Features

- Fixed Output Voltage: 2.048V, 2.5V, 3V, 4.096V, 5V, 8.192V and 10V
- High Initial Accuracy and Low Temperature Coefficient
  - Max 0.1%, 25ppm/°C – A Grade
  - Max 0.2%, 50ppm/°C – B Grade
- Operation From −40°C to 125°C
- Sink Current Capability: 150μA to 15mA
- Stable with Any Capacitive Loads

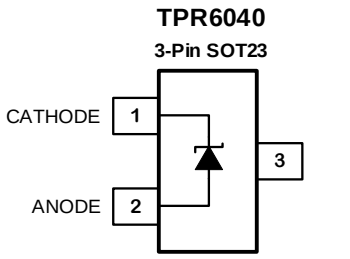
Applications

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

Description

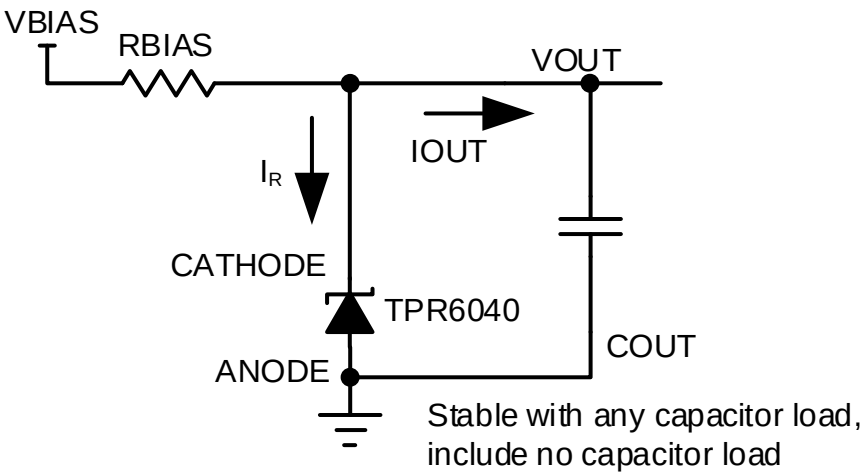
The TPR6040 is shunt voltage reference with guaranteed temperature stability over the entire operating temperature range. The device temperature range is extended for the automotive version from -40 °C up to +125 °C. The TPR6040 operate with a wide current range from 0.15 to 15 mA with a typical dynamic impedance of 0.3 Ω.

Pin Configuration



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

Typical Connection



I_R = (VBIAS - VOUT) / RBIAS - IOUT

I_{RMIN}(0.15mA)<= I_R <= I_{RMAX}(15mA)

Order Information

Order Number	Output Voltage	Grade	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TPR6040F20-S3TR-S	2.048	A	-40 to 125°C	SOT23-G	R6B	MSL 3	3000
TPR6040F25-S3TR-S	2.5	A	-40 to 125°C	SOT23-G	R6C	MSL 3	3000
TPR6040F30-S3TR-S	3	A	-40 to 125°C	SOT23-G	R6D	MSL 3	3000
TPR6040F33-S3TR-S Note1	3.3	A	-40 to 125°C	SOT23-G	R6E	MSL 3	3000
TPR6040F40-S3TR-S	4.096	A	-40 to 125°C	SOT23-G	R6F	MSL 3	3000
TPR6040F50-S3TR-S	5	A	-40 to 125°C	SOT23-G	R6G	MSL 3	3000
TPR6040F80-S3TR-S Note1	8.192	A	-40 to 125°C	SOT23-G	R6H	MSL 3	3000
TPR6040FA0-S3TR-S Note1	10	A	-40 to 125°C	SOT23-G	R6I	MSL 3	3000
TPR6040F20-S3TR	2.048	B	-40 to 125°C	SOT23-G	R6B	MSL 3	3000
TPR6040F25-S3TR	2.5	B	-40 to 125°C	SOT23-G	R6C	MSL 3	3000
TPR6040F30-S3TR	3	B	-40 to 125°C	SOT23-G	R6D	MSL 3	3000
TPR6040F33-S3TR Note1	3.3	B	-40 to 125°C	SOT23-G	R6E	MSL 3	3000
TPR6040F40-S3TR	4.096	B	-40 to 125°C	SOT23-G	R6F	MSL 3	3000
TPR6040F50-S3TR	5	B	-40 to 125°C	SOT23-G	R6G	MSL 3	3000
TPR6040F80-S3TR Note1	8.192	B	-40 to 125°C	SOT23-G	R6H	MSL 3	3000
TPR6040FA0-S3TR Note1	10	B	-40 to 125°C	SOT23-G	R6I	MSL 3	3000

Note 1: The sample will be ready after 2 months when production start.

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Revision History

Date	Revision	Notes
2019/12/25	Rev.Pre	Pre-Release version
2020/7/15	Rev.A	Initial version
2020/7/25	Rev.A.1	Add pin3 description in pin configuration. Add Tape and Reel Information.

Absolute Maximum Ratings Note 1

Parameters	Rating
Reverse current	20 mA
Forward current	10 mA
Maximum Junction Temperature	150°C
Operating Temperature Range	–40 to 125°C
Storage Temperature Range	–65 to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note 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 Rating

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
3-Pin SOT23	250	81	°C/W

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
I_R	Cathode Reverse Current	0.15	15	mA

Electrical Characteristics – TPR6040F20, 2.048V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA				0.8	mV
			-40 to 125°C			1	mV
		I_{RMIN} <=I_R < 15mA				2	mV
			-40 to 125°C			3	mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			72		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			40		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F25, 2.5V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA				0.8	mV
			-40 to 125°C			1	mV
		I_{RMIN} <=I_R < 15mA				2	mV
			-40 to 125°C			3	mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			90		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			50		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F30, 3.0V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			108		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			60		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F33, 3.3V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			119		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			66		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F40, 4.096V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			148		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			82		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F50, 5V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			180		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			100		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040F80, 8.196V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			295		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			164		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Electrical Characteristics – TPR6040FA0, 10V Output

All test condition is at T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_R	Reverse Breakdown Voltage Tolerance	I_R = 1mA, A Grade, "-S" suffix		-0.1		0.1	%
		I_R = 1mA, B Grade		-0.2		0.2	%
ΔV_R / ΔV_T	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 1mA, A Grade, "-S" suffix	-40 to 125°C	-25		25	ppm
		I_R = 1mA, B Grade		-50		50	ppm
I_{RMIN}	Minimum Operating Current				100	150	μA
			-40 to 125°C			150	μA
ΔV_R / ΔI_R	Reverse Breakdown Voltage Change with Operating Current Change Note 1	I_{RMIN} <=I_R < 1mA					mV
			-40 to 125°C				mV
		I_{RMIN} <=I_R < 15mA					mV
			-40 to 125°C				mV
	Wideband Noise	IR = 100 μA, 10 Hz ≤ f ≤ 10 kHz			360		μV_{RMS}
	Output voltage noise	f = 0.1 Hz to 10 Hz			200		μVpp
Z_R	Reverse Dynamic Impedance	I_R = 1mA, f = 120Hz			0.3	0.8	Ω
	Long Term Stability	0 to 1000hours	25°C				ppm
		1000 to 2000hours	25°C				ppm
	Thermal Hysteresis						ppm

Note 1. Output changes due to die temperature change must be taken into account separately.

Typical Performance Characteristics – TPR6040F25

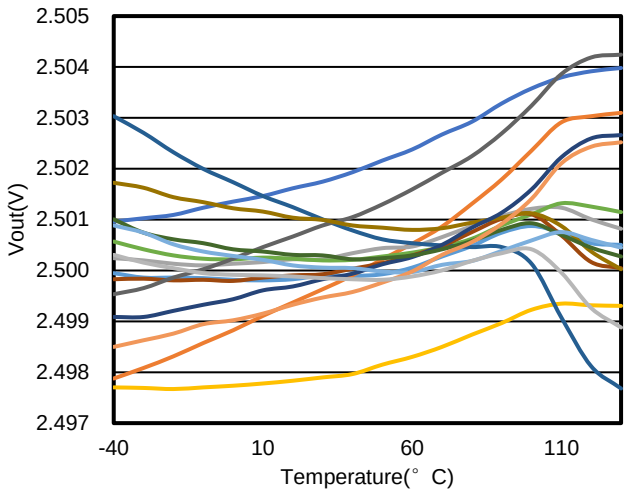


Figure 1. V_{OUT} vs. Temperature, 125μA,12pcs Sample

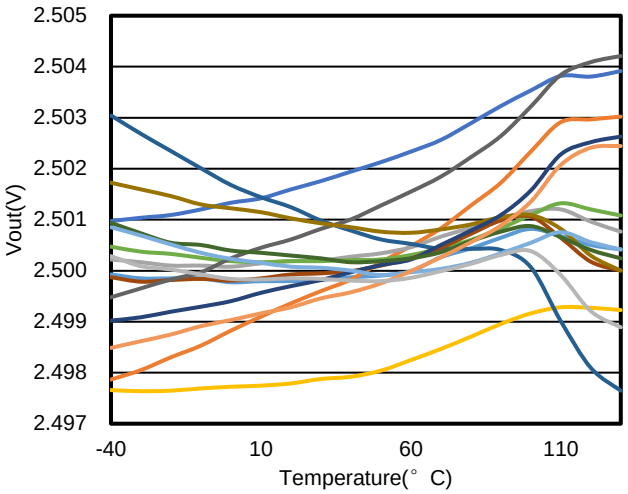


Figure 2. V_{OUT} vs. Temperature, 1mA,12pcs Sample

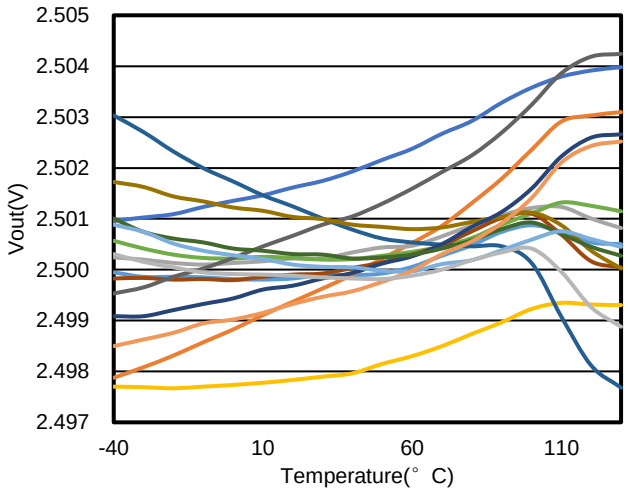


Figure 3. V_{OUT} vs. Temperature, 10mA,12pcs Sample

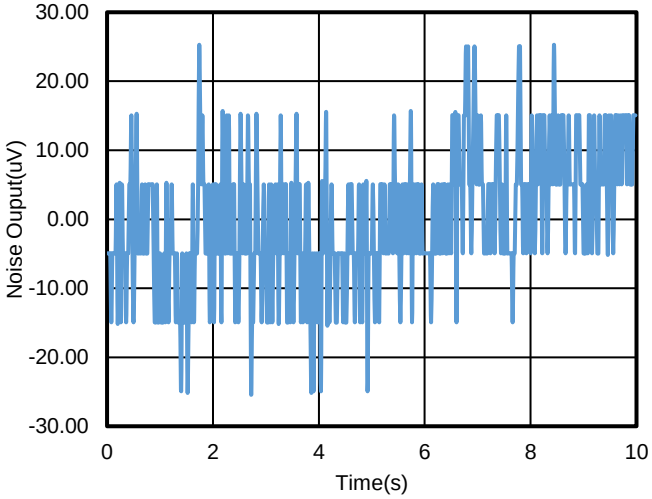


Figure 4. 0.1 to 10Hz Noise



Figure 5. Power Up, 100μs, V_{BIAS}=6.5V, R_{BIAS}=0.5K



Figure 6. Power Up, 15ms, V_{BIAS}=6.5V, R_{BIAS}=0.5K



Figure 7. Power Up, 100μs, V_{BIAS}=6.5V, R_{BIAS}=2.5K



Figure 8. Power Up, 15ms, V_{BIAS}=6.5V, R_{BIAS}=2.5K

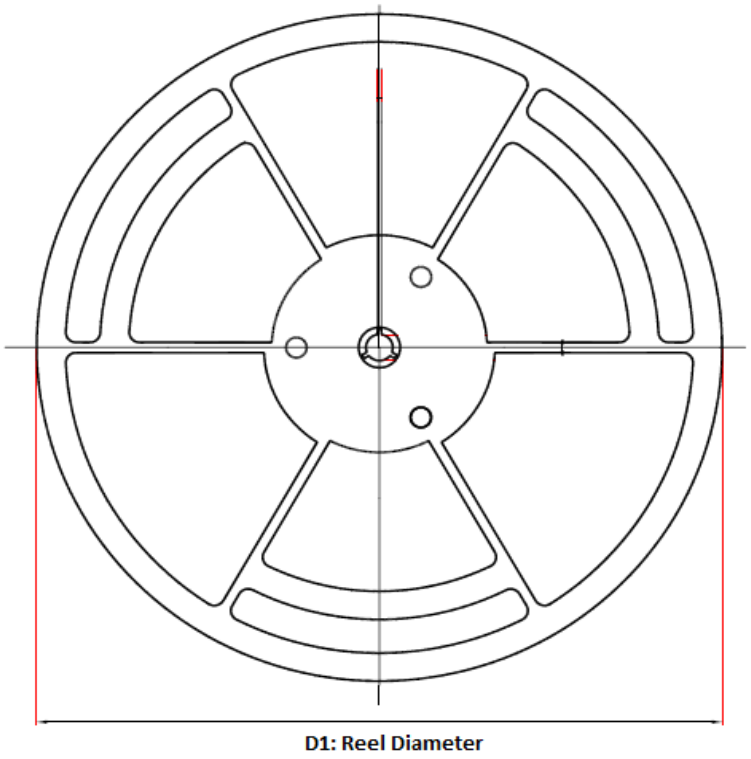


Figure 9. Power Up, 100μs, V_{BIAS}=6.5V, R_{BIAS}=20K



Figure 10. Power Up, 15ms, V_{BIAS}=6.5V, R_{BIAS}=20K

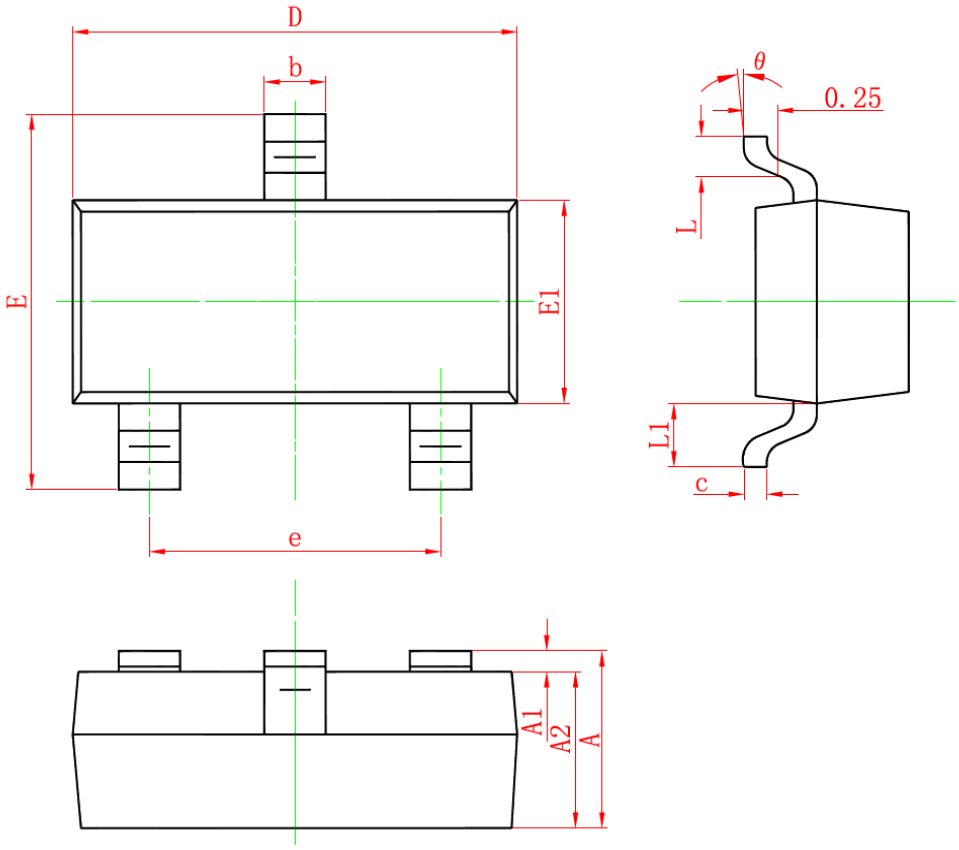
Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPR6040FXX-S3TR-S	3-Pin SOT23-G	178	12.1	3.15	2.77	1.22	4.0	8.0	Q3
TPR6040FXX-S3TR	3-Pin SOT23-G	178	12.1	3.15	2.77	1.22	4.0	8.0	Q3

Package Outline Dimensions

SOT23-G



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.15Max.		0.045Max.	
A1	0.000	0.100	0.000	0.004
A2	0.900	1.100	0.035	0.043
b	0.300	0.500	0.012	0.020
c	0.132	0.202	0.005	0.008
D	2.800	3.000	0.110	0.118
E	2.250	2.550	0.089	0.100
E1	1.200	1.400	0.047	0.055
e	1.800	2.000	0.071	0.079
L	0.300	0.500	0.012	0.020
L1	0.550 REF.		0.022 REF.	
θ	0°	8°	0°	8°

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