



# XS5A1T4157

Low-ohmic single-pole double-throw analog switch

Rev. 2.1 — 31 July 2024

Product data sheet

## 1. General description

The XS5A1T4157 is a low-ohmic single-pole double-throw analog switch suitable for use as an analog or digital 2:1 multiplexer/demultiplexer. It has a digital select input (S), two inputs/outputs (Y0 and Y1) and a common input/output (Z).

The XS5A1T4157 passes analog and digital voltages that may vary across the full voltage supply range (GND to  $V_{CC}$ ).

## 2. Features and benefits

- Supply voltage range from  $V_{CC} = 4.5$  V to 5.5 V
- Very low ON resistance: 4  $\Omega$  (typical) at  $V_{CC} = 5$  V
- Switch inputs voltage range:  $V_{SW} = \text{GND to } V_{CC}$
- Control input voltage range:  $V_{I(S)} = \text{GND to } V_{CC}$
- Latch-up performance exceeds 200 mA per JESD 78 Class II level A
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

## 3. Ordering information

Table 1. Ordering information

Type number	Package				Version
	Temperature range	Name	Description		
XS5A1T4157GW	-40 °C to +125 °C	TSSOP6	plastic thin shrink small outline package; 6 leads; body width 1.25 mm		<a href="#">SOT363-2</a>

## 4. Marking

Table 2. Marking codes

Type number	Marking code <sup>[1]</sup>
XS5A1T4157GW	zb

[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

**nexperia**

## 5. Functional diagram

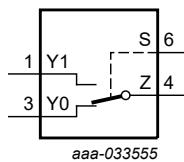
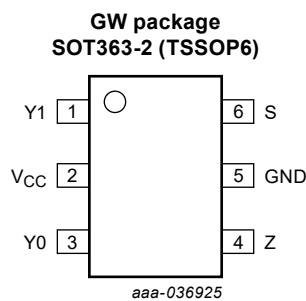


Fig. 1. Logic symbol

## 6. Pinning information

### 6.1. Pinning



### 6.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
Y1	1	independent input or output
V <sub>CC</sub>	2	supply voltage
Y0	3	independent input or output
Z	4	common output or input
GND	5	ground (0 V)
S	6	select input

## 7. Functional description

Table 4. Function table

*H* = HIGH voltage level; *L* = LOW voltage level.

Input	Channel on
S	
L	Y0
H	Y1

## 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		-0.5	+6.5	V
$V_I$	input voltage	S input [1]	-0.5	+6.5	V
$I_{IK}$	input clamping current	S input; $V_I < -0.5$ V	-50	-	mA
$I_{SK}$	switch clamping current	Z, Y0 and Y1 inputs/outputs; $V_{SW} < -0.5$ V or $V_{SW} > V_{CC} + 0.5$ V	-	$\pm 50$	mA
$V_{SW}$	switch voltage	Z, Y0 and Y1 inputs/outputs [2]	-0.5	$V_{CC} + 0.5$	V
$I_{SW}$	switch current	Z, Y0 and Y1 inputs/outputs; $-0.5$ V < $V_{SW} < V_{CC} + 0.5$ V [3]	-	$\pm 128$	mA
$T_{j(max)}$	maximum junction temperature		-	+150	°C
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +125 °C [4]	-	250	mW

[1] The minimum input voltage rating may be exceeded if the input current rating is observed.

[2] The minimum and maximum switch voltage ratings may be exceeded if the switch clamping current rating is observed.

[3] Continuous current sustained maximum of 2 years.

[4] For SOT363-2 (TSSOP6) package:  $P_{tot}$  derates linearly with 3.7 mW/K above 83 °C.

## 9. Recommended operating conditions

**Table 6. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		4.5	5.5	V
$V_I$	input voltage	S input	0	5.5	V
$V_{SW}$	switch voltage	Z, Y0 and Y1 inputs/outputs	0	$V_{CC}$	V
$I_{SW}$	switch current	Z, Y0 and Y1 inputs/outputs; $-0.5$ V < $V_{SW} < V_{CC} + 0.5$ V	-	$\pm 64$	mA
$T_{amb}$	ambient temperature		-40	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	S input	-	100	ns/V

## 10. Static characteristics

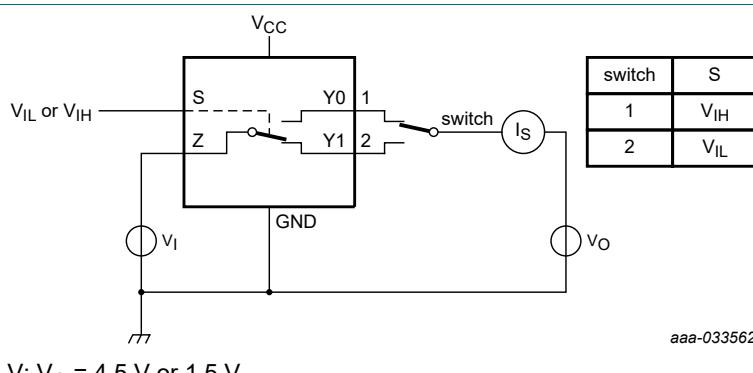
**Table 7. Static characteristics**

At recommended operating conditions; voltages are referenced to GND (ground 0 V).

Symbol	Parameter	Conditions	$T_{amb} = -40^{\circ}C$ to $+125^{\circ}C$			Unit
			Min	Typ[1]	Max	
$V_{IH}$	HIGH-level input voltage	S input; $V_{CC} = 4.5\text{ V}$ to $5.5\text{ V}$	1.4	-	-	V
$V_{IL}$	LOW-level input voltage	S input; $V_{CC} = 4.5\text{ V}$ to $5.5\text{ V}$	-	-	0.3	V
$I_I$	input leakage current	S input; $V_{I(S)} = 5.5\text{ V}$	-50	0.2	50	nA
$I_{S(OFF)}$	OFF-state leakage current	$V_{I(S)} = V_{IL}$ or $V_{IH}$ ; $V_I = 1.5\text{ V}$ or $4.5\text{ V}$ ; $V_O = 4.5\text{ V}$ or $1.5\text{ V}$ ; $V_{CC} = 5.0\text{ V}$ ; see <a href="#">Fig. 2</a>	-320	$\pm 0.02$	320	nA
$I_{S(ON)}$	ON-state leakage current	$V_{I(S)} = V_{IL}$ or $V_{IH}$ ; $V_I = V_O = 1\text{ V}$ or $4.5\text{ V}$ ; $V_{CC} = 5.0\text{ V}$ ; see <a href="#">Fig. 3</a>	-320	$\pm 0.02$	320	nA
$I_{CC}$	supply current	$V_{I(S)} = \text{GND}$ or $V_{CC}$ ; $V_{SW} = \text{GND}$ or $V_{CC}$ ; $V_{CC} = 5.0\text{ V}$	-	0.6	8000	nA
		$V_{I(S)} = 1.8\text{ V}$ ; $V_{SW} = \text{GND}$ or $V_{CC}$ ; $V_{CC} = 5.0\text{ V}$ ; see <a href="#">Fig. 4</a>	-	90	-	$\mu\text{A}$
$C_I$	input capacitance	S input; $V_{CC} = 5.0\text{ V}$	-	2	-	pF
$C_{S(OFF)}$	OFF-state capacitance	$Y_0, Y_1$ input/output; $V_{CC} = 5.0\text{ V}$ ; see <a href="#">Fig. 5</a>	-	11	-	pF
$C_{S(ON)}$	ON-state capacitance	Z input/output; $V_{CC} = 5.0\text{ V}$ ; see <a href="#">Fig. 6</a>	-	35	-	pF

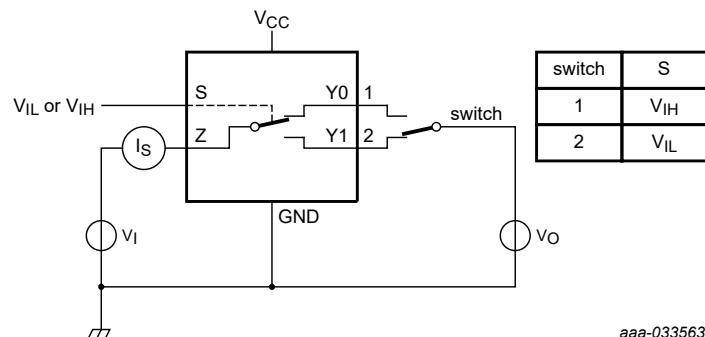
[1] Typical values are measured at  $T_{amb} = 25^{\circ}\text{C}$ .

### 10.1. Test circuits and graphs



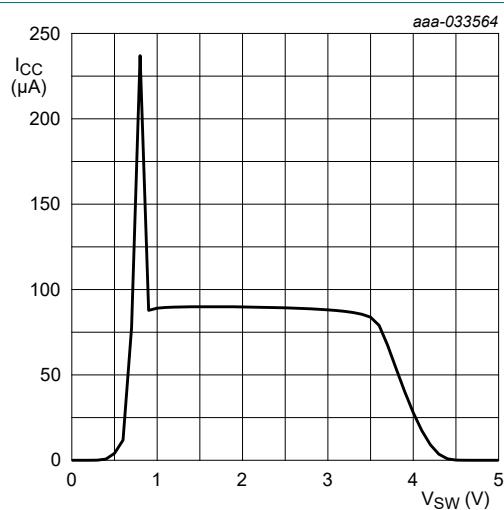
**Fig. 2. Test circuit for measuring OFF-state leakage current**

## Low-ohmic single-pole double-throw analog switch



$V_I = V_O = 1 \text{ V or } 4.5 \text{ V}$

Fig. 3. Test circuit for measuring ON-state leakage current



$T_{amb} = 25 \text{ }^{\circ}\text{C}$ ;  $V_{CC} = 5.0 \text{ V}$

Fig. 4. Typical supply current as function of the switch voltage

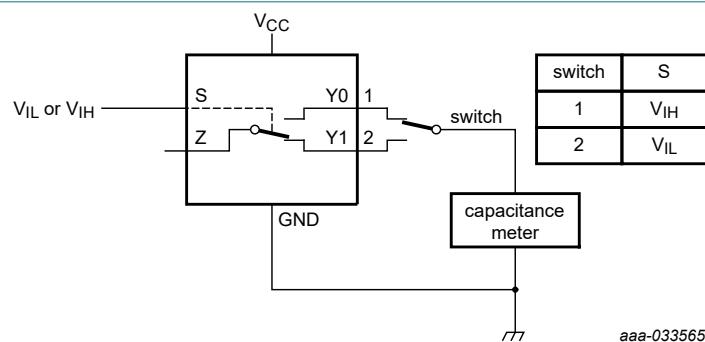


Fig. 5. Test circuit for measuring OFF-state capacitance

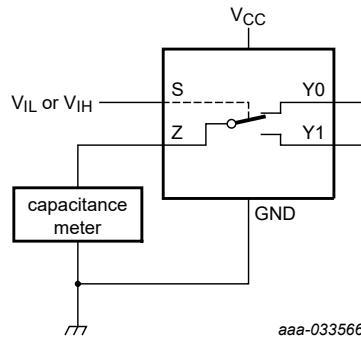


Fig. 6. Test circuit for measuring ON-state capacitance

## 10.2. ON resistance

Table 8. ON resistance

At recommended operating conditions; voltages are referenced to GND (ground 0 V);

For test circuit see Fig. 7; for graphs see Fig. 8 and Fig. 9.

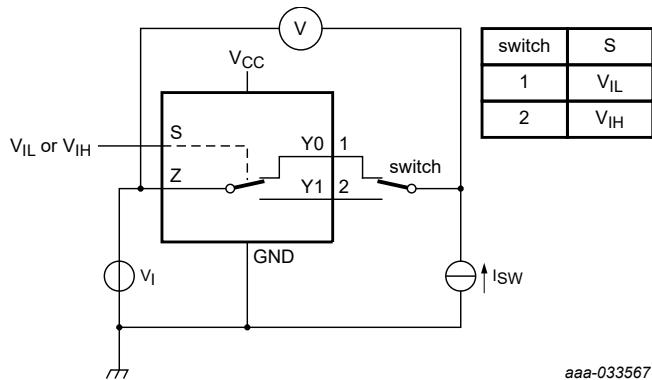
Symbol	Parameter	Conditions	$T_{amb} = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$			Unit
			Min	Typ[1]	Max	
$R_{ON(\text{peak})}$	ON resistance (peak)	$V_{I(S)} = V_{IL}$ or $V_{IH}$ ; $V_{I(Z)} = \text{GND}$ to $V_{CC}$ ; $V_{CC} = 4.5 \text{ V}$ to $5.5 \text{ V}$	[2]			
		$I_{SW} = 10 \text{ mA}$		2.2	4.0	7.5 $\Omega$
		$I_{SW} = 32 \text{ mA}$		2.2	4.0	7.7 $\Omega$
		$I_{SW} = 64 \text{ mA}$		2.2	4.0	7.7 $\Omega$
$\Delta R_{ON}$	ON resistance mismatch between channels	$I_{SW} = 64 \text{ mA}$ ; $V_{I(Z)} = \text{GND}$ to $V_{CC}$ ; $V_{CC} = 4.5 \text{ V}$ to $5.0 \text{ V}$	[2]	-	90	- $\text{m}\Omega$
$R_{ON(\text{flat})}$	ON resistance (flatness)	$V_{I(S)} = V_{IL}$ or $V_{IH}$ ; $V_{I(Z)} = \text{GND}$ to $V_{CC}$ ; $V_{CC} = 4.5 \text{ V}$ to $5.0 \text{ V}$	[2] [3]			
		$I_{SW} = 10 \text{ mA}$		0.2	0.8	3 $\Omega$
		$I_{SW} = 32 \text{ mA}$		0.2	0.8	3 $\Omega$
		$I_{SW} = 64 \text{ mA}$		0.2	0.9	3 $\Omega$

[1] Typical values are measured at  $T_{amb} = 25^{\circ}\text{C}$ .

[2] Measured by the voltage drop between Z and  $Y_n$  pins at the indicated current through the switch. ON resistance is determined by the lower of the voltages on the two (Z or  $Y_n$  pins).

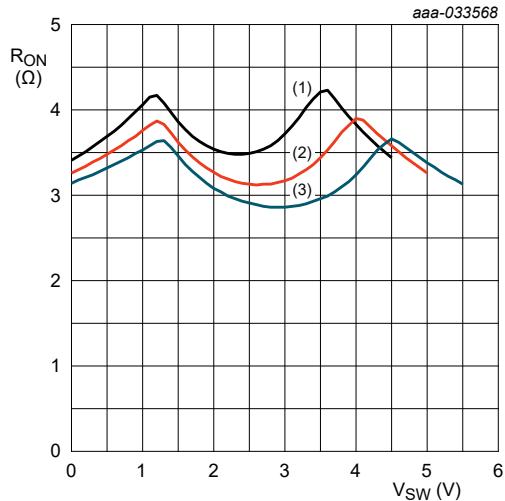
[3] Flatness is defined as the difference between the maximum and minimum value of ON resistance over the specified range of conditions.

### 10.3. ON resistance test circuit and graphs



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

Fig. 7. Test circuit for measuring ON resistance



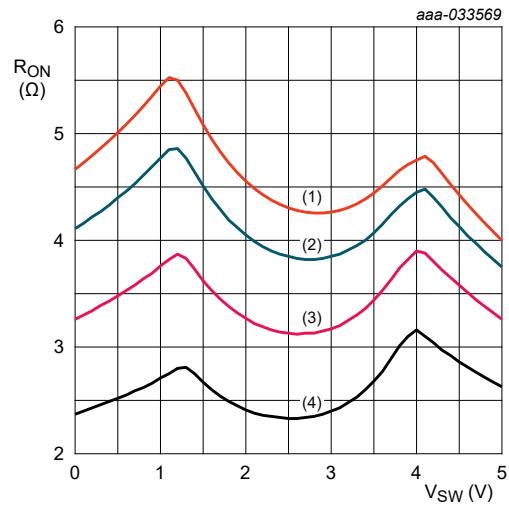
$I_{SW} = 10 \text{ mA}$

(1)  $V_{CC} = 4.5 \text{ V}$

(2)  $V_{CC} = 5.0 \text{ V}$

(3)  $V_{CC} = 5.5 \text{ V}$

Fig. 8. Typical ON resistance as a function of input voltage;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$



$I_{SW} = 10 \text{ mA}$

(1)  $T_{amb} = 125 \text{ }^{\circ}\text{C}$

(2)  $T_{amb} = 85 \text{ }^{\circ}\text{C}$

(3)  $T_{amb} = 25 \text{ }^{\circ}\text{C}$

(4)  $T_{amb} = -40 \text{ }^{\circ}\text{C}$

Fig. 9. ON resistance as a function of input voltage;  $V_{CC} = 5.0 \text{ V}$

## 11. Dynamic characteristics

**Table 9. Dynamic characteristics**

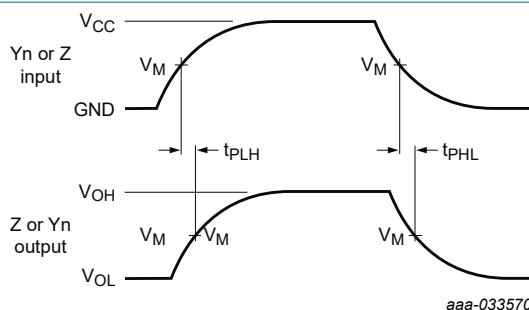
At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	$T_{amb} = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$			Unit
			Min	Typ[1]	Max	
$t_{pd}$	propagation delay	Z to $Y_n$ or $Y_n$ to Z; see <a href="#">Fig. 10</a> and <a href="#">Fig. 12</a> ; [2] $V_{CC} = 4.5\text{ V}$ to $5.5\text{ V}$	-	0.4	1.0	ns
$t_{TRAN}$	transition time between channels	S to Z or $Y_n$ ; see <a href="#">Fig. 11</a> and <a href="#">Fig. 13</a> ; $V_{CC} = 4.5\text{ V}$ to $5.5\text{ V}$	10	23	40	ns
$t_{b-m}$	break-before-make time	$C_L = 15\text{ pF}$ ; $R_L = 200\text{ }\Omega$ ; see <a href="#">Fig. 14</a> ; $V_{CC} = 4.5\text{ V}$ to $5.5\text{ V}$	1	7.5	17	ns

[1] Typical values are measured at  $T_{amb} = 25^{\circ}\text{C}$ .

[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$

### 11.1. Waveforms and test circuits

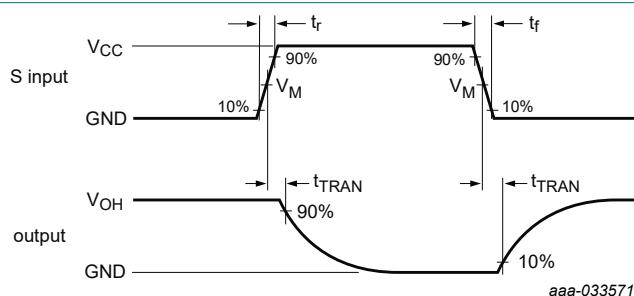


Measurement points are given in [Table 10](#).

Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Rise and fall times strongly depend on source impedance and load capacitance.

**Fig. 10. Input ( $Y_n$  or Z) to output (Z or  $Y_n$ ) propagation delays**



Measurement points are given in [Table 10](#).

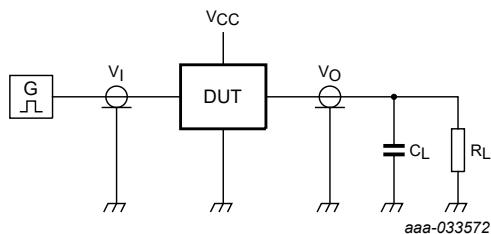
Logic levels:  $V_{OH}$  is a typical output voltage level that occur with the output load.

**Fig. 11. Transition time between channels**

**Table 10. Measurement points**

Supply voltage	Input	Output
$V_{CC}$	$V_M$	$V_M$
GND to $V_{CC}$	50%	50%

## Low-ohmic single-pole double-throw analog switch



Test data is given in [Table 11](#).

All input pulses are supplied by generators having the following characteristics:

PRR  $\leq$  10 MHz;  $Z_O = 50 \Omega$ ;  $t_r, t_f = 2$  ns.

Definitions test circuit:

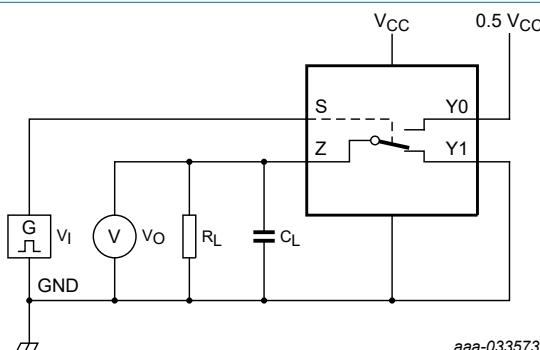
$C_L$  = Load capacitance (including jig and probe capacitance);

$R_L$  = Load resistance.

**Fig. 12. Test circuit for measuring propagation delay times**

**Table 11. Test data**

Load	
$C_L$	$R_L$
100 pF	1 M $\Omega$



Test data is given in [Table 12](#).

All input pulses are supplied by generators having the following characteristics:

PRR  $\leq$  10 MHz;  $Z_O = 50 \Omega$ .

Definitions test circuit:

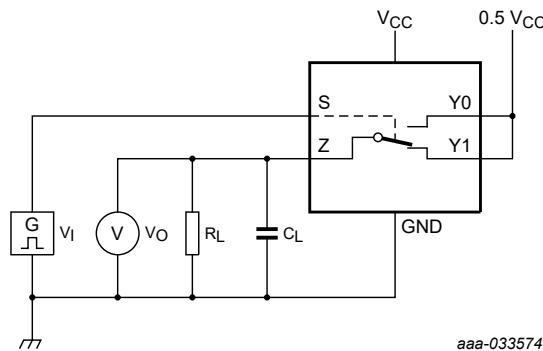
$C_L$  = Load capacitance (including jig and probe capacitance);

$R_L$  = Load resistance.

**Fig. 13. Test circuit for measuring transition times between channels**

**Table 12. Test data**

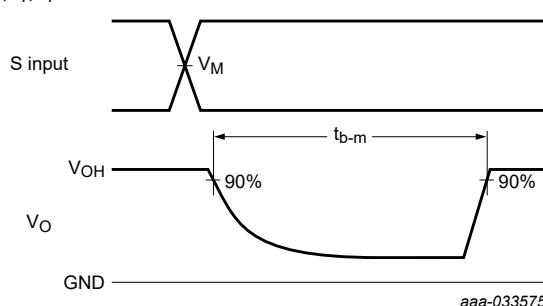
Input S	Load	
$t_r, t_f$	$C_L$	$R_L$
$\leq 2$ ns	15 pF	1 M $\Omega$



a. Test circuit

All input pulses are supplied by generators having the following characteristics:

PRR  $\leq$  10 MHz;  $Z_0 = 50 \Omega$ ;  $t_r, t_f = 2$  ns.



b. Input and output measurement points

Fig. 14. Test circuit for measuring break-before-make times

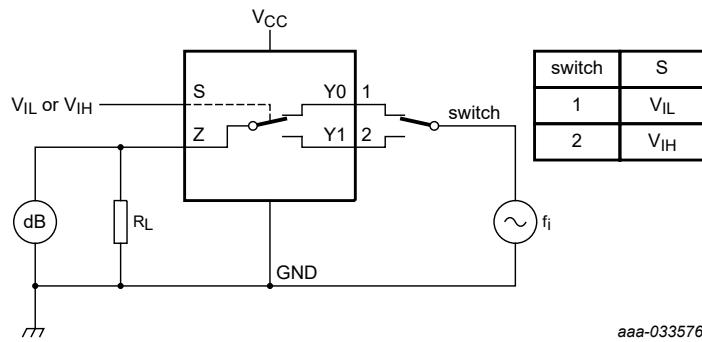
## 11.2. Additional dynamic characteristics

Table 13. Additional dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

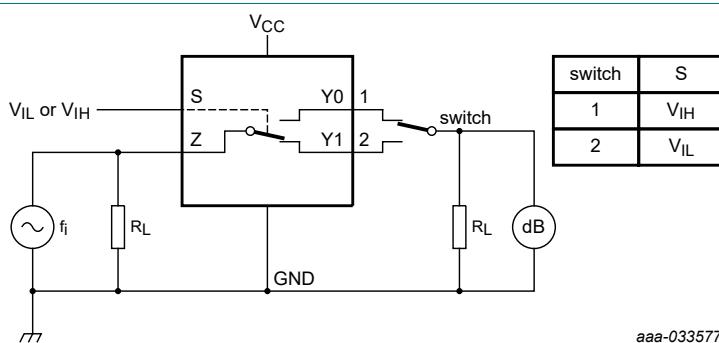
Symbol	Parameter	Conditions	$T_{amb} = 25^\circ\text{C}$			Unit
			Min	Typ	Max	
$f_{(-3\text{dB})}$	-3 dB frequency response	$R_L = 50 \Omega$ ; see Fig. 15; $V_{CC} = 5.0$ V	-	190	-	MHz
$\alpha_{iso}$	isolation (OFF-state)	$R_L = 50 \Omega$ ; $f_i = 10$ MHz; see Fig. 16; $V_{CC} = 5.0$ V	-	-56	-	dB
Xtalk	crosstalk	between switches; $R_L = 50 \Omega$ ; $f_i = 1$ MHz; $V_{CC} = 5.0$ V; see Fig. 17	-	-76	-	dB
$Q_{inj}$	charge injection	$C_L = 1$ nF; $V_{gen} = 0.5V_{CC}$ ; $R_{gen} = 0 \Omega$ ; $f_i = 1$ MHz; $R_L = 1$ M $\Omega$ ; $V_{CC} = 5.0$ V; see Fig. 18	-	4.5	-	pC

### 11.3. Test circuits



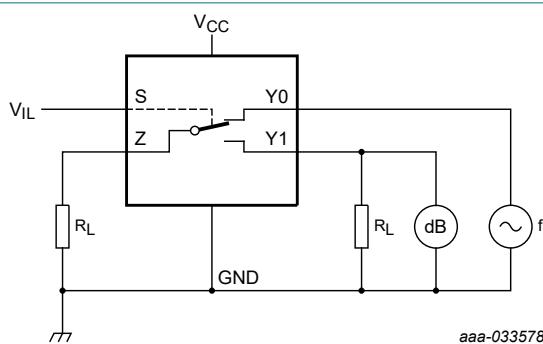
$f_i$  voltage source:  $Z_0 = 50 \Omega$ . The  $f_i$  voltage level is set for  $R_L = 50 \Omega$ : DC = 0.5V<sub>CC</sub>, AC = 0 dBm.  
Increase  $f_i$  frequency until  $dB$  meter reads -3 dB

Fig. 15. Test circuit for measuring the -3 dB frequency response when switch is in ON-state



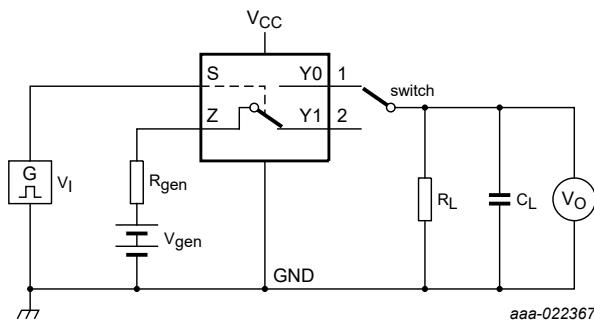
$f_i$  voltage source:  $Z_0 = 50 \Omega$ . The  $f_i$  voltage level is set for  $R_L = 50 \Omega$ : DC = 0.5V<sub>CC</sub>, AC = 0 dBm.

Fig. 16. Test circuit for measuring isolation (OFF-state)

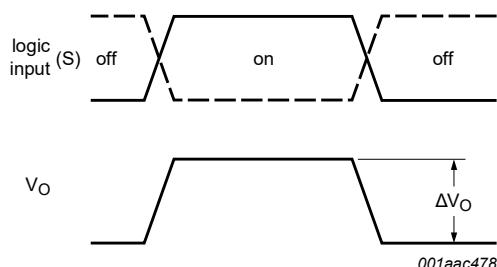


$f_i$  voltage source:  $Z_0 = 50 \Omega$ . The  $f_i$  voltage level is set for  $R_L = 50 \Omega$ : DC = 0.5V<sub>CC</sub>, AC = 0 dBm.

Fig. 17. Test circuit for measuring crosstalk between switches



a. Test circuit



b. Input and output pulse definitions

Definitions for test circuit:

$$Q_{\text{inj}} = \Delta V_O \times C_L;$$

$\Delta V_O$  = output voltage variation;

$R_{\text{gen}}$  = generator resistance;

$V_{\text{gen}}$  = generator voltage.

Fig. 18. Test circuit for measuring charge injection

## 12. Package outline

TSSOP6: plastic thin shrink small outline package; 6 leads; body width 1.25 mm

SOT363-2

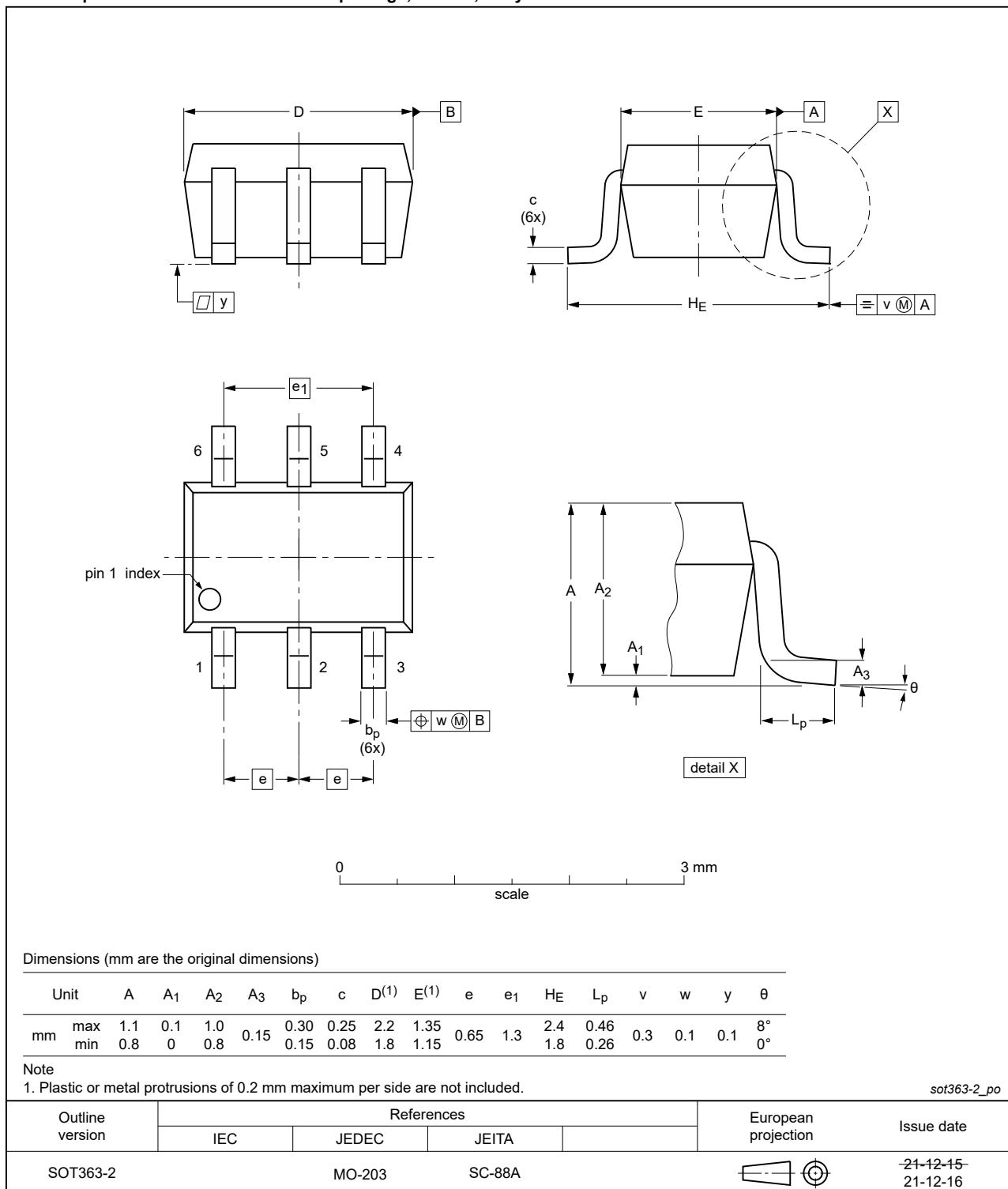


Fig. 19. Package outline SOT363-2 (TSSOP6)

## 13. Abbreviations

**Table 14. Abbreviations**

Acronym	Description
ANSI	American National Standards Institute
CDM	Charged Device Model
DUT	Device Under Test
ESD	ElectroStatic Discharge
ESDA	ElectroStatic Discharge Association
HBM	Human Body Model
JEDEC	Joint Electron Device Engineering Council
PRR	Pulse Rate Repetition

## 14. Revision history

**Table 15. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
XS5A1T4157 v.2.1	20240731	Product data sheet	-	XS5A1T4157 v.2
XS5A1T4157 v.2	20220209	Product data sheet	-	XS5A1T4157 v.1
Modifications:	• Package SOT363 (SC-88) changed to SOT363-2 (TSSOP6).			
XS5A1T4157 v.1	20210716	Product data sheet	-	-

## 15. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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## Contents

<b>1. General description.....</b>	<b>1</b>
<b>2. Features and benefits.....</b>	<b>1</b>
<b>3. Ordering information.....</b>	<b>1</b>
<b>4. Marking.....</b>	<b>1</b>
<b>5. Functional diagram.....</b>	<b>2</b>
<b>6. Pinning information.....</b>	<b>2</b>
6.1. Pinning.....	2
6.2. Pin description.....	2
<b>7. Functional description.....</b>	<b>2</b>
<b>8. Limiting values.....</b>	<b>3</b>
<b>9. Recommended operating conditions.....</b>	<b>3</b>
<b>10. Static characteristics.....</b>	<b>4</b>
10.1. Test circuits and graphs.....	4
10.2. ON resistance.....	6
10.3. ON resistance test circuit and graphs.....	7
<b>11. Dynamic characteristics.....</b>	<b>8</b>
11.1. Waveforms and test circuits.....	8
11.2. Additional dynamic characteristics.....	10
11.3. Test circuits.....	11
<b>12. Package outline.....</b>	<b>13</b>
<b>13. Abbreviations.....</b>	<b>14</b>
<b>14. Revision history.....</b>	<b>14</b>
<b>15. Legal information.....</b>	<b>15</b>

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