

Features

- Analog Switch Voltage: 3.3V, 5V, 10V, $\pm 5V$
- Low ON-State Resistance:
 - typical 50Ω at $V_s = \pm 4.5V$ or $9V$
 - typical 60Ω at $V_s = 4.5V$
 - typical 300Ω at $V_s = 3V$
- Bandwidth: 200 MHz
- Fast switching times: $t_{ON} = 60ns$, $t_{OFF} = 50ns$
- Break-Before-Make Switching
- Operation Temperature Range: $-40^{\circ}C$ to $125^{\circ}C$

Applications

- Industry control systems
- Battery-powered systems
- Audio Signal Routing
- Instrumentation

Description

The TPW4053 is a three single-pole dual-throw analog switch (SPDT) 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 switch. The digital enable input (/E), turn off the switches When /E is HIGH.

The device is designed on an enhanced process that provides lower power dissipation yet gives high switching speeds. These devices can operate equally well as either multiplexers or demultiplexers and have an input range that extends to the supplies. All channels exhibit break-before-make switching action, preventing momentary shorting when switching channels.

Switch Selection Guide

Product	Switch Configuration	Supply Voltage(V)	Ron(OHM)	Bandwidth(MHz)	Package
TPW4051	8:1	12	50	200	SOIC-16, TSSOP-16, QFN-16
TPW4052	(4:1)*2	12	50	200	SOIC-16, TSSOP-16
TPW4053	(2:1)*3	12	50	200	SOIC-16, TSSOP-16
TPW3111	1:1	5.5	1	100	SC70-5
TPW3115	1:1	5.5	5	250	SC70-5, SOT23-5
TPW4157	2:1	5.5	1	100	SC70-6
TPW3157A	2:1	5.5	2	100	SC70-6
TPW3221	(2:1)*2	5.5	1	100	MSOP-10
TPW3223	(2:1)*2	5.5	1	100	QFN-10, 1.4*1.8mm

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Revision History

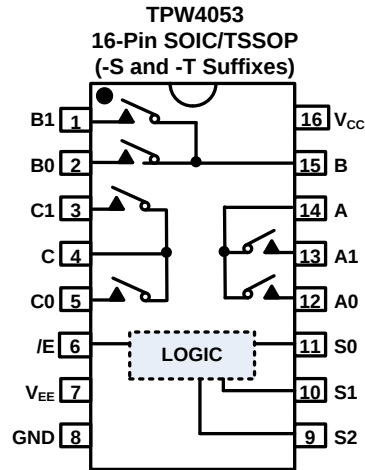
Date	Revision	Notes
2018/8/8	Rev.Pre	Pre-Release Version
2019/3/4	Rev.0	Initial Version
2019/10/2	Rev.0.01	HBM: 2KV -> 1KV
2019/12/25	Rev.0.02	Correct test conditions of RON and switch leakage to follow the product test(Product test is not changed): all of "0V" -> "VEE"; On Resistance Match between Channels at 3 to 3.6V Vcc: -> remove; On Resistance Match between Channels at 9 to 11V Vcc: VIS = 3.5V -> VIS = 1V; On Resistance Match between Channels at 4.5 to 5.5V Vcc, Vee = -4.5V to 5.5V: VIS = 3.5V -> VIS = -3.5V
2020/1/14	Rev.0.03	Correct the "P0" information of TR in Tape and Reel Information

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TPW4053-SR	-40 to 125°C	16-Pin SOIC	W4053	3	Tape and Reel, 2500
TPW4053-TR	-40 to 125°C	16-Pin TSSOP	W4053	3	Tape and Reel, 3000

Pin Configuration, Description and Functional Table ^{Note 1}

TPW4053



Pin Description

Pin No.	Pin Name	Input / Output	Description	Pin No.	Pin Name	Input / Output	Description
1	B1	Input / Output	Channel B1 input or output	9	S2	Input	Control Input
2	B0	Input / Output	Channel B0 input or output	10	S1	Input	Control Input
3	C1	Input / Output	Channel C1 input or output	11	S0	Input	Control Input
4	C	Input / Output	C Common input or output	12	A0	Input / Output	Channel A0 input or output
5	C0	Input / Output	Channel C0 input or output	13	A1	Input / Output	Channel A1 input or output
6	/E	Input	Enable switches, active low	14	A	Input / Output	A Common input or output
7	V _{EE}		Negative Power Input	15	B	Input / Output	B Common input or output
8	GND		Ground	16	V _{CC}		Positive Power Input

Functional Table

/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	X	X	None

X = Don't care

Absolute Maximum Ratings Note 1

Parameters	Rating
Supply Voltage, $V_{CC} - V_{EE}$	-0.5V to 13V
Supply Voltage, $V_{CC} - GND$	-0.5V to 13V
Supply Voltage, $V_{EE} - GND$	-6.5V to 0.5V
Analog Switch Voltage	$V_{EE} - 0.5V$ to $V_{CC} + 0.5V$
Analog Switch Current	$\pm 25mA$
Analog Switch Diode Current	$\pm 20mA$
Digital Input Voltage, /E, S2, S1, S0	GND to $V_{CC} + 0.5V$
Digital Input Diode Current	$\pm 20mA$
Maximum Junction Temperature	150°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	1	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
16-Pin SOIC	100	50	°C/W
16-Pin TSSOP	150	60	°C/W

Recommended Operating Conditions Note 1

Over operating temperature range

Parameters	Min	Max	Unit
Supply Voltage, $V_{CC} - V_{EE}$	3	12	V
Supply Voltage, $V_{CC} - GND$ Note2	3	12	V
Supply Voltage, $V_{EE} - GND$ Note2	-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

Note 1: Select input must be held HIGH or LOW and it must not float.

Note 2: The voltage of V_{CC} , V_{EE} need be in the range of $V_{CC}-V_{EE}$

Electrical Characteristics

Single Supply, $V_{CC} = 4.5$ to $5.5V$, $V_{EE} = 0V$, $GND = 0V$, 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	$V_{IN} = 0V$ or V_{CC}	5.5	4	6	8	Max	μA
Digital Input								
V_{IH}	Input Voltage High				2.0	2.0	Min	V
V_{IL}	Input Voltage Low				0.8	0.8	Max	V
I_{IN}	Control Input Leakage	$V_{IN} = 0V$ or V_{CC}	5.5	± 0.4	± 1	± 1	Max	μA
Analog Switch								
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	4.5	60			Typ	Ω
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	4.5	100	130	150	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	$I_{OUT} = 1mA$, $V_{IS} = 2.5V$	4.5	20	30	35	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	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	$C_L = 50pF$	4.5	5			Typ	ns
t_{ON}	Switch turn-on time	$C_L = 50pF$	4.5	60			Max	ns
t_{OFF}	Switch turn-off time	$C_L = 50pF$	4.5	50			Max	ns
	OFF-Isolation	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	5	-70			Typ	dB
	Crosstalk in channel	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	5	-70			Typ	dB
	Crosstalk in control	Between control and any switch; $R_L = 600\Omega$; $f = 1MHz$; E or Sn square wave between V_{CC} and GND	5	110			Typ	mV
BW	Bandwidth	$R_L = 50\Omega$	5	200			Typ	MHz
THD	Total Harmonic Distortion	$R_L = 10k\Omega$, $f = 1kHz$	5	0.05			Typ	%
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

Single Supply, $V_{CC} = 3$ to $3.6V$, $V_{EE} = 0V$, $GND = 0V$, 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	$V_{IN} = 0V$ or V_{CC}	3.6	4	6	8	Max	μA
Digital Input								
V_{IH}	Input Voltage High				2.0	2.0	Min	V
V_{IL}	Input Voltage Low				0.8	0.8	Max	V
I_{IN}	Control Input Leakage	$V_{IN} = 0V$ or V_{CC}	3.6		± 1	± 1	Max	μA
Analog Switch								
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	3	300			Typ	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	3	100			Typ	Ω
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	$V_{IS} = V_{EE}$, $V_{OS} = V_{CC}$; or $V_{IS} = V_{CC}$, $V_{OS} = V_{EE}$	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	$C_L = 50pF$	3	5			Typ	ns
t_{ON}	Switch turn-on time	$C_L = 50pF$	3	70			Max	ns
t_{OFF}	Switch turn-off time	$C_L = 50pF$	3	60			Max	ns
	OFF-Isolation	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	3.3	-70			Typ	dB
	Crosstalk	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	3.3	-70			Typ	dB
	Crosstalk in control	Between control and any switch; $R_L = 600\Omega$; $f = 1MHz$; E or Sn square wave between V_{CC} and GND	3.3	110			Typ	mV
BW	Bandwidth	$R_L = 50\Omega$	3.3	200			Typ	MHz
THD	Total Harmonic Distortion	$R_L = 10k\Omega$, $f = 1kHz$	3.3	0.2			Typ	%
Capacitance								
C_{IN}	Switch Input Capacitance		3.3	5			Typ	pF
C_{COM}	Common Output Capacitance		3.3	10			Typ	pF
C_{PD}	Power Dissipation Capacitance		3.3	50			Typ	pF

Single Supply, $V_{CC} = 9V$ to $11V$, $V_{EE} = 0V$, $GND = 0V$, 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	$V_{IN} = 0V$ 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	$V_{IN} = 0V$ or V_{CC}	11	± 0.4	± 1	± 1	Max	μA
Analog Switch								
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	9	50			Typ	Ω
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	9	80	95	105	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	$I_{OUT} = 1mA$, $V_{IS} = 1V$	9	15	25	30	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	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	$C_L = 50pF$	9	5			Typ	ns
t_{ON}	Switch turn-on time	$C_L = 50pF$	9	60			Max	ns
t_{OFF}	Switch turn-off time	$C_L = 50pF$	9	50			Max	ns
	OFF-Isolation	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	10	-70			Typ	dB
	Crosstalk	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	10	-70			Typ	dB
	Crosstalk in control	Between control and any switch; $R_L = 600\Omega$; $f = 1MHz$; E or Sn square wave between V_{CC} and GND	10	220			Typ	mV
BW	Bandwidth	$R_L = 50\Omega$	10	200			Typ	MHz
THD	Total Harmonic Distortion	$R_L = 10k\Omega$, $f = 1kHz$	10	0.03			Typ	%
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

Dual Supply, $V_{CC} = 4.5$ to $5.5V$, $V_{EE} = -4.5$ to $5.5V$, GND = 0V, 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	$V_{IN} = 0V$ 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	$V_{IN} = 0V$ or V_{CC}	5.5/-5.5	± 0.4	± 1	± 1	Max	μA
Analog Switch								
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	4.5/-4.5	50			Typ	Ω
R_{ON}		$I_{OUT} = 1mA$, $V_{IS} = V_{EE}$ or V_{CC}	4.5/-4.5	80	95	105	Max	Ω
ΔR_{ON}	On Resistance Match between Channels	$I_{OUT} = 1mA$, $V_{IS} = -3.5V$	4.5/-4.5	15	25	30	Max	Ω
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	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	$C_L = 50pF$	4.5/-4.5	5			Typ	ns
t_{ON}	Switch turn-on time	$C_L = 50pF$	4.5/-4.5	60			Max	ns
t_{OFF}	Switch turn-off time	$C_L = 50pF$	4.5/-4.5	50			Max	ns
	OFF-Isolation	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	5/-5	-70			Typ	dB
	Crosstalk	$f = 1MHz$, $R_L = 50\Omega$, $C_L = 10pF$	5/-5	-70			Typ	dB
	Crosstalk in control	Between control and any switch; $R_L = 600\Omega$; $f = 1MHz$; E or Sn square wave between V_{CC} and GND	5/-5	220			Typ	mV
BW	Bandwidth	$R_L = 50\Omega$	5/-5	100			Typ	MHz
THD	Total Harmonic Distortion	$R_L = 10k\Omega$, $f = 1kHz$	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

Typical Performance Characteristics

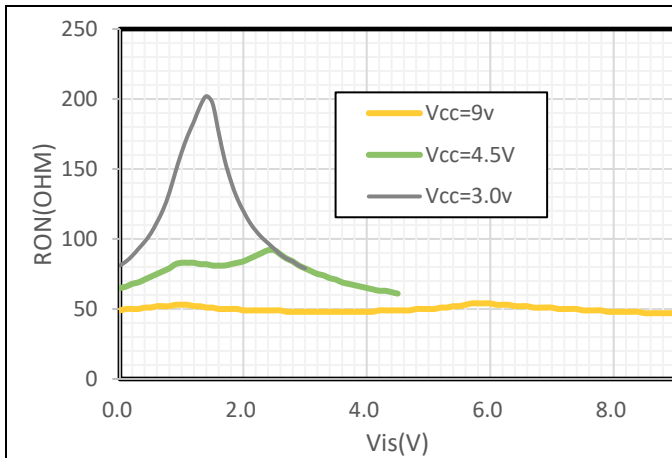


Figure 1. R_{ON} vs. V_{IS}

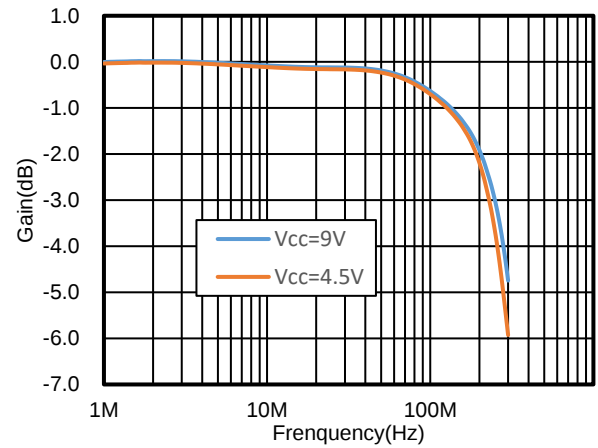
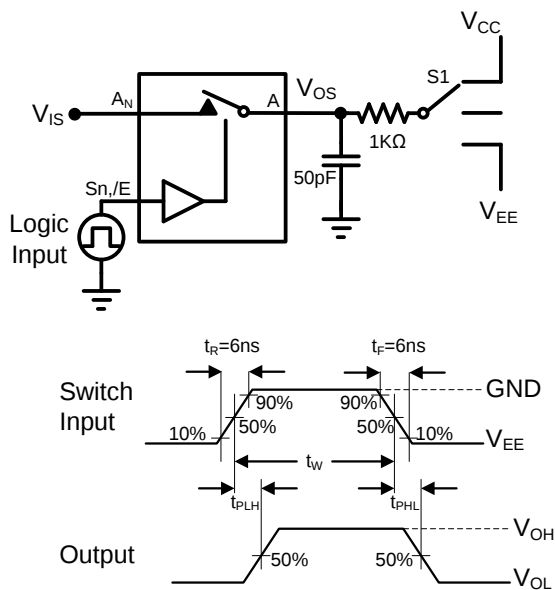


Figure 2. Bandwidth

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}

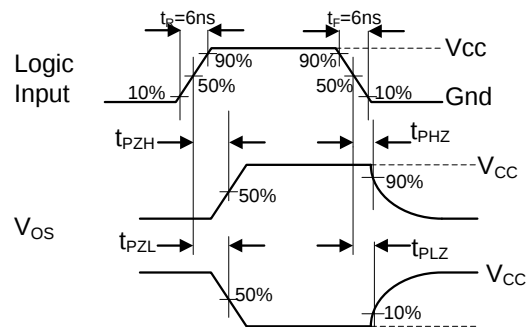
 $t_{ON}: t_{PZH} \text{ or } t_{PZL}$
 $t_{OFF}: t_{PHZ} \text{ or } t_{PLZ}$


Figure 3 AC Test Circuit and Test Waveforms

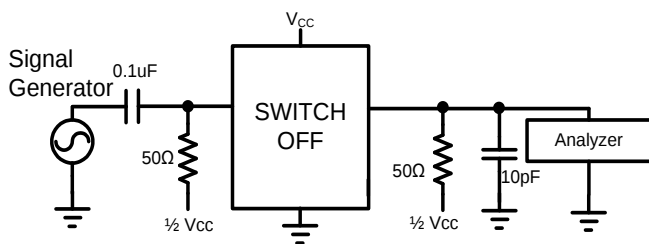


Figure 4 Off Isolation

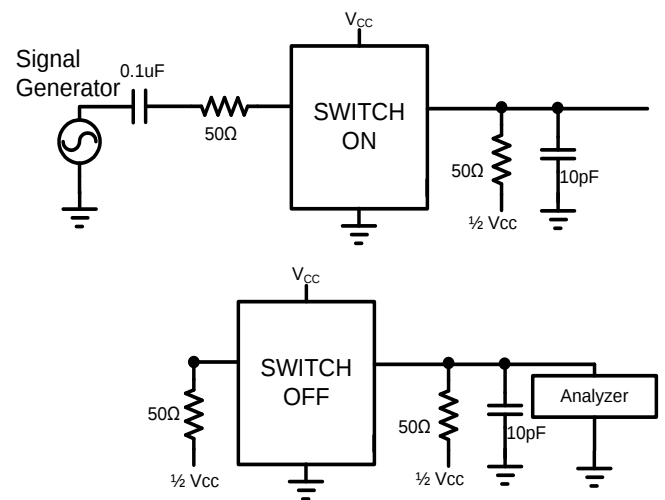
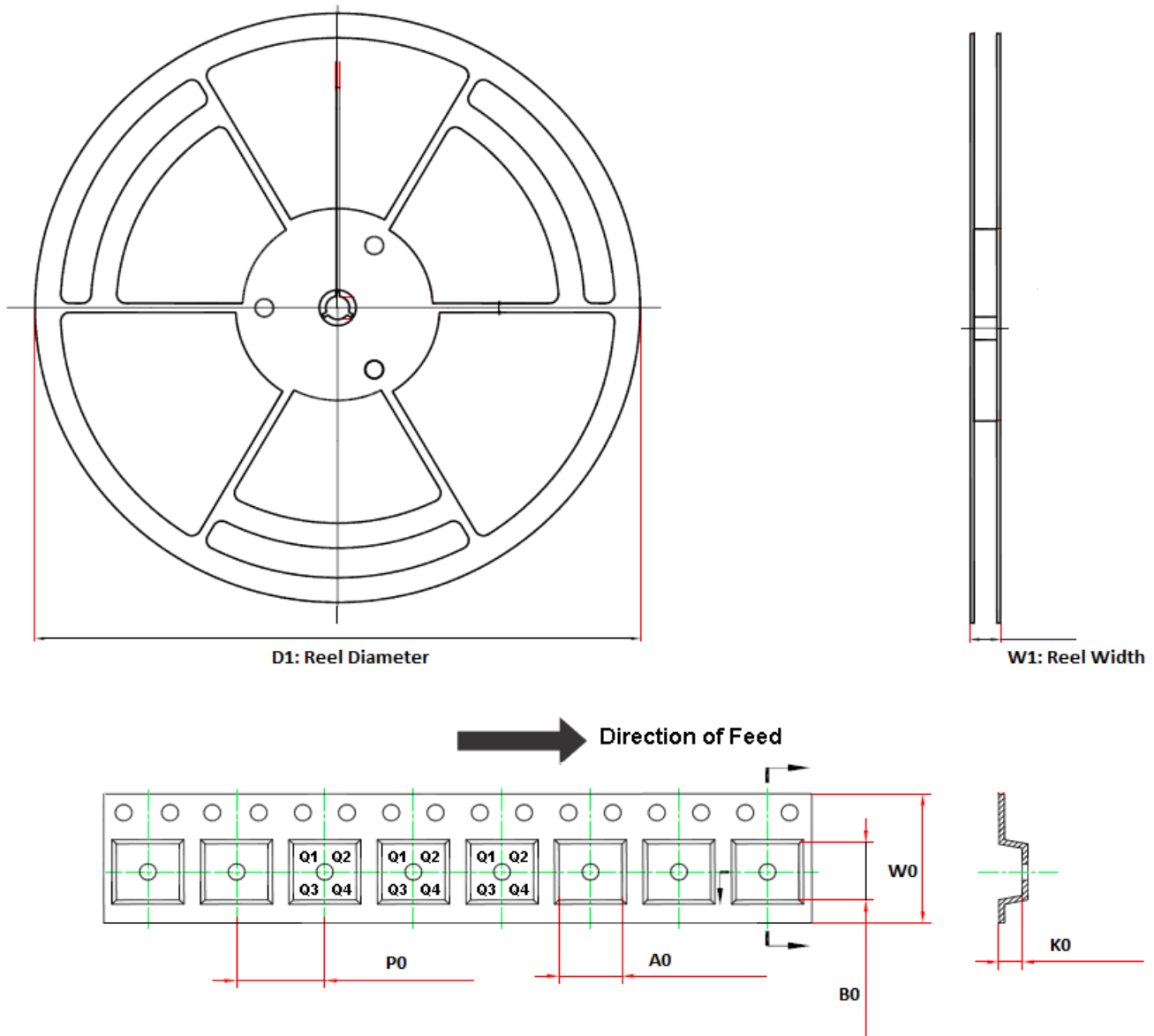


Figure 5 Crosstalk

Application Information

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

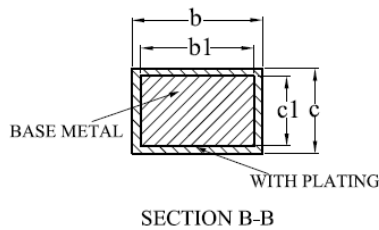
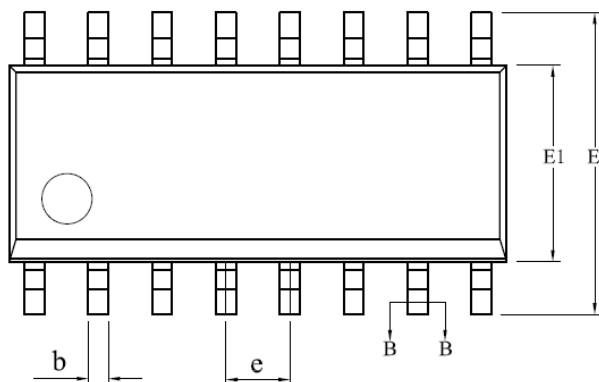
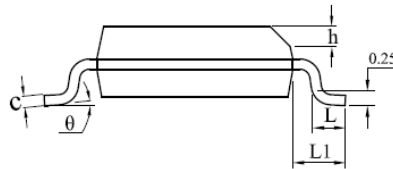
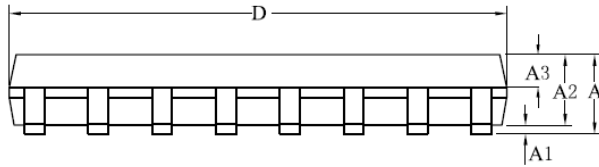
Tape and Reel Information



Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TPW4053-SR	SOIC-16	330	21.6	6.7±0.1	10.4±0.1	2.1±0.1	8.0±0.1	16.0±0.3	Q1
TPW4053-TR	TSSOP-16	330	17.6	6.8±0.1	5.4±0.1	1.3±0.1	8.0±0.1	12.0±0.1	Q1

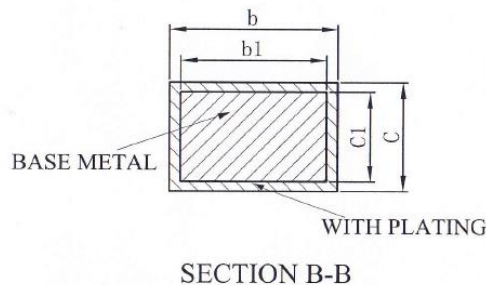
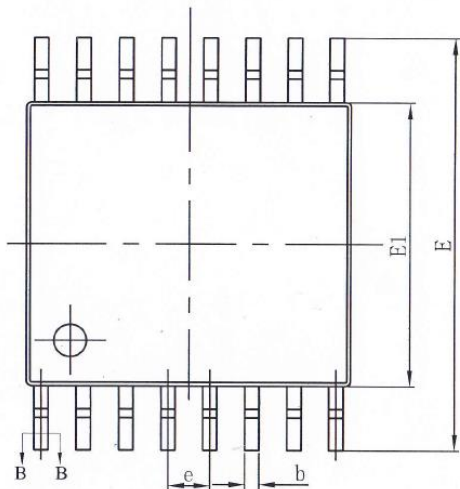
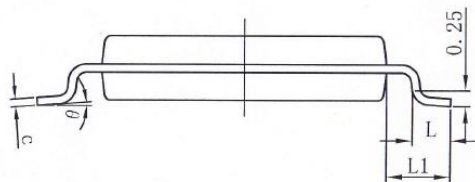
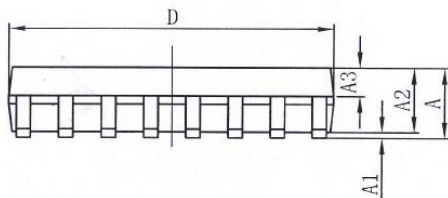
Package Outline Dimensions

SOIC-16



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

TSSOP-16



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°

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