Low-Voltage 1-Ω SPDT Analog Switch

Features

- Latch-up Performance Exceeds 800 mA per JESD 78, Class II
- Supply Voltage: 1.65 V to 5.5 V
- Low On-State Resistance: Typical 0.95 Ω at V_S = 4.5 V
- Bandwidth: 100 MHz
- Fast Switching Times: t_{ON} = 40 ns, t_{OFF} = 15 ns
- Break-Before-Make Switching
- Operation Temperature Range: –40°C to 125°C

Applications

- Industry Control Systems
- Battery-Powered Systems
- Audio Signal Routing
- Portable Instruments and Mobile Devices

Description

The TPW4157 is a high-performance Single Pole/Double Throw (SPDT) analog switch. The device features ultra-low RON of 1.15-Ω maximum at 4.5-V V_{CC} and operates over a wide V_{CC} range from 1.65 V to 5.5 V.

The TPW4157 features very low quiescent current even when the control voltage is lower than the V_{CC} supply. This feature serves the portable applications very well allowing for a direct interface with processor general purpose I/Os.

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Revision History

Date	Revision	Notes
2018-03-24	Rev.Pre.0	Preliminary version.
2018-11-01	Rev.A.0	Initial release.
2019-04-21	Rev.A.1	• Updated the Marking Information. • Updated the Package Outline Dimensions. • Corrected the T_{off} test condition in Figure 6: from 50% of output to 90% of output. • Corrected the T_b test condition in Electrical Characteristics: from B0 or B1 = 3 V to B0 or B1 = 1.5 V. • Corrected the T_b test condition in Figure 7: from 0.9 × V_{out} to 0.9 V. • Changed the spec of ΔRON at 1.65 V_{CC} change: from 2/3/3 ohm to 5/7/7 ohm.
2021-04-01	Rev.A.2	Added the TPW4157-TR.
2022-03-23	Rev.B.0	Updated the SOT23-6 MSL from 1 to 3.
2024-12-04	Rev.B.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. Updated to a new datasheet format. Updated the Tape and Reel Information. Updated the Package Outline Dimensions.

Pin Configuration and Functions

TPW4157
SOT363/SOT23-6
Top View

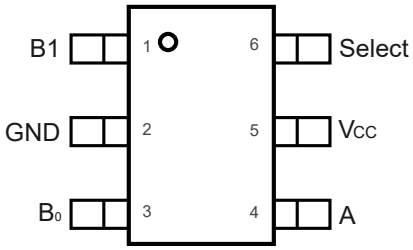


Table 1. Pin Functions

Pin No.	Name	I/O	Description
1	B_1		Switch port 1
2	GND		Ground
3	B_0		Switch port 0
4	A		Common switch port
5	V_{CC}		Power supply
6	Select		Select pin

Table 2. Function Table

Input: Select Pin	Function
Low	B0 connected to A
High	B1 connected to A

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage, V_{CC}	−0.5	6	V
	Select Input Voltage	−0.5	6	V
	Select Input Diode Current		–50	mA
	Switch I/O Port Voltage	–0.5	V_{CC} + 0.5	V
	Switch I/O Port Diode Current	−50	50	mA
	Switch Current		200	mA
T_J	Maximum Junction Temperature		150	°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)	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	2	kV
LU	Latch Up	JESD 78, 25°C	800	mA
		JESD 78, 125°C	800	mA

(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 (1)

All test conditions: over operating temperature range, unless otherwise noted.

Parameter	Min	Max	Unit
Supply Voltage, V_{CC}	1.65	5.5	V
Select Input Voltage	0	V_{CC}	V
Input Transition Rise and Fall Rate		100	ns/V
Switch I/O Port Voltage	0	V_{CC}	V
Operating Temperature Range	–40	125	°C

(1) The select input must be held HIGH or LOW and must not float.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT363	400		°C/W

Electrical Characteristics

All test conditions: V_{CC} = 4.5 V to 5.5 V, unless otherwise noted.

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
Power Supply								
I_{CC}	Quiescent Supply Current	V_{IN} = 0 V or V_{CC}	5.5	0.3	0.5	1.5	Max	μA
ΔI_{CC}	Increase in I_{CC} per Input	Select input at 2.7 V, others at V_{CC} or GND	4.3	20	25	25	Max	μA
Digital Input								
V_{IH}	Input Voltage High				2.4	2.4	Min	V
V_{IL}	Input Voltage Low				0.8	0.8	Max	V
I_{IN}	Control Input Leakage	V_{IN} = 0 V or V_{CC}	5.5		±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 100 mA, B0 or B1 = 3.5 V	4.5	0.95			Typ	Ω
R_{ON}		I_{OUT} = 100 mA, B0 or B1 = 3.5 V	4.5	1.15	1.4	1.5	Max	Ω
ΔR_{ON}	Maximum On Resistance	I_{OUT} = 100 mA, B0 or B1 = 3.5 V	4.5	0.12	0.15	0.2	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 100 mA, B0 or B1 = 0 V, 1 V, 2 V	4.5	0.3	0.4	0.5	Max	Ω
$I_{NO(OFF)}$, $I_{NC(OFF)}$	Switch OFF Leakage Current on B0, B1	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	5.5	±10	±25	±50	Max	nA
$I_{A(OFF)}$	Switch OFF Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	5.5	±10	±50	±100	Max	nA
$I_{A(ON)}$	Switch ON Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 1 V, 4.5 V, or Floating	5.5	±10	±50	±100	Max	nA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	B0 or B1 = 3 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	4.5	5			Typ	ns
t_{ON}	Switch Turn-on Time	B0 or B1 = 3 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	4.5	40	45	45	Max	ns
t_{OFF}	Switch Turn-off Time	B0 or B1 = 3 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	4.5	15	20	20	Max	ns
t_B	Break-Before-Make Time	B0 or B1 = 1.5 V, R_L = 50 Ω, C_L = 35 pF, Figure 7	4.5	20	40	40	Max	ns
Q	Charge Injection	C_L = 1.0 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 8	5.5	20			Typ	pC

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, Figure 9	5	−65			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, Figure 10	5	−65			Typ	dB
BW	Bandwidth	R_L = 50 Ω	5	100			Typ	MHz
THD	Total Harmonic Distortion	R_L = 600 Ω, V_{IN} = 0.5 V_{PP}, f = 20 Hz to 20 kHz	5	0.004			Typ	%
Capacitance								
C_{IN}	Select Input Capacitance		5	5			Typ	pF
C_{OFF}	B-Port Off Capacitance		5	12			Typ	pF
C_{ON}	ON Capacitance		5	40			Typ	pF

Electrical Characteristics (Continued)

All test conditions: V_{CC} = 2.7 V to 3.6 V, unless otherwise noted.

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
Power Supply								
I_{CC}	Quiescent Supply Current	V_{IN} = 0 V or V_{CC}	3.6	0.3	0.5	1.5	Max	μA
Digital Input								
V_{IH}	Input Voltage High				1.65	1.65	Min	V
V_{IL}	Input Voltage Low				0.6	0.6	Max	V
I_{IN}	Control Input Leakage	V_{IN} = 0 V or V_{CC}	3.6		±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 100 mA, B0 or B1 = 1.5 V	2.7	2			Typ	Ω
R_{ON}		I_{OUT} = 100 mA, B0 or B1 = 1.5 V	2.7	2.5	2.7	3	Max	Ω
ΔR_{ON}	Maximum On resistance	I_{OUT} = 100 mA, B0 or B1 = 1.5 V	2.7	0.25	0.3	0.35	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 100 mA, B0 or B1 = 0 V, 0.75 V, 1.5 V	2.7	1	1.1	1.2	Max	Ω
$I_{NO(OFF)}$, $I_{NC(OFF)}$	Switch OFF Leakage Current on B0, B1	A = 0 V, 3.6 V, B0 or B1 = 3.6 V, 0 V	3.6	±10	±25	±50	Max	nA
$I_{A(OFF)}$	Switch OFF Leakage Current on A	A = 0 V, 3.6 V, B0 or B1 = 3.6 V, 0 V	3.6	±10	±50	±100	Max	nA
$I_{A(ON)}$	Switch ON Leakage Current on A	A = 0 V, 3.6 V, B0 or B1 = 0 V, 3.6 V, or Floating	3.6	±10	±50	±100	Max	nA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	B0 or B1 = 1.5 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	2.7	10			Typ	ns
t_{ON}	Switch Turn-on Time	B0 or B1 = 1.5 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	2.7	60	70	70	Max	ns
t_{OFF}	Switch Turn-off Time	B0 or B1 = 1.5 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	2.7	25	30	30	Max	ns
t_B	Break-Before-Make Time	B0 or B1 = 1.5 V, R_L = 50 Ω, C_L = 35 pF, Figure 7	2.7	20			Typ	ns
Q	Charge Injection	C_L = 1.0 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 8	3	20			Typ	pC

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, Figure 9	3	−65			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, Figure 10	3	−65			Typ	dB
BW	Bandwidth	R_L = 50 Ω	3	100			Typ	MHz
THD	Total Harmonic Distortion	R_L = 600 Ω, V_{IN} = 0.5 V_{PP}, f = 20 Hz to 20 kHz	3	0.01			Typ	%

Electrical Characteristics (Continued)

All test conditions: V_{CC} = 1.65 V to 1.95 V, unless otherwise noted.

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
Power Supply								
I_{CC}	Quiescent Supply Current	V_{IN} = 0 V or V_{CC}	1.95	0.3	0.5	1.5	Max	μA
Digital Input								
V_{IH}	Input Voltage High				1.4	1.4	Min	V
V_{IL}	Input Voltage Low				0.4	0.4	Max	V
I_{IN}	Control Input Leakage	V_{IN} = 0 V or V_{CC}	1.95		±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 10 mA, B0 or B1 = 0.9 V	1.65	10			Typ	Ω
R_{ON}		I_{OUT} = 10 mA, B0 or B1 = 0.9 V	1.65	15	18	18	Max	Ω
ΔR_{ON}	Maximum On Resistance	I_{OUT} = 10 mA, B0 or B1 = 0.9 V	1.65	5	7	7	Max	Ω
$I_{NO(OFF)}$, $I_{NC(OFF)}$	Switch OFF Leakage Current on B0, B1	A = 0 V, 1.95 V, B0 or B1 = 1.95 V, 0 V	1.95	±10	±25	±50	Max	nA
$I_{A(OFF)}$	Switch OFF Leakage Current on A	A = 0 V, 1.95 V, B0 or B1 = 1.95 V, 0 V	1.95	±10	±50	±100	Max	nA
$I_{A(ON)}$	Switch ON Leakage Current on A	A = 0 V, 1.95 V, B0 or B1 = 0 V, 1.95 V, or Floating	1.95	±10	±50	±100	Max	nA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	B0 or B1 = 1.0 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	1.65	10			Typ	ns
t_{ON}	Switch Turn-on Time	B0 or B1 = 1.0 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	1.65	80	90	90	Max	ns
t_{OFF}	Switch Turn-off Time	B0 or B1 = 1.0 V, R_L = 50 Ω, C_L = 35 pF, Figure 6	1.65	50	70	70	Max	ns
t_B	Break-BeforeMake Time	B0 or B1 = 1.0 V, R_L = 50 Ω, C_L = 35 pF, Figure 7	1.65	20			Typ	ns
Q	Charge Injection	C_L = 1.0 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 8	1.8	20			Typ	pC
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, Figure 9	1.8	−65			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, Figure 10	1.8	−65			Typ	dB

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
BW	Bandwidth	R_L = 50 Ω	1.8	100			Typ	MHz
THD	Total Harmonic Distortion	R_L = 600 Ω, V_{IN} = 0.5 V_{PP}, f = 20 Hz to 20 kHz	1.8	0.01			Typ	%

Electrical Characteristics (Continued)

All test conditions: T_A = 0°C to 50°C, unless otherwise noted.

Symbol	Parameter	Conditions	V_{CC} (V)	Spec	Limit	Unit
$I_{NO(OFF)}$, $I_{NC(OFF)}$	Switch OFF Leakage Current on B0, B1	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	3.6	±10	Max	nA
$I_{A(OFF)}$	Switch OFF Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	3.6	±20	Max	nA
$I_{A(ON)}$	Switch ON Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 1 V, 4.5 V, or Floating	3.6	±20	Max	nA
$I_{NO(OFF)}$, $I_{NC(OFF)}$	Switch OFF Leakage Current on B0, B1	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	5.5	±10	Max	nA
$I_{A(OFF)}$	Switch OFF Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 4.5 V, 1 V	5.5	±20	Max	nA
$I_{A(ON)}$	Switch ON Leakage Current on A	A = 1 V, 4.5 V, B0 or B1 = 1 V, 4.5 V, or Floating	5.5	±20	Max	nA

Typical Performance Characteristics

All test conditions: V_{CC} = 5 V, unless otherwise noted.

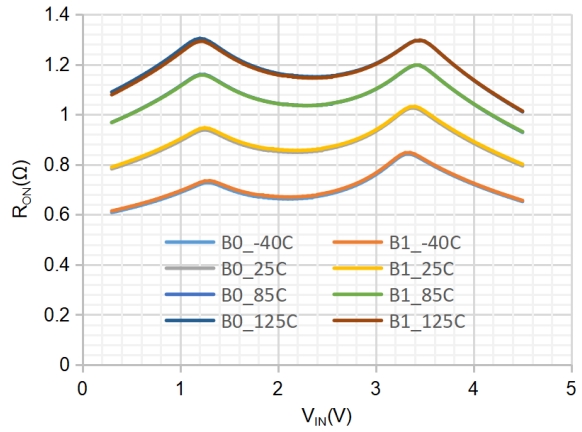


Figure 1. R_{ON}, V_{CC} = 4.5 V, Temp = −40, 25, 85, 125°C

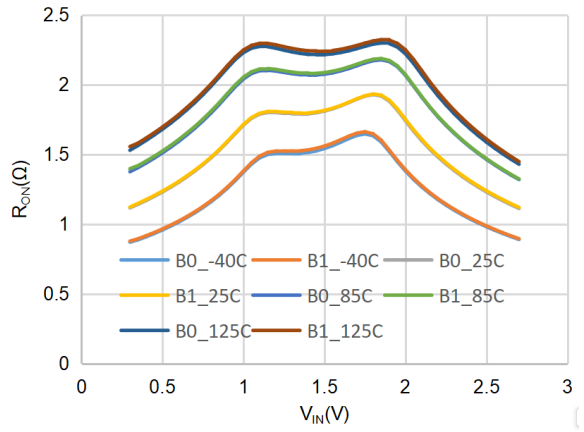


Figure 2. R_{ON}, V_{CC} = 2.7 V, Temp = −40, 25, 85, 125°C

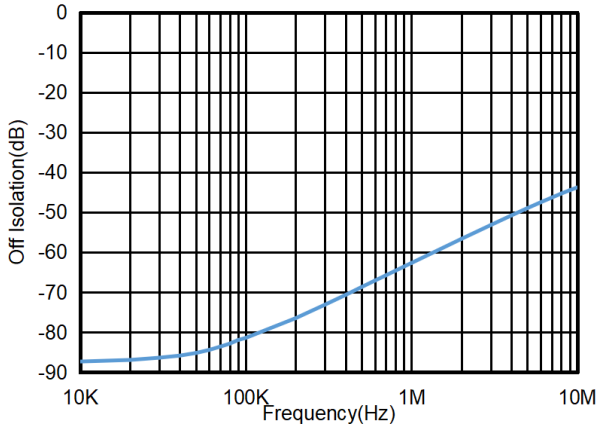


Figure 3. Off-Isolation, V_{CC} = 4.5 V

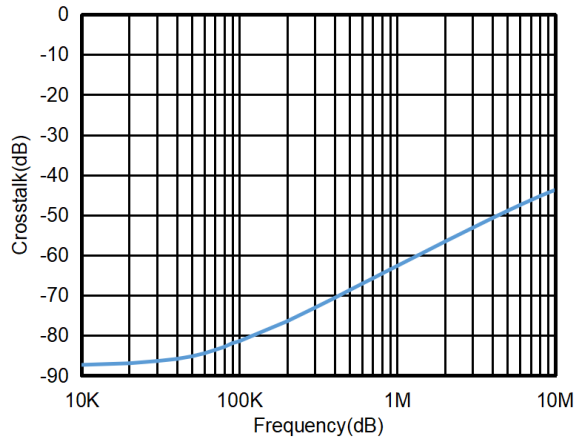


Figure 4. Crosstalk, V_{CC} = 4.5 V

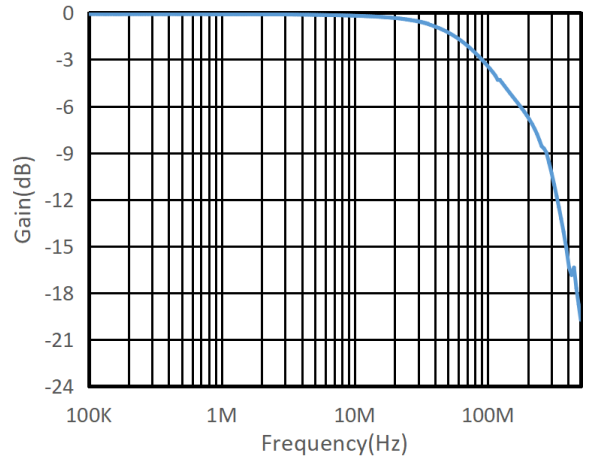


Figure 5. Bandwidth, V_{CC} = 4.5 V

Test Circuit and Waveforms

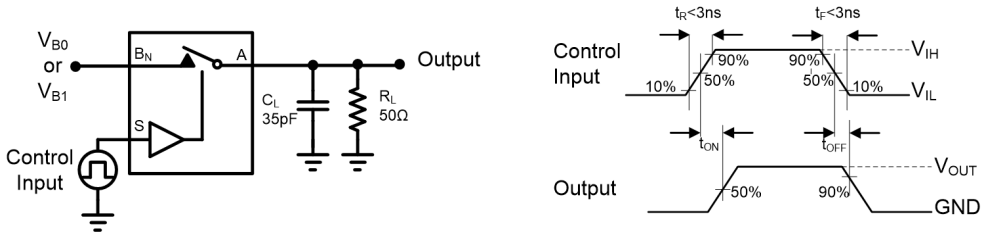


Figure 6. AC Test Circuit and Test Waveforms

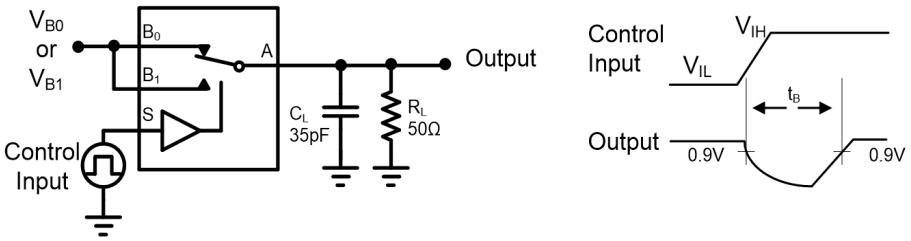


Figure 7. Switch Break Time

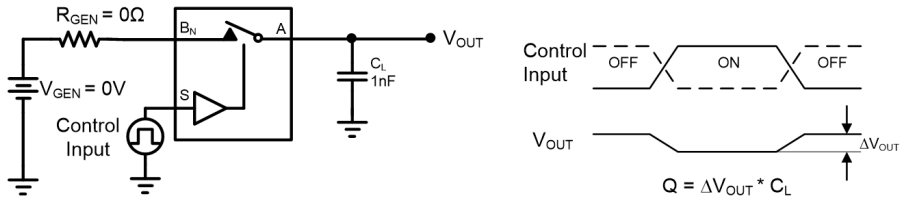


Figure 8. Charge Injection

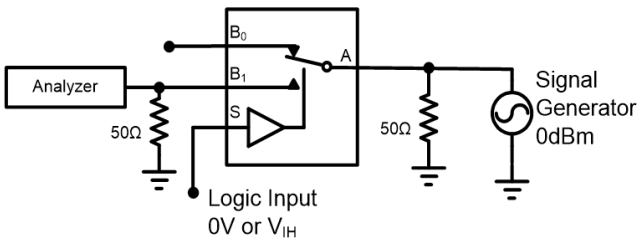


Figure 9. Off Isolation

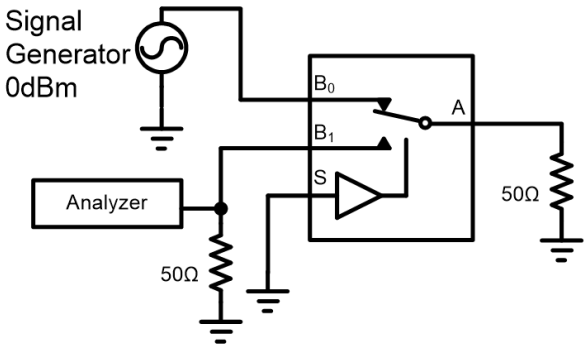


Figure 10. Crosstalk

Application and Implementation

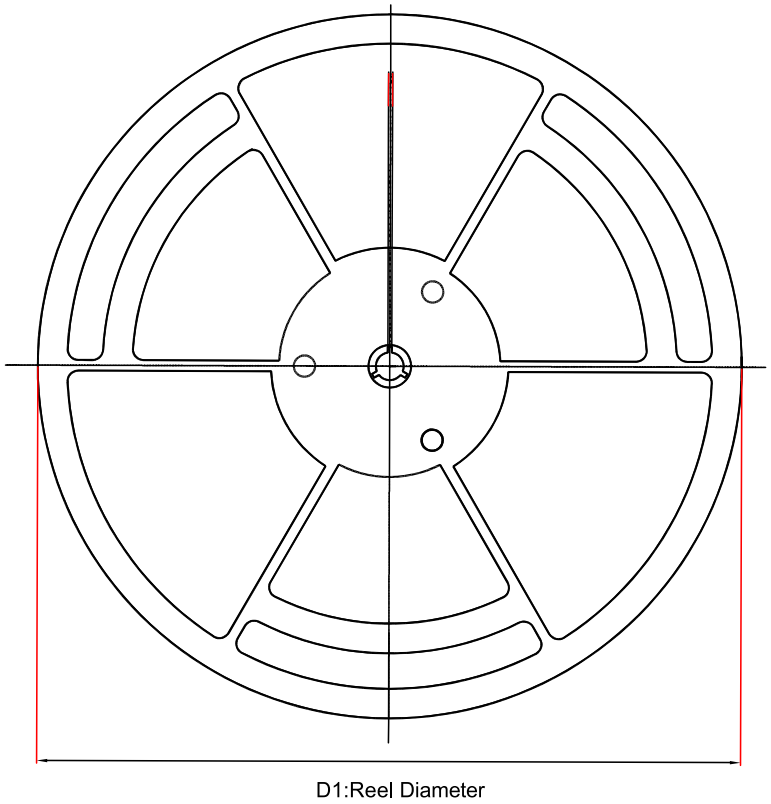
Note

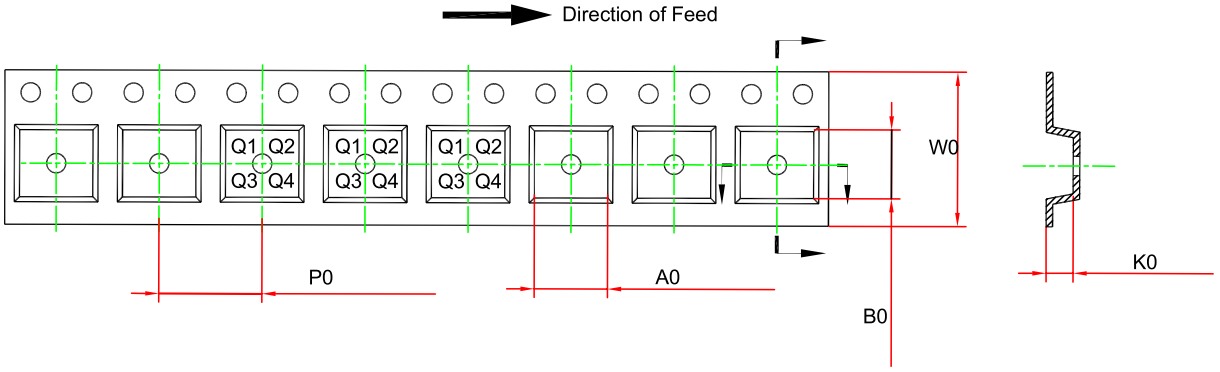
Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

A 0.1-μF bypass capacitor on V_{CC} and GND is recommended to prevent power disturbance.

Tape and Reel Information





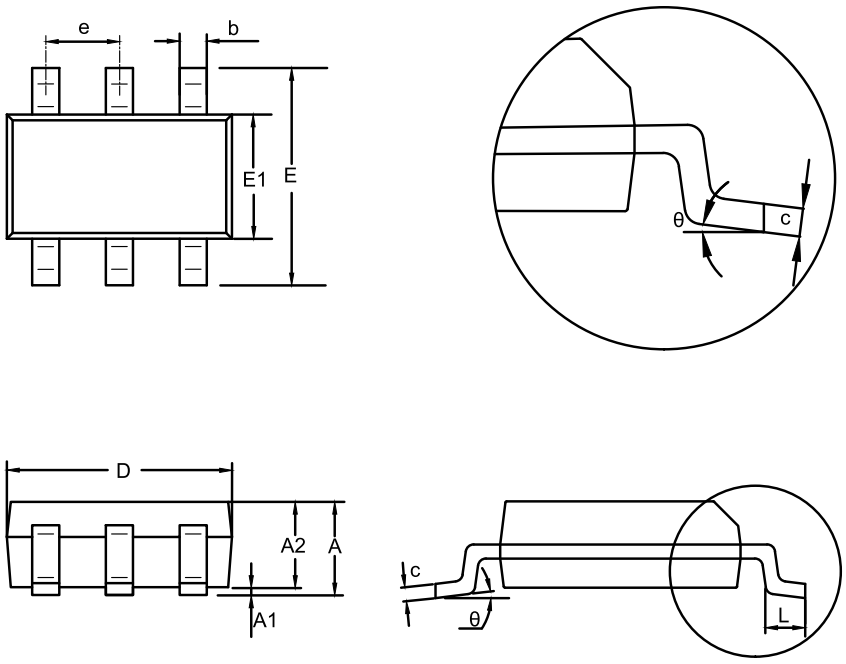
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPW4157-CR	SOT363 (SC70-6)	178	12.1	2.4	2.5	1.2	4	8	Q3
TPW4157-TR	SOT23-6	180	12	3.3	3.2	1.4	4	8	Q3

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

Package Outline Dimensions

SOT363

Package Outline Dimensions SC6(SOT363-6-A)



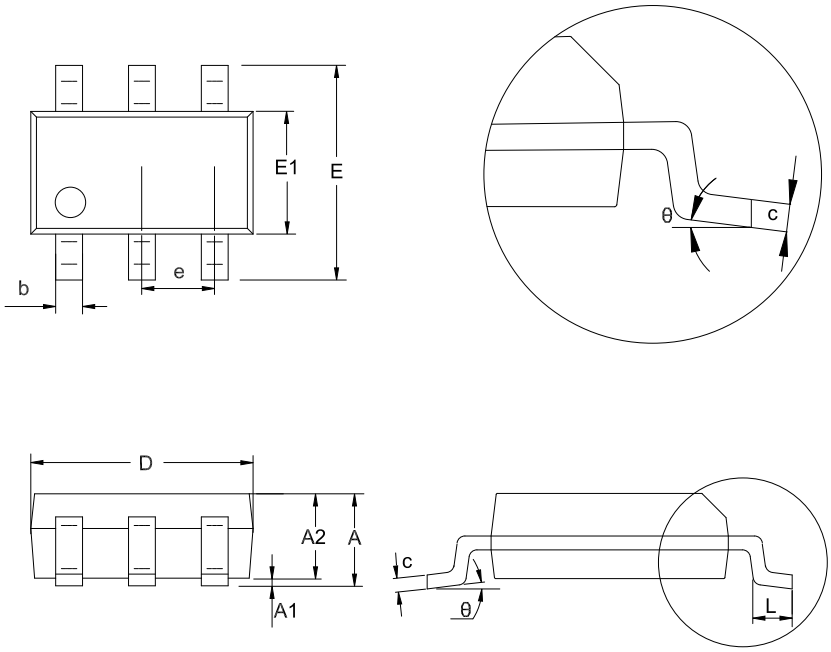
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.850	1.100	0.033	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.230	0.003	0.009
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 BSC		0.026 BSC	
L	0.260	0.460	0.010	0.018
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOT23-6

Package Outline Dimensions S6T(SOT23-6-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
TPW4157-CR	−40 to 125°C	SOT363	415XX (1)	1	Tape and Reel, 3000	Green
TPW4157-TR	−40 to 125°C	SOT23-6	415XX (1)	3	Tape and Reel, 3000	Green

(1) "XX" identifies the date code information.

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

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