Negative Voltage SPDT Switch

Features

- Operating Voltage Range: V_{EE} = −12 V to −4 V
- Switch Signal Voltage Range: V_{IS} = V_{EE} to GND
- Positive Control Signal Voltage: V_{IN} = 0 to 3.3 V
- Low R_{ON}: R_{ON} ≤ 8 Ω @ V_{EE} = −4 V
- Latch-up Performance: exceeds 300 mA
- Package: SOT363-6
- Pb-free and RoHS compliance
- ESD: HBM: 500 V; CDM: 2000 V
- Operating Temperature Range: −40°C to 125°C

Applications

- Communication Systems
- Data Acquisition Systems
- Sample-and-hold Systems
- Automatic Test Equipment

Description

The TPW3157N contains a single-pole-dual-throw (SPDT) switch.

This device passes analog and digital negative voltage that varies across the full power supply from V_{EE} to GND.

The TPW3157N is designed to operate from a single −12-V to −4-V supply. It features high bandwidth and low resistance, targeting applications for communication, audio switch, etc.

The TPW3157N features guaranteed on-resistance matching between switches and guaranteed on-resistance flatness over the signal range. This ensures excellent linearity and low distortion when switching control signals.

The TPW3157N is available in a SOT363-6 (SC70-6) package.

Table 1. Functional Table

Input: Select Pin	Function
Low	B_0 Connected to A
High	B_1 Connected to A

Typical Application Circuit

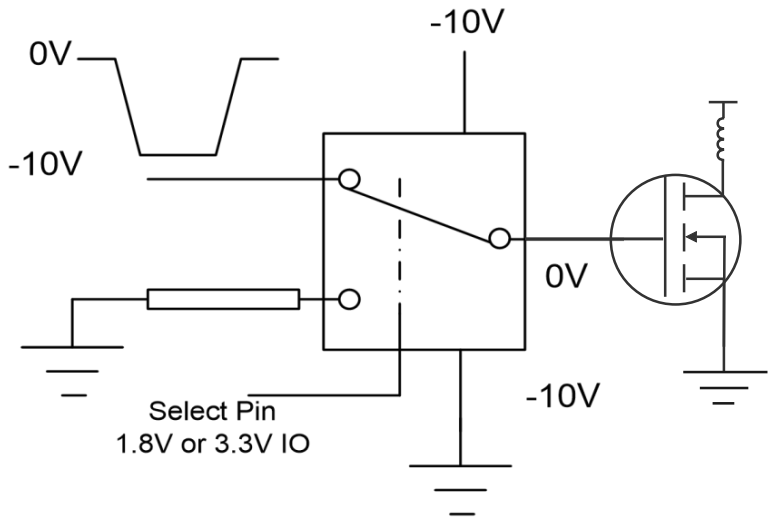


Table of Contents

Revision History

Date	Revision	Notes
2016-11-21	Rev.A.0	Initial version
2017-06-26	Rev.A.1	Adjusted the Part Number to TPW3157N
2017-09-10	Rev.A.2	Added the function table and updated the datasheet with a new document template
2019-07-03	Rev.A.3	Added the Pin 1 mark on the Pin Configuration
2025-07-22	Rev.A.4	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 Package Outlines Dimensions • Updated the Typical Application Circuit

Pin Configuration and Functions

TPW3157N
SOT363-6 Package
Top View

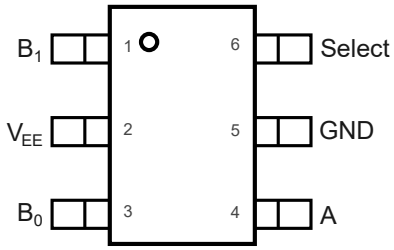


Table 2. Pin Functions: TPW3157N

Pin No.	Name	I/O	Description
1	B_1	I/O	Input 1
2	V_{EE}	-	Power supply
3	B_0	I/O	Input 0
4	A	I/O	Output
5	GND	-	Ground
6	Select	I	Select pin

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V_{EE}	DC Supply Voltage	−13	+0.5	V
V_{IS}	Analog Input Voltage	V_{EE} − 0.5	+0.5	V
V_{IN}	Digital Select Input Voltage	−0.5	+3.6	V
I_{IOK}	Switch Input and Output Diode Current	−50	+50	mA
I_{IK}	Select Input Diode Current	−50		mA
P_D	Power Dissipation in Still Air		60	mW
T_L	Lead Temperature, 1 mm from Case for 10 seconds		260	°C
T_J	Junction Bias Under Bias		150	°C
F_R	Flammability Rating; Oxygen Index: 30% − 35%		UL94-V0 (0.125 in)	°C
I_L	Latch−up Current (1), below GND and above V_{EE} at 125°C	−300	+300	mA
	Latch−up Current (1), below GND and above V_{EE} at 25°C	−300	+300	
T_{STG}	Storage Temperature	−65	150	°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	Value	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8	500	V
CDM	Charged Device Model ESD	MIL-STD-883H Method 3015.8	2000	V

Recommended Operating Conditions (1)

Parameter		Min	Max	Unit
V_{EE}	DC Supply Voltage	−12	−4	V
V_S	Switch Input / Output Voltage (B_0, B_1, A) (2)	V_{EE}	GND	V
V_{IN}	Digital Select Input Voltage	GND	3.3	V
T_A	Operating Temperature Range	−40	125	℃
t_r, t_f	Input Transition Rise or Fall Time (Select Input)	0	100	ns/V

(1) Functional operation above the stresses listed in the Recommended Operating ranges is not implied. Extended exposure to stress beyond. The Recommended Operating Ranges limits may affect device reliability.
(2) Select input must be held high or low, it must not be floated.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT363-6	400	150	°C/W

Capacitances (1)

Parameter		Condition	Typical at 25℃	Unit
C_{IN}	Input Capacitance, Select Inputs	V_{EE} = −12 V	2	pF
C_{IOB}	B-Port off Capacitance	V_{EE} = −10 V	66	pF
C_{IOA_ON}	A Port Capacitance when Switch is Enabled	V_{EE} = −10 V	27	pF

(1) T_A = +25℃, f = 1 MHz, capacitance is designed guaranteed.

Electrical Characteristics

All test conditions: voltages referenced to GND, typical characteristics are T_A at 25°C, unless otherwise noted.

Parameter		Condition	V_{EE}, V	−40℃ to 125℃			Unit
				Min	Typ	Max	
R_{ON}	Maximum ON Resistance (1)	V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND IO ≤ 10 mA	−12		1.5	3.5	Ω
			−10		1.8	3.8	
			−8		2	4	
			−6		2.4	4.5	
		V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND IO ≤ 5 mA	−4		4	8	
R_{FLAT}	ON Resistance Flatness (1) (2) (4)	V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND IO ≤ 10 mA	−12		0.3		Ω
			−10		0.4		
			−8		0.6		
			−6		1.0		
		V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND IO ≤ 5 mA	−4		2.5		
Δ R_{ON}	R_{ON} Mismatch between (1) (2) (3)	I_A = −10 mA, V_{Bn} = −8.4 V	−12		0.2		Ω
		I_A = −10 mA, V_{Bn} = −7 V	−10		0.3		
		I_A = −10 mA, V_{Bn} = −5.6 V	−8		0.3		
		I_A = −10 mA, V_{Bn} = −4.2 V	−6		0.3		
		I_A = −5 mA, V_{Bn} = −2.8 V	−4		0.3		
T_B	Switch Break Time	R_L = 50 Ω, C_L = 100 pF, V_{IS} = −2.5 V	−12		72		ns
			−10		82		
			−8		105		
			−6		155		
			−4		275		
T_{PHL}, T_{PLH}	Propagation Delay, Bus to Bus (5)	C_L = 100 pF	−12 to −4		2		ns
T_{PZL},T_{PZH}	Switch Enable Time Turn−On Time	C_L = 100 pF	−12		160		ns
			−10		170		
			−8		200		
			−6		250		
			−4		370		
T_{PLZ},T_{PHZ}	Switch Disable Time Turn−Off Time	C_L = 100 pF	−12		100		ns
			−10		100		
			−8		95		

Parameter		Condition	V_{EE}, V	−40℃ to 125℃			Unit
				Min	Typ	Max	
			−6		90		
			−4		85		
T_{POR}	Power on Reset Time	Measured from V_{EE} = −4 V	−12 to −4			20	μs
OIRR	Off-isolation (6)	R_L = 50 Ω, f = 10 MHz	−12 to −4		−38		dB
SIRR	Select Pin Isolation	R_L = 50 Ω, f = 10 MHz	−8		−40		dB
			No Power		−50		dB
X_{talk}	Cross Talk	R_L = 50 Ω, f = 10 MHz	−12 to −4		−37		dB
BW	−3-dB Bandwidth	R_L = 50 Ω	−12 to −4		200		MHz
Q	Charge Injection (7)	C_L = 100 pF, V_{GEN} = 0 V R_{GEN} = 0 Ω	−12		180		pC
			−10		140		
			−8		100		
			−6		65		
			−4		36		
V_{IH}	Mini High-level Input Voltage		−12	1.8		3.3	V
			−10	1.6		3.3	
			−8	1.6		3.3	
			−6	1.6		3.3	
			−4	1.6		3.3	
V_{IL}	Max High-level Input Voltage		−12	0		0.7	V
			−10	0		0.7	
			−8	0		0.7	
			−6	0		0.7	
			−4	0		0.7	
I_{IN}	Max Input Leakage Current	V_{IN} = 3.3 V or GND	−10		+/−0.01	+/−10	μA
I_{CC}	Max Quiescent Supply Current	Select = 3.3 V or GND, V_{IS} = V_{EE} or GND	−10 V to −4 V		35	70	μA
$I_{NC(OFF)}$	NC or NO off Leakage Current	V_{IN} = V_{IL} or VIH, V_{Bn} = GND, V_A = V_{EE} to GND	−10 V		+/−0.1	+/−10	μA
$I_{COM(ON)}$	COM ON Leakage Current	V_{IN} = V_{IL} or V_{IH}; V_A = GND V or V_{EE}; V_{B1} = GND or V_{EE} with V_{B0} floating, or V_{B0} = GND or V_{EE} with V_{B1} floating	−10 V		+/−0.1	+/−10	μA

(1) Measured by the voltage drop between A and B pins at the indicated current through the switch. On resistance is determined by the lower of the voltages on the two (A or B ports).

(2) The parameter is characterized but not tested in production.

(3) ΔR_{ON} = R_{ONMAX}- R_{ONMIN} measured at identical V_{EE}, temperature, and voltage levels.

(4) Flatness is defined as the difference between the maximum and minimum value of ON resistance over the specified range of conditions.
(5) This parameter is guaranteed by design but not tested, the bus switch contributed no propagation delay other than the RC delay of the ON resistance of the switch and the 50-pF load capacitance, when driven by an ideal voltage source.
(6) Off Isolation = 20 $\log_{10}$ [V_A/V_{Bn}].
(7) Guaranteed by design but not tested in production.

Typical Performance Characteristics

All test conditions: T_A = 25°C, V_{EE} = −4 V to −12 V, unless otherwise noted.

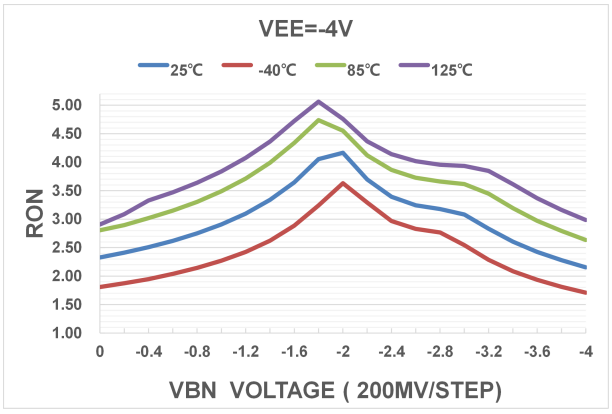


Figure 1. R_{ON} vs. Signal Voltage

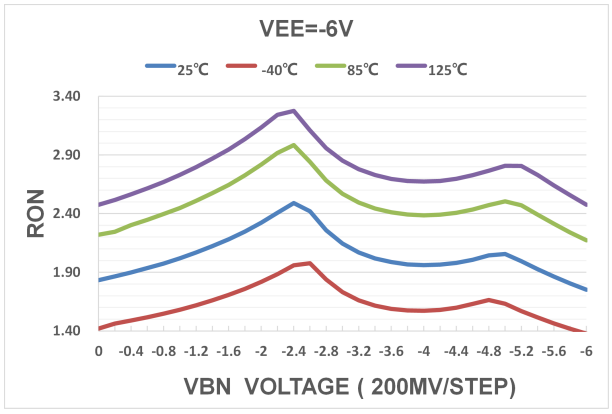


Figure 2. R_{ON} vs. Signal Voltage

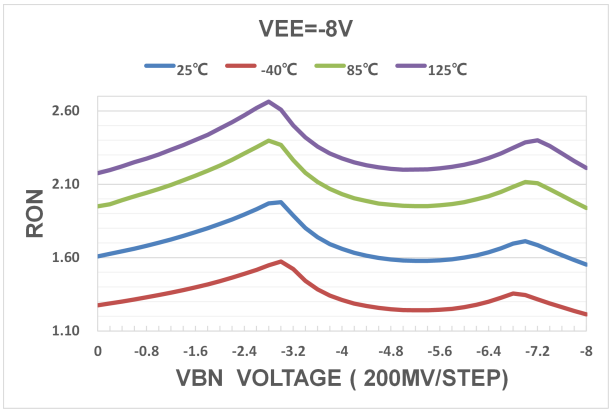


Figure 3. R_{ON} vs. Signal Voltage

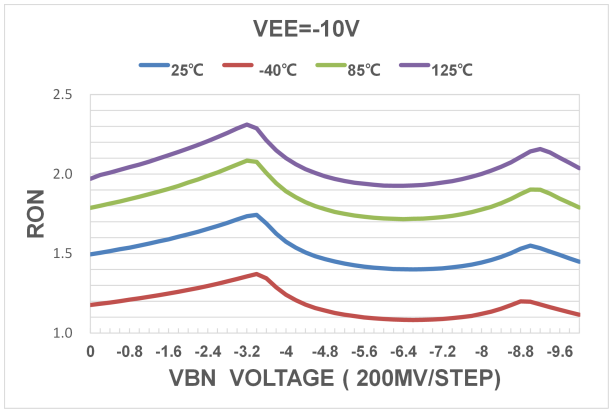


Figure 4. R_{ON} vs. Signal Voltage

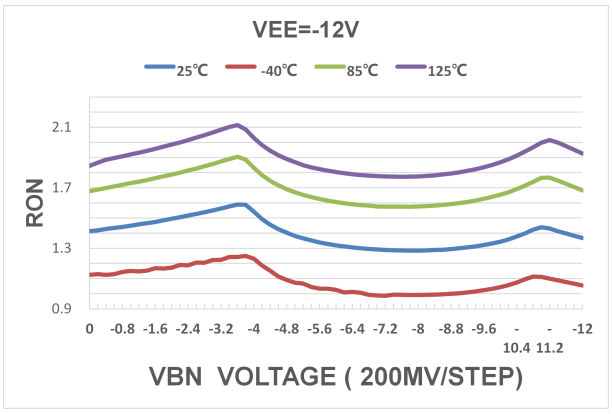


Figure 5. R_{ON} vs. Signal Voltage

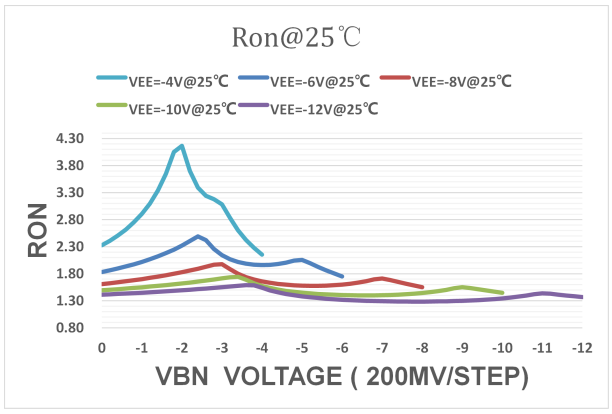


Figure 6. R_{ON} vs. V_{EE}

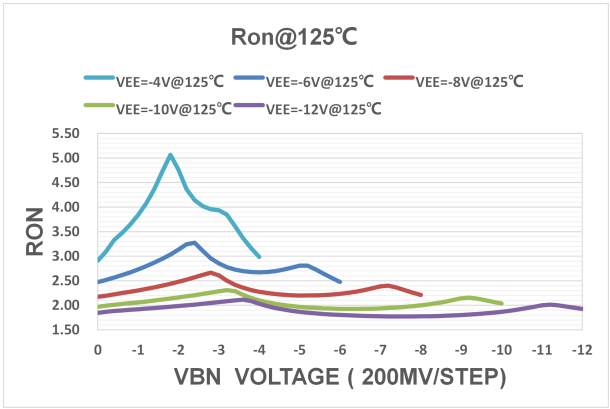


Figure 7. R_{ON} vs. V_{EE}

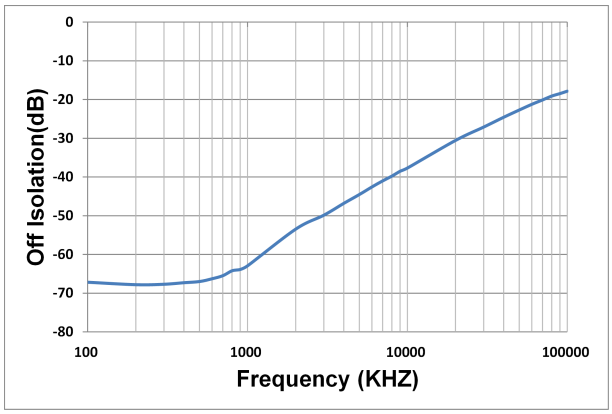


Figure 8. Off Isolation vs. Frequency

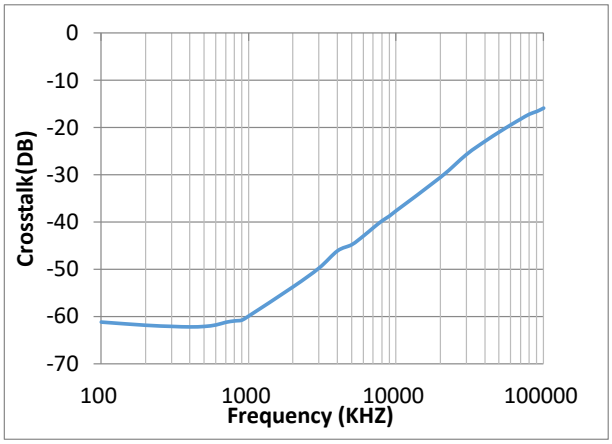


Figure 9. Cross Talk vs. Frequency

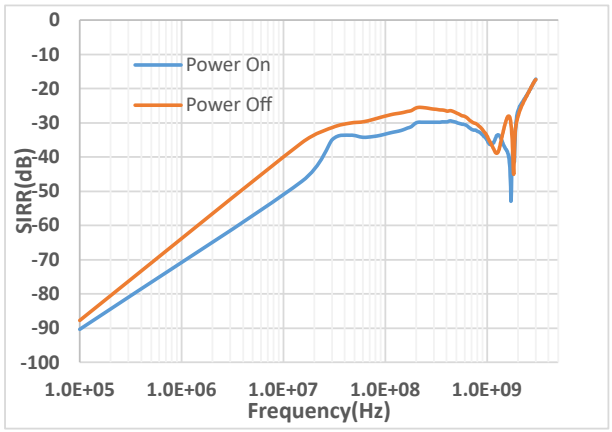
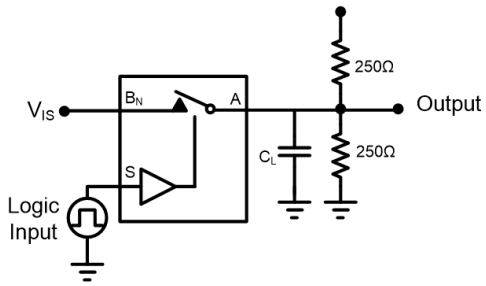
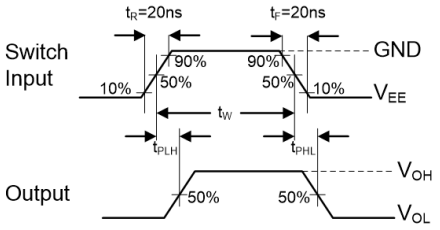


Figure 10. Select Pin Isolation vs. Frequency

Test Circuit and Waveforms



Parameter	V_I	V_{IS}
t_{PLH} / t_{PHL}	Open	Source
t_{PZL} / t_{PLZ}	GND	V_{EE}
t_{PZH} / t_{PHZ}	2*V_{EE}	GND



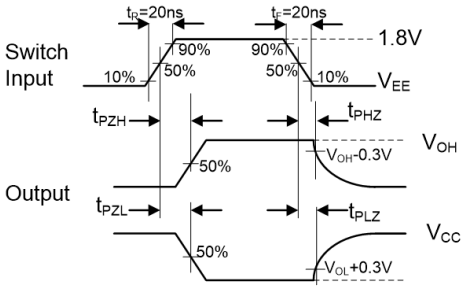
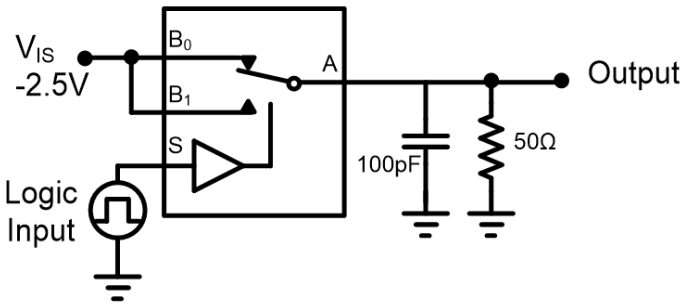


Figure 11. AC Test Circuit and Test Waveforms



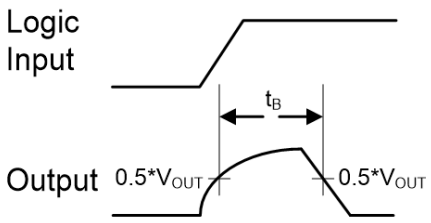
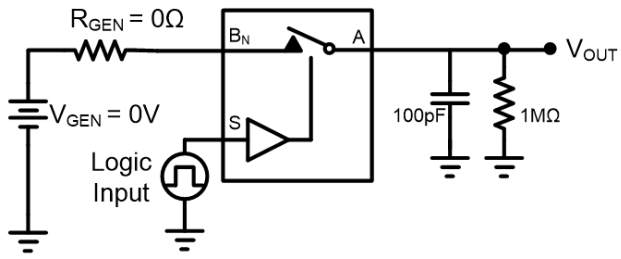


Figure 12. Switch Break Time



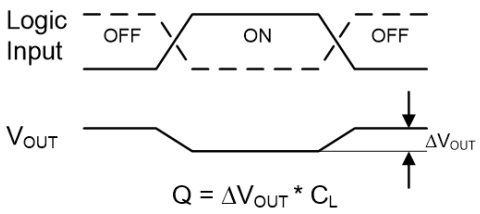


Figure 13. Charge Injection

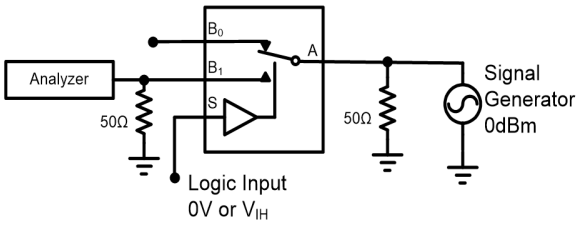


Figure 14. Off Isolation

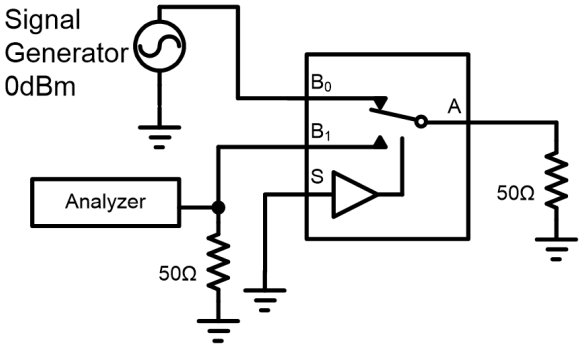


Figure 15. Crosstalk

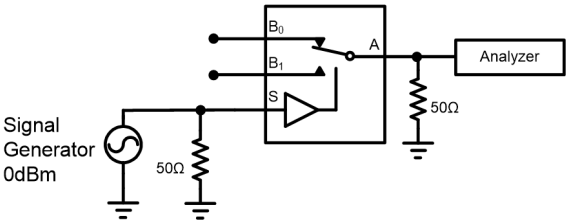


Figure 16. Select Pin Isolation

Detailed Description

Overview

The TPW3157N is designed to operate from a single −12-V to −4-V supply. It features high bandwidth and low resistance, targeting applications for communication, audio switch, etc.

The TPW3157N features guaranteed on-resistance matching between switches and guaranteed on-resistance flatness over the signal range. This ensures excellent linearity and low distortion when switching control signals.

Functional Block Diagram

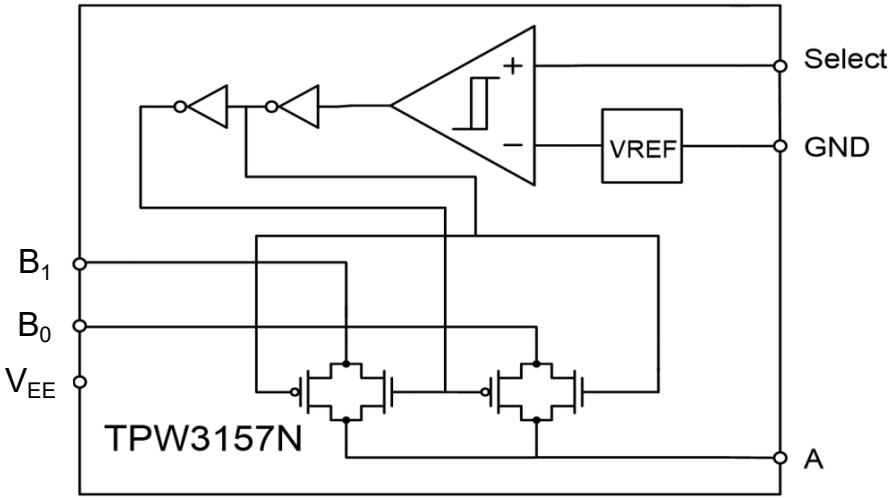


Figure 17. Functional Block Diagram

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 TPW3157N offers outstanding input and output leakage currents and ultra-low charge injection. This device operates from −12 V to −4 V and offers true rail-to-rail input and output. The on-resistance of the TPW3157N is very low. These features make the TPW3157N a precision, robust, high-performance analog switch with a negative voltage in communication systems.

Typical Application

Figure 18 shows a TPW3157N typical application on the communication system.

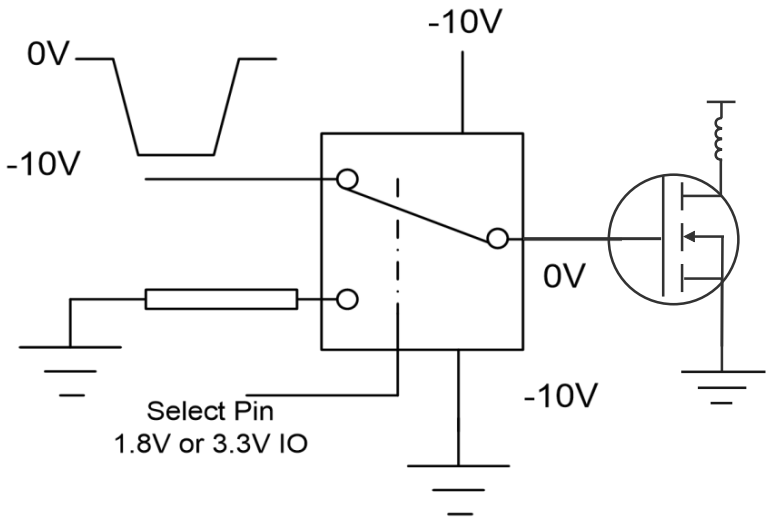
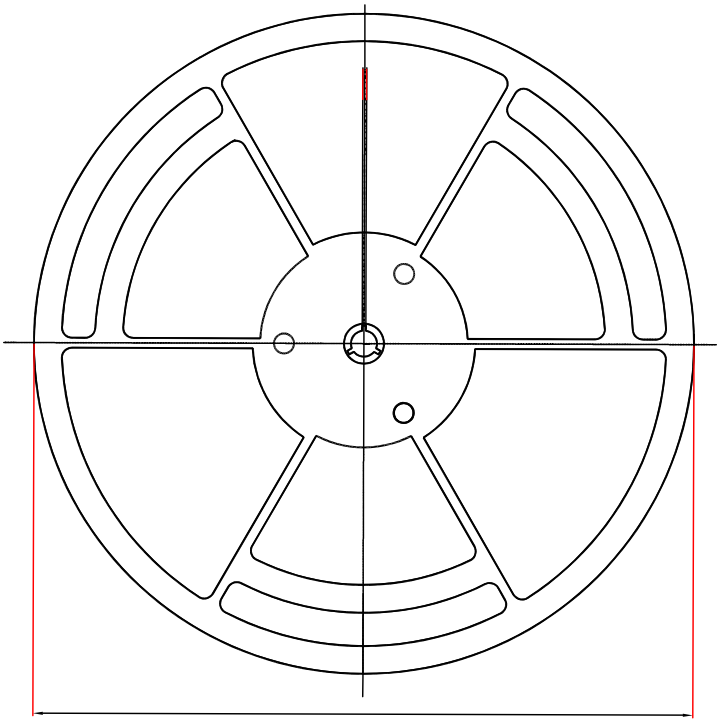
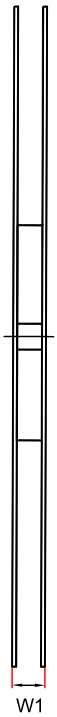
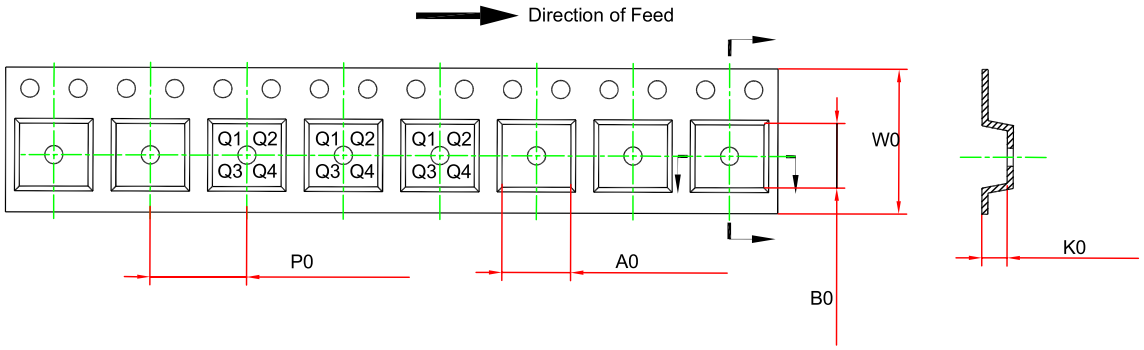


Figure 18. Typical Application Circuit

Tape and Reel Information







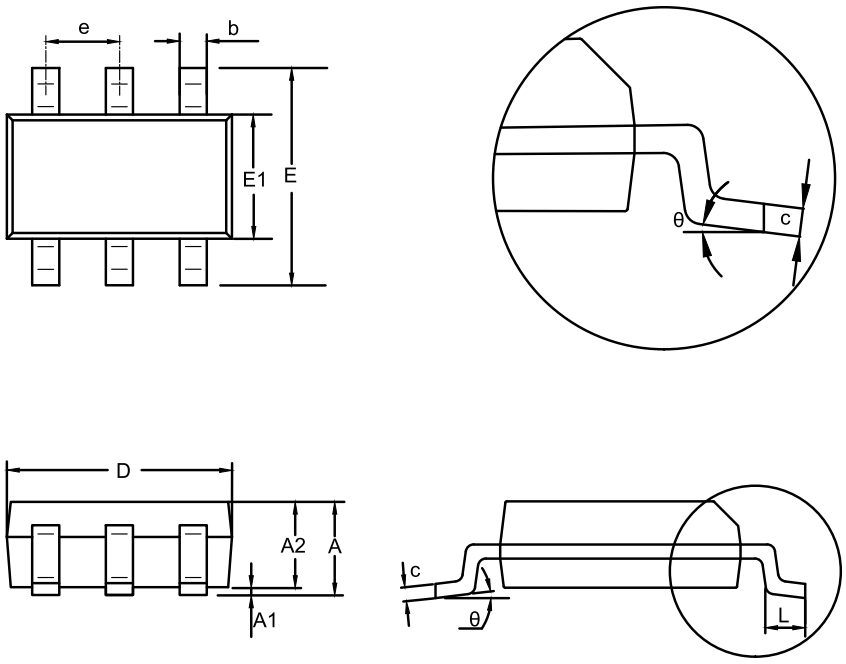
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPW3157N-CR	SOT363-6	178.0	12.1	2.4	2.5	1.2	4.0	8.0	Q3

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

Package Outline Dimensions

SOT363-6

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.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPW3157N-CR	−40 to 125°C	SOT363-6	S12	1	Tape and Reel, 3000	Green

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

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