

High-Precision Shunt Voltage Reference

Features

- Fixed Output Voltage:
 - 2.048 V, 2.5 V, 3 V, 3.3 V, 4.096 V, and 5 V
- High Initial Accuracy and Low-Temperature Coefficient
 - Grade A: Max 0.1%, 25 ppm/°C
 - Grade B: Max 0.2%, 50 ppm/°C
- Operation Temperature Range: -40°C to 125°C
- Sink Current Capability: 150 µA to 15 mA
- Stable with Any Capacitive Loads
- Qualified for Automotive Applications with AEC-Q100 Reliability Test
- Package: SOT23G-3

Applications

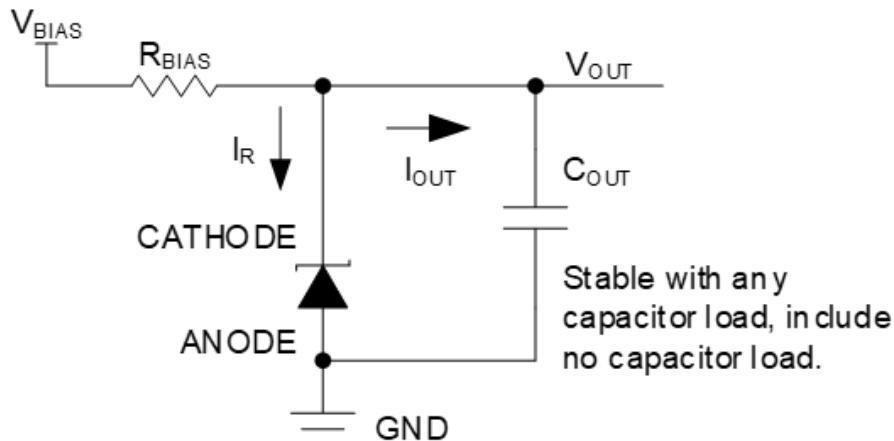
- Power
- Led Lighting
- Current Sensing
- Instrumentation
- Industry

Description

The TPR6040-S is a shunt voltage reference with guaranteed temperature stability over the entire operating temperature range. The temperature range is extended from -40 °C to +125 °C.

The TPR6040-S operates with a wide current range from 0.15 to 15 mA with a typical dynamic impedance of 0.3 Ω.

Typical Application Circuit



$$\begin{aligned}I_R &= (V_{BIAS} - V_{OUT})/R_{BIAS} - I_{OUT} \\I_{RMIN}(0.15mA) &\leqslant I_R \leqslant I_{RMAX}(15mA)\end{aligned}$$

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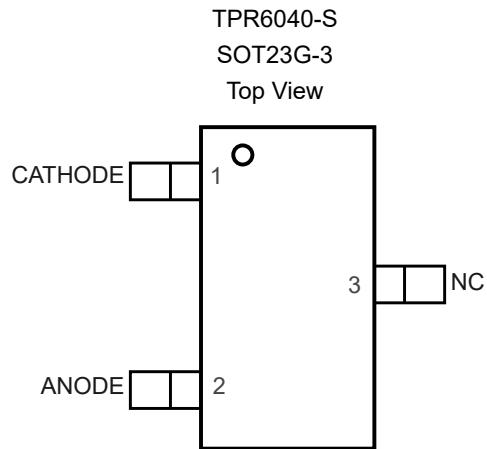
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Product Family Table

Order Number	Voltage (V) Output	Grade	AEC-Q100 Reliability Test	Accuracy	Package
TPR6040F20-S3TR-S	2.048	A	Pass	0.1%	SOT23G-3
TPR6040F25-S3TR-S	2.5	A	Pass	0.1%	SOT23G-3
TPR6040F30-S3TR-S	3	A	Pass	0.1%	SOT23G-3
TPR6040F33-S3TR-S	3.3	A	Pass	0.1%	SOT23G-3
TPR6040F40-S3TR-S	4.096	A	Pass	0.1%	SOT23G-3
TPR6040F50-S3TR-S	5	A	Pass	0.1%	SOT23G-3

Revision History

Date	Revision	Notes
2019-12-25	Rev.Pre.0	Pre-released version.
2020-07-15	Rev.A.0	Initial version.
2020-07-25	Rev.A.1	1. Added the description of the pin 3 in Pin Configuration. 2. Added Tape and Reel Information.
2022-05-15	Rev.A.2	1. Added the maximum value of $\Delta V_R / \Delta I_R$ 2. Added the typical value of Long-Term Stability and Thermal Hysteresis. 3. Removed the Electrical Characteristics table of 8.192 V and 10 V.
2022-12-01	Rev.A.3	Added "Qualified for Automotive Applications with AEC-Q100 Reliability Test".
2024-10-23	Rev.A.4	1. Updated to a new datasheet format. 2. Added Pin function description.

High-Precision Shunt Voltage Reference**Pin Configuration and Functions**

Pin 3 must be left floating or connected to Pin 2.

Table 1. Pin Functions: TPR6040-S

Pin No.	Pin Name	I/O	Description
2	ANODE	O	ANODE pin. Connect this pin to ground.
1	CATHODE	I/O	CATHODE pin. Shunt current and input voltage.
3	NC	-	Do not connect. This pin must be left floating or connected to Pin 2.

High-Precision Shunt Voltage Reference

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Reverse Current		20	mA
	Forward Current		10	mA
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.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	4000	V
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1000	V

(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	Max	Unit
I _R	Cathode Reverse Current	0.15	15	mA

Thermal Information

Package Type	θ _{JA}	θ _{Jc}	Unit
SOT23G-3	250	81	°C/W

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F20, 2.048-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			0.8	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			1	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			2	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			3	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		72		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		40		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F25, 2.5-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			0.8	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			1	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			2	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			3	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		90		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		50		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F30, 3-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			1	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			1.2	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			2.4	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			3.6	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		108		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		60		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F33, 3.3-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			1.1	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			1.4	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			2.7	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			4	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		119		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		66		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F40, 4.096-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			1.4	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			1.7	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			3.3	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			5	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		148		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		82		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference
Electrical Characteristics – TPR6040F50, 5-V Output

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_R	Reverse Breakdown Voltage Tolerance	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$	-0.1		0.1	%
		$I_R = 1 \text{ mA}, \text{B Grade}$	-0.2		0.2	%
$\Delta V_R / \Delta V_T$	Average Reverse Breakdown Voltage Temperature Coefficient	$I_R = 1 \text{ mA}, \text{A Grade, “-S” suffix}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-25		25	ppm
		$I_R = 1 \text{ mA}, \text{B Grade}$ $T_A = -40 \text{ to } 125^\circ\text{C}$	-50		50	ppm
I_{RMIN}	Minimum Operating Current			100	150	μA
		$T_A = -40 \text{ to } 125^\circ\text{C}$			150	μA
$\Delta V_R / \Delta I_R$	Reverse Breakdown Voltage Change with Operating Current Change ⁽¹⁾	$I_{RMIN} \leq I_R < 1 \text{ mA}$			1.6	mV
		$I_{RMIN} \leq I_R < 1 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			2	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}$			4	mV
		$I_{RMIN} \leq I_R < 15 \text{ mA}, T_A = -40 \text{ to } 125^\circ\text{C}$			6	mV
Noise	Wideband Noise	$I_R = 100 \mu\text{A}, 10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		180		μV_{RMS}
	Output Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$		100		μV_{PP}
Z_R	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}, f = 120 \text{ Hz}$		0.3	0.8	Ω
LTD	Long-Term Stability	0 to 1000 hours		200		ppm
		1000 to 2000 hours		200		ppm
TH	Thermal Hysteresis			80		ppm

(1) The changing output due to die temperature change must be considered separately.

High-Precision Shunt Voltage Reference

Typical Performance Characteristics

All test conditions: $V_{OUT} = 2.5$ V, $T_A = +25^\circ\text{C}$, unless otherwise noted.

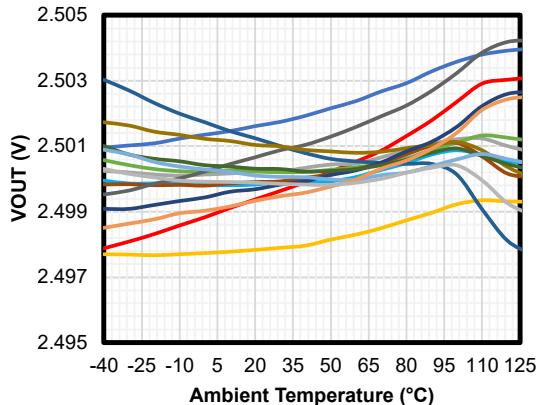


Figure 1. V_{OUT} vs. Temperature

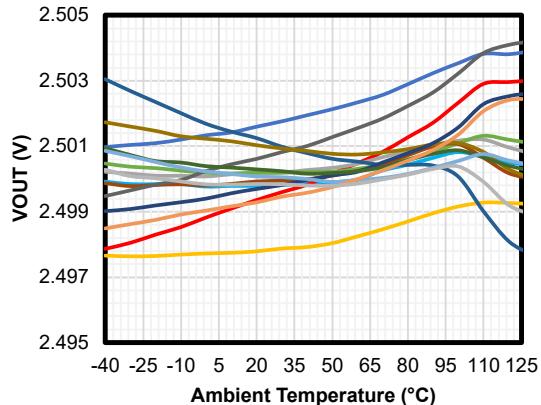


Figure 2. V_{OUT} vs. Temperature

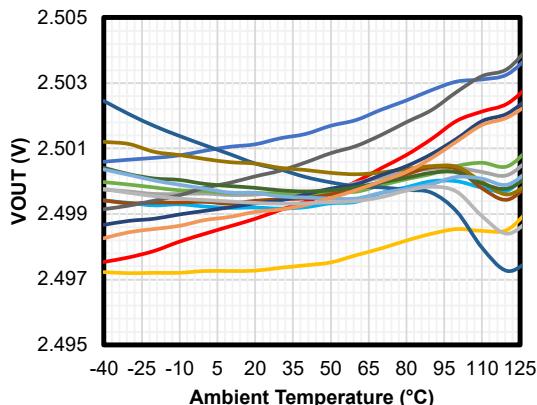


Figure 3. V_{OUT} vs. Temperature

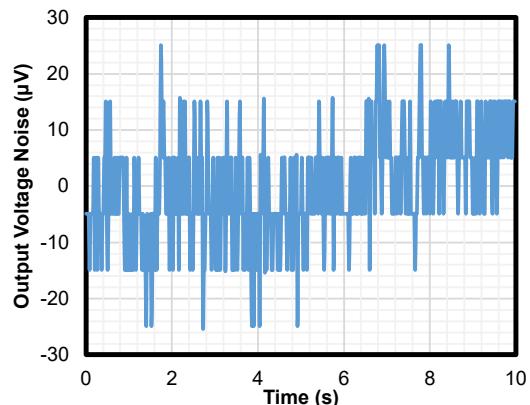


Figure 4. 0.1-Hz to 10-Hz Noise



Figure 5. Power Up, 100 μs , $V_{BIAS} = 6.5$ V, $R_{BIAS} = 0.5 \text{ k}\Omega$



Figure 6. Power Up, 15 ms, $V_{BIAS} = 6.5$ V, $R_{BIAS} = 0.5 \text{ k}\Omega$

High-Precision Shunt Voltage Reference

Typical Performance Characteristics (continued)

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



Figure 7. Power up, 100 μs , $V_{BIAS} = 6.5 \text{ V}$, $R_{BIAS} = 2.5 \text{ k}\Omega$



Figure 8. Power up, 15 ms, $V_{BIAS} = 6.5 \text{ V}$, $R_{BIAS} = 2.5 \text{ k}\Omega$



Figure 9. Power up, 100 μs , $V_{BIAS} = 6.5 \text{ V}$, $R_{BIAS} = 20 \text{ k}\Omega$



Figure 10. Power up, 15 ms, $V_{BIAS} = 6.5 \text{ V}$, $R_{BIAS} = 20 \text{ k}\Omega$

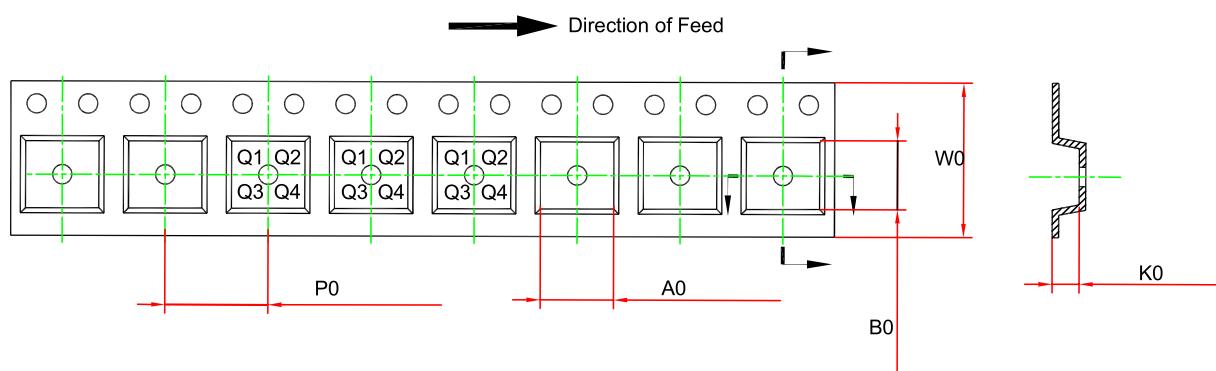
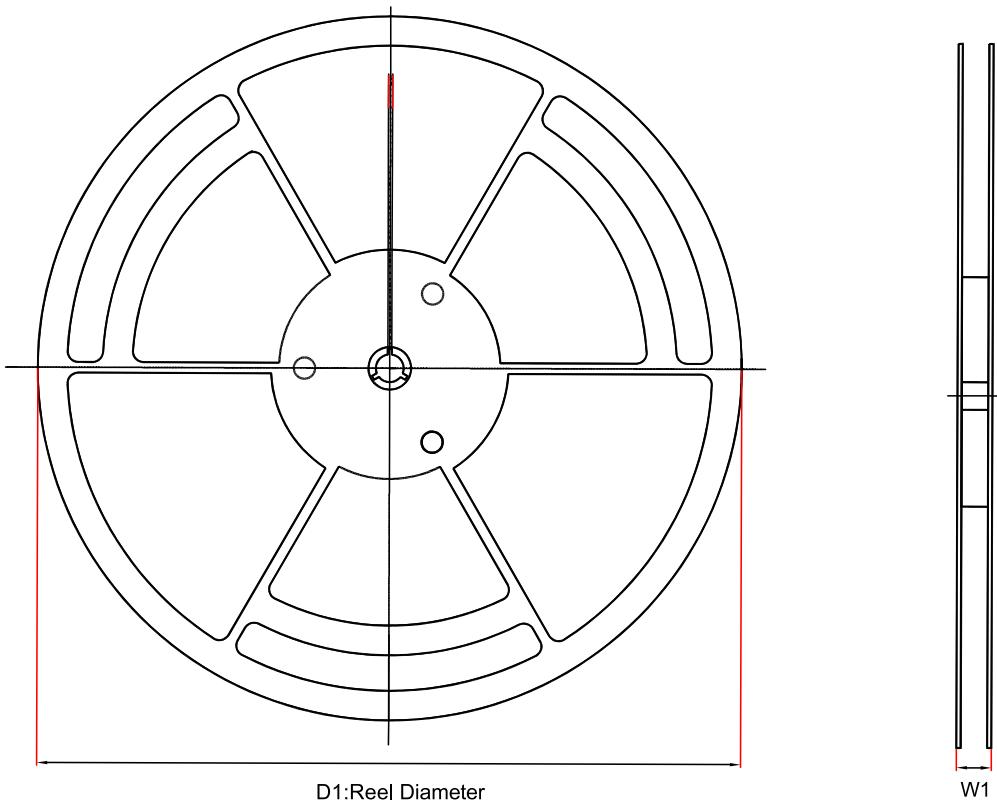
High-Precision Shunt Voltage Reference

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.

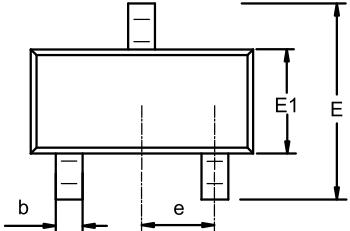
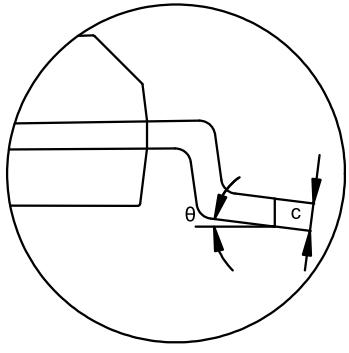
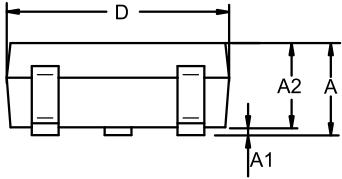
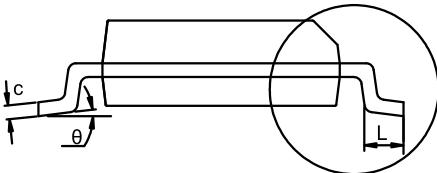
Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPR6040Fxx-S3TR-S	SOT23G-3	178	12.1	3.15	2.77	1.22	4.0	8.0	Q3

(1) Output voltage, xx = 20 to 50.

High-Precision Shunt Voltage Reference
Package Outline Dimensions
SOT23G-3

Package Outline Dimensions		3ST(SOT23G-3-A)			
					
					
Symbol	Dimensions In Millimeters		Dimensions In Inches		
	MIN	MAX	MIN	MAX	
A	0.890	1.120	0.035	0.044	
A1	0.000	0.100	0.000	0.004	
A2	0.890	1.100	0.035	0.043	
b	0.300	0.500	0.012	0.020	
c	0.132	0.230	0.005	0.009	
D	2.800	3.000	0.110	0.118	
E	2.250	2.640	0.089	0.104	
E1	1.200	1.400	0.047	0.055	
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.

High-Precision Shunt Voltage Reference**Order Information**

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPR6040F20-S3TR-S	-40 to 125°C	SOT23G-3	R6B	3	Tape and Reel, 3000	Green
TPR6040F25-S3TR-S	-40 to 125°C	SOT23G-3	R6C	3	Tape and Reel, 3000	Green
TPR6040F30-S3TR-S	-40 to 125°C	SOT23G-3	R6D	3	Tape and Reel, 3000	Green
TPR6040F33-S3TR-S	-40 to 125°C	SOT23G-3	R6E	3	Tape and Reel, 3000	Green
TPR6040F40-S3TR-S	-40 to 125°C	SOT23G-3	R6F	3	Tape and Reel, 3000	Green
TPR6040F50-S3TR-S	-40 to 125°C	SOT23G-3	R6G	3	Tape and Reel, 3000	Green

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

High-Precision Shunt Voltage Reference

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