Dual 4-channel Analog Multiplexer/Demultiplexer

CJ74LV4052 Logic

1 Introduction

The CJ74LV4052 is a dual 4-channel analog multiplexer/demultiplexer with a common select logic. Each multiplexer has four independent inputs/outputs (nY0 to nY3) and a common input/output (nZ). The common channel select logics include two digital select inputs (S0 and S1) and an active LOW enable input (/E). With /E LOW, one of the four switches is selected (low impedance ON-state) by S0 and S1. With /E HIGH, all switches are in the high impedance OFF-state, independent of S0 and S1.

V_{CC} and GND are the supply voltage pins for the digital control inputs (S0, S1 and /E). The V_{CC} to GND ranges are 2.0V to 6.0V. The analog inputs/outputs (nY0, to nY3, and nZ) can swing between V_{CC} as a positive limit and V_{EE} as a negative limit. V_{CC}-V_{EE} may not exceed 6.0V.

For operation as a digital multiplexer/demultiplexer, V_{EE} is connected to GND (typically ground).

2 Available Packages

PART NUMBER	PACKAGE
CJ74LV4052	SOP16
	TSSOP16

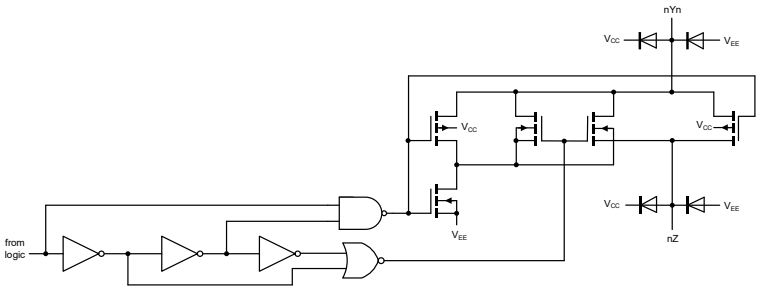
Note: For all available packages, please refer to the part Orderable Information.

3 Features

- Optimized for low-voltage applications: 2.0V to 6.0V
- Accepts TTL input levels between V_{CC}=2.7V and V_{CC}=3.6V
- Low ON resistance:
  - 110Ω (typical) at V_{CC}-V_{EE}=2.0V
  - 90Ω (typical) at V_{CC}-V_{EE}=3.0V
  - 60Ω (typical) at V_{CC}-V_{EE}=4.5V
- Logic level translation: to enable 3V logic to communicate with ±3V analog signals
- Typical 'break before make' built in
- Specified from -40°C to +125°C

4 Applications

- Telecommunications
- Infotainment
- Signal gating and isolation
- Home appliances
- Programmable logic circuits
- Modulation and demodulation



Schematic diagram

5 Orderable Information

DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
CJ74LV4052AEN	SOP16	-40~125°C	RoHS & Green	Level 3 168HR	Tape and Reel 4000 Units/Reel	Active
CJ74LV4052BEN	TSSOP16	-40~125°C	RoHS & Green	Level 3 168HR	Tape and Reel 5000 Units/Reel	Active

Note:

ECO PLAN: For the RoHS and Green certification standards of this product, please refer to the official report provided by JSCJ.

MSL: Moisture Sensitivity Level. Determined according to JEDEC industry standard classification.

SORT: Specifically defined as follows:
Active: Recommended for new products;
Customized: Products manufactured to meet the specific needs of customers;
Preview: The device has been released and has not been fully mass produced. The sample may or may not be available;
NoRD: It is not recommended to use the device for new design. The device is only produced for the needs of existing customers;
Obsolete: The device has been discontinued.

6 Pin Configuration and Marking Information

6.1 Pin Configuration

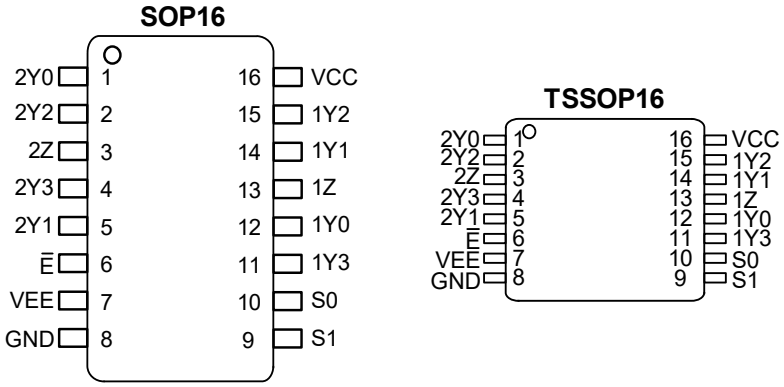


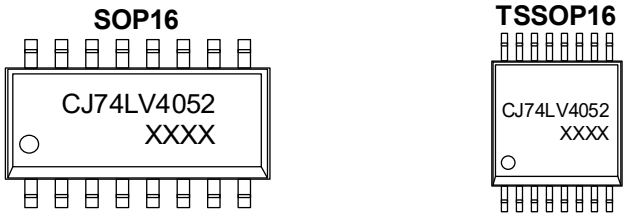
Figure 6-1 Pin configuration

6.2 Pin Function

PIN		I/O(1)	DESCRIPTION
No.	NAME		
1	2Y0	I/O	Independent input or output
2	2Y2	I/O	Independent input or output
3	2Z	I/O	Common output or input
4	2Y3	I/O	Independent input or output
5	2Y1	I/O	Independent input or output
6	$\overline{E}$	I	Enable input (active LOW)
7	VEE	P	Supply voltage
8	GND	G	Ground (0V)
9	S1	I	Select input
10	S0	I	Select input
11	1Y3	I/O	Independent input or output
12	1Y0	I/O	Independent input or output
13	1Z	I/O	Common output or input
14	1Y1	I/O	Independent input or output
15	1Y2	I/O	Independent input or output
16	VCC	P	Supply voltage

(1) I-Input, O-Output, P-Power, G-Ground.

6.3 Marking Information



XXXX: Code, indicates weekly record information.

7 Specifications

7.1 Absolute Maximum Ratings

Voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	MAX.	UNIT
V_{CC}	Supply voltage	-		-0.5	+7.0	V
I_{IK}	Input clamping current	V_I< -0.5V or V_I>V_{CC}+0.5V		-	±20	mA
I_{SK}	Switch clamping current	V_{SW}< -0.5V or V_{SW}>V_{CC}+0.5V		-	±20	mA
I_{SW}	Switch current	V_{SW}> -0.5V or V_{SW}<V_{CC}+0.5V; Source or sink current		-	±25	mA
T_{stg}	Storage temperature	-		-65	+150	°C
P_{tot}	Total power dissipation	-		-	500	mW
T_L	Soldering temperature	10s	SOP/TSSOP	-	260	°C

Note: Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to GND. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

7.2 Recommended Operating Conditions

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC}	Supply voltage	-	2	3.3	6	V
V_I	Input voltage	-	0	-	V_{CC}	V
V_{SW}	Switch voltage	-	0	-	V_{CC}	V
T_{amb}	Ambient temperature	In free air	-40	-	+125	°C
Δt/ΔV	Input transition rise and fall rate	V_{CC}=2.0V to 2.7V	-	-	200	ns/V
		V_{CC}=2.7V to 6.0V	-	-	100	ns/V

7.3 Electrical Characteristics

7.3.1 DC Characteristics 1

T_{amb}=-40°C to +85°C, voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
V_{IH}	HIGH-level input voltage	V_{CC}=2.0V		1.4	-	-	V
		V_{CC}=2.7V to 3.6V		2.0	-	-	V
		V_{CC}=4.5V		3.15	-	-	V
		V_{CC}=6.0V		4.20	-	-	V
V_{IL}	LOW-level input voltage	V_{CC}=2.0V		-	-	0.6	V
		V_{CC}=2.7V to 3.6V		-	-	0.8	V
		V_{CC}=4.5V		-	-	1.35	V
		V_{CC}=6.0V		-	-	1.80	V
I_I	Input leakage current	V_I=V_{CC} or GND	V_{CC}=3.6V	-	-	1.0	uA
			V_{CC}=6.0V	-	-	2.0	uA
$I_{S(OFF)}$	OFF-state leakage current	V_I=V_{IH} or V_{IL}; See Figure 8-13	V_{CC}=3.6V	-	-	1.0	uA
			V_{CC}=6.0V	-	-	2.0	uA
$I_{S(ON)}$	ON-state leakage current	V_I=V_{IH} or V_{IL}; See Figure 8-14	V_{CC}=3.6V	-	-	1.0	uA
			V_{CC}=6.0V	-	-	2.0	uA
I_{CC}	Supply current	V_I=V_{CC} or GND; I_O=0A	V_{CC}=3.6V	-	-	20	uA
			V_{CC}=6.0V	-	-	40	uA
ΔI_{CC}	Additional supply current	Per input; V_I=V_{CC}-0.6V; V_{CC}=2.7V to 3.6V		-	-	500	uA
$R_{ON(peak)}$	ON resistance (peak)	V_I=0V to V_{CC}-V_{EE}	V_{CC}=2.0V; I_{SW}=1000uA	-	290	650	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	150	300	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	100	200	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	80	160	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	65	130	Ω
ΔR_{ON}	ON resistance mismatch between channels	V_I=0V to V_{CC}-V_{EE}	V_{CC}=2.0V; I_{SW}=1000uA	-	5	-	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	4	-	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	4	-	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	3	-	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	2	-	Ω

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
$R_{ON(rail)}$	ON resistance (rail)	V_I=GND	V_{CC}=2.0V; I_{SW}=1000uA	-	110	235	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	85	170	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	65	130	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	60	120	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	50	100	Ω
		V_I=V_{CC}-V_{EE}	V_{CC}=2.0V; I_{SW}=1000uA	-	150	320	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	110	220	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	85	170	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	70	140	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	60	120	Ω

Note: Typical values are measured at T_{amb}=25°C.

7.3.2 DC Characteristics 2

T_{amb}=-40°C to +125°C, voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
V_{IH}	HIGH-level input voltage	V_{CC}=2.0V		1.4	-	-	V
		V_{CC}=2.7V to 3.6V		2.0	-	-	V
		V_{CC}=4.5V		3.15	-	-	V
		V_{CC}=6.0V		4.20	-	-	V
V_{IL}	LOW-level input voltage	V_{CC}=2.0V		-	-	0.6	V
		V_{CC}=2.7V to 3.6V		-	-	0.8	V
		V_{CC}=4.5V		-	-	1.35	V
		V_{CC}=6.0V		-	-	1.80	V
I_I	Input leakage current	V_I=V_{CC} or GND	V_{CC}=3.6V	-	-	2.0	uA
			V_{CC}=6.0V	-	-	4.0	uA
$I_{S(OFF)}$	OFF-state leakage current	V_I=V_{IH} or V_{IL}; See Figure 8-13	V_{CC}=3.6V	-	-	2.0	uA
			V_{CC}=6.0V	-	-	4.0	uA
$I_{S(ON)}$	ON-state leakage current	V_I=V_{IH} or V_{IL}; See Figure 8-14	V_{CC}=3.6V	-	-	2.0	uA
			V_{CC}=6.0V	-	-	4.0	uA
I_{CC}	Supply current	V_I=V_{CC} or GND; I_O=0A	V_{CC}=3.6V	-	-	40	uA
			V_{CC}=6.0V	-	-	80	uA
ΔI_{CC}	Additional supply current	Per input; V_I=V_{CC}-0.6V; V_{CC}=2.7V to 3.6V		-	-	850	uA

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
$R_{ON(peak)}$	ON resistance (peak)	V_I=0V to V_{CC}-V_{EE}	V_{CC}=2.0V; I_{SW}=1000uA	-	-	750	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	-	350	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	-	250	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	-	200	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	-	150	Ω
$R_{ON(rail)}$	ON resistance (rail)	V_I=GND	V_{CC}=2.0V; I_{SW}=1000uA	-	-	750	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	-	270	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	-	200	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	-	150	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	-	140	Ω
		V_I=V_{CC}-V_{EE}	V_{CC}=2.0V; I_{SW}=1000uA	-	-	120	Ω
			V_{CC}=2.7V; I_{SW}=1000uA	-	-	370	Ω
			V_{CC}=3.0V to 3.6V; I_{SW}=1000uA	-	-	250	Ω
			V_{CC}=4.5V; I_{SW}=1000uA	-	-	205	Ω
			V_{CC}=6.0V; I_{SW}=1000uA	-	-	150	Ω

7.3.3 AC Characteristics 1

T_{amb}=-40°C to +85°C, voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
t_{pd}	Propagation delay	nYn to nZ, nZ to nYn; See Figure 8-4	V_{CC}=2.0V	-	9	17	ns
			V_{CC}=2.7V	-	6	13	ns
			V_{CC}=3.0V to 3.6V	-	5	10	ns
			V_{CC}=4.5V	-	4	9	ns
			V_{CC}=6.0V	-	3	7	ns
t_{en}	Enable time	$\overline{E}$, Sn to nYn, nZ; See Figure 8-5	V_{CC}=2.0V	-	65	121	ns
			V_{CC}=2.7V	-	48	89	ns
			V_{CC}=3.0V to 3.6V; C_L=15pF	-	30	-	ns
			V_{CC}=3.0V to 3.6V	-	36	71	ns
			V_{CC}=4.5V	-	32	60	ns
			V_{CC}=6.0V	-	25	46	ns
t_{dis}	Disable time	$\overline{E}$, Sn to nYn, nZ; See Figure 8-5	V_{CC}=2.0V	-	43	80	ns
			V_{CC}=2.7V	-	33	59	ns
			V_{CC}=3.0V to 3.6V; C_L=15pF	-	22	-	ns
			V_{CC}=3.0V to 3.6V	-	26	48	ns
			V_{CC}=4.5V	-	23	41	ns
			V_{CC}=6.0V	-	28	32	ns

Note:

(1) Typical values are measured at T_{amb}=25°C.

(2) t_{pd} is the same as t_{PLH} and t_{PHL}.
t_{en} is the same as t_{PZL} and t_{PZH}.
t_{dis} is the same as t_{PLZ} and t_{PHZ}.

7.3.4 AC Characteristics 2

T_{amb}=-40°C to +125°C, voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
t_{pd}	Propagation delay	nYn to nZ, nZ to nYn; See Figure 8-4	V_{CC}=2.0V	-	-	20	ns
			V_{CC}=2.7V	-	-	15	ns
			V_{CC}=3.0V to 3.6V	-	-	12	ns
			V_{CC}=4.5V	-	-	10	ns
			V_{CC}=6.0V	-	-	8	ns
t_{en}	Enable time	$\overline{E}$, Sn to nYn, nZ; See Figure 8-5	V_{CC}=2.0V	-	-	146	ns
			V_{CC}=2.7V	-	-	108	ns
			V_{CC}=3.0V to 3.6V	-	-	86	ns
			V_{CC}=4.5V	-	-	73	ns
			V_{CC}=6.0V	-	-	56	ns
t_{dis}	Disable time	$\overline{E}$, Sn to nYn, nZ; See Figure 8-5	V_{CC}=2.0V	-	-	95	ns
			V_{CC}=2.7V	-	-	71	ns
			V_{CC}=3.0V to 3.6V	-	-	57	ns
			V_{CC}=4.5V	-	-	49	ns
			V_{CC}=6.0V	-	-	38	ns

Note:

(1) t_{pd} is the same as t_{PLH} and t_{PHL}.
t_{en} is the same as t_{PZL} and t_{PZH}.
t_{dis} is the same as t_{PLZ} and t_{PHZ}.

7.3.5 AC Characteristics 3

T_{amb}=25°C, GND=0V, $t_r=t_f$≤6.0ns, V_I=GND or V_{CC}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
THD	Total harmonic distortion	f_i=1kHz; C_L=50pF; R_L=10kΩ; See Figure 8-8	V_{CC}=3.0V; V_I=2.75V(p-p)	-	0.8	-	%
			V_{CC}=6.0V; V_I=5.5V(p-p)	-	0.4	-	%
		f_i=10kHz; C_L=50pF; R_L=10kΩ; See Figure 8-8	V_{CC}=3.0V; V_I=2.75V(p-p)	-	2.4	-	%
			V_{CC}=6.0V; V_I=5.5V(p-p)	-	1.2	-	%
$f_{(-3dB)}$	-3dB frequency response	C_L=50pF; R_L=50Ω; See Figure 8-6	V_{CC}=3.0V	-	180	-	MHz
			V_{CC}=6.0V	-	200	-	MHz
α_{iso}	Isolation (OFF-state)	f_i=1MHz; C_L=50pF; R_L=600Ω; See Figure 8-7	V_{CC}=3.0V	-	-50	-	dB
			V_{CC}=6.0V	-	-50	-	dB
V_{ct}	Crosstalk voltage	Between digital inputs and switch; f_i=1MHz; C_L=50pF; R_L=600Ω; See Figure 8-9	V_{CC}=3.0V	-	0.11	-	V
			V_{CC}=6.0V	-	0.12	-	V
Xtalk	Crosstalk	Between switches; f_i=1MHz; C_L=50pF; R_L=600Ω; See Figure 8-10	V_{CC}=3.0V	-	-60	-	dB
			V_{CC}=6.0V	-	-60	-	dB

Note:

(1) To obtain 0dBm level at output for 1MHz (0dBm=1mW into 50Ω), adjust f_i voltage.

(2) To obtain 0dBm level at output for 1MHz (0dBm=1mW into 600Ω), adjust f_i voltage.

8 Detailed Description

8.1 Overview

The CJ74LV4052 is a dual 4-channel analog multiplexer/demultiplexer with a common select logic. Each multiplexer has four independent inputs/outputs (nY0 to nY3) and a common input/output (nZ). The common channel select logics include two digital select inputs (S0 and S1) and an active LOW enable input (/E). With /E LOW, one of the four switches is selected (low impedance ON-state) by S0 and S1. With /E HIGH, all switches are in the high impedance OFF-state, independent of S0 and S1.

V_{CC} and GND are the supply voltage pins for the digital control inputs (S0, S1 and /E). The V_{CC} to GND ranges are 2.0V to 6.0V. The analog inputs/outputs (nY0, to nY3, and nZ) can swing between V_{CC} as a positive limit and V_{EE} as a negative limit. V_{CC}-V_{EE} may not exceed 6.0V.

For operation as a digital multiplexer/demultiplexer, V_{EE} is connected to GND (typically ground).

8.2 Functional Block Diagram

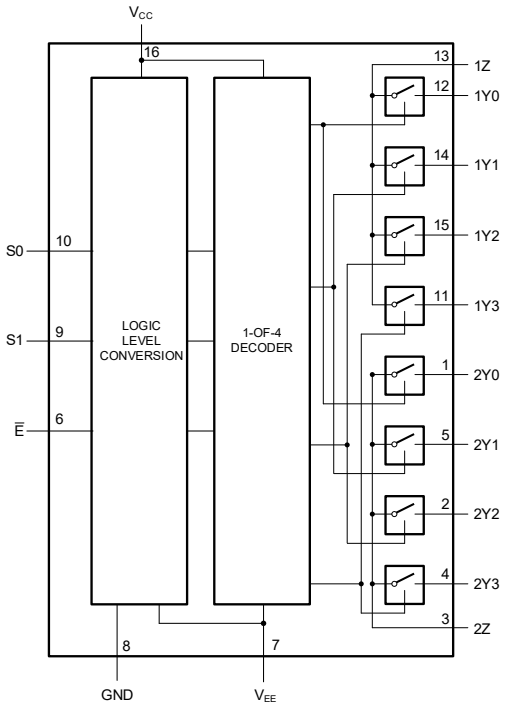


Figure 8-1 Functional diagram

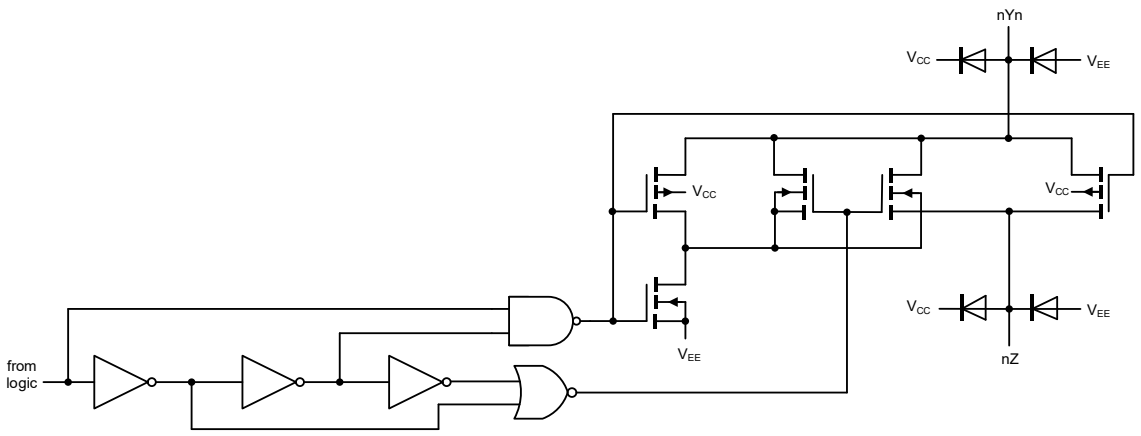


Figure 8-2 Schematic diagram (one switch)

8.3 Function Table

INPUT			CHANNEL ON
$\overline{E}$	S1	S0	
L	L	L	nY0 to nZ
L	L	H	nY1 to nZ
L	H	L	nY2 to nZ
L	H	H	nY3 to nZ
H	X	X	None

Note: H=HIGH voltage level; L=LOW voltage level; X=don't care.

8.4 Testing Circuit

8.4.1 AC Testing Circuit 1

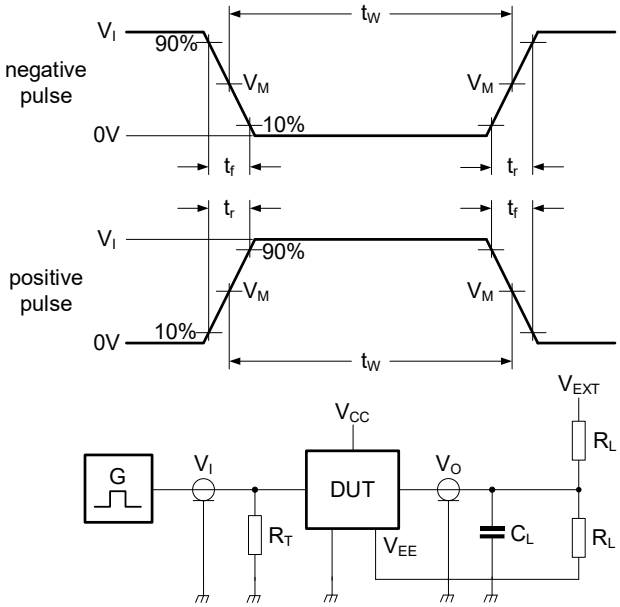


Figure 8-3 Test circuit for switching times

Definitions for test circuit:

C_L=Load capacitance including jig and probe capacitance.

R_T=Termination resistance should be equal to the output impedance Z_o of the pulse generator.

R_L=Load resistance.

V_{EXT}=External voltage for measuring switching times.

8.4.2 AC Testing Waveforms

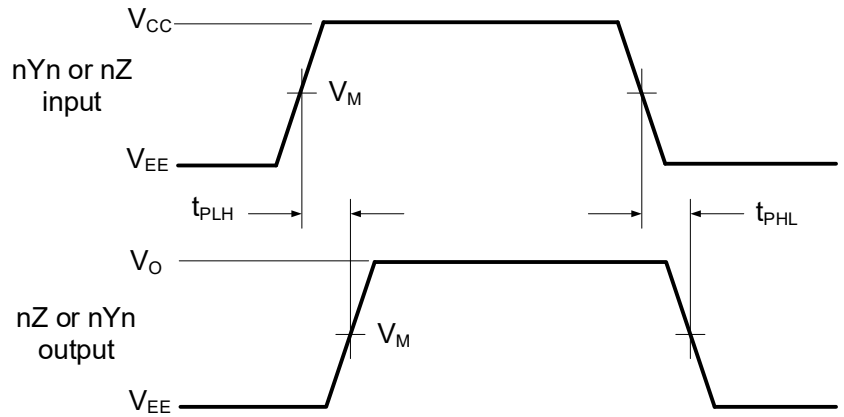


Figure 8-4 nYn, nZ to nZ, nYn propagation delays

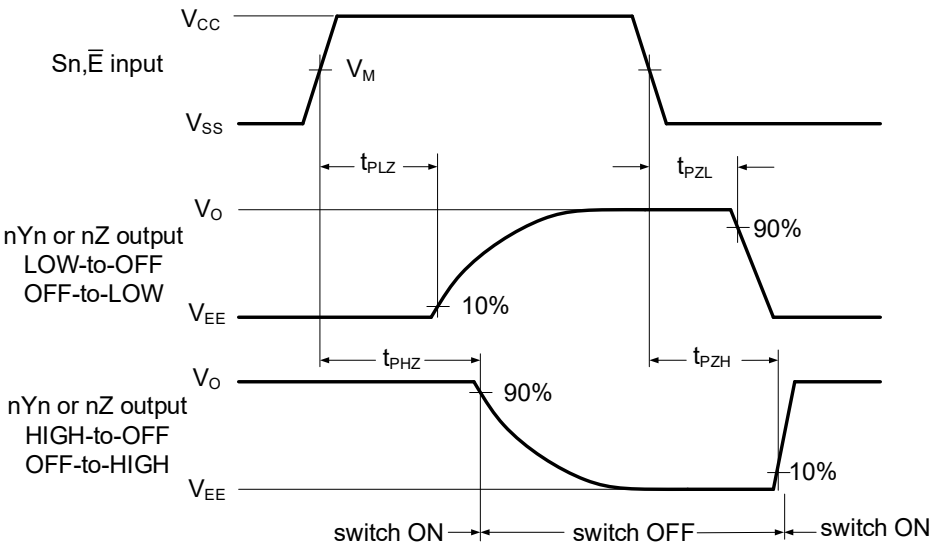


Figure 8-5 Enable and disable times

8.4.3 AC Testing Circuit 2

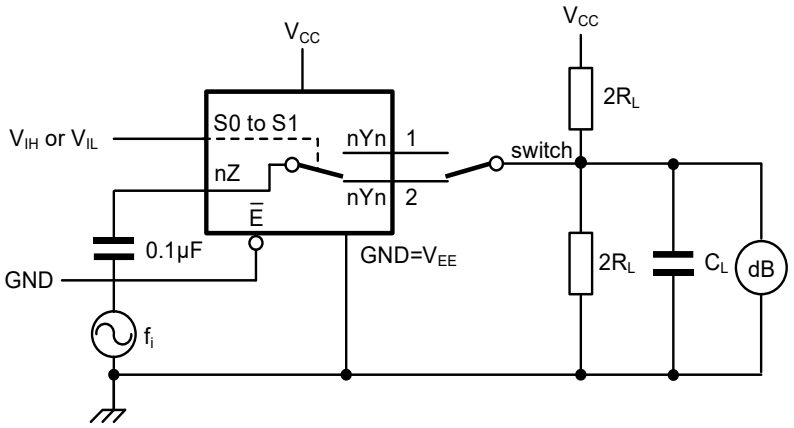


Figure 8-6 Test circuit for measuring frequency response

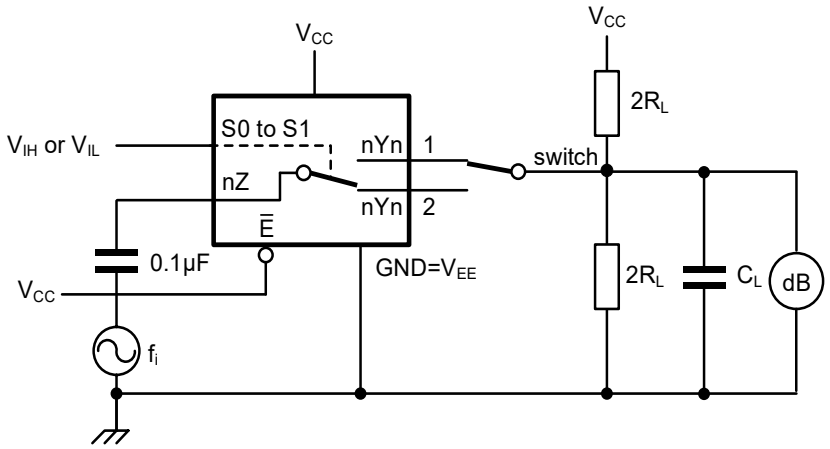


Figure 8-7 Test circuit for measuring isolation (OFF-state)

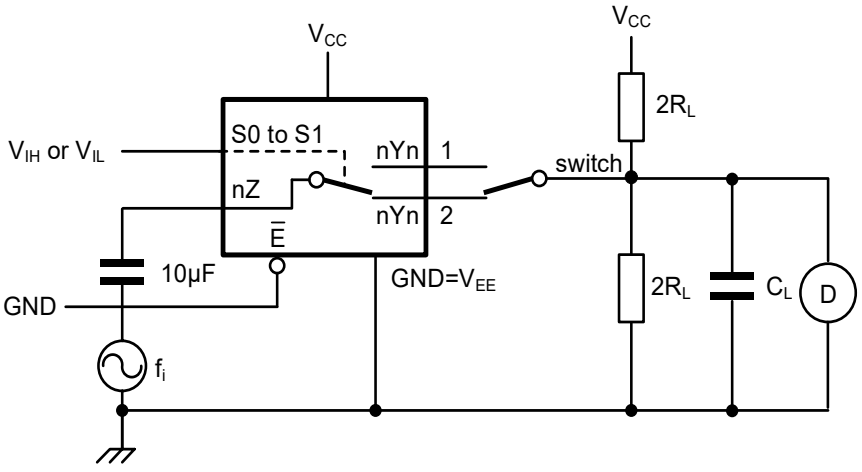
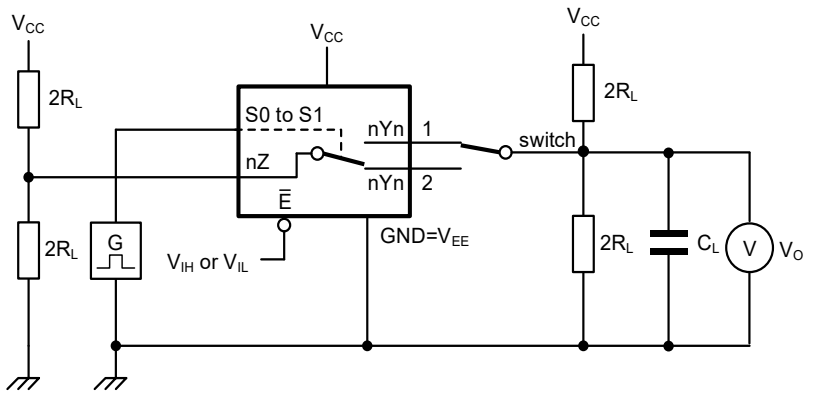
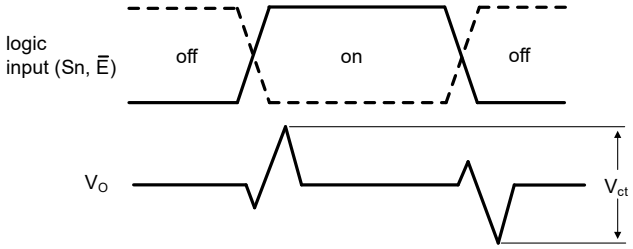


Figure 8-8 Test circuit for measuring total harmonic distortion



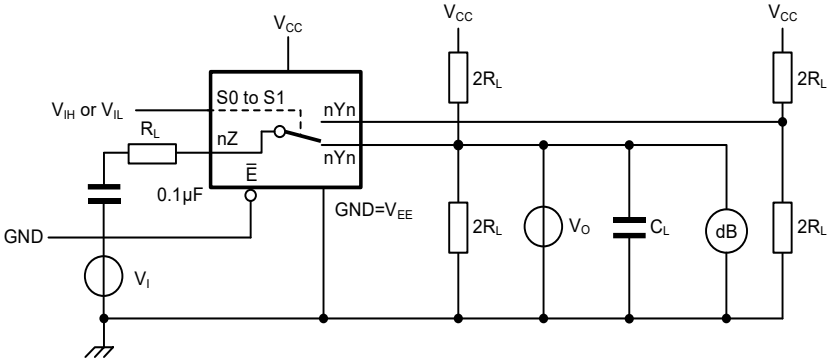
a. Test circuit



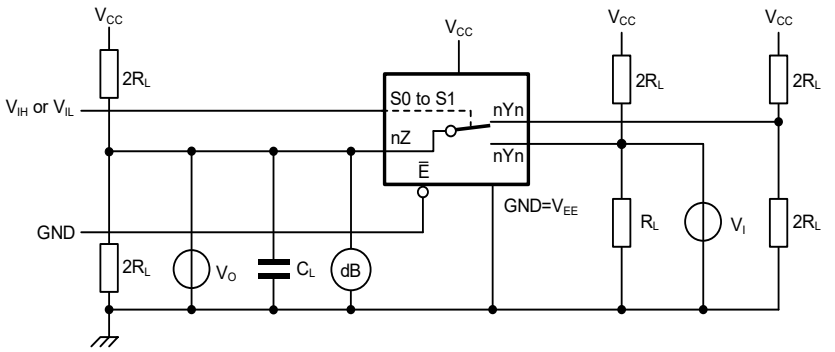
b. Input and output pulse definitions

V_I may be connected to Sn or $\overline{E}$

Figure 8- 9 Test circuit for measuring crosstalk voltage between digital inputs and switch



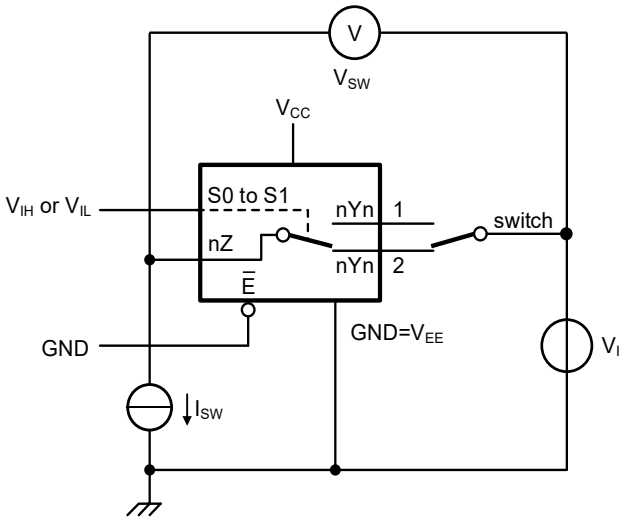
a. Switch on channel



b. Switch off channel

Figure 8-10 Test circuit for measuring crosstalk between switches

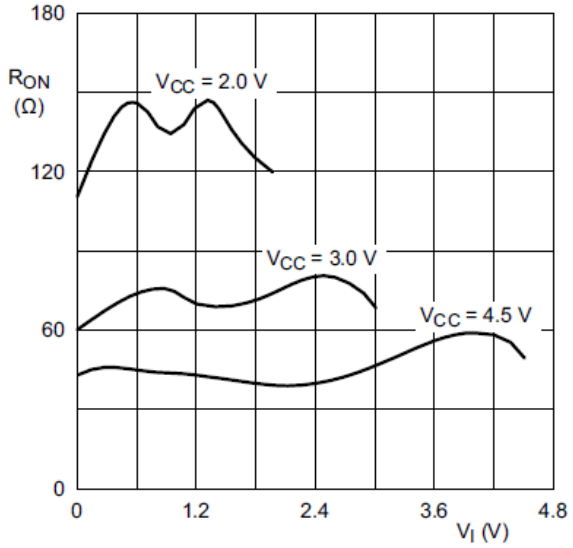
8.4.4 ON Resistance Testing Circuit



$R_{ON}=V_{SW}/I_{SW}$

Figure 8-11 Test circuit for measuring R_{ON}

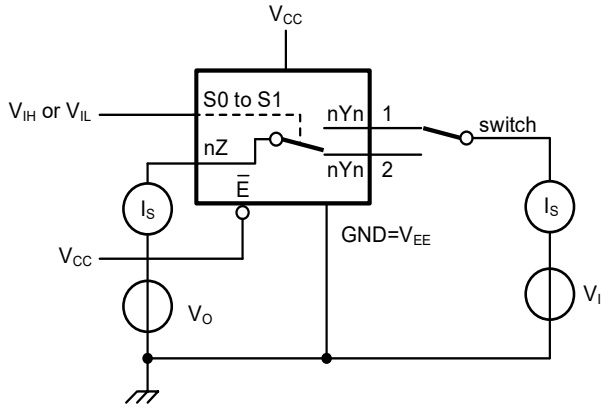
8.4.5 ON Resistance Waveform



V_I=0V to V_{CC}-V_{EE}

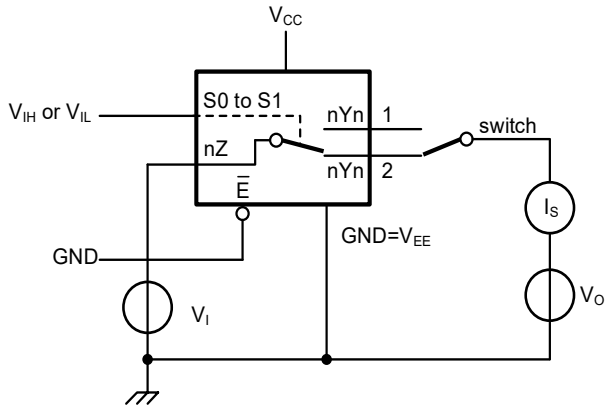
Figure 8-12 Typical R_{ON} as a function of input voltage

8.4.6 DC Testing Circuit



V_I=V_{CC} or V_{EE} and V_O=V_{EE} or V_{CC}

Figure 8-13 Test circuit for measuring OFF-state leakage current



V_I=V_{CC} or V_{EE} and V_O=open circuit

Figure 8-14 Test circuit for measuring ON-state leakage current

8.4.7 Measurement Points

SUPPLY VOLTAGE	INPUT	OUTPUT
V_{CC}	V_M	V_M
<2.7V	0.5xV_{CC}	0.5xV_{CC}
2.7V to 3.6V	1.5V	1.5V
>3.6V	0.5xV_{CC}	0.5xV_{CC}

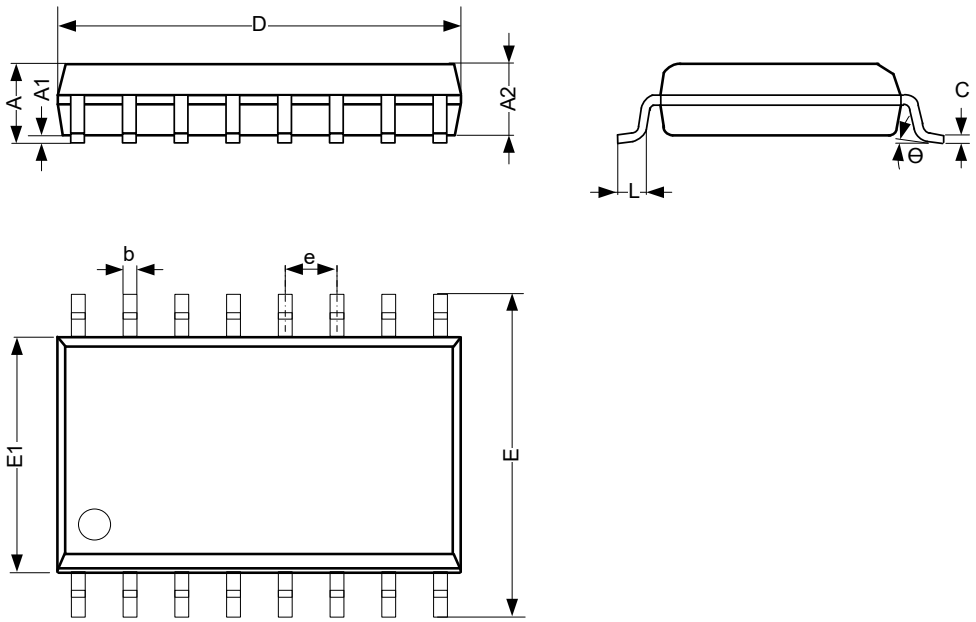
8.4.8 Test Data

SUPPLY VOLTAGE	INPUT		LOAD		V_{EXT}		
V_{CC}	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}
<2.7V	V_{CC}	≤6ns	50pF	1kΩ	Open	V_{EE}	2xV_{CC}
2.7V to 3.6V	2.7V	≤6ns	15 pF,50pF	1kΩ	Open	V_{EE}	2xV_{CC}
>3.6V	V_{CC}	≤6ns	50pF	1kΩ	Open	V_{EE}	2xV_{CC}

9 Mechanical Information

9.1 SOP16 Mechanical Information

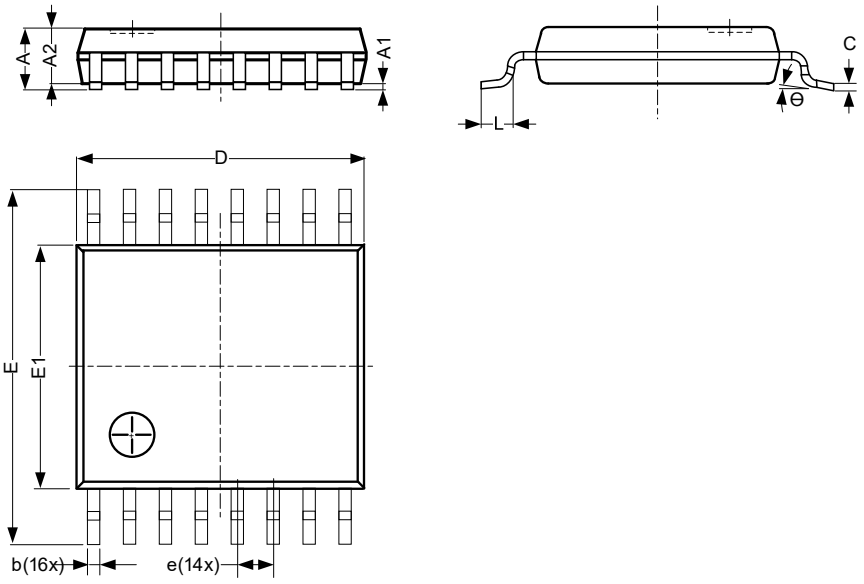
9.1.1 SOP16 Outline Dimensions



SYMBOL	Dimensions In Millimeters		
	Min.	Typ.	Max.
A	1.35	-	1.80
A1	0.10	-	0.25
A2	1.25	-	1.55
b	0.33	-	0.51
c	0.19	-	0.25
D	9.50	-	10.10
E	5.80	-	6.30
E1	3.70	-	4.10
e	1.27 BSC		
L	0.35	-	0.89
Θ	0°	-	8°
Unit: mm			

9.2 TSSOP16 Mechanical Information

9.2.1 TSSOP16 Outline Dimensions



SYMBOL	Dimensions In Millimeters		
	Min.	Typ.	Max.
A	-	-	1.20
A1	0.05	-	0.15
A2	0.80	-	1.05
b	0.19	-	0.30
c	0.09	-	0.20
D	4.90	-	5.10
E	6.20	-	6.60
E1	4.30	-	4.50
e	0.65 BSC		
L	0.45	-	0.75
Θ	0°	-	8°
Unit: mm			

10 Notes and Revision History

10.1 Associated Product Family and Others

To view other products of the same type or IC products of other types, click the official website of JSCJ -- ***https:www.jscj-elec.com*** for more details.

10.2 Notes

Electrostatic Discharge Caution

This IC may be damaged by ESD. Relevant personnel shall comply with correct installation and use specifications to avoid ESD damage to the IC. If appropriate measures are not taken to prevent ESD damage, the hazards caused by ESD include but are not limited to degradation of integrated circuit performance or complete damage of integrated circuit. For some precision integrated circuits, a very small parameter change may cause the whole device to be inconsistent with its published specifications.

DISCLAIMER

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