

## Features

- Analog Switch Voltage: 3.3V, 5V, 10V
- Low ON-State Resistance:
  - typical 50Ω at Vs = 9V
  - typical 60Ω at Vs = 4.5V
  - typical 300Ω at Vs = 3V
- Bandwidth: 200 MHz
- Fast switching times: t<sub>ON</sub> = 60ns, t<sub>OFF</sub> = 50ns
- 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 TPW4054 is a single-pole four-throw analog switch (SP4T) suitable for use in analog or digital 4:1 multiplexer/demultiplexer applications. The switch features two digital select inputs (S0, S1), four independent inputs/outputs (An), a common input/output (A) and a digital enable input (/E). When /E is HIGH, the switches are turned off.

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
TPW4054	4:1	12	50	200	MSOP-10
TPW4066	(1:1)*4	12	50	200	SOP-14, TSSOP-14
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

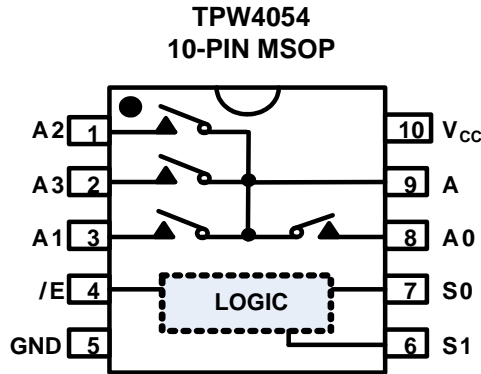
Date	Revision	Notes
2019/12/25	Rev.Pre	Pre-release version
2020/3/31	Rev.A	Initial version

## Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TPW4054-VR	-40 to 125°C	10-Pin MSOP	W4054	3	Tape and Reel, 3000

Pin Configuration, Description and Functional Table <sup>Note 1</sup>

TPW4054



Pin Description

Pin No.	Pin Name	Input / Output	Description	Pin No.	Pin Name	Input / Output	Description
1	A2	Input / Output	Channel 2 input or output	6	S1	Input	Control Input
2	A3	Input / Output	Channel 3 input or output	7	S0	Input	Control Input
3	A1	Input / Output	Channel 1 input or output	8	A0	Input / Output	Channel 0 input or output
4	/E	Input	Enable switches, active low	9	A	Input / Output	Common input or output
5	GND		Ground	10	V <sub>CC</sub>		Power Input

Functional Table

/E, Enable	S1	S0	ON Channel
L	L	L	A0
L	L	H	A1
L	H	L	A2
L	H	H	A3
H	X	X	None

X = Don't care, NA = Not Available

## Absolute Maximum Ratings <sup>Note 1</sup>

Parameters	Rating
Supply Voltage, $V_{CC}$ - GND	-0.5V to 13V
Analog Switch Voltage	- 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	$\theta_{JA}$	$\theta_{JC}$	Unit
16-Pin SOIC	100	50	°C/W
16-Pin TSSOP	150	60	°C/W

## Recommended Operating Conditions <sup>Note 1</sup>

Over operating temperature range

Parameters	Min	Max	Unit
Supply Voltage, $V_{CC}$	3	12	V
Select Input Voltage	0	$V_{CC}$	V
Input Transition Rise and Fall Rate		100	ns/V
Switch I/O Port Voltage	GND	$V_{CC}$	V
Operating Temperature Range	-40	125	°C

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

## Electrical Characteristics

Single Supply,  $V_{CC} = 4.5$  to  $5.5V$ ,  $GND = 0V$ , unless otherwise noted.

Symbol	Parameter	Conditions	$V_{CC}$ (V)	25°C	-40°C to 85°C	-40°C to 125°C	Limit	Unit
<b>Power Supply</b>								
$I_{CC}$	Quiescent Supply Current	$V_{IN} = 0V$ or $V_{CC}$	5.5	4	6	8	Max	$\mu A$
<b>Digital Input</b>								
$V_{IH}$	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	$\pm 0.4$	$\pm 1$	$\pm 1$	Max	$\mu A$
<b>Analog Switch</b>								
$R_{ON}$		$I_{OUT} = 1mA$ , $V_{IS} = GND$ or $V_{CC}$	4.5	60			Typ	$\Omega$
$R_{ON}$		$I_{OUT} = 1mA$ , $V_{IS} = GND$ or $V_{CC}$	4.5	100	130	150	Max	$\Omega$
$\Delta R_{ON}$	On Resistance Match between Channels	$I_{OUT} = 1mA$ , $V_{IS} = 2.5V$	4.5	20	30	35	Max	$\Omega$
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	4.5	60	80	80	Max	$\Omega$
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$	5.5	$\pm 0.4$	$\pm 1$	$\pm 1$	Max	$\mu A$
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$ ,	5.5	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
$I_{(ON)}$	Switch ON Leakage Current	$V_{IS} = GND$ or $V_{CC}$	5.5	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
<b>Dynamic Characteristics</b>								
$t_{PHL}$ , $t_{PLH}$	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	%
<b>Capacitance</b>								
$C_{IN}$	Switch Input Capacitance		5	5			Typ	pF
$C_{COM}$	Common Output Capacitance		5	12			Typ	pF
$C_{PD}$	Power Dissipation Capacitance		5	50			Typ	pF

**Single Supply,  $V_{CC} = 3$  to  $3.6V$ ,  $GND = 0V$ , unless otherwise noted.**

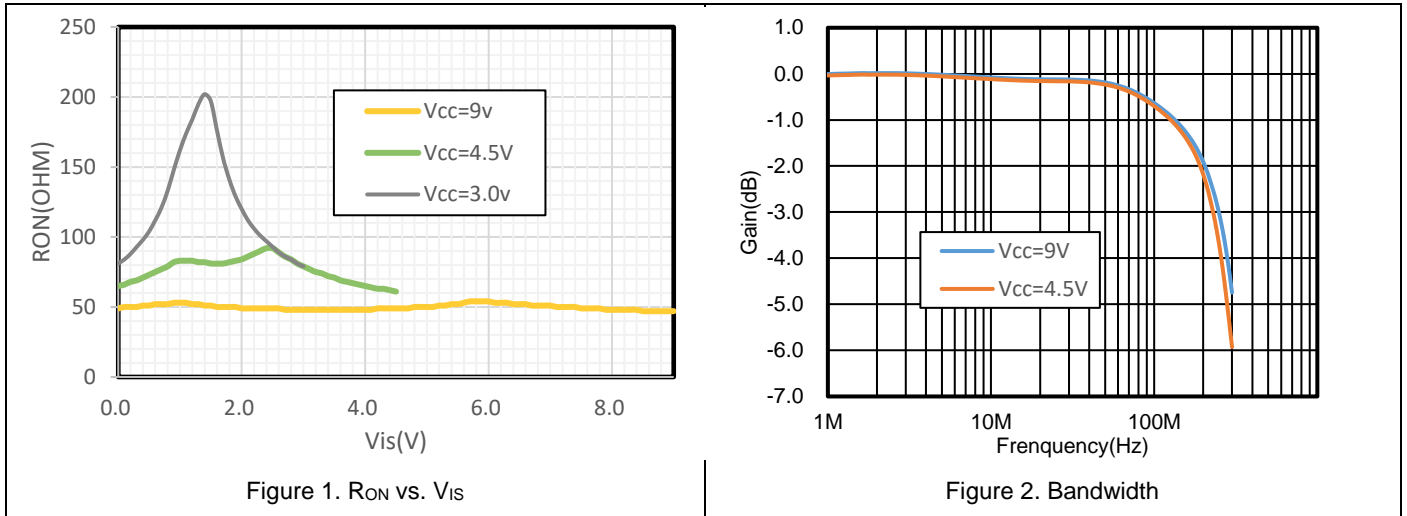
Symbol	Parameter	Conditions	$V_{CC}$ (V)	25°C	-40°C to 85°C	-40°C to 125°C	Limit	Unit
<b>Power Supply</b>								
$I_{CC}$	Quiescent Supply Current	$V_{IN} = 0V$ or $V_{CC}$	3.6	4	6	8	Max	$\mu A$
<b>Digital Input</b>								
$V_{IH}$	Input Voltage High				2.0	2.0	Min	V
$V_{IL}$	Input Voltage Low				0.8	0.8	Max	V
$I_{IN}$	Control Input Leakage	$V_{IN} = 0V$ or $V_{CC}$	3.6		$\pm 1$	$\pm 1$	Max	$\mu A$
<b>Analog Switch</b>								
$R_{ON}$		$I_{OUT} = 1mA$ , $V_{IS} = GND$ or $V_{CC}$	3	300			Typ	$\Omega$
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	3	100			Typ	$\Omega$
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$	3.6	$\pm 0.4$	$\pm 1$	$\pm 1$	Max	$\mu A$
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$ ,	3.6	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
$I_{(ON)}$	Switch ON Leakage Current	$V_{IS} = GND$ or $V_{CC}$	3.6	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
<b>Dynamic Characteristics</b>								
$t_{PHL}$ , $t_{PLH}$	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	100			Typ	MHz
THD	Total Harmonic Distortion	$R_L = 10k\Omega$ , $f = 1kHz$	3.3	0.2			Typ	%
<b>Capacitance</b>								
$C_{IN}$	Switch Input Capacitance		3.3	5			Typ	pF
$C_{COM}$	Common Output Capacitance		3.3	12			Typ	pF
$C_{PD}$	Power Dissipation Capacitance		3.3	50			Typ	pF

**Single Supply,  $V_{CC} = 9V$  to  $11V$ ,  $GND = 0V$ , unless otherwise noted.**

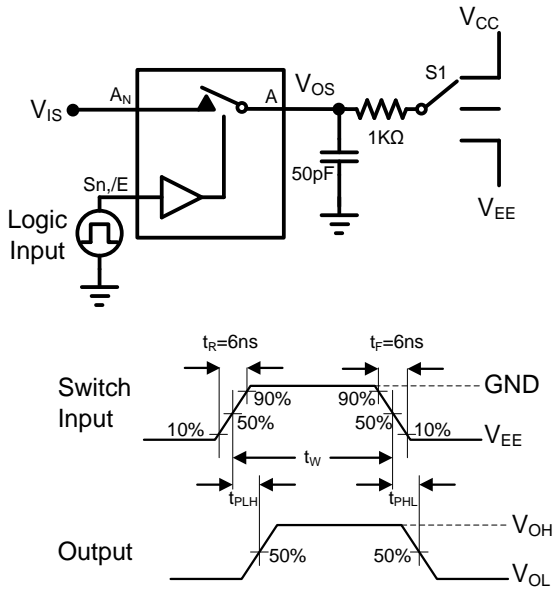
Symbol	Parameter	Conditions	$V_{CC}$ (V)	25°C	-40°C to 85°C	-40°C to 125°C	Limit	Unit
<b>Power Supply</b>								
$I_{CC}$	Quiescent Supply Current	$V_{IN} = 0V$ or $V_{CC}$	9	8	12	16	Max	$\mu A$
<b>Digital Input</b>								
$V_{IH}$	Input Voltage High				2.4	2.4	Min	V
$V_{IL}$	Input Voltage Low				0.8	0.8	Max	V
$I_{IN}$	Control Input Leakage	$V_{IN} = 0V$ or $V_{CC}$	11	$\pm 0.4$	$\pm 1$	$\pm 1$	Max	$\mu A$
<b>Analog Switch</b>								
$R_{ON}$		$I_{OUT} = 1mA$ , $V_{IS} = GND$ or $V_{CC}$	9	50			Typ	$\Omega$
$R_{ON}$		$I_{OUT} = 1mA$ , $V_{IS} = GND$ or $V_{CC}$	9	80	95	105	Max	$\Omega$
$\Delta R_{ON}$	On Resistance Match between Channels	$I_{OUT} = 1mA$ , $V_{IS} = 1V$	9	15	25	30	Max	$\Omega$
$R_{FLAT(ON)}$	On Resistance Flatness	$I_{OUT} = 1mA$	9	30	40	40	Max	$\Omega$
$I_{CH(OFF)}$	Switch OFF Leakage Current on Channel	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$	11	$\pm 0.4$	$\pm 1$	$\pm 1$	Max	$\mu A$
$I_{COM(OFF)}$	Switch OFF Leakage Current on Common	$V_{IS} = GND$ , $V_{OS} = V_{CC}$ ; or $V_{IS} = V_{CC}$ , $V_{OS} = GND$ ,	11	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
$I_{(ON)}$	Switch ON Leakage Current	$V_{IS} = GND$ or $V_{CC}$	11	$\pm 0.4$	$\pm 2$	$\pm 2$	Max	$\mu A$
<b>Dynamic Characteristics</b>								
$t_{PHL}$ , $t_{PLH}$	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	%
<b>Capacitance</b>								
$C_{IN}$	Switch Input Capacitance		10	5			Typ	pF
$C_{COM}$	Common Output Capacitance		10	12			Typ	pF
$C_{PD}$	Power Dissipation Capacitance		10	50			Typ	pF



**Typical Performance Characteristics**



**Test Circuit and Waveforms**



Parameter	Vis	S1 Position
t <sub>PHL</sub> , t <sub>PLH</sub>	Pulse	Open
t <sub>PZH</sub> , t <sub>PHZ</sub>	V <sub>CC</sub>	V <sub>EE</sub>
t <sub>PZL</sub> , t <sub>PLZ</sub>	V <sub>EE</sub>	V <sub>CC</sub>

t<sub>ON</sub>: t<sub>PZH</sub> OR t<sub>PZL</sub>

t<sub>OFF</sub>: t<sub>PHZ</sub> OR t<sub>PLZ</sub>

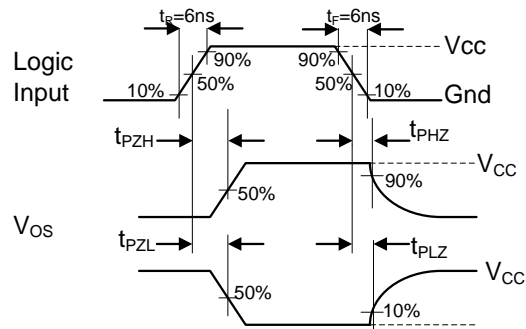


Figure 3 AC Test Circuit and Test Waveforms

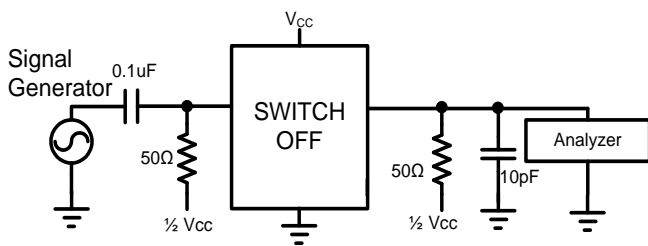


Figure 4 Off Isolation

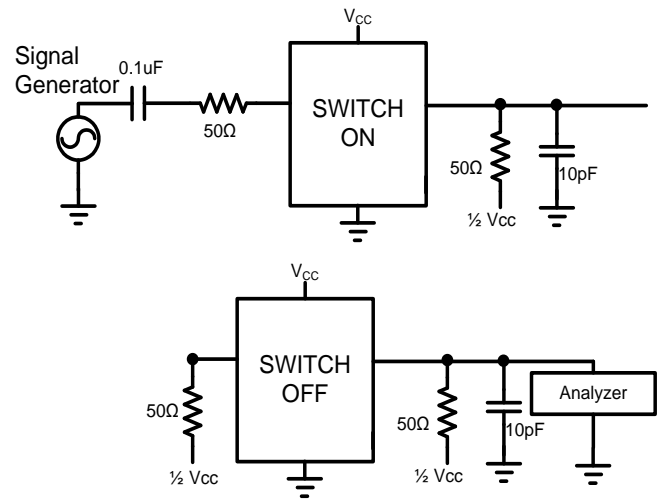
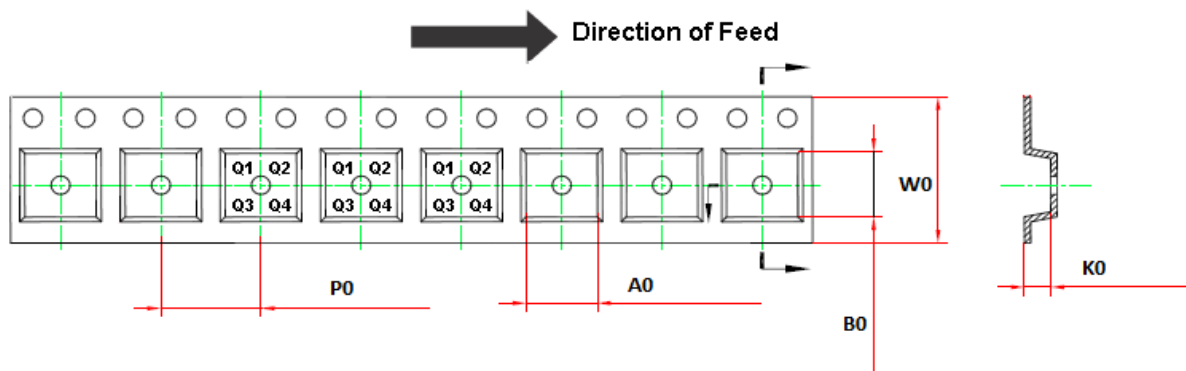
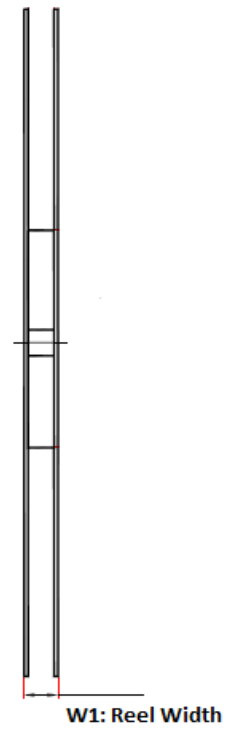
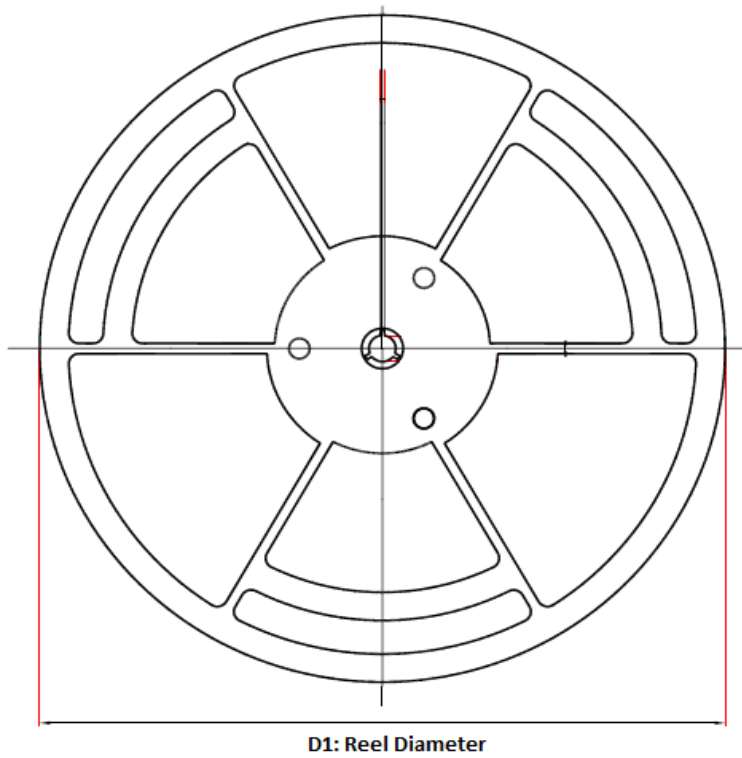


Figure 5 Crosstalk

## Application Information

A 0.1- $\mu$ F bypass capacitor on V<sub>CC</sub> and GND is recommended to prevent power disturbance.

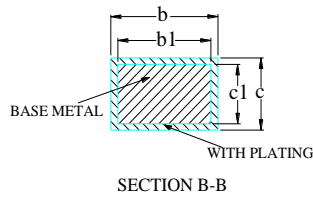
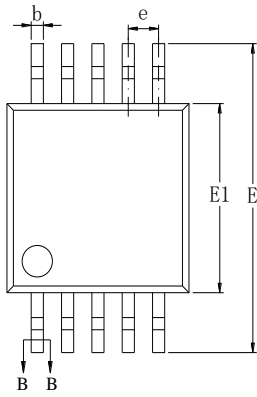
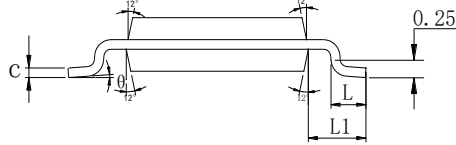
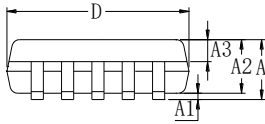
### Tape and Reel Information



Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TPW4054-VR	10-Pin MSOP	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1

Package Outline Dimensions

MSOP-10



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.05	—	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.18	—	0.26
b1	0.17	0.20	0.23
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.50BSC		
L	0.40	—	0.70
L1	0.95REF		
θ	0	—	8°

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