12-V, 3*(SPDT) Analog Switch

Features

- Analog Switch Voltage: 3.3 V, 5 V, 10 V, ±5 V
- Low On-State Resistance:
  - Typical 50 Ω at V_S = ±4.5 V or 9 V
  - Typical 60 Ω at V_S = 4.5 V
  - Typical 300 Ω at V_S = 3 V
- Bandwidth: 200 MHz
- Fast Switching Times: t_{ON} = 60 ns, t_{OFF} = 50 ns
- Break-Before-Make Switching
- Operation Temperature Range: –40°C to 125°C

Applications

- Industry Control Systems
- Battery-Powered systems
- Audio Signal Routing
- Instrumentation

Description

The TPW4053 is a three single-pole dual-throw (SPDT) analog switch suitable for use in analog or digital multiplexer/demultiplexer applications. The switch features three digital select inputs (S0, S1, and S2), to control three independent switches. The digital enables input ($\overline{E}$), and turns off the switches When $\overline{E}$ is HIGH.

The device is designed on an enhanced process that provides lower power dissipation and high switching speed. The device can operate equally well as either a multiplexer or a demultiplexer and has an input range that extends to the supplies. All channels exhibit break-before-make switching action, preventing momentary shorting when switching channels.

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Switch Selection Guide

Product	Switch Configuration	Supply Voltage (V)	Ron (OHM)	Bandwidth (MHz)	Package
TPW4051	8:1	12	50	200	SOP16, TSSOP16, QFN16
TPW4052	(4:1) × 2	12	50	200	SOP16, TSSOP16
TPW4053	(2:1) × 3	12	50	200	SOP16, TSSOP16
TPW3111	1:1	5.5	1	100	SOT353
TPW3115	1:1	5.5	5	250	SOT353, SOT23-5
TPW4157	2:1	5.5	1	100	SOT363
TPW3157A	2:1	5.5	2	100	SOT363
TPW3221	(2:1) × 2	5.5	1	100	MSOP10
TPW3223	(2:1) × 2	5.5	1	100	QFN1.4X1.8-10

Revision History

Date	Revision	Notes
2018-08-08	Rev.Pre.0	Pre-release version.
2019-03-04	Rev.A.0	Initial version.
2019-10-02	Rev.A.1	Changed HBM from 2 KV to 1 KV.
2019-12-25	Rev.A.2	Corrected the test conditions of RON and switch leakage to follow the product test (Product test is not changed): • Changed all "0 V" to "V_{EE}"; • Removed the On Resistance Match between Channels at 3-V to 3.6-V V_{CC}; • Changed the On Resistance Match between Channels at 9-V to 11-V V_{CC}, V_{IS} = 3.5 V to V_{IS} = 1 V; • Changed the On Resistance Match between Channels at 4.5-V to 5.5-V V_{CC}, V_{EE} = −4.5 V to 5.5 V, V_{IS} = 3.5 V to V_{IS} = −3.5 V.
2020-01-14	Rev.A.3	Corrected the "P0" information of TR in Tape and Reel Information.
2023-04-11	Rev.A.4	Updated the RON max value @ V_{CC} = 3.0 V to 3.6 V.
2024-12-04	Rev.A.5	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

TPW4053
SOP16/TSSOP16
Top View

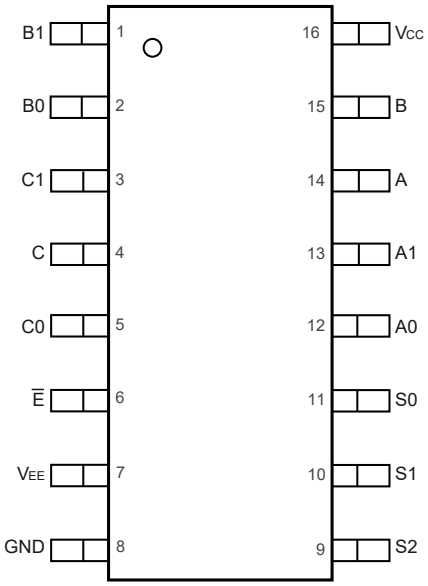


Table 1. Pin Functions

Pin No.	Name	I/O	Description
1	B1	Input / Output	Channel B1 input or output
2	B0	Input / Output	Channel B0 input or output
3	C1	Input / Output	Channel C1 input or output
4	C	Input / Output	C common input or output
5	C0	Input / Output	Channel C0 input or output
6	$\overline{E}$	Input	Enable switch, active low
7	V_{EE}		Negative power input
8	GND		Ground
9	S2	Input	Control input
10	S1	Input	Control input
11	S0	Input	Control input
12	A0	Input / Output	Channel A0 input or output
13	A1	Input / Output	Channel A1 input or output

Pin No.	Name	I/O	Description
14	A	Input / Output	A common input or output
15	B	Input / Output	B common input or output
16	V_{CC}		Positive power input

Table 2. Functional Table

$\overline{E}$, Enable	S2	S1	S0	ON Channel
L	L	L	L	C0, B0, A0
L	L	L	H	C0, B0, A1
L	L	H	L	C0, B1, A0
L	L	H	H	C0, B1, A1
L	H	L	L	C1, B0, A0
L	H	L	H	C1, B0, A1
L	H	H	L	C1, B1, A0
L	H	H	H	C1, B1, A1
H	X (1)	X (1)	X (1)	None

(1) X = Don't care.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage, V_{CC} − V_{EE}	−0.5	13	V
	Supply Voltage, V_{CC} − GND	−0.5	13	V
	Supply Voltage, V_{EE} − GND	−6.5	0.5	V
	Analog Switch Voltage	V_{EE} – 0.5	V_{CC} + 0.5	V
	Analog Switch Current	−25	25	mA
	Analog Switch Diode Current	−20	20	mA
	Digital Input Voltage, $\overline{E}$, S2, S1, S0	GND	V_{CC} + 0.5	V
	Digital Input Diode Current	−20	20	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)	1	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 (1)

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

Parameter	Min	Max	Unit
Supply Voltage, V_{CC} − V_{EE}	3	12	V
Supply Voltage, V_{CC} − GND (2)	3	12	V
Supply Voltage, V_{EE} − GND (2)	−6	0	V
Select Input Voltage	0	V_{CC}	V
Input Transition Rise and Fall Rate		100	ns/V
Switch I/O Port Voltage	V_{EE}	V_{CC}	V
Operating Temperature Range	−40	125	°C

(1) The select input must be held HIGH or LOW and must not float.
(2) The voltage of V_{CC}, and V_{EE} need to be in the range of V_{CC} − V_{EE}.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP16	100	50	°C/W
TSSOP16	150	60	°C/W

Electrical Characteristics

All test conditions: single supply, V_{CC} = 4.5 V to 5.5 V, V_{EE} = 0 V, GND = 0 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	4	6	8	Max	μA
Digital Input								
V_{IH}	Input Voltage High				2	2	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	±0.4	±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	4.5	60			Typ	Ω
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	4.5	100	130	150	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	I_{OUT} = 1 mA, V_{IS} = 2.5 V	4.5	20	30	35	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 1 mA	4.5	60	80	80	Max	Ω
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	5.5	±0.4	±1	±1	Max	μA
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	5.5	±0.4	±1	±1	Max	μA
$I_{(ON)}$	Switch ON Leakage Current	V_{IS} = V_{EE} or V_{CC}	5.5	±0.4	±1	±1	Max	μA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	C_L = 50 pF	4.5	5			Typ	ns
t_{ON}	Switch Turn-on Time	C_L = 50 pF	4.5	60			Max	ns
t_{OFF}	Switch Turn-off Time	C_L = 50 pF	4.5	50			Max	ns
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	5	−70			Typ	dB
	Crosstalk in Channel	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	5	−70			Typ	dB
	Crosstalk in Control	Between control and any switch; R_L = 600 Ω; f = 1 MHz; E or Sn square wave between V_{CC} and GND	5	110			Typ	mV
BW	Bandwidth	R_L = 50 Ω	5	200			Typ	MHz
THD	Total Harmonic Distortion	R_L = 10 kΩ, f = 1 kHz	5	0.05			Typ	%

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
Capacitance								
C_{IN}	Switch Input Capacitance		5	5			Typ	pF
C_{COM}	Common Output Capacitance		5	10			Typ	pF
C_{PD}	Power Dissipation Capacitance		5	50			Typ	pF

(1) Test data is based on bench tests and design simulation.

Electrical Characteristics (Continued)

All test conditions: single supply, V_{CC} = 3 V to 3.6 V, V_{EE} = 0 V, GND = 0 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	4	6	8	Max	μA
Digital Input								
V_{IH}	Input Voltage High				2	2	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}	3.6		±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	3	200			Typ	Ω
R_{ON} (1)		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	3	300	330	350	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 1 mA	3	100			Typ	Ω
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{EE}, V_{OS} = V_{CC};	3.6	±0.4	±1	±1	Max	μA
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	3.6	±0.4	±1	±1	Max	μA
$I_{(ON)}$	Switch ON Leakage Current	V_{IS} = V_{EE} or V_{CC}	3.6	±0.4	±1	±1	Max	μA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	C_L = 50 pF	3	5			Typ	ns
t_{ON}	Switch Turn-on Time	C_L = 50 pF	3	70			Max	ns
t_{OFF}	Switch Turn-off Time	C_L = 50 pF	3	60			Max	ns
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	3.3	−70			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	3.3	−70			Typ	dB
	Crosstalk in Control	Between control and any switch; R_L = 600 Ω; f = 1 MHz; E or Sn square wave between V_{CC} and GND	3.3	110			Typ	mV
BW	Bandwidth	R_L = 50 Ω	3.3	200			Typ	MHz
THD	Total Harmonic Distortion	R_L = 10 kΩ, f = 1 kHz	3.3	0.2			Typ	%
Capacitance								
C_{IN}	Switch Input Capacitance		3.3	5			Typ	pF

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
C_{COM}	Common Output Capacitance		3.3	10			Typ	pF
C_{PD}	Power Dissipation Capacitance		3.3	50			Typ	pF

(1) Test data is based on bench tests and design simulation.

Electrical Characteristics (Continued)

All test conditions: single supply, V_{CC} = 9 V to 11 V, V_{EE} = 0 V, GND = 0 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}	9	8	12	16	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}	11	±0.4	±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	9	50			Typ	Ω
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	9	80	95	105	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	I_{OUT} = 1 mA, V_{IS} = 1 V	9	15	25	30	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 1 mA	9	30	40	40	Max	Ω
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	11	±0.4	±1	±1	Max	μA
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	11	±0.4	±1	±1	Max	μA
$I_{(ON)}$	Switch ON Leakage Current	V_{IS} = V_{EE} or V_{CC}	11	±0.4	±1	±1	Max	μA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	C_L = 50 pF	9	5			Typ	ns
t_{ON}	Switch Turn-on Time	C_L = 50 pF	9	60			Max	ns
t_{OFF}	Switch Turn-off Time	C_L = 50 pF	9	50			Max	ns
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	10	−70			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	10	−70			Typ	dB
	Crosstalk in Control	Between control and any switch; R_L = 600 Ω; f = 1 MHz; E or Sn square wave between V_{CC} and GND	10	220			Typ	mV
BW	Bandwidth	R_L = 50 Ω	10	200			Typ	MHz
THD	Total Harmonic Distortion	R_L = 10 kΩ, f = 1 kHz	10	0.03			Typ	%

Symbol	Parameter	Conditions	V_{CC} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
Capacitance								
C_{IN}	Switch Input Capacitance		10	5			Typ	pF
C_{COM}	Common Output Capacitance		10	10			Typ	pF
C_{PD}	Power Dissipation Capacitance		10	50			Typ	pF

(1) Test data is based on bench tests and design simulation.

Electrical Characteristics (Continued)

All test conditions: dual supply, V_{CC} = 4.5 V to 5.5 V, V_{EE} = −4.5 V to 5.5 V, GND = 0 V, unless otherwise noted.

Symbol	Parameter	Conditions	V_{CC} / V_{EE} (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/ −5.5	8	12	16	Max	μA
Digital Input								
V_{IH}	Input Voltage High				70% × V_{CC}	70% × V_{CC}	Min	V
V_{IL}	Input Voltage Low				30% × V_{CC}	30% × V_{CC}	Max	V
I_{IN}	Control Input Leakage	V_{IN} = 0 V or V_{CC}	5.5/ −5.5	±0.4	±1	±1	Max	μA
Analog Switch								
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	4.5/ −4.5	50			Typ	Ω
R_{ON}		I_{OUT} = 1 mA, V_{IS} = V_{EE} or V_{CC}	4.5/ −4.5	80	95	105	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	I_{OUT} = 1 mA, V_{IS} = −3.5 V	4.5/ −4.5	15	25	30	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	I_{OUT} = 1 mA	4.5/ −4.5	30	40	40	Max	Ω
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	5.5/ −5.5	±0.4	±1	±1	Max	μA
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	V_{IS} = V_{EE}, V_{OS} = V_{CC}; or V_{IS} = V_{CC}, V_{OS} = V_{EE}	5.5/ −5.5	±0.4	±1	±1	Max	μA
$I_{(ON)}$	Switch ON Leakage Current	V_{IS} = V_{EE} or V_{CC}	5.5/ −5.5	±0.4	±1	±1	Max	μA
Dynamic Characteristics								
t_{PHL}, t_{PLH}	Switch IN to OUT Time	C_L = 50 pF	4.5/ −4.5	5			Typ	ns
t_{ON}	Switch Turn-on Time	C_L = 50 pF	4.5/ −4.5	60			Max	ns
t_{OFF}	Switch Turn-off Time	C_L = 50 pF	4.5/ −4.5	50			Max	ns
	OFF-Isolation	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	5/−5	−70			Typ	dB
	Crosstalk	f = 1 MHz, R_L = 50 Ω, C_L = 10 pF	5/−5	−70			Typ	dB

Symbol	Parameter	Conditions	V_{CC} / V_{EE} (V)	25°C	−40°C to 85°C	−40°C to 125°C	Limit	Unit
	Crosstalk in Control	Between control and any switch; R_L = 600 Ω; f = 1 MHz; E or Sn square wave between V_{CC} and GND	5/−5	220			Typ	mV
BW	Bandwidth	R_L = 50 Ω	5/−5	100			Typ	MHz
THD	Total Harmonic Distortion	R_L = 10 kΩ, f = 1 kHz	5/−5	0.03			Typ	%
Capacitance								
C_{IN}	Switch Input Capacitance		5/−5	5			Typ	pF
C_{COM}	Common Output Capacitance		5/−5	10			Typ	pF
C_{PD}	Power Dissipation Capacitance		5/−5	50			Typ	pF

(1) Test data is based on bench tests and design simulation.

Typical Performance Characteristics

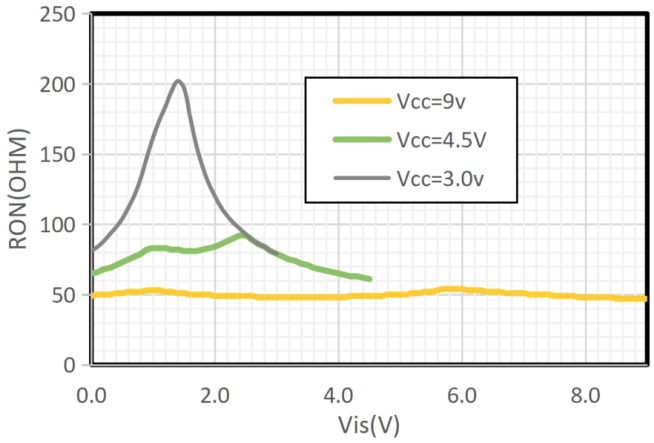


Figure 1. R_{ON} vs. V_{IS}

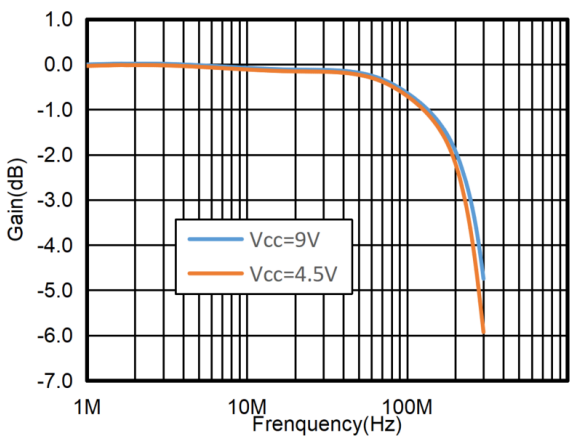
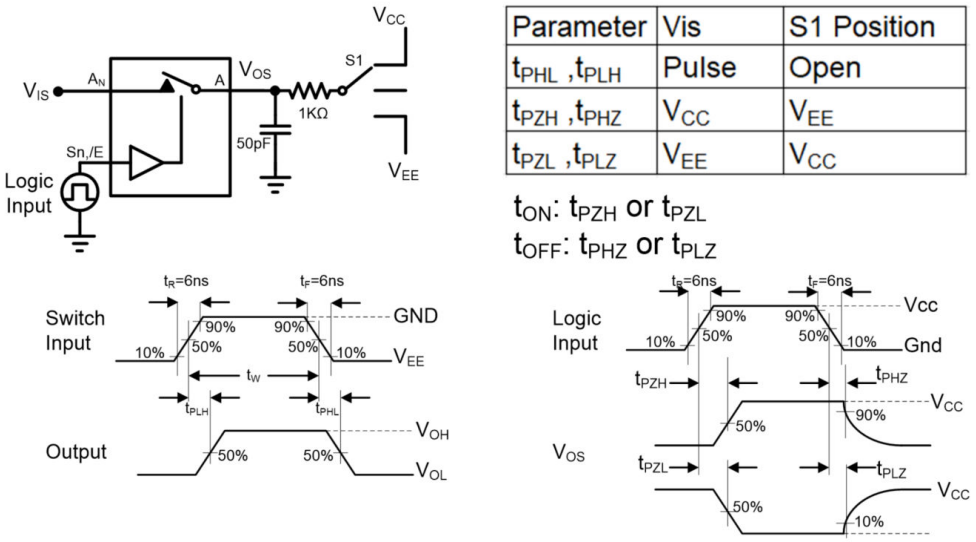


Figure 2. Bandwidth

Test Circuit and Waveforms



Parameter	Vis	S1 Position
t_{PHL} ,t_{PLH}	Pulse	Open
t_{PZH} ,t_{PHZ}	V_{CC}	V_{EE}
t_{PZL} ,t_{PLZ}	V_{EE}	V_{CC}

t_{ON}: t_{PZH} or t_{PZL}
t_{OFF}: t_{PHZ} or t_{PLZ}

Figure 3. AC Test Circuit and Test Waveforms

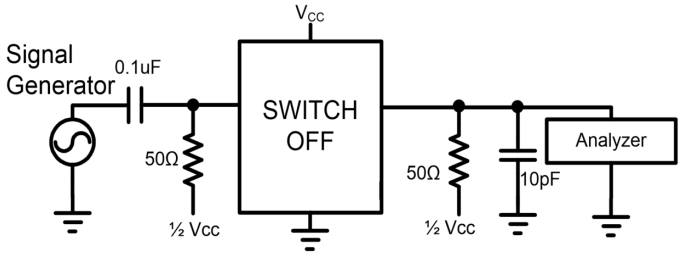


Figure 4. Off Isolation

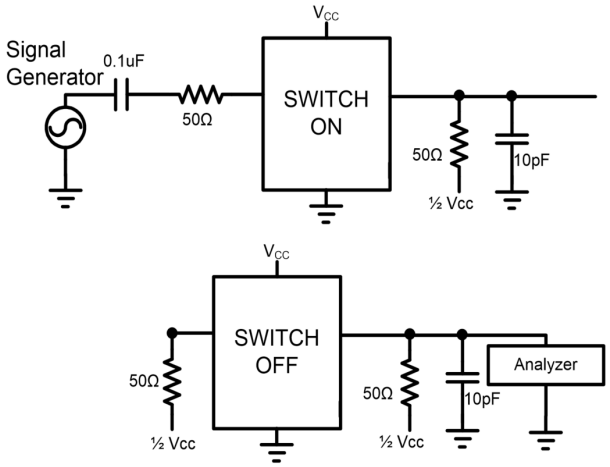


Figure 5. Crosstalk

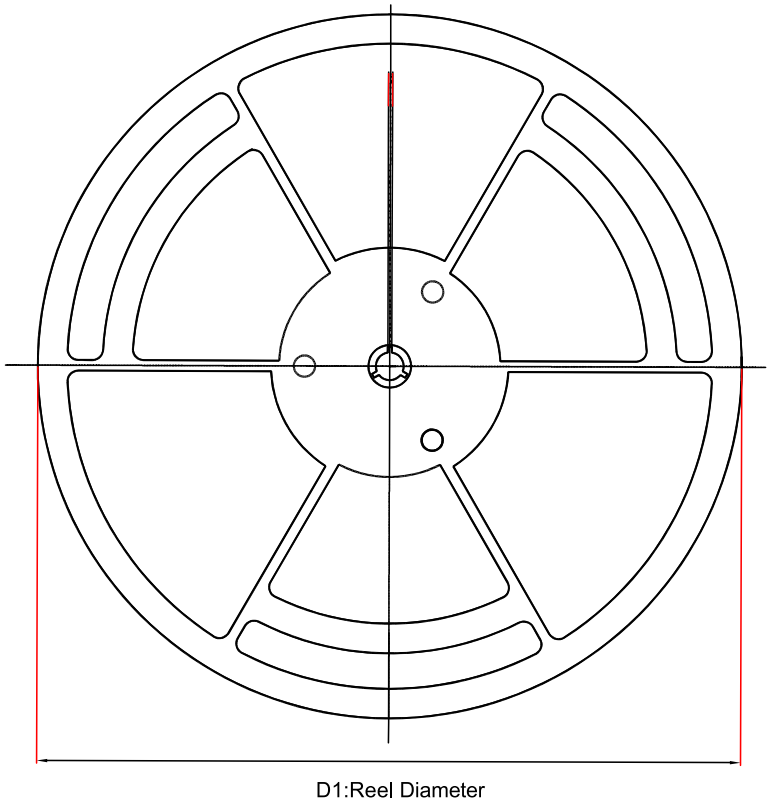
Application and Implementation

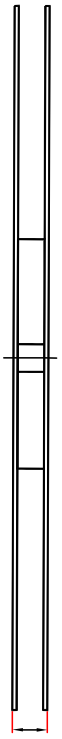
> Note
>
> Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their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

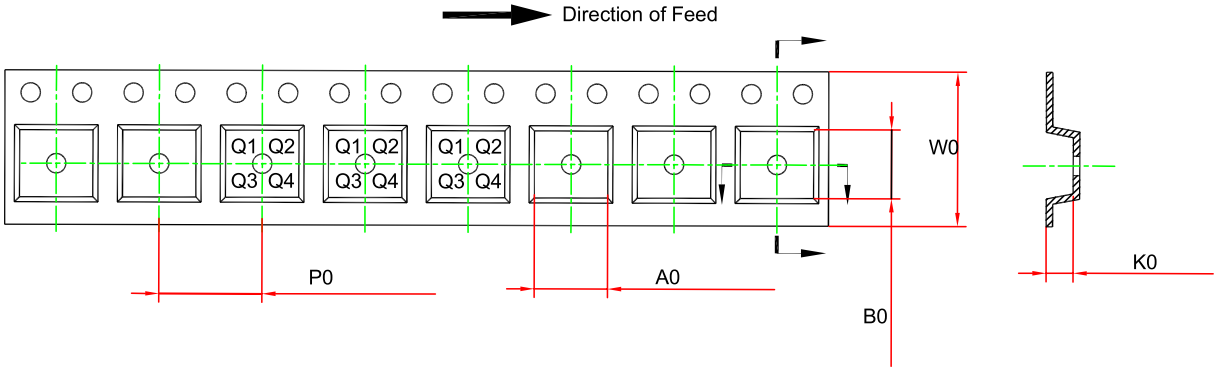
Application Information

A 0.1-μF bypass capacitor on V_{CC} and GND is recommended to prevent power disturbance, and another 0.1-μF bypass capacitor on V_{EE} and GND is also recommended if V_{EE} is not connected to GND.

Tape and Reel Information







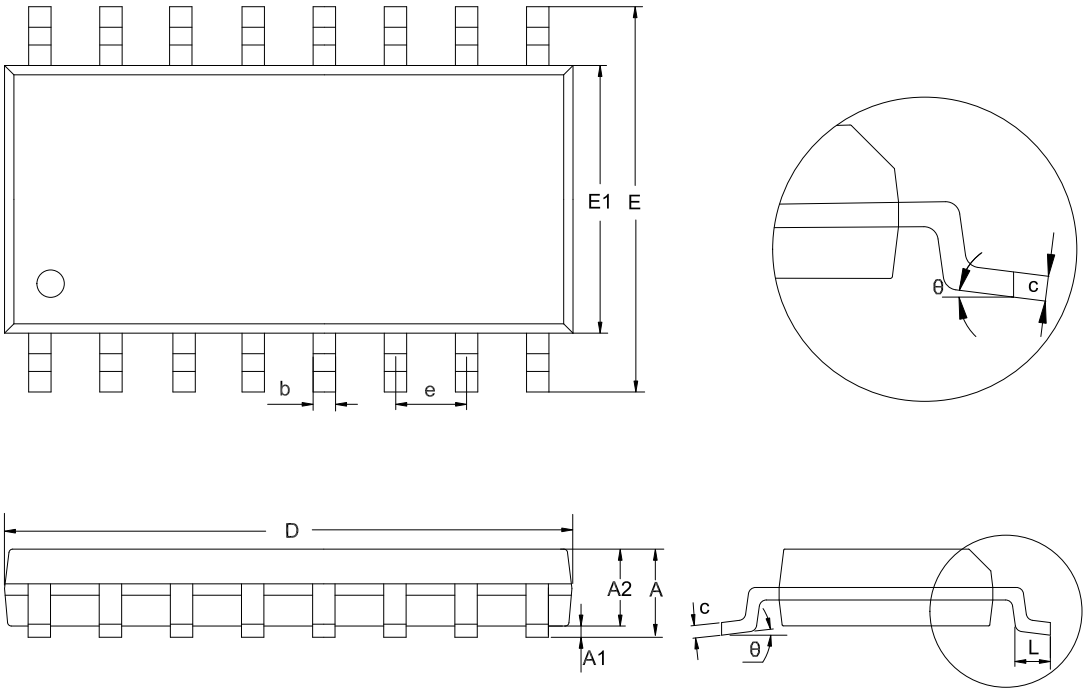
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPW4053-SR	SOP16	330	21.6	6.6	10.4	2.1	8	16	Q1
TPW4053-TR	TSSOP16	330	17.6	6.8	5.5	1.5	8	12	Q1

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

Package Outline Dimensions

SOP16

Package Outline Dimensions SO3(SOP-16-A)



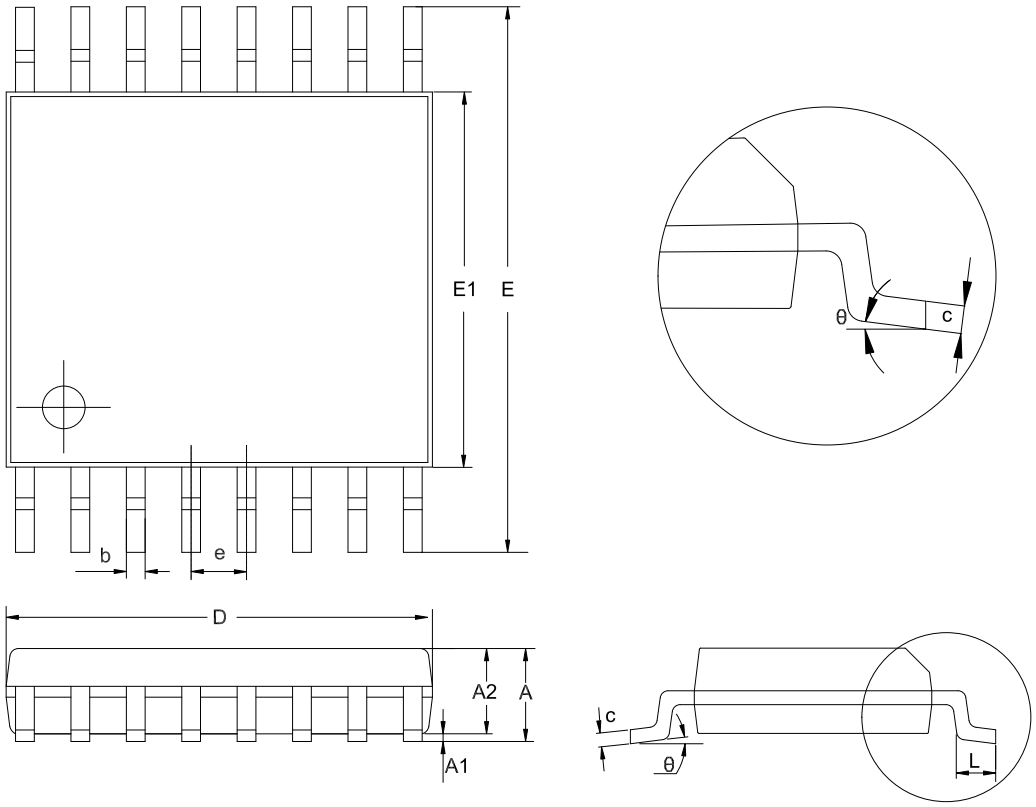
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.300	1.600	0.051	0.063
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.000	0.386	0.394
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

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

TSSOP16

Package Outline Dimensions TS3(TSSOP-16-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
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
TPW4053-SR	−40 to 125°C	SOP16	W4053	3	Tape and Reel, 2500	Green
TPW4053-TR	−40 to 125°C	TSSOP16	W4053	3	Tape and Reel, 3000	Green

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

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