR3150-S5TR-S (1)	−40°C to +125°C	SOT23-5	R5G	MSL3	Tape and Reel, 3,000	Green

(1) For future products, contact 3PEAK factory for more information and samples.
(2) **Green**: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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