XS3A4052

Low-ohmic dual-pole quad-throw analog switch

Rev. 1 — 11 February 2022 Product data sheet

1. General description

The XS3A4052 is a low-ohmic dual-pole quad-throw analog switch (DP4T), suitable for use as an analog or digital multiplexer/demultiplexer. Each switch features four independent inputs/outputs (nY0, nY1, nY2 and nY3) and a common input/output (nZ). A digital enable input ($\overline{E}$) and two digital select inputs (S0 and S1) are common to both switches. When $\overline{E}$ is HIGH, the switches are turned off.

Schmitt trigger action at the digital inputs makes the circuit tolerant to slower input rise and fall times. Low threshold digital inputs allows this device to be driven by 1.8 V logic levels in 3.3 V applications without significant increase in supply current I_{CC}. This makes it possible for the XS3A4052 to switch 4.3 V signals with a 1.8 V digital controller, eliminating the need for logic level translation. The XS3A4052 allows signals with amplitude up to V_{CC} to be transmitted from nZ to nYn or from nYn to nZ. Its low ON resistance (0.5 Ω) and flatness (0.13 Ω) ensures minimal attenuation and distortion of transmitted signals.

2. Features and benefits

- Wide supply voltage range from 1.4 V to 4.3 V
- Very low ON resistance (peak):
  - 1.6 Ω (typical) at V_{CC} = 1.4 V
  - 1.0 Ω (typical) at V_{CC} = 1.65 V
  - 0.55 Ω (typical) at V_{CC} = 2.3 V
  - 0.50 Ω (typical) at V_{CC} = 2.7 V
  - 0.50 Ω (typical) at V_{CC} = 4.3 V
- Break-before-make switching
- High noise immunity
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 exceeds 6000 V
  - CDM ANSI/ESDA/JEDEC JS-002 exceeds 1000 V
  - IEC61000-4-2 contact discharge exceeds 8000 V for switch ports
- CMOS low-power consumption
- Latch-up performance exceeds 100 mA per JESD78 Class II Level A
- Low-switching threshold levels
- Control input accepts voltages above supply voltage
- Very low supply current, even when input is below V_{CC}
- High current handling capability (350 mA continuous current under 3.3 V supply)
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Applications

- Appliances
- Communication Systems
- Medical Equipment
- Analog Sensor Monitoring
- Audio Routing/Switching
- Test and Measurement

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4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
XS3A4052PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

5. Functional diagram

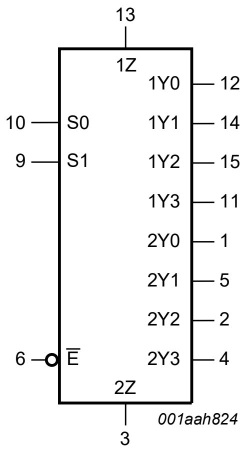


Fig. 1. Logic symbol

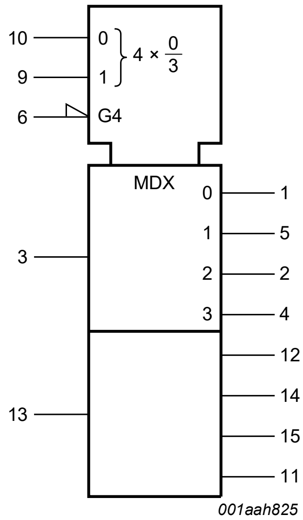


Fig. 2. IEC logic symbol

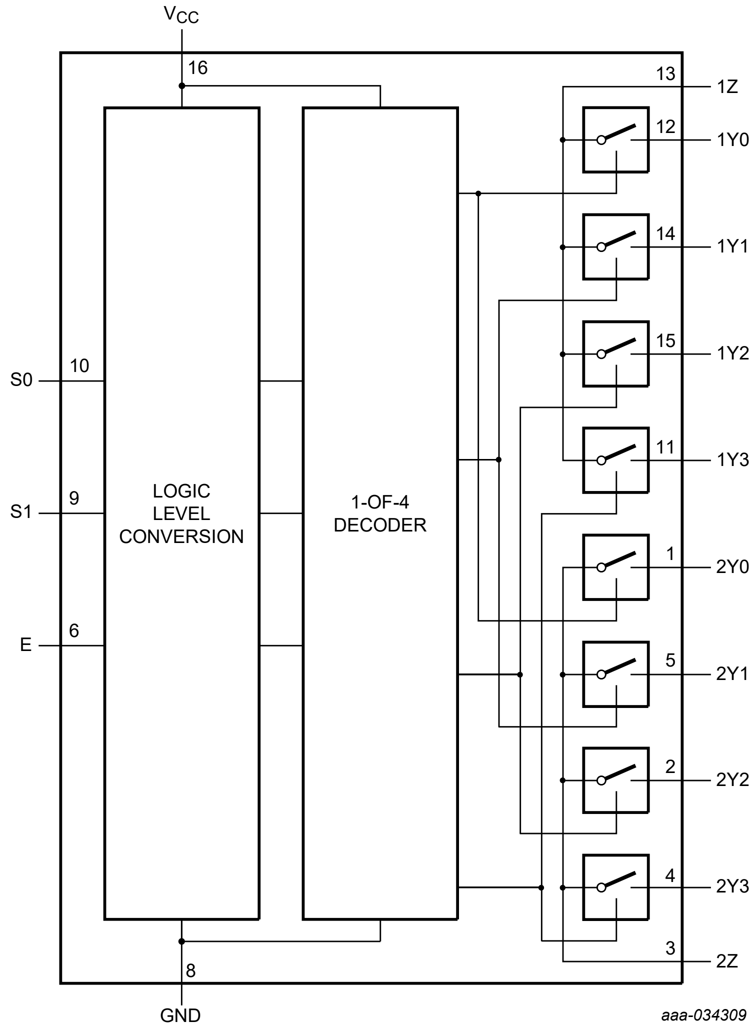


Fig. 3. Functional diagram

6. Pinning information

6.1. Pinning

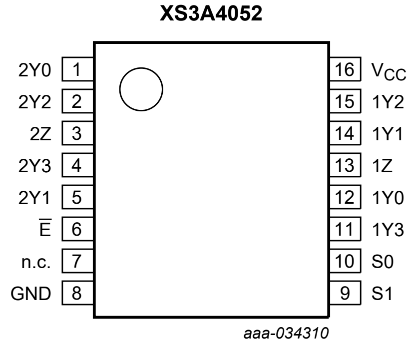


Fig. 4. Pin configuration SOT403-1 (TSSOP16)

6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
2Y0, 2Y1, 2Y2, 2Y3	1, 5, 2, 4	independent input or output
1Z, 2Z	13, 3	common output or input
$\overline{E}$	6	enable input (active LOW)
n.c.	7	not connected
GND	8	ground supply voltage
S0, S1	10, 9	select input
1Y0, 1Y1, 1Y2, 1Y3	12, 14, 15, 11	independent input or output
V_{CC}	16	supply voltage

7. Functional description

Table 3. Function table

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

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	switches off

8. Limiting values

Table 4. 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	+4.6	V
V_I	input voltage	Sn and $\overline{E}$ inputs	[1]	-0.5	+4.6	V
V_{SW}	switch voltage		[2]	-0.5	V_{CC} + 0.5	V
I_{IK}	input clamping current	V_I < -0.5 V		-50	-	mA
I_{SK}	switch clamping current	V_I < -0.5 V or V_I > V_{CC} + 0.5 V		-	±50	mA
I_{SW}	switch current	V_{SW} > -0.5 V or V_{SW} < V_{CC} + 0.5 V; source or sink current		-	±350	mA
		V_{SW} > -0.5 V or V_{SW} < V_{CC} + 0.5 V; pulsed at 1 ms duration, < 10 % duty cycle; peak current		-	±500	mA
T_{stg}	storage temperature			-65	+150	°C
P_{tot}	total power dissipation	T_{amb} = -40 °C to +125 °C	[3]	-	500	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 but may not exceed 4.6 V.

[3] For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			1.4	4.3	V
V_I	input voltage	Sn and $\overline{E}$ inputs		0	4.3	V
V_{SW}	switch voltage		[1]	0	V_{CC}	V
T_{amb}	ambient temperature			-40	+125	°C
Δt/ΔV	input transition rise and fall rate	Sn and $\overline{E}$ inputs; V_{CC} = 1.4 V to 4.3 V	[2]	-	200	ns/V

[1] To avoid sinking GND current from terminal Z when switch current flows in terminal Yn, the voltage drop across the bidirectional switch must not exceed 0.4 V. If the switch current flows into terminal Z, no GND current will flow from terminal Yn. In this case, there is no limit for the voltage drop across the switch.

[2] Applies to control signal levels.

10. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = −40 °C to +85 °C		T_{amb} = −40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	V_{CC} = 1.4 V to 1.6 V	0.9	-	-	0.9	-	0.9	-	V
		V_{CC} = 1.65 V to 1.95 V	0.9	-	-	0.9	-	0.9	-	V
		V_{CC} = 2.3 V to 2.7 V	1.1	-	-	1.1	-	1.1	-	V
		V_{CC} = 2.7 V to 3.6 V	1.3	-	-	1.3	-	1.3	-	V
		V_{CC} = 3.6 V to 4.3 V	1.4	-	-	1.4	-	1.4	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 1.4 V to 1.6 V	-	-	0.3	-	0.3	-	0.3	V
		V_{CC} = 1.65 V to 1.95 V	-	-	0.4	-	0.4	-	0.3	V
		V_{CC} = 2.3 V to 2.7 V	-	-	0.4	-	0.4	-	0.4	V
		V_{CC} = 2.7 V to 3.6 V	-	-	0.5	-	0.5	-	0.5	V
		V_{CC} = 3.6 V to 4.3 V	-	-	0.6	-	0.6	-	0.6	V
I_I	input leakage current	Sn and $\overline{E}$ inputs; V_I = GND to 4.3 V; V_{CC} = 1.4 V to 4.3 V	-	-	-	-	±0.5	-	±1	μA
$I_{S(OFF)}$	OFF-state leakage current	nYn port; see Fig. 5								
		V_{CC} = 1.4 V to 3.6 V	-	-	±5	-	±50	-	±500	nA
		V_{CC} = 3.6 V to 4.3 V	-	-	±10	-	±50	-	±500	nA
$I_{S(ON)}$	ON-state leakage current	nZ port; see Fig. 6								
		V_{CC} = 1.4 V to 3.6 V	-	-	±15	-	±150	-	±1500	nA
		V_{CC} = 3.6 V to 4.3 V	-	-	±20	-	±150	-	±1500	nA
I_{CC}	supply current	V_I = V_{CC} or GND; V_{SW} = GND or V_{CC}								
		V_{CC} = 3.6 V	-	-	100	-	690	-	6000	nA
		V_{CC} = 4.3 V	-	-	150	-	800	-	7000	nA

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = −40 °C to +85 °C		T_{amb} = −40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
ΔI_{CC}	additional supply current	V_{SW} = GND or V_{CC}								
		V_I = 2.6 V; V_{CC} = 4.3 V	-	2.0	4.0	-	7	-	7	µA
		V_I = 2.6 V; V_{CC} = 3.6 V	-	0.35	0.7	-	1	-	1	µA
		V_I = 1.8 V; V_{CC} = 4.3 V	-	7.0	10.0	-	15	-	15	µA
		V_I = 1.8 V; V_{CC} = 3.6 V	-	2.5	4.0	-	5	-	5	µA
		V_I = 1.8 V; V_{CC} = 2.5 V	-	50	200	-	300	-	500	nA
C_I	input capacitance	Sn and $\overline{E}$ inputs	-	1.0	-	-	-	-	-	pF
$C_{S(OFF)}$	OFF-state capacitance		-	35	-	-	-	-	-	pF
$C_{S(ON)}$	ON-state capacitance		-	tbd	-	-	-	-	-	pF

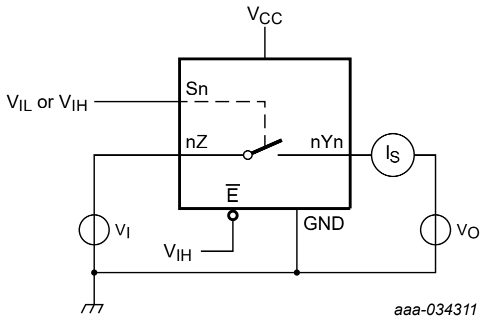
Table 7. ON resistance

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for graphs see Fig. 8 to Fig. 14.

Symbol	Parameter	Conditions	T_{amb} = -40 °C to +85 °C			T_{amb} = -40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
$R_{ON(peak)}$	ON resistance (peak)	V_I = GND to V_{CC}; I_{SW} = 100 mA; see Fig. 7						
		V_{CC} = 1.4 V	-	1.6	3.7	-	4.1	Ω
		V_{CC} = 1.65 V	-	1.0	1.6	-	1.7	Ω
		V_{CC} = 2.3 V	-	0.55	0.8	-	0.9	Ω
		V_{CC} = 2.7 V	-	0.5	0.75	-	0.9	Ω
		V_{CC} = 4.3 V	-	0.5	0.75	-	0.9	Ω
ΔR_{ON}	ON resistance mismatch between channels	V_I = GND to V_{CC}; I_{SW} = 100 mA [2]						
		V_{CC} = 1.4 V; V_{SW} = 0.4 V	-	0.07	0.3	-	0.3	Ω
		V_{CC} = 1.65 V; V_{SW} = 0.5 V	-	0.06	0.2	-	0.3	Ω
		V_{CC} = 2.3 V; V_{SW} = 0.7 V	-	0.06	0.10	-	0.13	Ω
		V_{CC} = 2.7 V; V_{SW} = 0.8 V	-	0.06	0.10	-	0.13	Ω
		V_{CC} = 4.3 V; V_{SW} = 0.8 V	-	0.06	0.10	-	0.13	Ω
$R_{ON(flat)}$	ON resistance (flatness)	V_I = GND to V_{CC}; I_{SW} = 100 mA [3]						
		V_{CC} = 1.4 V	-	1.0	3.3	-	3.6	Ω
		V_{CC} = 1.65 V	-	0.5	1.2	-	1.3	Ω
		V_{CC} = 2.3 V	-	0.15	0.3	-	0.35	Ω
		V_{CC} = 2.7 V	-	0.13	0.3	-	0.35	Ω
		V_{CC} = 4.3 V	-	0.2	0.4	-	0.45	Ω

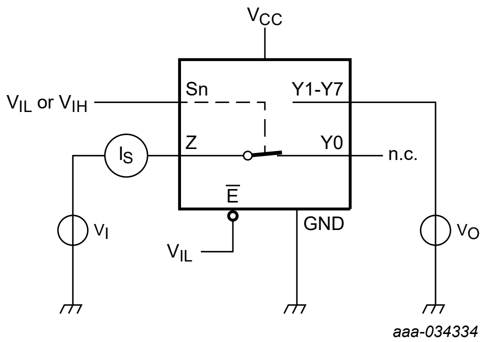
[1] Typical values are measured at T_{amb} = 25 °C.
[2] Measured at identical V_{CC}, temperature and input voltage.
[3] Flatness is defined as the difference between the maximum and minimum value of ON resistance measured at identical V_{CC} and temperature.

10.1. Test circuits and graphs



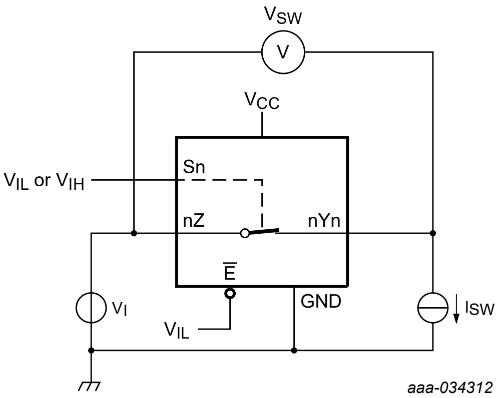
V_I = 0.3 V or V_{CC} - 0.3 V; V_O = V_{CC} - 0.3 V or 0.3 V

Fig. 5. Test circuit for measuring OFF-state leakage current



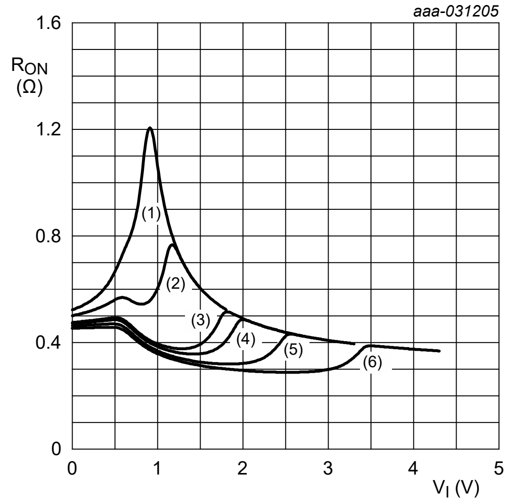
V_I = 0.3 V or V_{CC} - 0.3 V; V_O = V_{CC} - 0.3 V or 0.3 V

Fig. 6. Test circuit for measuring ON-state leakage current



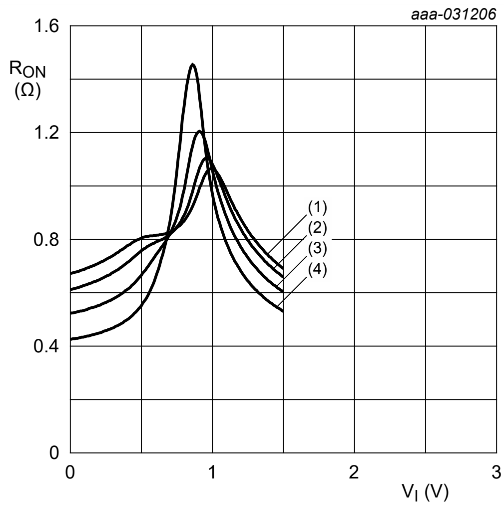
$R_{ON} = V_{SW} / I_{SW}$

Fig. 7. Test circuit for measuring ON resistance



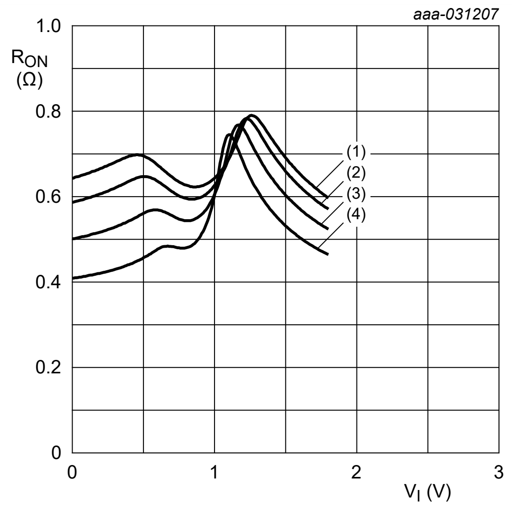
(1) V_{CC} = 1.5 V
(2) V_{CC} = 1.8 V
(3) V_{CC} = 2.5 V
(4) V_{CC} = 2.7 V
(5) V_{CC} = 3.3 V
(6) V_{CC} = 4.3 V
Measured at T_{amb} = 25 °C

Fig. 8. Typical ON resistance as a function of input voltage



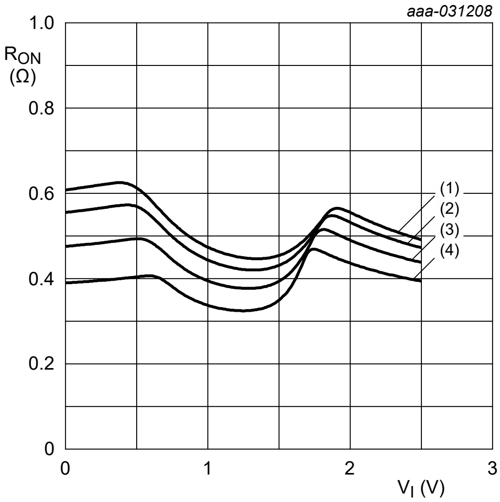
(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 9. ON resistance as a function of input voltage; V_{CC} = 1.5 V



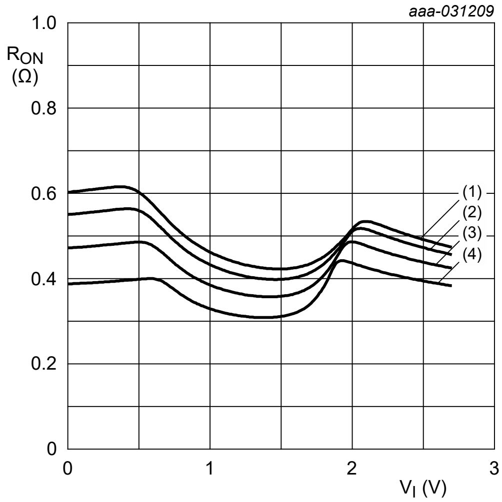
(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 10. ON resistance as a function of input voltage; V_{CC} = 1.8 V



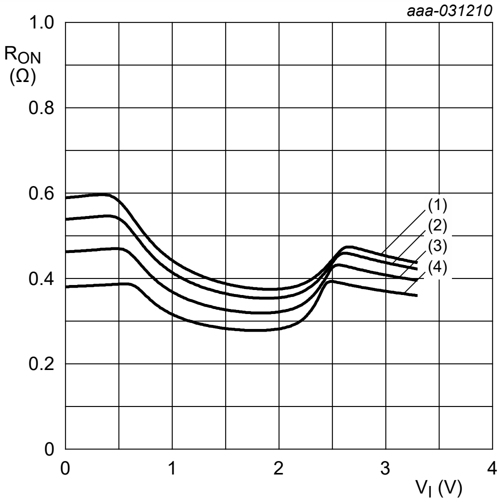
(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 11. ON resistance as a function of input voltage; V_{CC} = 2.5 V



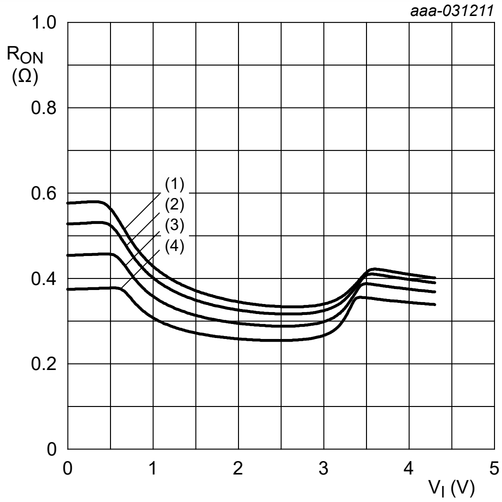
(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 12. ON resistance as a function of input voltage; V_{CC} = 2.7 V



(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 13. ON resistance as a function of input voltage; V_{CC} = 3.3 V



(1) T_{amb} = 125 °C
(2) T_{amb} = 85 °C
(3) T_{amb} = 25 °C
(4) T_{amb} = -40 °C

Fig. 14. ON resistance as a function of input voltage; V_{CC} = 4.3 V

11. Dynamic characteristics

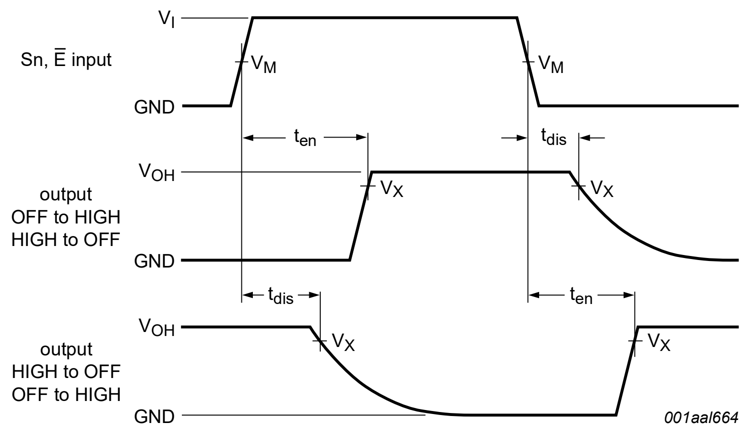
Table 8. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 17.

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = −40 °C to +85 °C		T_{amb} = −40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
t_{en}	enable time	$\overline{E}$, Sn to nZ or nYn; see Fig. 15								
		V_{CC} = 1.4 V to 1.6 V	-	50	110	-	120	-	120	ns
		V_{CC} = 1.65 V to 1.95 V	-	36	70	-	80	-	90	ns
		V_{CC} = 2.3 V to 2.7 V	-	24	45	-	50	-	55	ns
		V_{CC} = 2.7 V to 3.6 V	-	22	40	-	45	-	50	ns
		V_{CC} = 3.6 V to 4.3 V	-	22	40	-	45	-	50	ns
t_{dis}	disable time	$\overline{E}$, Sn to nZ or nYn; see Fig. 15								
		V_{CC} = 1.4 V to 1.6 V	-	32	90	-	90	-	90	ns
		V_{CC} = 1.65 V to 1.95 V	-	20	55	-	60	-	65	ns
		V_{CC} = 2.3 V to 2.7 V	-	12	25	-	30	-	35	ns
		V_{CC} = 2.7 V to 3.6 V	-	10	20	-	25	-	30	ns
		V_{CC} = 3.6 V to 4.3 V	-	10	20	-	25	-	30	ns
t_{b-m}	break-before-make time	see Fig. 16 [2]								
		V_{CC} = 1.4 V to 1.6 V	-	19	-	9	-	9	-	ns
		V_{CC} = 1.65 V to 1.95 V	-	17	-	7	-	7	-	ns
		V_{CC} = 2.3 V to 2.7 V	-	13	-	4	-	4	-	ns
		V_{CC} = 2.7 V to 3.6 V	-	10	-	3	-	3	-	ns
		V_{CC} = 3.6 V to 4.3 V	-	10	-	2	-	2	-	ns

[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 1.5 V, 1.8 V, 2.5 V, 3.3 V and 4.3 V respectively.
[2] Break-before-make guaranteed by design.

11.1. Waveforms and test circuit



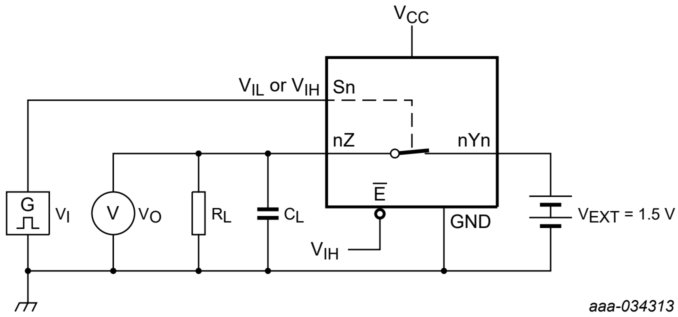
Measurement points are given in Table 9.

Logic level: V_{OH} is typical output voltage level that occurs with the output load.

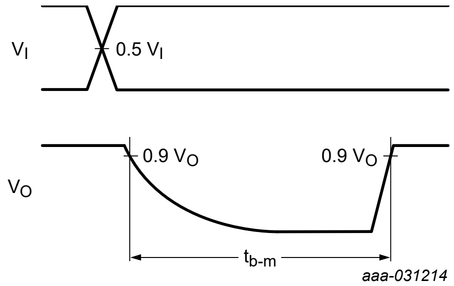
Fig. 15. Enable and disable times

Table 9. Measurement points

Supply voltage	Input	Output
V_{CC}	V_M	V_X
1.4 V to 4.3 V	$0.5V_{CC}$	$0.9V_{OH}$

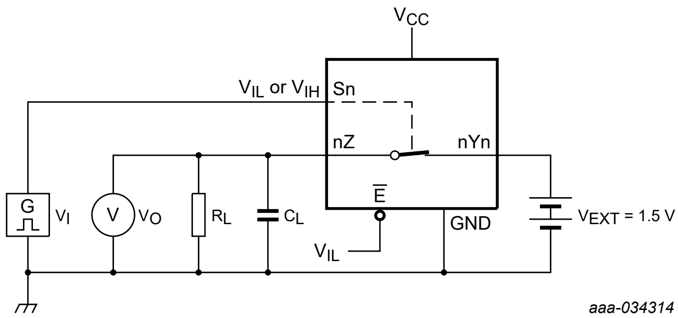


a. Test circuit



b. Input and output measurement points

Fig. 16. Test circuit for measuring break-before-make times



Test data is given in Table 10.
Definitions test circuit:
R_L = Load resistance.
C_L = Load capacitance including jig and probe capacitance.
V_{EXT} = External voltage for measuring switching times.

Fig. 17. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Input		Load	
V_{CC}	V_I	t_r, t_f	C_L	R_L
1.4 V to 4.3 V	V_{CC}	≤ 2.5 ns	35 pF	50 Ω

11.2. Additional dynamic characteristics

Table 11. Additional dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); *V_I = GND or V_{CC} (unless otherwise specified); t_r = t_f ≤ 2.5 ns.*

Symbol	Parameter	Conditions		Tamb = 25 °C		Unit
			Min	Typ	Max	
THD	total harmonic distortion	f_i = 20 Hz to 20 kHz; R_L = 32 Ω; see Fig. 18 [1]				
		V_{CC} = 1.4 V; V_I = 1 V (p-p)	-	0.17	-	%
		V_{CC} = 1.65 V; V_I = 1.2 V (p-p)	-	0.10	-	%
		V_{CC} = 2.3 V; V_I = 1.5 V (p-p)	-	0.05	-	%
		V_{CC} = 2.7 V; V_I = 2 V (p-p)	-	0.04	-	%
		V_{CC} = 4.3 V; V_I = 2 V (p-p)	-	0.01	-	%
$f_{(-3dB)}$	-3 dB frequency response	R_L = 50 Ω; see Fig. 19 [1]				
		V_{CC} = 1.4 V to 4.3 V	-	25	-	MHz
α_{iso}	isolation (OFF-state)	f_i = 100 kHz; R_L = 50 Ω; see Fig. 20 [1]				
		V_{CC} = 1.4 V to 4.3 V	-	-90	-	dB
V_{ct}	crosstalk voltage	between digital inputs and switch; f_i = 1 MHz; C_L = 50 pF; R_L = 50 Ω; see Fig. 21 [1]				
		V_{CC} = 1.4 V to 3.6 V	-	0.2	-	V
		V_{CC} = 3.6 V to 4.3 V	-	0.4	-	V
Xtalk	crosstalk	between switches; f_i = 100 kHz; R_L = 50 Ω; see Fig. 22 [1]				
		V_{CC} = 1.4 V to 4.3 V	-	-90	-	dB
Q_{inj}	charge injection	f_i = 1 MHz; C_L = 0.1 nF; R_L = 1 MΩ; V_{gen} = 0 V; R_{gen} = 0 Ω; see Fig. 23 [1]				
		V_{CC} = 1.5 V	-	3	-	pC
		V_{CC} = 1.8 V	-	4	-	pC
		V_{CC} = 2.5 V	-	6	-	pC
		V_{CC} = 3.3 V	-	9	-	pC
		V_{CC} = 4.3 V	-	15	-	pC

[1] f_i is biased at $0.5V_{CC}$.

11.3. Additional test circuits

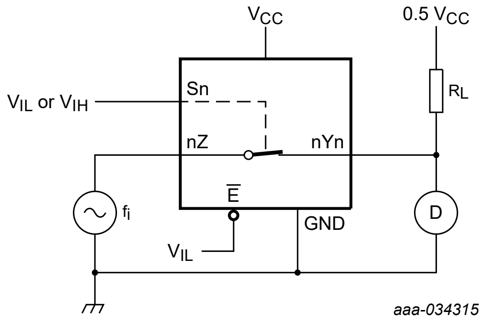
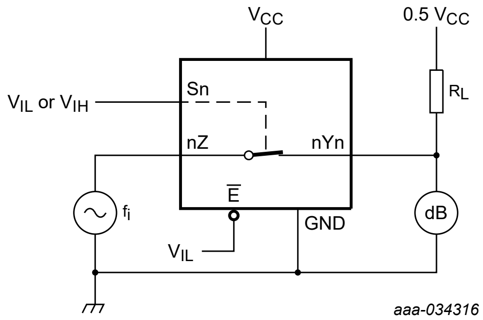
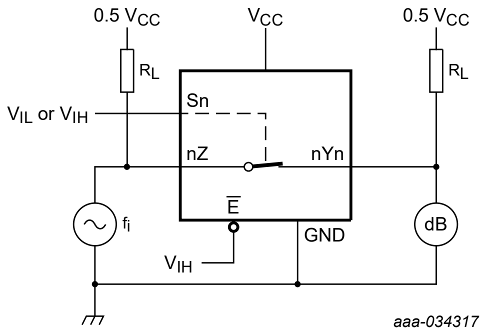


Fig. 18. Test circuit for measuring total harmonic distortion



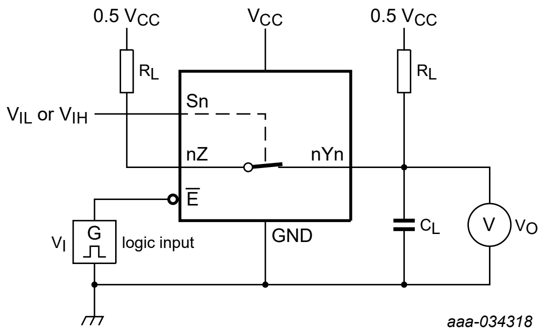
Adjust f_i voltage to obtain 0 dBm level at output. Increase f_i frequency until dB meter reads -3 dB.
$R_S = R_L = 50\ \Omega$ (standard 50 Ω system).

Fig. 19. Test circuit for measuring the frequency response when channel is in ON-state

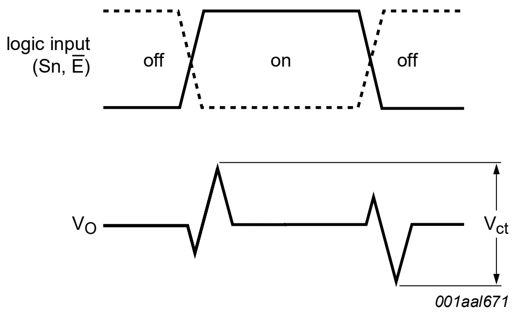


Adjust f_i voltage to obtain 0 dBm level at input.

Fig. 20. Test circuit for measuring isolation (OFF-state)



a. Test circuit



b. Input and output pulse definitions

Fig. 21. Test circuit for measuring crosstalk voltage between digital input and switch

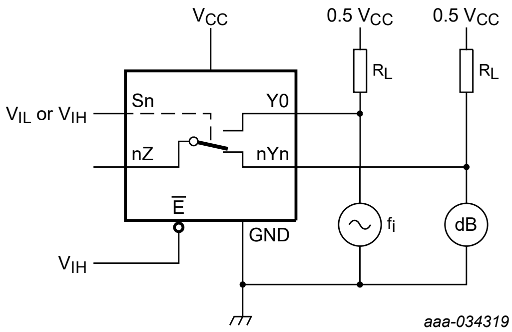
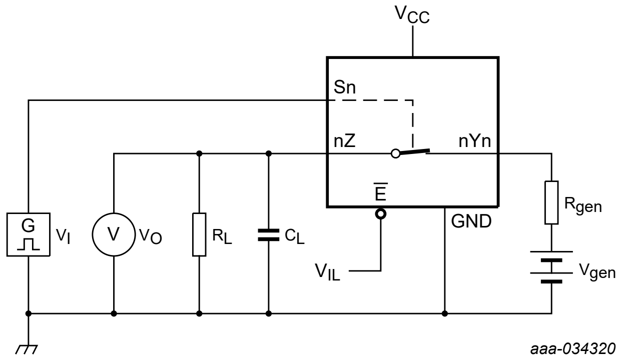
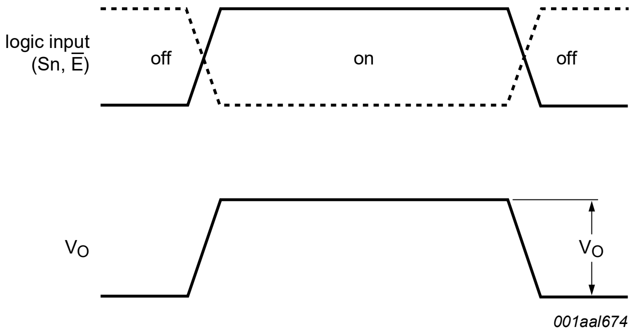


Fig. 22. Test circuit for measuring crosstalk between switches



a. Test circuit



b. Input and output pulse definitions

$Q_{inj} = \Delta V_O \times C_L$.

ΔV_O = output voltage variation.

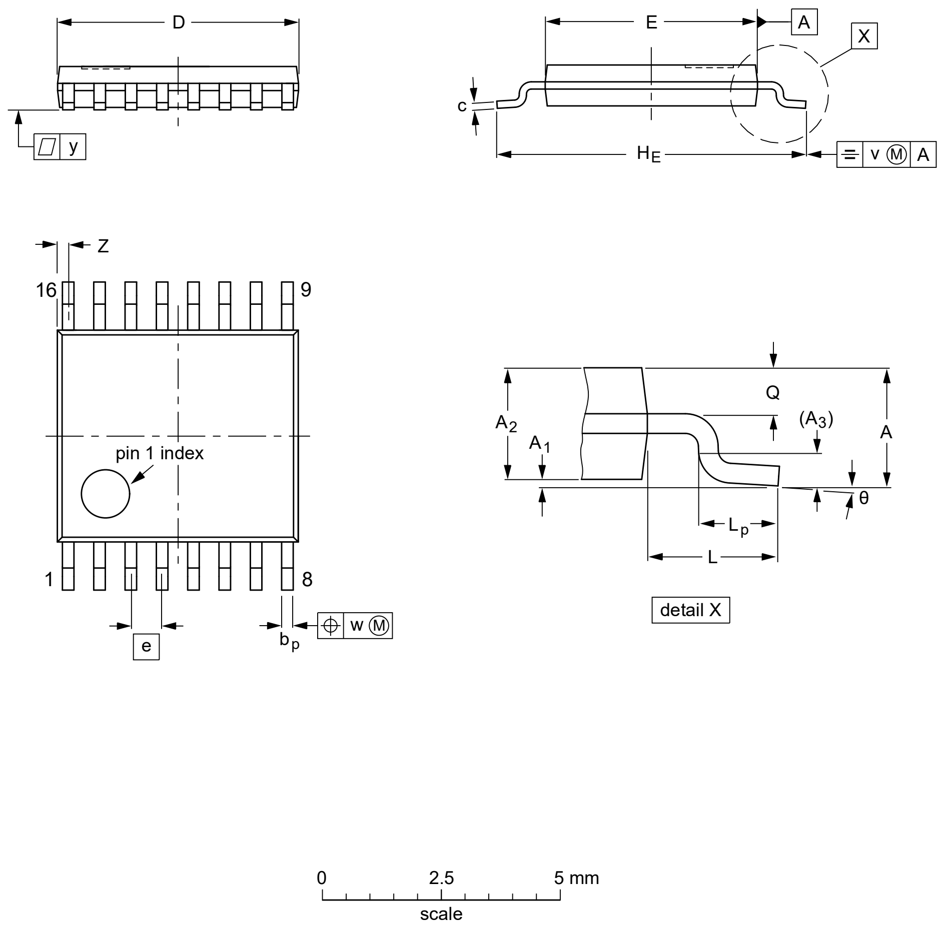
R_{gen} = generator resistance.

V_{gen} = generator voltage.

Fig. 23. Test circuit for measuring charge injection

12. Package outline

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm **SOT403-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (2)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT403-1		MO-153				~~99-12-27~~ 03-02-18

Fig. 24. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 12. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model

14. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
XS3A4052 v.1	20220211	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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