

# NMUX1309

1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Rev. 1.4 — 23 August 2024

Product data sheet

## 1. General description

The NMUX1309 is a general purpose, CMOS, bi-directional, dual 4 channel analog switch, with an operating voltage range of 1.5 V to 5.5 V. The NMUX1309 is dual source compatible with existing 4852 and 4052 devices. The NMUX1309 extends the digital logic thresholds to be compatible with 1.8 V systems without the need for voltage translation.

The analog signal pins are comprised of two common inputs/outputs (nZ) and eight independent inputs/outputs (nY0 to nY3). All analog signal pins are bi-directional and support a voltage range from GND to  $V_{CC}$ .

All analog signal pins integrate injection current control circuitry. This control circuitry isolates overvoltage spikes on disconnected analog signal pins from coupling to the connected analog signal path, thereby preserving measurement accuracy. Additionally, this integration makes the use of external overvoltage clamp components (e.g. resistive diode network) unnecessary.

There are three control signal pins (S0, S1, and  $\bar{E}$ ). S0 and S1 determine the analog channels to connect between nZ and nYn.  $\bar{E}$  can be used to override S0 and S1, disconnecting all analog channels. The control signal pins support 1.8 V logic thresholds across all operating voltages. In addition, these pins are 5.5 V tolerant, enabling up to 5.5 V operation independent of supply voltage.

## 2. Features and benefits

- Wide operating range: 1.5 V to 5.5 V
- 2x SP4T-Z functionality
- Rail-to-Rail operation on analog signal pins
- Injection current control
- 1.8 V digital logic thresholds
  - Digital pins compatible with 1.8 V logic thresholds across full  $V_{CC}$  range
  - Removes need for up-translation device for compatibility with low voltage GPIOs
- $I_{off}$  circuitry
  - Enables wider latitude for power sequencing considerations
  - Isolates backflow between supply rail and any biased digital/analog input when  $V_{CC} = 0$  V
  - Prevents any biased digital/analog input from backpowering  $V_{CC}$  when  $V_{CC} = 0$  V
  - Maintains Hi-Z state of analog switch when  $V_{CC} = 0$  V
- 5.5 V overvoltage tolerant digital inputs
  - Supports switching of 5.5 V digital signals across full  $V_{CC}$  operating range
  - Removes need for down-translation when switching thresholds are met
- Pin compatible with industry standard 4052 and 4852 analog switch products
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C2b exceeds 750 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

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### 3. Applications

- Analog or digital multiplexing/demultiplexing
- System monitoring and diagnostics
- Enterprise computing
- Appliances

### 4. Ordering information

Table 1. Ordering information

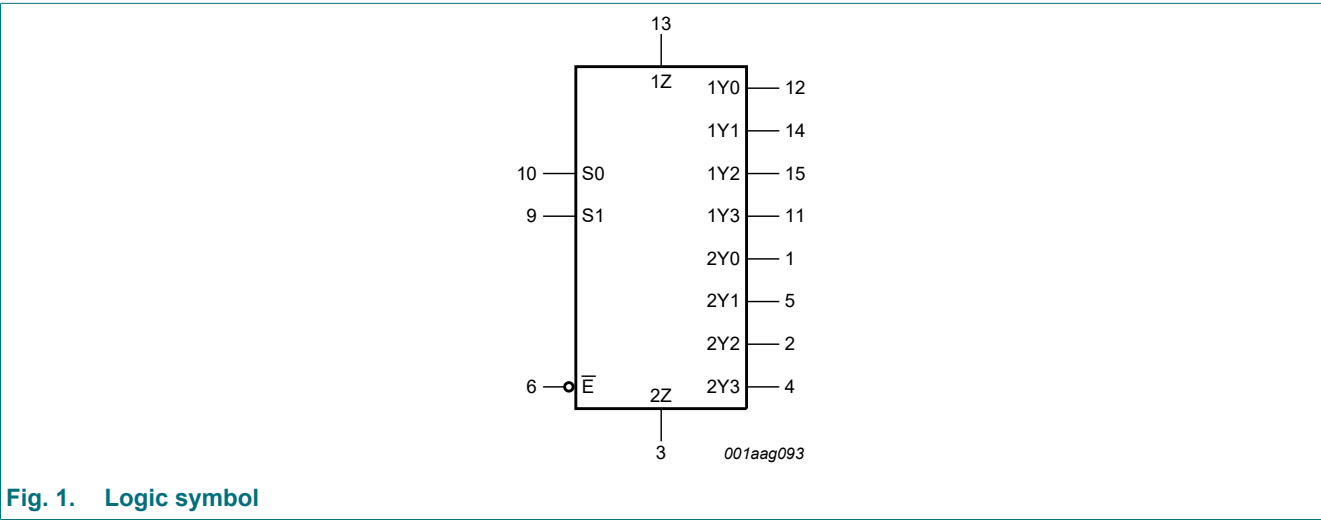
Type number	Package			
	Temperature range	Name	Description	Version
NMUX1309PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	<a href="#">SOT403-1</a>
NMUX1309BQ	-40 °C to +125 °C	DHVQFN16	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm	<a href="#">SOT763-1</a>

### 5. Marking

Table 2. Marking

Type number	Marking code
NMUX1309PW	NMU1309
NMUX1309BQ	NM1309

### 6. Functional diagram



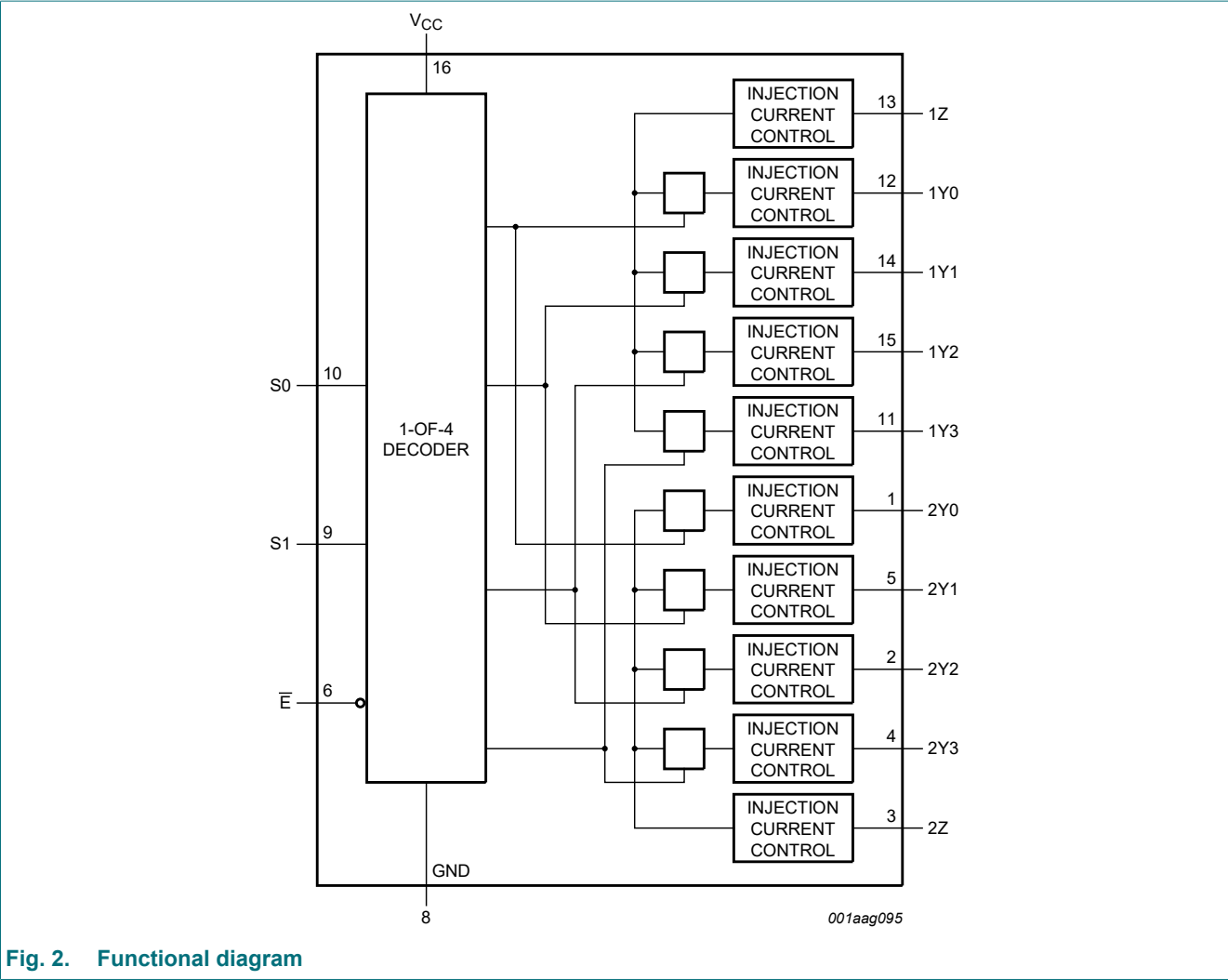


Fig. 2. Functional diagram

7. Pinning information

7.1. Pinning

**PW package**  
**SOT403-1 (TSSOP16)**

2Y0 1 16 V<sub>CC</sub>  
2Y2 2 15 1Y2  
2Z 3 14 1Y1  
2Y3 4 13 1Z  
2Y1 5 12 1Y0  
E 6 11 1Y3  
n.c. 7 10 S0  
GND 8 9 S1

aaa-039533

**BQ package**  
**SOT763-1 (DHVQFN16)**

terminal 1 index area

2Y0 1 16 V<sub>CC</sub>  
2Y2 2 15 1Y2  
2Z 3 14 1Y1  
2Y3 4 13 1Z  
2Y1 5 12 1Y0  
E 6 11 1Y3  
n.c. 7 10 S0  
GND 8 9 S1

GND S1

Transparent top view

aaa-035179

(1) This is not a supply pin. There is no electrical or mechanical requirement to solder the pad. In case soldered, the solder land should remain floating or connected to GND.

7.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
2Y0	1	independent input/output
2Y2	2	independent input/output
2Z	3	common input/output
2Y3	4	independent input/output
2Y1	5	independent input/output
E	6	enable input (active LOW); do not leave this pin floating
n.c.	7	not connected
GND	8	ground (0 V)
S1	9	select input; do not leave this pin floating
S0	10	select input; do not leave this pin floating
1Y3	11	independent input/output
1Y0	12	independent input/output
1Z	13	common input/output
1Y1	14	independent input/output
1Y2	15	independent input/output
V <sub>CC</sub>	16	supply voltage

## 8. Functional description

**Table 4. Function table**  
*H = HIGH voltage level; L = LOW voltage level; X = don't care.*

Input			Channel ON
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	-

### 8.1. Overview

The NMUX1309 is a general purpose analog switch with a 2 poles, each of which can be configured to select between one of four possible connection paths (2x SP4T). Each analog connection path is bi-directional, with similar electrical characteristics independent of the direction of signal propagation.

### 8.2. Key features

#### Injection current control

Current injection can occur in systems where an analog voltage can experience transient spikes due to signal propagation over long distances with high inductance. Voltage exposure above the supply voltage will source excessive current into an analog input, which is referred to as positive injection. Voltage exposure below the ground voltage will sink excessive current from an analog input, which is referred to as negative injection. Both types of injection current elevate the risk of device damage to an analog input and can introduce a large voltage error to the analog signal itself.

The NMUX1309 mitigates both risks by integrating an injection current control circuit to divert both positive injection and negative injection through a bypass FET that connects to GND. This implementation minimizes any shift in the supply voltage, therefore minimizing any shift in the device's ON Resistance, and thus minimizes changes in the measured analog voltage. The injection current control circuit is active on all analog pins, independent of whether the channel is selected/unselected.

#### 1.8 V Compatible digital logic thresholds

It is common for modern systems to operate digital signals from lower voltage nodes such as 1.8 V, while operating their analog signals at higher voltage nodes such as 3.3 V or 5.0 V. To remove the requirements for a voltage translation device, the NMUX1309 digital control pins maintain 1.8 V logic compatible thresholds at higher operating voltages, up to 5.5 V.

#### I<sub>off</sub> protection circuitry of digital inputs

The NMUX1309 implements I<sub>off</sub> protection circuitry on the digital control pins, isolating those pins from the internal circuits when the supply is unpowered (i.e., V<sub>CC</sub> = 0 V). The ESD protection diodes on the digital input pins do not have a connection path to V<sub>CC</sub>. If the digital input pins are biased when the V<sub>CC</sub> pin is unpowered:

1. The high impedance of the digital input pins minimizes input current leakage.

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- 2. The isolation between the digital input pins and the  $V_{CC}$  pin ensures no back-powering to the supply rail.

**$I_{off}$  protection circuitry of analog inputs/outputs**

The NMUX1309 implements  $I_{off}$  protection circuitry on the analog switch pins, isolating those pins from the internal circuits when the supply is unpowered (i.e.,  $V_{CC} = 0\text{ V}$ ). The ESD protection diodes on the analog switch pins do not have a connection path to  $V_{CC}$ . If the analog switch pins are biased when the  $V_{CC}$  pin is unpowered:

- 1. The high impedance of the analog pins minimizes input current leakage.
- 2. The isolation between the analog pins and the  $V_{CC}$  pin ensures no back-powering to the supply rail.
- 3. The high impedance of the analog switch path itself minimizes signal coupling across the switch.

9. 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	+6.0	V
$V_I$	input voltage	E, S0, S1 [1]	-0.5	+6.0	V
$V_{SW}$	switch voltage	nYn, nZ [2]	-0.5	$V_{CC} + 0.5$	V
$I_{SW}$	switch current	nYn, nZ; $V_{SW} > -0.5\text{ V}$ or $V_{SW} < V_{CC} + 0.5\text{ V}$ ; $T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$	-50	+50	mA
		nYn, nZ; $V_{SW} > -0.5\text{ V}$ or $V_{SW} < V_{CC} + 0.5\text{ V}$ ; $T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	-25	+25	mA
$I_I$	input current	E, S0, S1	-30	30	mA
$I_{GND}$	ground current		-100	100	mA
$T_{stg}$	storage temperature		-65	+150	$^{\circ}\text{C}$
$P_{tot}$	total power dissipation	$T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ [3]	-	500	mW
$T_J$	junction temperature		-	+150	$^{\circ}\text{C}$

[1] The minimum and maximum input voltage rating may be exceeded if the input clamping current rating is observed.  
[2] The minimum and maximum switch voltage rating may be exceeded if the switch clamping current rating is observed.  
[3] For SOT403-1 (TSSOP16) package:  $P_{tot}$  derates linearly with 8.5 mW/K above 91  $^{\circ}\text{C}$ .  
For SOT763-1 (DHVQFN16) package:  $P_{tot}$  derates linearly with 11.2 mW/K above 106  $^{\circ}\text{C}$ .

10. Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage		1.50	-	5.5	V
V <sub>I</sub>	input voltage	$\bar{E}$ , S0, S1	0	-	5.5	V
V <sub>SW</sub>	switch voltage	nYn, nZ; enable and disable mode	0	-	V <sub>CC</sub>	V
		nYn, nZ; V <sub>CC</sub> = 0 V	0	-	5.5	V
I <sub>SW</sub>	switch current	nYn, nZ; V <sub>SW</sub> > GND or V <sub>SW</sub> < V <sub>CC</sub> ; T <sub>amb</sub> = -40 °C to +85 °C	-50	-	50	mA
		nYn, nZ; V <sub>SW</sub> > GND or V <sub>SW</sub> < V <sub>CC</sub> ; T <sub>amb</sub> = -40 °C to +125 °C	-25	-	25	mA
I <sub>SK</sub>	switch clamping current	nYn, nZ; V <sub>SW</sub> < GND or V <sub>SW</sub> > V <sub>CC</sub> [1]	-50	-	50	mA
I <sub>GND</sub>	ground current		-100	-	100	mA
I <sub>INJ</sub>	injected current	single off switch	-25	-	50	mA
		all off switches combined	-100	-	100	mA
T <sub>amb</sub>	ambient temperature		-40	-	+125	°C

[1] If the V<sub>SW</sub> > V<sub>CC</sub> or if V<sub>SW</sub> < GND, the pin will be shunted to GND through an internal FET. The current must be limited within the specified value.

11. Static characteristics

Table 7. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground 0 V); for test circuit see Fig. 4.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
Analog switch										
R <sub>ON</sub>	ON resistance	V <sub>I</sub> = V <sub>CC</sub> to GND; I <sub>SW</sub> = 0.5 mA; $\bar{E}$ = V <sub>IL</sub> ; see <a href="#">Fig. 5</a>								
		V <sub>CC</sub> = 1.8 V ± 10%	-	450	1151	-	1245	-	1245	Ω
		V <sub>CC</sub> = 2.5 V ± 10%	-	160	388	-	419	-	436	Ω
		V <sub>CC</sub> = 3.3 V ± 10%	-	95	231	-	262	-	278	Ω
		V <sub>CC</sub> = 5 V ± 10%	-	60	146	-	167	-	178	Ω
ΔR <sub>ON</sub>	ON resistance mismatch between channels	V <sub>I</sub> = 0.5V <sub>CC</sub> ; I <sub>SW</sub> = 0.5 mA; $\bar{E}$ = V <sub>IL</sub>								
		V <sub>CC</sub> = 1.8 V ± 10%	-	5	91	-	91	-	91	Ω
		V <sub>CC</sub> = 2.5 V ± 10%	-	4	35	-	39	-	41	Ω
		V <sub>CC</sub> = 3.3 V ± 10%	-	2	17	-	19	-	19	Ω
		V <sub>CC</sub> = 5 V ± 10%	-	1	11	-	11	-	12	Ω

## 1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
I <sub>S(OFF)</sub>	OFF-state leakage current	nYn pins; switch off; $\bar{E} = V_{IH}$ ; $V_I = 0.8V_{CC}$ or $0.2V_{CC}$ ; $V_O = 0.2V_{CC}$ or $0.8V_{CC}$ ; see Fig. 3								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	$\pm 1$	-	-25	25	-800	800	nA
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	$\pm 1$	-	-25	25	-800	800	nA
		$V_{CC} = 3.3 \text{ V} \pm 10\%$	-	$\pm 1$	-	-25	25	-800	800	nA
		$V_{CC} = 5 \text{ V} \pm 10\%$	-	$\pm 1$	-	-25	25	-800	800	nA
		Z pins; switch off; $\bar{E} = V_{IH}$ ; $V_I = 0.8V_{CC}$ or $0.2V_{CC}$ ; $V_O = 0.2V_{CC}$ or $0.8V_{CC}$ ; see Fig. 3								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
I <sub>S(ON)</sub>	ON-state leakage current	nZ, nYn pins; switch on; $\bar{E} = V_{IL}$ ; $V_I = V_O = 0.8V_{CC}$ or $V_I = V_O = 0.2V_{CC}$ ; see Fig. 4								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
		$V_{CC} = 3.3 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
		$V_{CC} = 5 \text{ V} \pm 10\%$	-	$\pm 1$	-	-45	45	-800	800	nA
C <sub>SW</sub>	switch capacitance	nYn pins, OFF-state; $V_I = 0.5V_{CC}$ ; $f = 1 \text{ MHz}$								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	4	10	-	10	-	10	pF
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	4	9	-	9	-	9	pF
		$V_{CC} = 3.3 \text{ V} \pm 10\%$	-	4	9	-	9	-	9	pF
		$V_{CC} = 5 \text{ V} \pm 10\%$	-	4	9	-	9	-	9	pF
		nZ pins, OFF-state; $V_I = 0.5V_{CC}$ ; $f = 1 \text{ MHz}$								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	10	23	-	23	-	23	pF
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	10	22	-	22	-	22	pF
		$V_{CC} = 3.3 \text{ V} \pm 10\%$	-	9	21	-	22	-	22	pF
		$V_{CC} = 5 \text{ V} \pm 10\%$	-	9	20	-	20	-	20	pF
		nZ, nYn pins; ON-state; $V_I = 0.5V_{CC}$ ; $f = 1 \text{ MHz}$								
		$V_{CC} = 1.8 \text{ V} \pm 10\%$	-	16	31	-	32	-	32	pF
		$V_{CC} = 2.5 \text{ V} \pm 10\%$	-	16	31	-	31	-	31	pF
		$V_{CC} = 3.3 \text{ V} \pm 10\%$	-	16	30	-	31	-	31	pF
		$V_{CC} = 5 \text{ V} \pm 10\%$	-	15	29	-	30	-	30	pF



1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
Power supply										
I <sub>CC</sub>	supply current	E, Sn inputs; V <sub>I</sub> = GND or V <sub>CC</sub>								
		V <sub>CC</sub> = 1.8 V ± 10%	-	-	1	-	1	-	1	µA
		V <sub>CC</sub> = 2.5 V ± 10%	-	-	1	-	1	-	1	µA
		V <sub>CC</sub> = 3.3 V ± 10%	-	-	1	-	1	-	1	µA
		V <sub>CC</sub> = 5 V ± 10%	-	-	1	-	1	-	1	µA

Table 8. Static characteristics

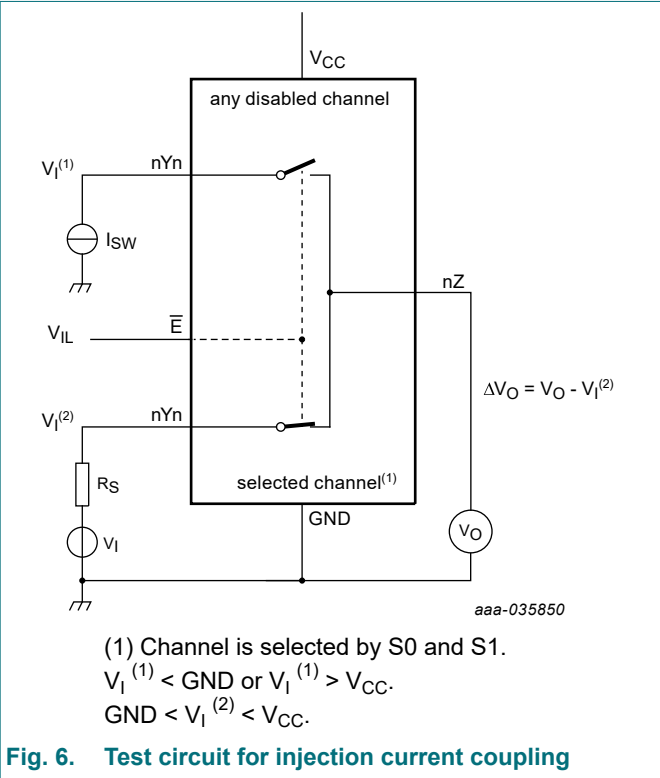
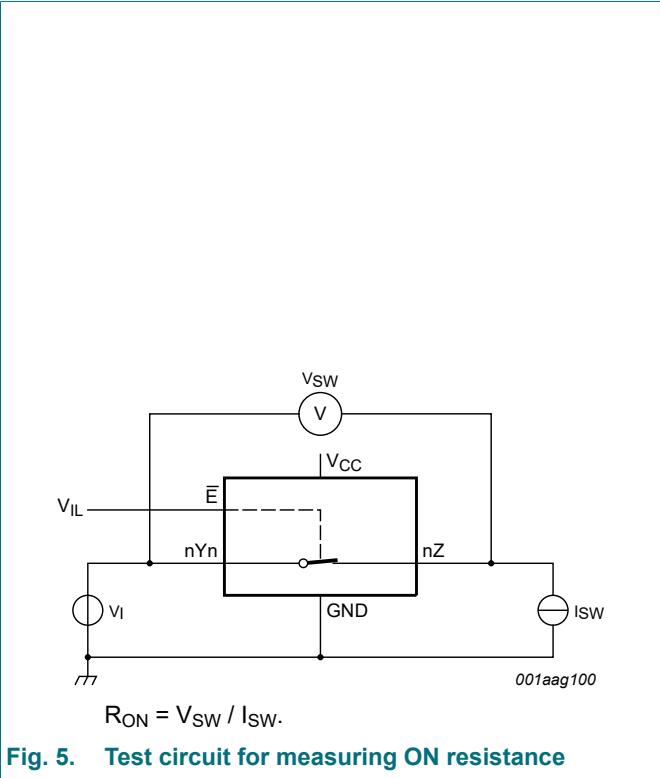
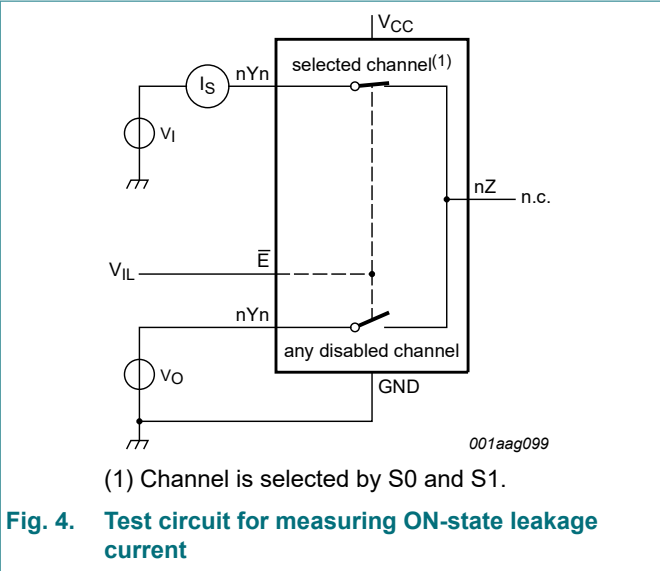
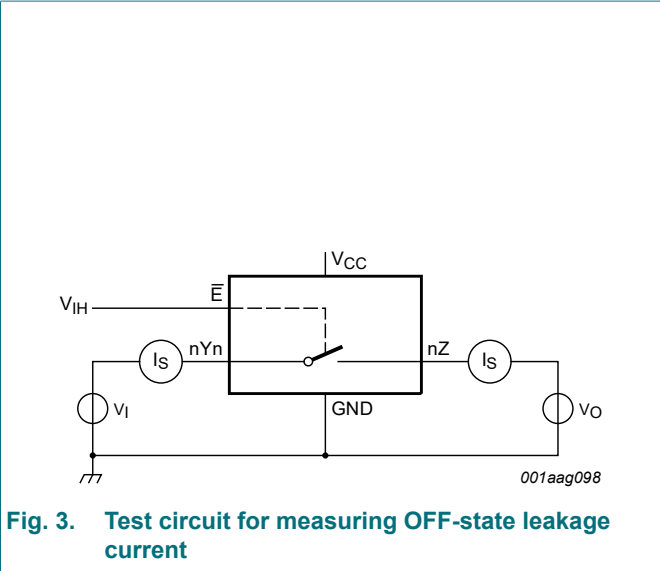
At recommended operating conditions; voltages are referenced to GND (ground 0 V); for test circuit see Fig. 5.

Symbol	Parameter	Conditions	-40 to +125 °C			Unit
			Min	Typ [1]	Max	
Injection current coupling						
ΔV <sub>O</sub>	output voltage variation	I <sub>SW</sub> ≤ 1 mA; R <sub>S</sub> ≤ 3.9 kΩ [2] [3]				
		V <sub>CC</sub> = 1.8 V ± 10%	-	0.1	1	mV
		V <sub>CC</sub> = 3.3 V ± 10%	-	0.2	1	mV
		V <sub>CC</sub> = 5 V ± 10%	-	0.4	2	mV
		I <sub>SW</sub> ≤ 10 mA; R <sub>S</sub> ≤ 3.9 kΩ [2] [3]				
		V <sub>CC</sub> = 1.8 V ± 10%	-	0.1	2	mV
		V <sub>CC</sub> = 3.3 V ± 10%	-	0.2	2	mV
		V <sub>CC</sub> = 5 V ± 10%	-	0.4	2	mV
		I <sub>SW</sub> ≤ 1 mA; R <sub>S</sub> ≤ 20 kΩ [2][3]				
		V <sub>CC</sub> = 1.8 V ± 10%	-	0.1	2	mV
		V <sub>CC</sub> = 3.3 V ± 10%	-	0.2	2	mV
		V <sub>CC</sub> = 5 V ± 10%	-	0.4	2	mV
		I <sub>SW</sub> ≤ 10 mA; R <sub>S</sub> ≤ 20 kΩ [2][3]				
		V <sub>CC</sub> = 1.8 V ± 10%	-	0.1	5	mV
		V <sub>CC</sub> = 3.3 V ± 10%	-	0.2	5	mV
		V <sub>CC</sub> = 5 V ± 10%	-	0.4	5	mV
Logic inputs						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.8 V ± 10%	0.99	-	5.5	V
		V <sub>CC</sub> = 2.5 V ± 10%	1.08	-	5.5	V
		V <sub>CC</sub> = 3.3 V ± 10%	1.15	-	5.5	V
		V <sub>CC</sub> = 5 V ± 10%	1.32	-	5.5	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.8 V ± 10%	0	-	0.53	V
		V <sub>CC</sub> = 2.5 V ± 10%	0	-	0.61	V
		V <sub>CC</sub> = 3.3 V ± 10%	0	-	0.68	V
		V <sub>CC</sub> = 5 V ± 10%	0	-	0.79	V
I <sub>IH</sub>	HIGH-level input current	V <sub>I</sub> = 1.8 V or V <sub>CC</sub>	-	-	1	μA
I <sub>IL</sub>	LOW-level input current	V <sub>I</sub> = 0 V	-1	-	-	μA

1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Symbol	Parameter	Conditions	-40 to +125 °C			Unit
			Min	Typ [1]	Max	
C <sub>I</sub>	input capacitance	S0, S1, and $\bar{E}$ pins; V <sub>I</sub> = 0 V, 1.8 V, or V <sub>CC</sub> ; f = 1 MHz	-	1.5	3.5	pF

- [1] Typical values are measured at T<sub>amb</sub> = 25 °C.
- [2] ΔV<sub>O</sub> here is the maximum variation of output voltage of an enabled analog channel when current is injected into any disabled channel.
- [3] I<sub>SW</sub> = total current injected into all disabled channels.



## 12. Dynamic characteristics

Table 9. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground 0 V); for test circuit see Fig. 10.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>pd</sub>	propagation delay	nZ to nYn, nYn to nZ; C <sub>L</sub> = 50 pF; see Fig. 7 [1]								
		V <sub>CC</sub> = 1.8 V ± 10%	-	9	22	-	25	-	26	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	6	10	-	11	-	12	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	4	6	-	7	-	8	ns
		V <sub>CC</sub> = 5 V ± 10%	-	2	4	-	5	-	5	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	1	3	-	3	-	3	ns
t <sub>pd</sub>	transition time between inputs	Sn to nZ; R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF; see Fig. 8 [1]								
		V <sub>CC</sub> = 1.8 V ± 10%	-	52	93	-	93	-	93	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	40	67	-	74	-	74	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	36	61	-	71	-	71	ns
		V <sub>CC</sub> = 5.0 V ± 10%	-	33	60	-	70	-	70	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	31	58	-	70	-	70	ns
		Sn to nYn; R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF; see Fig. 8 [1]								
		V <sub>CC</sub> = 1.8 V ± 10%	-	108	359	-	363	-	364	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	96	349	-	351	-	351	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	93	344	-	344	-	344	ns
		V <sub>CC</sub> = 5.0 V ± 10%	-	85	335	-	335	-	336	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	40	93	-	94	-	94	ns
t <sub>en</sub>	enable time	$\bar{E}$ to nZ, $\bar{E}$ to nYn; R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF; see Fig. 9 [2]								
		V <sub>CC</sub> = 1.8V ± 10%	-	15	25	-	27	-	29	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	12	17	-	18	-	18	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	12	17	-	18	-	18	ns
		V <sub>CC</sub> = 5 V ± 10%	-	12	17	-	18	-	18	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	11	16	-	17	-	17	ns

1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>dis</sub>	disable time	$\bar{E}$ to nZ, $\bar{E}$ to nYn; R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF; S1 = GND; see Fig. 9 [3]								
		V <sub>CC</sub> = 1.8 V ± 10%	-	23	47	-	48	-	49	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	16	37	-	37	-	37	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	16	37	-	37	-	37	ns
		V <sub>CC</sub> = 5 V ± 10%	-	16	31	-	32	-	33	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	3	5	-	5	-	6	ns
		$\bar{E}$ to nYn; R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF; S1 = V <sub>CC</sub> ; see Fig. 9								
		V <sub>CC</sub> = 1.8 V ± 10%	-	13	72	-	72	-	72	ns
		V <sub>CC</sub> = 2.5 V ± 10%	-	10	70	-	70	-	71	ns
		V <sub>CC</sub> = 3.3 V ± 10%	-	9	70	-	70	-	70	ns
		V <sub>CC</sub> = 5 V ± 10%	-	7	69	-	69	-	70	ns
		V <sub>CC</sub> = 5.0 V ± 10%; C <sub>L</sub> = 15 pF	-	5	34	-	34	-	35	ns
t <sub>b-m</sub>	break-before-make time	R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 15 pF; nYn to nZ								
		V <sub>CC</sub> = 1.8 V ± 10%	1	35	-	1	-	1	-	ns
		V <sub>CC</sub> = 2.5 V ± 10%	1	30	-	1	-	1	-	ns
		V <sub>CC</sub> = 3.3 V ± 10%	1	29	-	1	-	1	-	ns
		V <sub>CC</sub> = 5 V ± 10%	1	27	-	1	-	1	-	ns

[1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.  
[2] t<sub>en</sub> is the same as t<sub>PZH</sub> and t<sub>PZL</sub>.  
[3] t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.

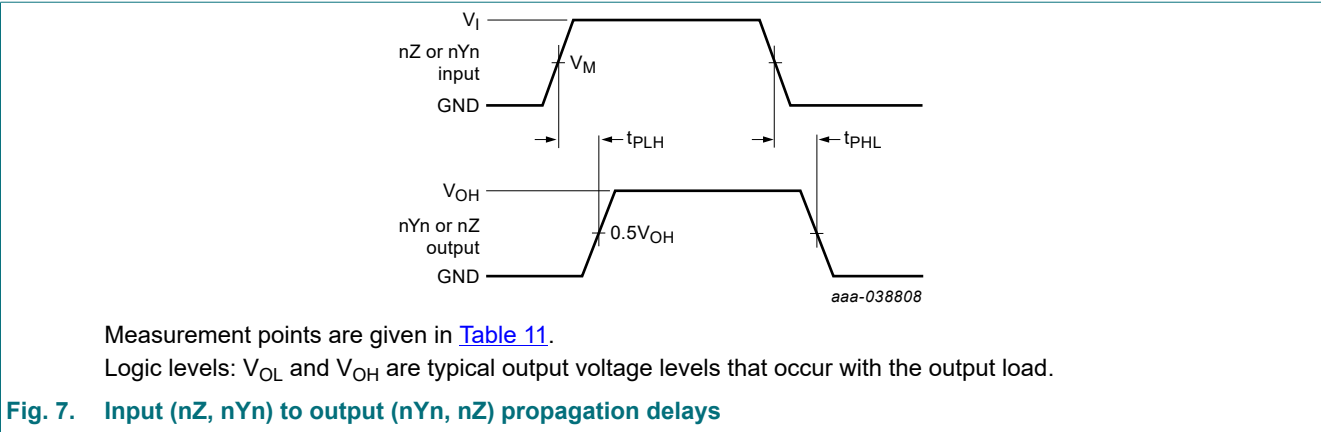
Table 10. Dynamic characteristics

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +125 °C			Unit
			Min	Typ	Max	
Q <sub>inj</sub>	charge injection	V <sub>I</sub> = 0.5V <sub>CC</sub> ; R <sub>S</sub> = 0 Ω; C <sub>L</sub> = 100 pF				
		V <sub>CC</sub> = 1.8 V ± 10%	-	1	-	pC
		V <sub>CC</sub> = 2.5 V ± 10%	-	2	-	pC
		V <sub>CC</sub> = 3.3 V ± 10%	-	3	-	pC
		V <sub>CC</sub> = 5 V ± 10%	-	8	-	pC

1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +125 °C			Unit
			Min	Typ	Max	
$\alpha_{iso}$	isolation (OFF-state)	$V_{bias} = 0.5V_{CC}$ ; $V_I = 200\text{ mVpp}$ ; $R_L = 50\ \Omega$ ; $C_L = 5\text{ pF}$ ; $f = 100\text{ kHz}$				
		$V_{CC} = 1.8\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 2.5\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 3.3\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 5\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{bias} = 0.5V_{CC}$ ; $V_I = 200\text{ mVpp}$ ; $R_L = 50\ \Omega$ ; $C_L = 5\text{ pF}$ ; $f = 1\text{ MHz}$				
		$V_{CC} = 1.8\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 2.5\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 3.3\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 5\text{ V} \pm 10\%$	-	-80	-	dB
$X_{talk}$	crosstalk	$V_{bias} = 0.5V_{CC}$ ; $V_I = 200\text{ mVpp}$ ; $R_L = 50\ \Omega$ ; $C_L = 5\text{ pF}$ ; $f = 100\text{ kHz}$				
		$V_{CC} = 1.8\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 2.5\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 3.3\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{CC} = 5\text{ V} \pm 10\%$	-	-105	-	dB
		$V_{bias} = 0.5V_{CC}$ ; $V_I = 200\text{ mVpp}$ ; $R_L = 50\ \Omega$ ; $C_L = 5\text{ pF}$ ; $f = 1\text{ MHz}$				
		$V_{CC} = 1.8\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 2.5\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 3.3\text{ V} \pm 10\%$	-	-80	-	dB
		$V_{CC} = 5\text{ V} \pm 10\%$	-	-80	-	dB
BW	Bandwidth	$V_{bias} = 0.5V_{CC}$ ; $V_I = 200\text{ mVpp}$ ; $R_L = 50\ \Omega$ ; $C_L = 5\text{ pF}$				
		$V_{CC} = 1.8\text{ V} \pm 10\%$	-	330	-	MHz
		$V_{CC} = 2.5\text{ V} \pm 10\%$	-	355	-	MHz
		$V_{CC} = 3.3\text{ V} \pm 10\%$	-	365	-	MHz
		$V_{CC} = 5\text{ V} \pm 10\%$	-	380	-	MHz

12.1. Waveforms and test circuit



1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

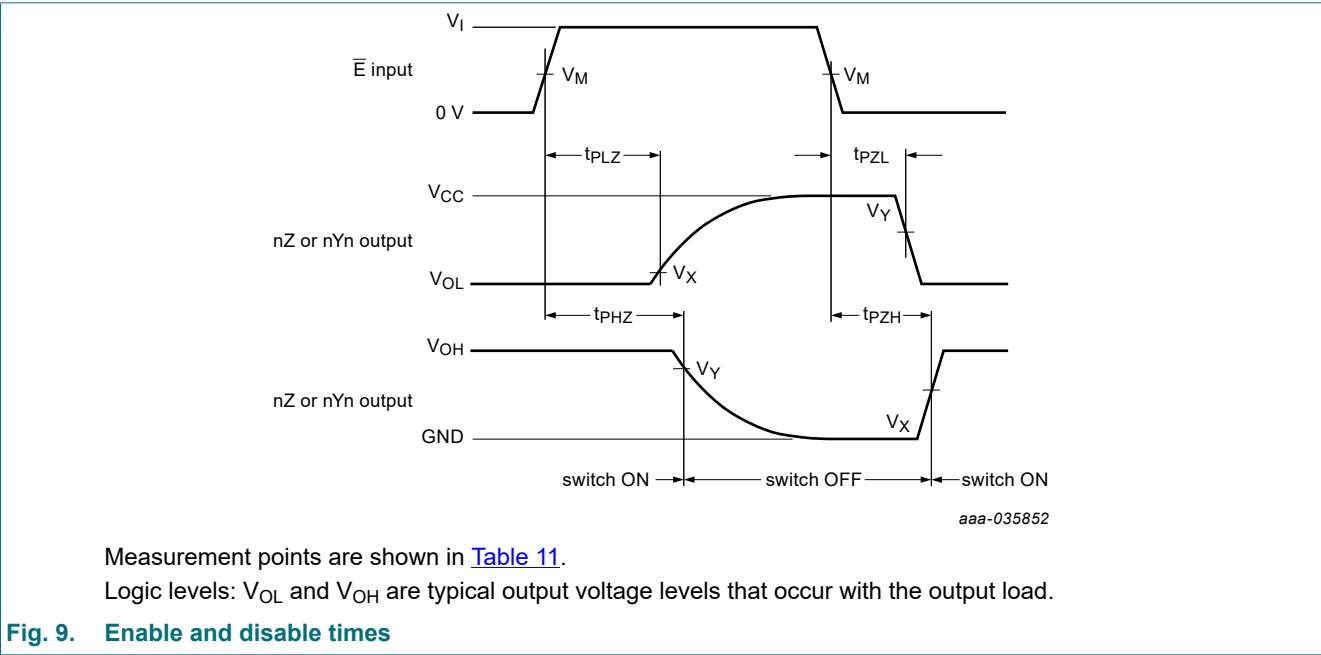
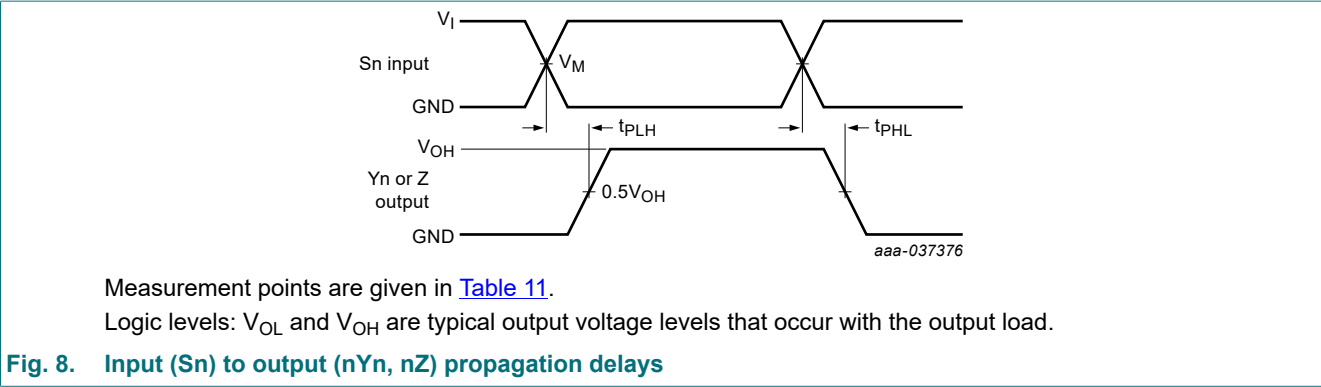


Table 11. Measurement points

Input		Output	
$V_M$	$V_I$	$V_X$	$V_Y$
$0.5 \times V_{CC}$	$V_{CC}$	$V_{OL} + 0.1(V_{CC} - V_{OL})$	$0.9 \times V_{OH}$

1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

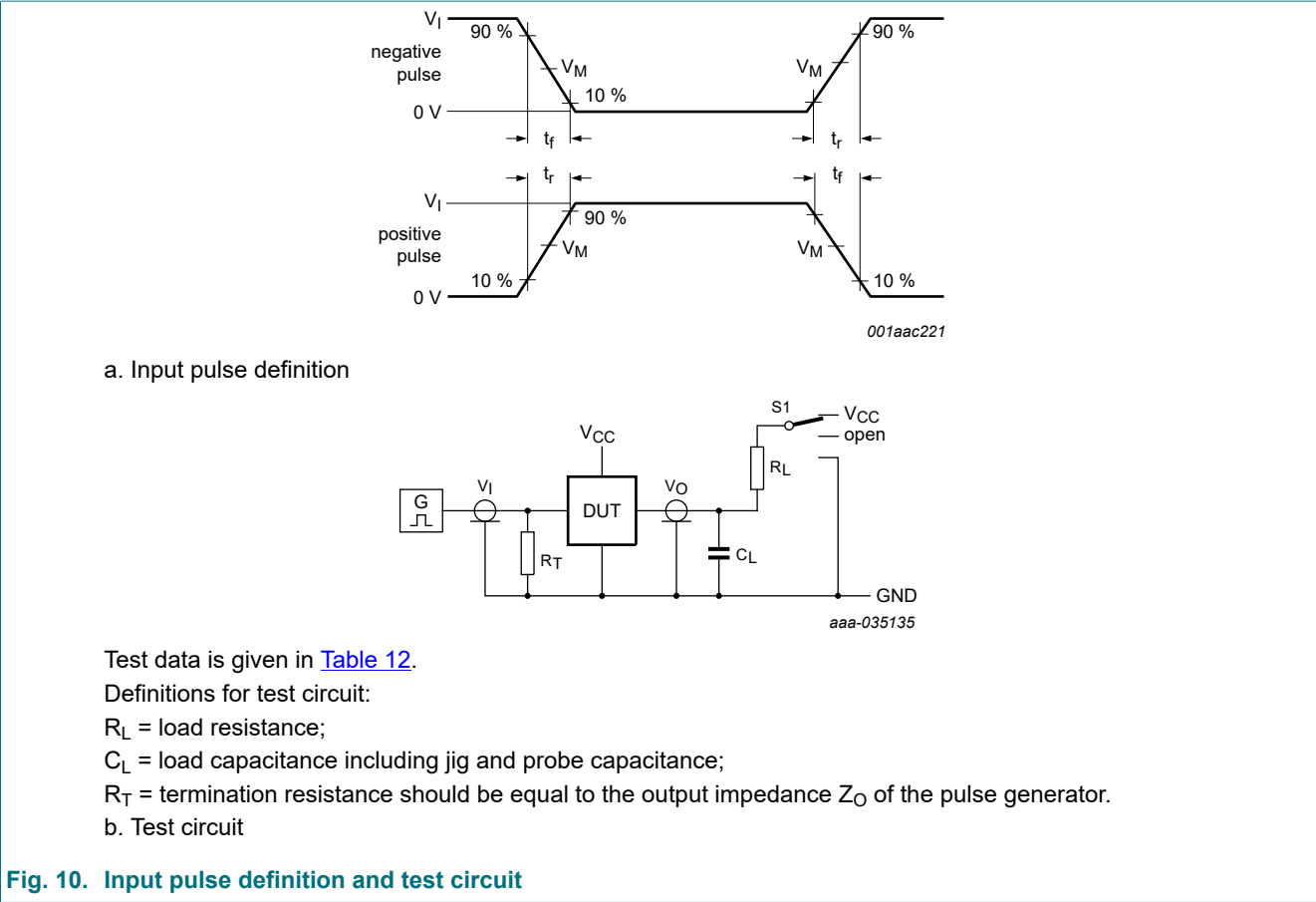


Fig. 10. Input pulse definition and test circuit

Table 12. Test data

Test	Input			Output		S1 position
	Control $\bar{E}$ , Sn	Switch nYn (nZ)	$t_r$ , $t_f$	Switch nZ (nYn)		
	$V_I$	$V_I$		$C_L$	$R_L$	
$t_{PHL}$ , $t_{PLH}$	$V_{CC}$	$V_{CC}$	< 5 ns	50 pF	-	open
$t_{PHZ}$ , $t_{PZH}$	$V_{CC}$	$V_{CC}$	< 5 ns	50 pF	10 k $\Omega$	GND
$t_{PLZ}$ , $t_{PZL}$	$V_{CC}$	$V_{CC}$	< 5 ns	50 pF	10 k $\Omega$	$V_{CC}$

13. Application information

NMUX1309

The NMUX1309 is a versatile CMOS bi-directional dual (4:1) analog switch designed for general-purpose use, operating within a voltage range of 1.5 V to 5.5 V. It features 5.5V overvoltage tolerant digital inputs and is compatible with 1.8 V CMOS levels, eliminating the need for voltage translation.

Each analog signal pin on the NMUX1309 incorporates injection current control circuitry. This innovative feature serves to isolate overvoltage spikes on disconnected analog signal pins, preventing them from affecting the connected analog signal path. Two other protective features include Fail-Safe-Logic and Power-off-Protection. These attributes make the NMUX130X family of devices the ideal choice for applications aiming to simplify signal management and reduce system complexity, resulting in a lower component count and a smaller PCB area. This utilization allows users to adopt a design approach centered around modularity, reuse, and scalability.

Typical application schematic

A typical example is provided in Fig. 11. In this instance, two sensors or voltage inputs are simultaneously sampled, such as 1Y0 and 2Y0, while sequentially stepping to the next two inputs based on the control input values. These inputs are read and accessed by the input of the SAR ('Successive Approximation Register') ADC. In the example below, the SAR ADC is integrated in the Microcontroller – ADC1 and ADC2. The operational amplifiers serve the purpose of satisfying the SAR ADCs recommendation of being driven with a low-impedance source, especially when input sensors or signals have large output impedance. This enhancement improves the performance of the SAR ADC, ensuring fast and accurate conversions while minimizing errors during the sampling process. Additionally, the op-amp eliminates potential error sources, such as ADC input leakage current, that can cause a small drop, resulting in a minor voltage error across the analog multiplexer.

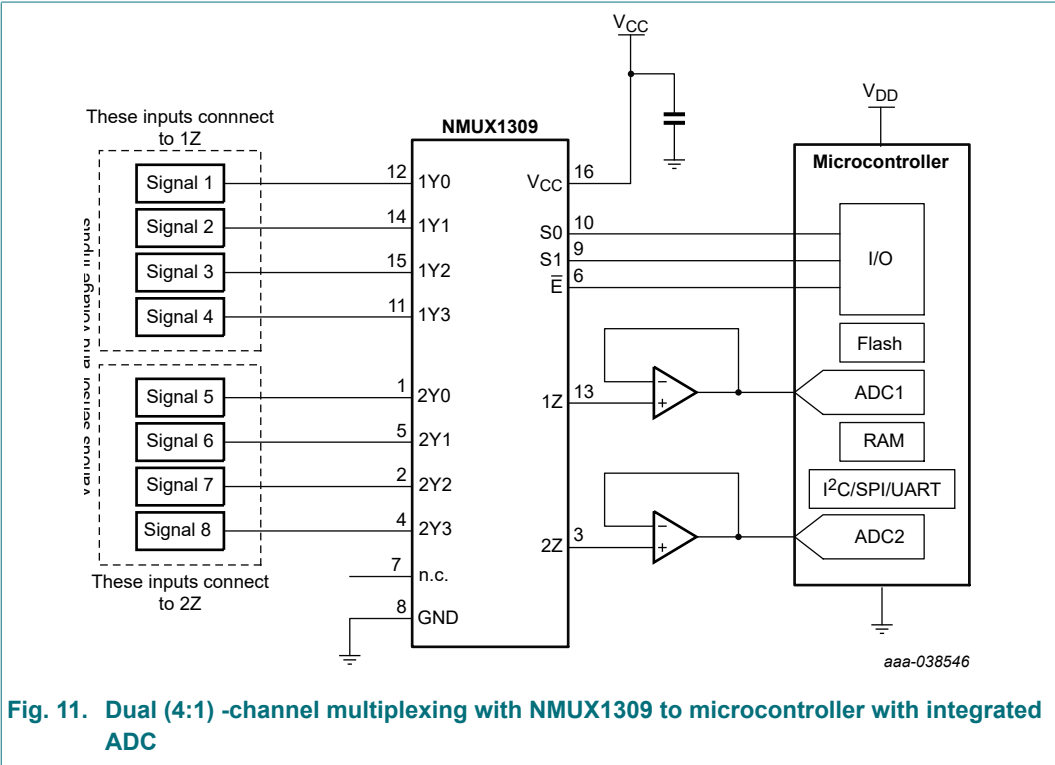


Fig. 11. Dual (4:1) -channel multiplexing with NMUX1309 to microcontroller with integrated ADC



1.5 V to 5.5 V, dual 4-channel switch analog multiplexer and demultiplexer with injection-current control

The benefits of this design type include the capability to route and switch multiple analog signals through two output channels. This is particularly crucial when the number of ADC input channels is limited.

Table 13. Example design parameters with NMUX1309

Important Design Parameters	Example Value
Supply range (V <sub>CC</sub> )	1.5 V to 5.5 V
Analog input voltage range	0 V to V <sub>CC</sub> (rail-to-rail)
Control input logic	1.8 V compatible (5.5 V overvoltage tolerant)
I <sub>SW</sub> independent switch current (maximum)	50 mA
Total analog input continuous current to GND (maximum)	100 mA

Additional example application

The circuit shown in Fig. 12 highlights the use of the NMUX1309 to create a high-precision selectable gain circuit. It eliminates error sources attributed to on-resistance and non-linearities by establishing a Kelvin sense connection from the second-stage buffer to the selected connected inputs.

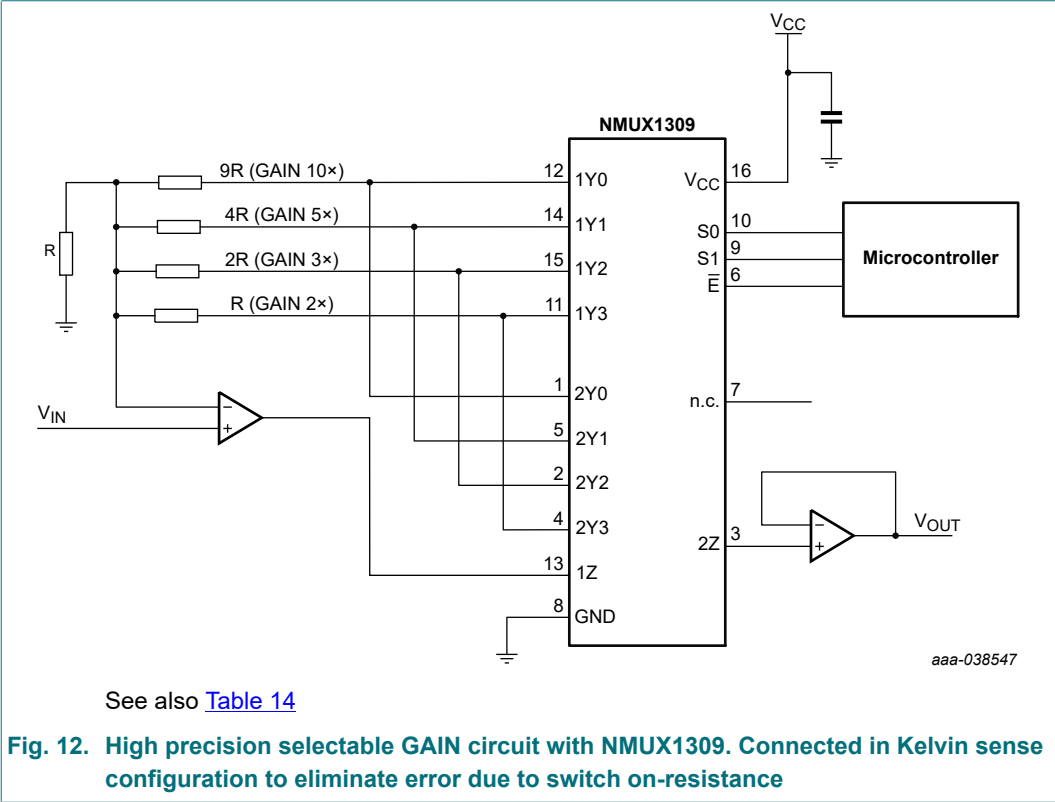


Table 14. Gain select

S1	S0	Gain
0	0	V <sub>OUT</sub> = 10x V <sub>IN</sub>
0	1	V <sub>OUT</sub> = 5x V <sub>IN</sub>
1	0	V <sub>OUT</sub> = 3x V <sub>IN</sub>
1	1	V <sub>OUT</sub> = 2x V <sub>IN</sub>

### NMUX1309 layout example

The image provided below (Fig. 13) offers a glimpse into an example PCB layout with the (PW) package. Bypass capacitors should be positioned near the  $V_{CC}$  pin, and the GND pin should be connected to external/internal GND planes. A uniform GND plane helps in reducing noise and minimizing loop inductance, thereby ensuring optimal performance.

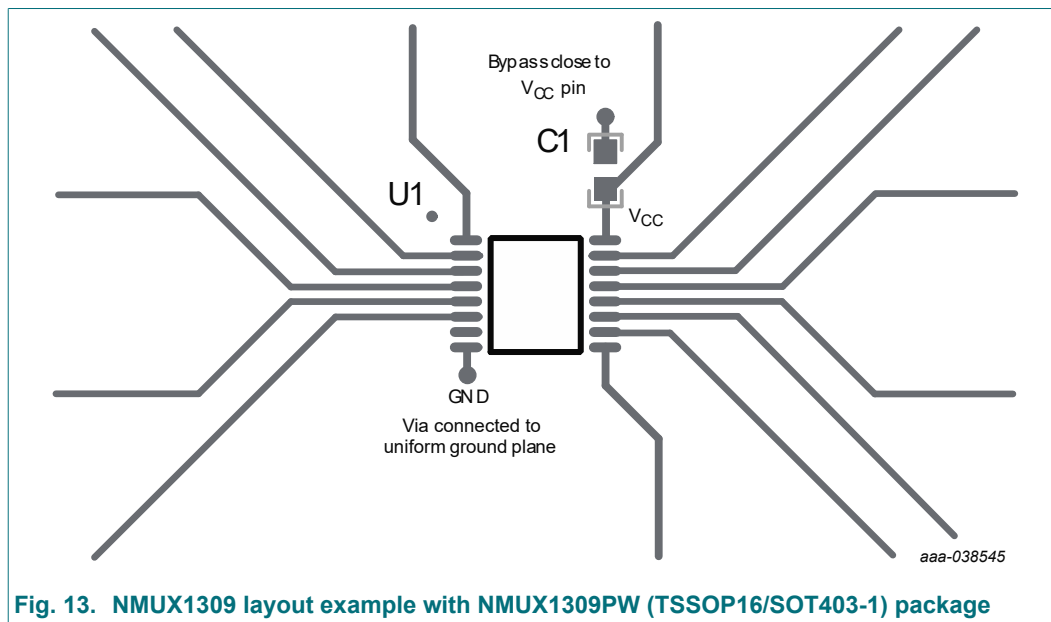


Fig. 13. NMUX1309 layout example with NMUX1309PW (TSSOP16/SOT403-1) package

### Layout recommendations

As with all board designs, proper layout techniques should be employed. Some quick good layout practices and considerations are listed below for quick reference.

- Ceramic capacitors with low ESR should be used to properly decouple or bypass power-supply pins. Ceramic capacitors with high temperature coefficients and low dissipation factors include X5R, X7R and NP0. The recommended minimum value is 0.1  $\mu\text{F}$ .
- For improved noise suppression, additional bypass capacitors can be implemented. It is a common practice to use two different capacitor values to ensure proper filtering of both low-frequency and high-frequency transients. The smaller capacitor, typically in a 0402 package, is placed very near the device pin, while the larger capacitor is positioned farther away.
- To minimize coupling and improve performance all switching nets should travel across a uniform ground plane. Reducing crosstalk can also be achieved by separating traces with a small polygon ground plane.
- Net traces should only have serpentine or 45° bend. Sharper bends, such as 90° should be avoided.

14. Package outline

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

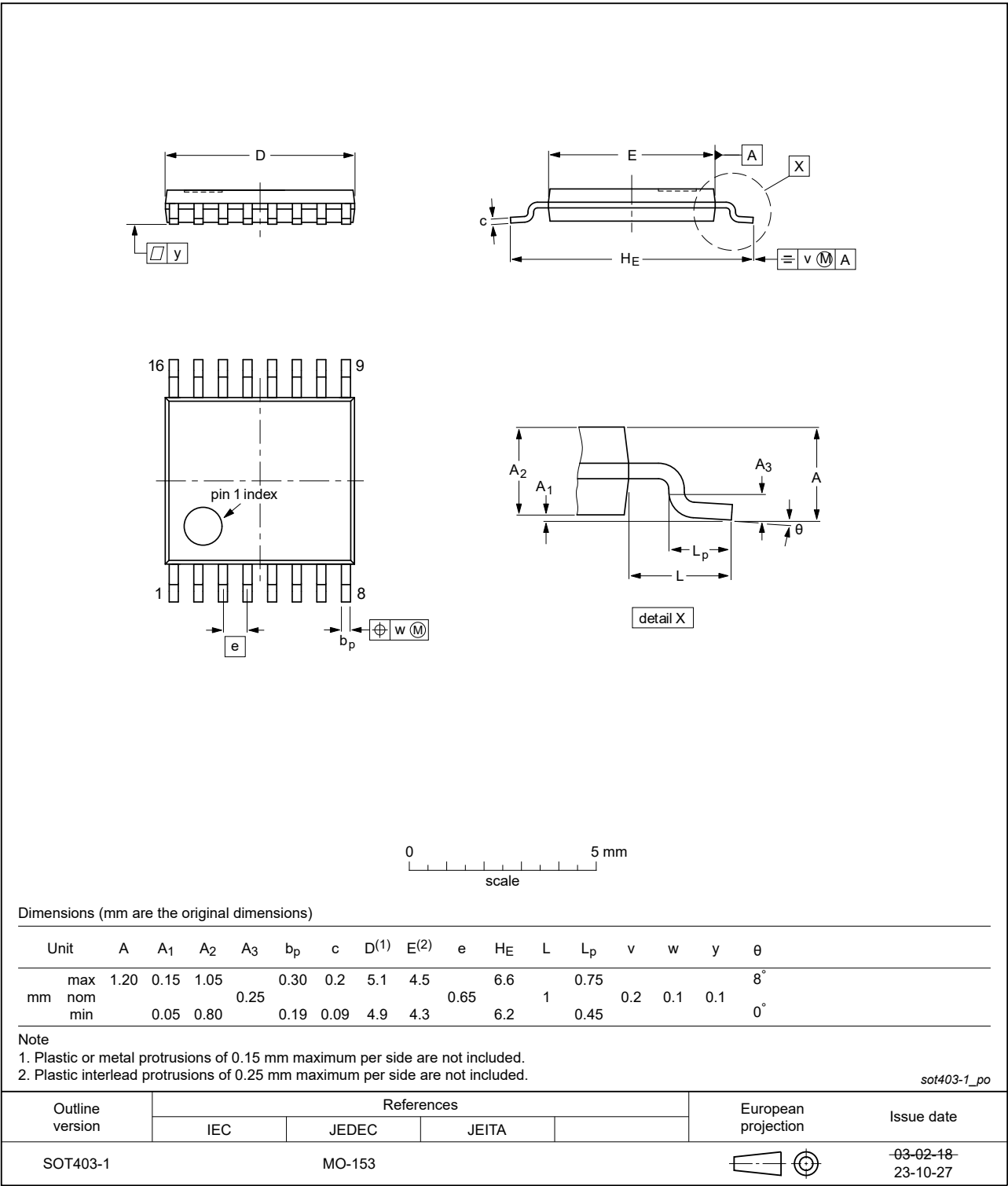


Fig. 14. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads;
16 terminals; body 2.5 x 3.5 x 0.85 mm

SOT763-1

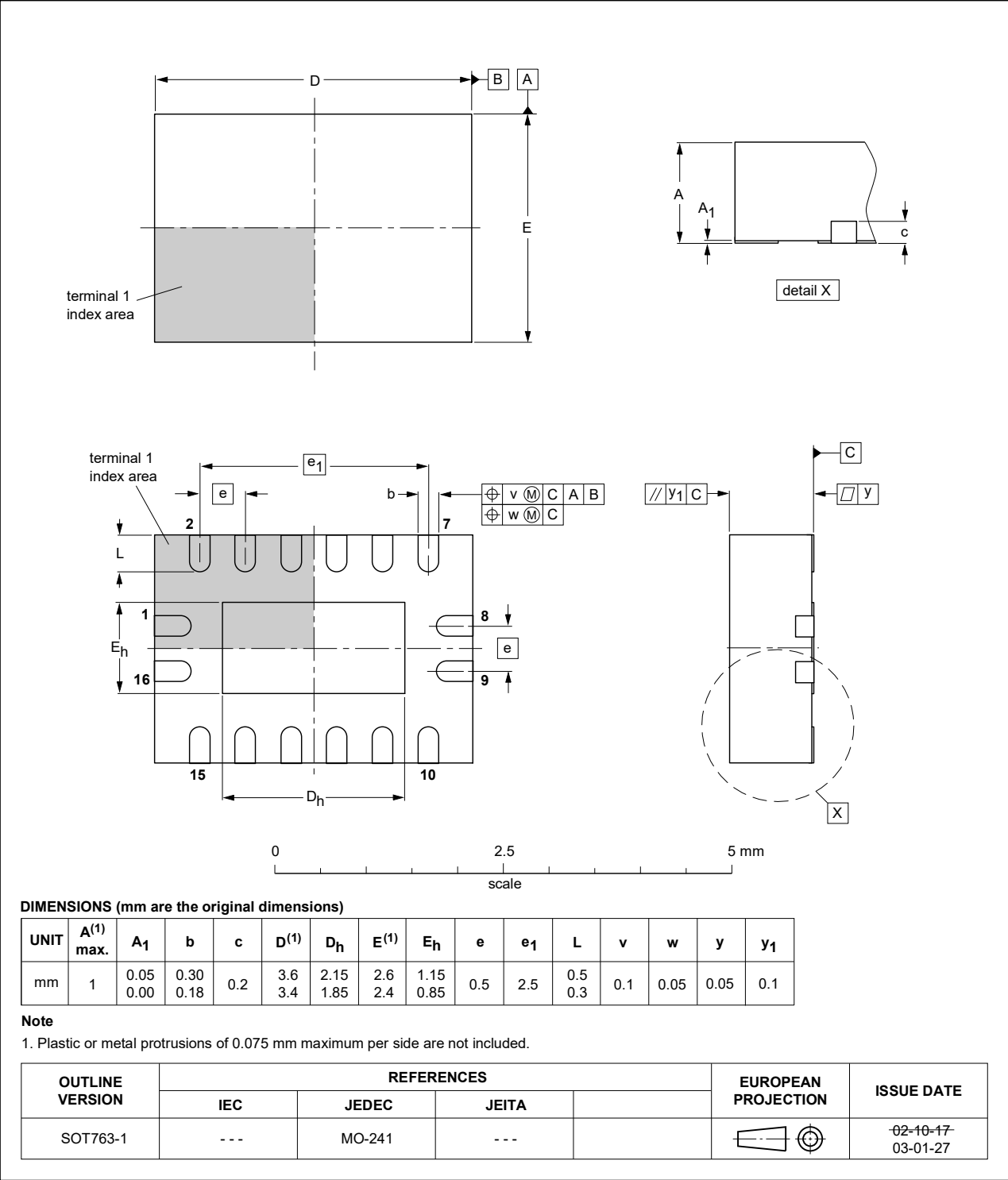


Fig. 15. Package outline SOT763-1 (DHVQFN16)

15. Abbreviations

Table 15. Abbreviations

Acronym	Description
ANSI	American National Standards Institute
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
ESDA	ElectroStatic Discharge Association
HBM	Human Body Model
JEDEC	Joint Electron Device Engineering Council

16. Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NMUX1309 v. 1.4	20240823	Product data sheet	-	NMUX1309 v. 1.3
Modification	• Changes to datasheet made for v. 1.3 were added to this table.			
NMUX1309 v. 1.3	20240725	Product data sheet	-	NMUX1309 v. 1.2
Modification	• Abbreviation table updated.			
NMUX1309 v. 1.2	20240416	Product data sheet	-	NMUX1309 v. 1.1
Modification	• <a href="#">Section 7.1</a> : Pin configuration drawing of the SOT403-1/TSSOP16 package corrected. (Errata)			
NMUX1309 v. 1.1	20240221	Product data sheet	-	NMUX1309 v. 1
Modification	• <a href="#">Fig. 10</a> : Errata. • <a href="#">Section 5</a> : added.			
NMUX1309 v. 1	20240118	Product data sheet	-	-

## 17. 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".
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