

NPIC6C596

Power logic 8-bit shift register; open-drain outputs

Rev. 3 — 22 June 2020

Product data sheet

1. General description

The NPIC6C596 is an 8-bit serial-in/serial or parallel-out shift register with a storage register and open-drain outputs. Both the shift and storage register have separate clocks. The device features a serial input (DS) and a serial output (Q7S) to enable cascading and an asynchronous reset MR input. A LOW on MR resets both the shift register and storage register. Data is shifted on the LOW-to-HIGH transitions of the SHCP input. The data in the shift register is transferred to the storage register on a LOW-to-HIGH transition of the STCP input. If both clocks are connected together, the shift register is always one clock pulse ahead of the storage register. To provide additional hold time in cascaded applications, the serial output QS7 is clocked out on the falling edge of SHCP. Data in the storage register drives the gate of the output extended-drain NMOS (EDNMOS) transistor whenever the output enable input ($\overline{OE}$) is LOW. A HIGH on $\overline{OE}$ causes the outputs to assume a high-impedance OFF-state. Operation of the $\overline{OE}$ input does not affect the state of the registers.

The open-drain outputs are 33 V/100 mA continuous current extended-drain NMOS transistors designed for use in systems that require moderate load power such as LEDs. Integrated voltage clamps in the outputs provide protection against inductive transients making the device suitable for power driver applications such as relays, solenoids and other low-current or medium-voltage loads.

2. Features and benefits

- Specified from -40 °C to +125 °C
- Low R_{DSon}
- Eight Power EDMOS transistor outputs of 100 mA continuous current
- 250 mA current limit capability
- Output clamping voltage 33 V
- 30 mJ avalanche energy capability
- Enhanced cascading for multiple stages
- All registers cleared with single input
- Low power consumption
- ESD protection:
 - HBM JDS-001 Class 2 exceeds 2500 V
 - CDM JESD22-C101E exceeds 1000 V

3. Applications

- LED sign
- Graphic status panel
- Fault status indicator

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
NPIC6C596D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
NPIC6C596PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
NPIC6C596BQ	-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	SOT763-1

5. Functional diagram

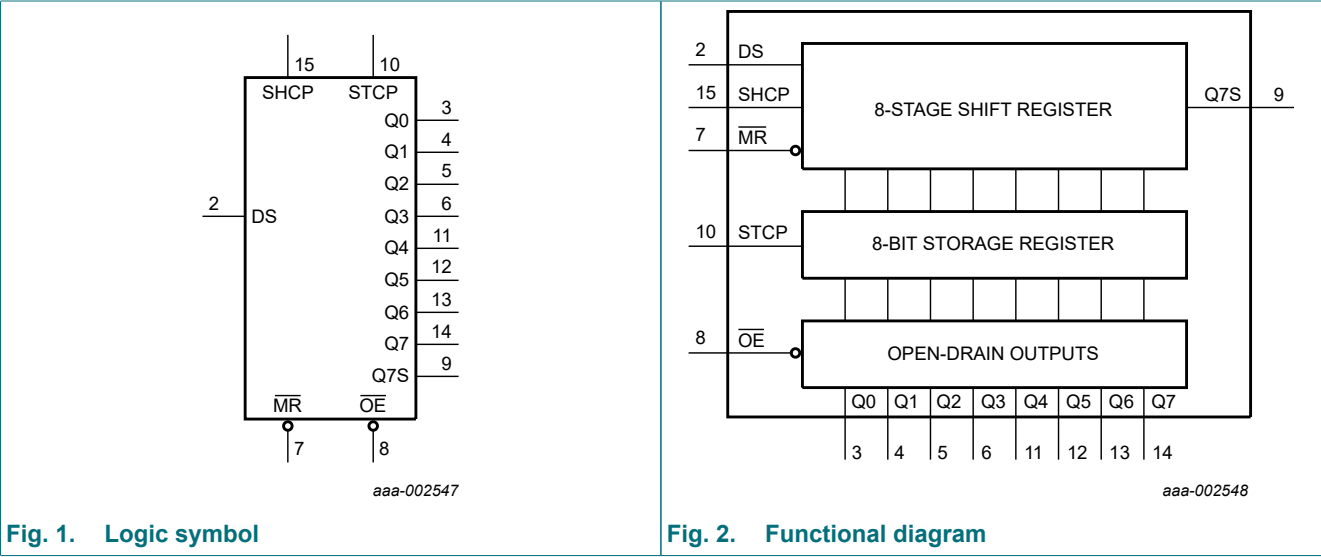


Fig. 1. Logic symbol

Fig. 2. Functional diagram

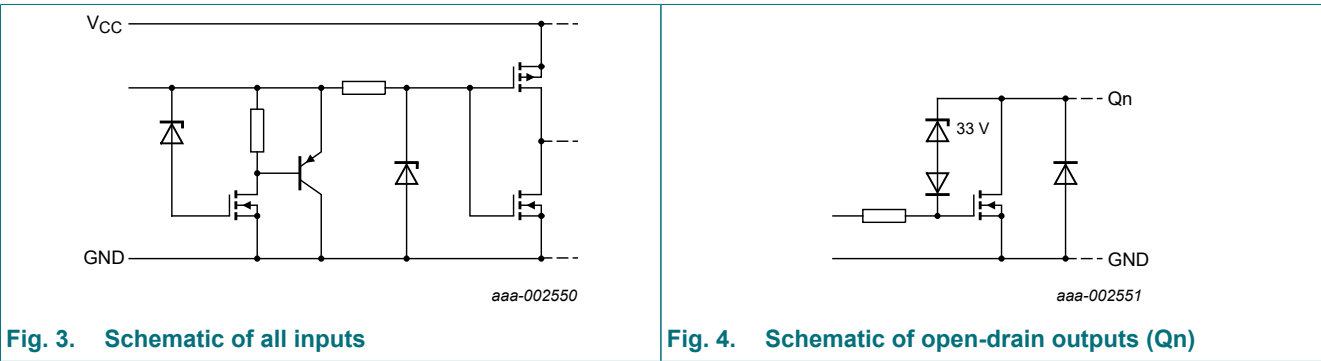


Fig. 3. Schematic of all inputs

Fig. 4. Schematic of open-drain outputs (Qn)

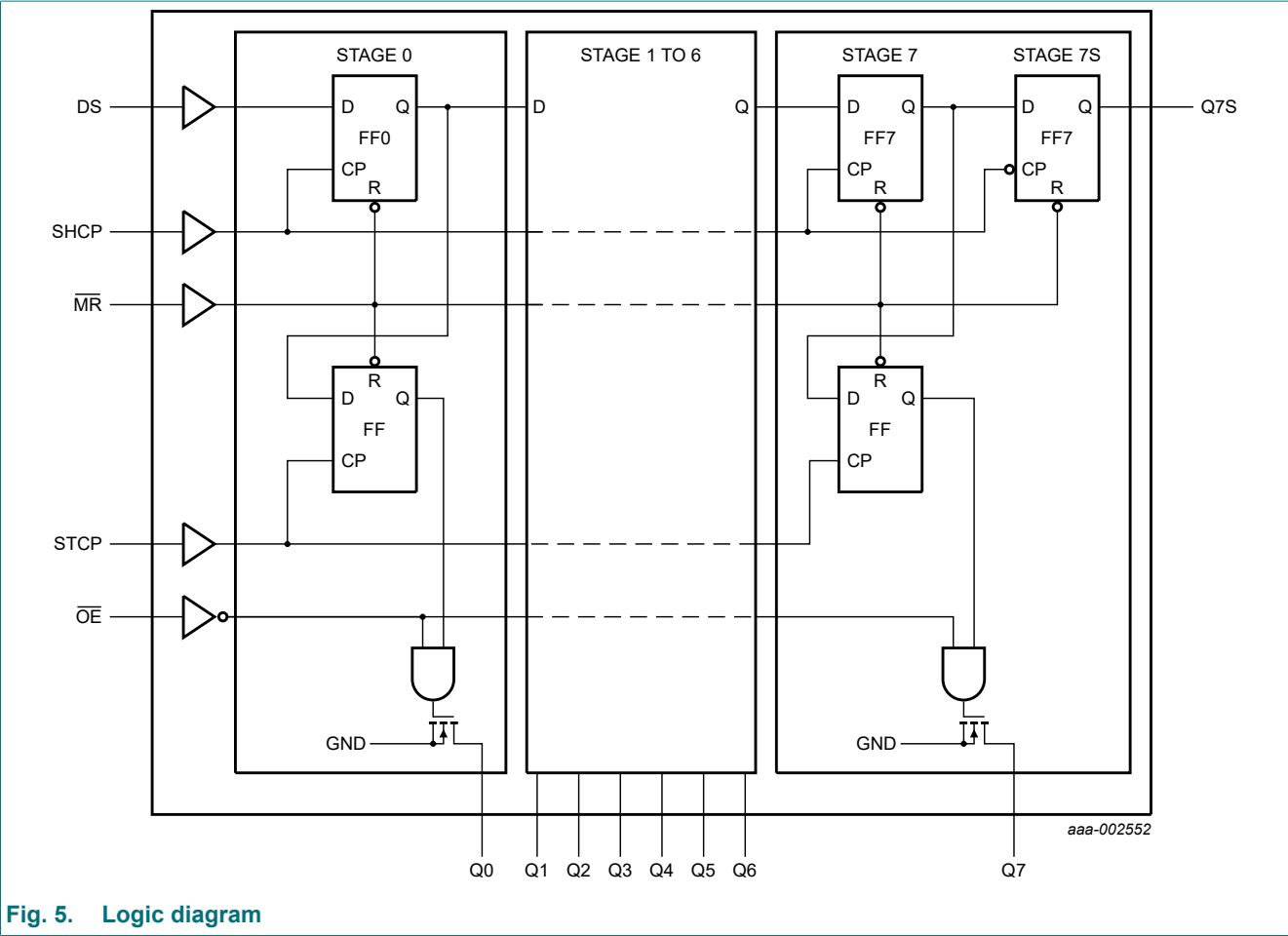


Fig. 5. Logic diagram

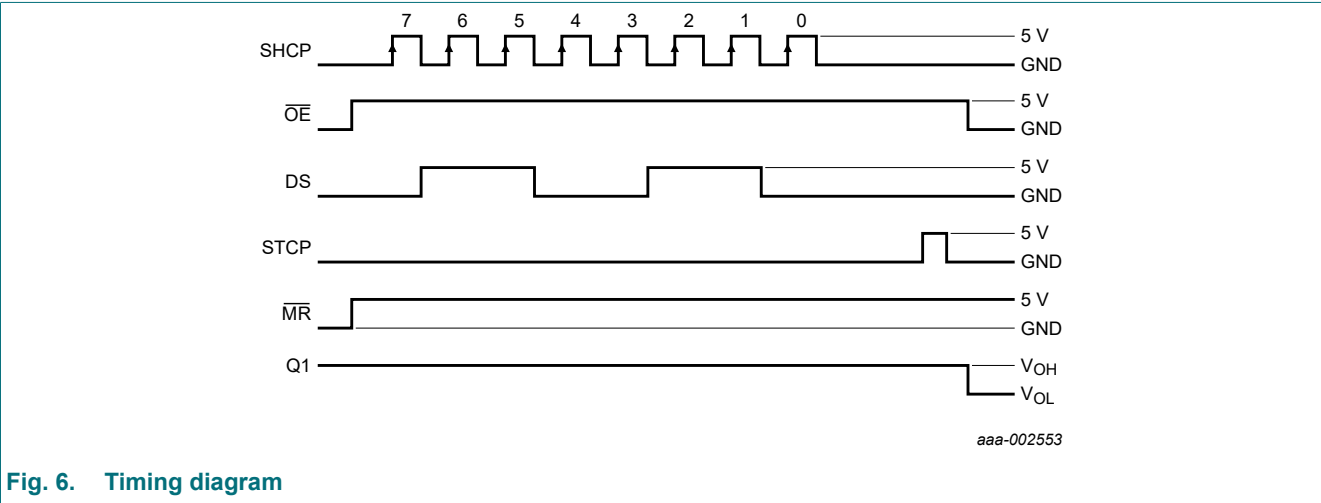


Fig. 6. Timing diagram

6. Pinning information

6.1. Pinning

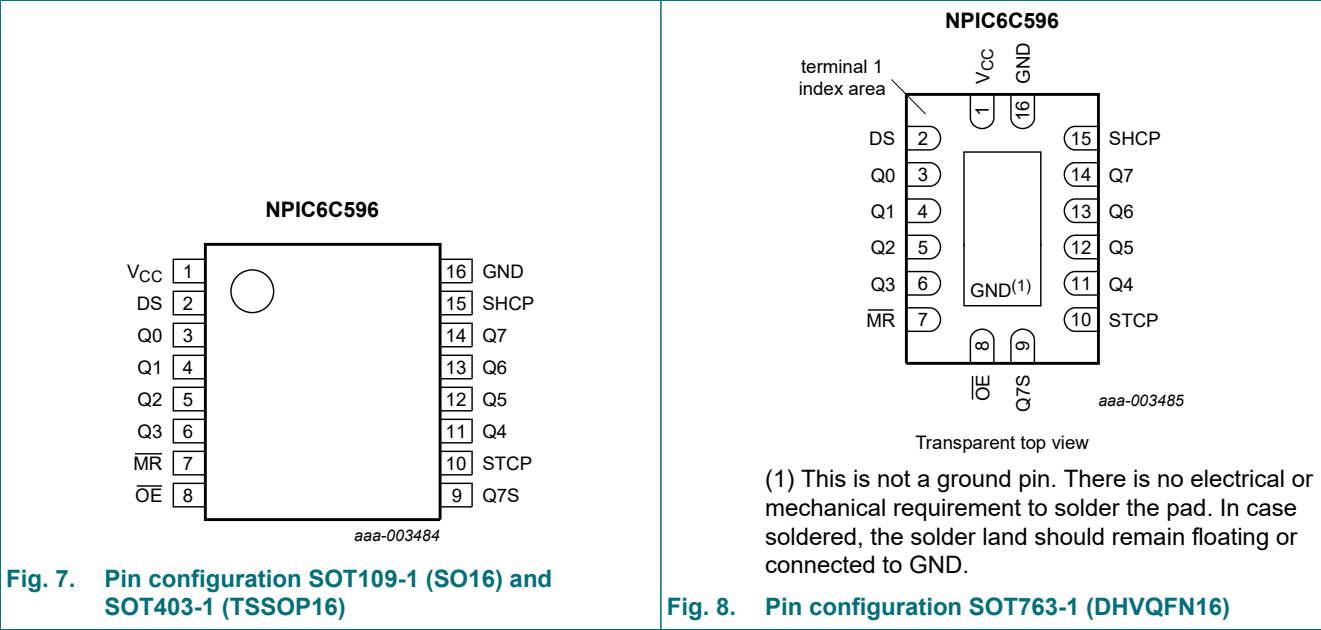


Fig. 7. Pin configuration SOT109-1 (SO16) and SOT403-1 (TSSOP16)

Fig. 8. Pin configuration SOT763-1 (DHVQFN16)

6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
V _{CC}	1	supply voltage
DS	2	serial data input
Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7	3, 4, 5, 6, 11, 12, 13, 14	parallel data output (open-drain)
MR	7	master reset (active LOW)
OE	8	output enable input (active LOW)
Q7S	9	serial data output
STCP	10	storage register clock input
SHCP	15	shift register clock input
GND	16	ground (0 V)

7. Limiting values

Table 3. 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	+7.0	V
V_I	input voltage		-0.3	+7.0	V
V_{DS}	drain-source voltage	power EDNMOS drain-source voltage [1]	-	+33	V
$I_{d(SD)}$	source-drain diode current	continuous	-	250	mA
		pulsed [2]	-	500	mA
I_D	drain current	$T_{amb} = 25\text{ }^{\circ}\text{C}$			
		continuous; each output; all outputs on	-	100	mA
		pulsed; each output; all outputs on [2]	-	250	mA
I_{DM}	peak drain current	single output; $T_{amb} = 25\text{ }^{\circ}\text{C}$ [2]	-	250	mA
E_{AS}	avalanche energy	single pulse; see Fig. 9 [3]	-	30	mJ
I_{AL}	avalanche current	see Fig. 9 [3]	-	200	mA
T_{stg}	storage temperature		-65	+150	$^{\circ}\text{C}$
P_{tot}	total power dissipation	$T_{amb} = 25\text{ }^{\circ}\text{C}$ [4]			
		SOT109-1 (SO16)	-	800	mW
		SOT403-1 (TSSOP16)	-	725	mW
		SOT763-1 (DHVQFN16)	-	1825	mW
		$T_{amb} = 125\text{ }^{\circ}\text{C}$ [4]			
		SOT109-1 (SO16)	-	160	mW
		SOT403-1 (TSSOP16)	-	145	mW
		SOT763-1 (DHVQFN16)	-	365	mW

[1] Each power EDNMOS source is internally connected to GND.

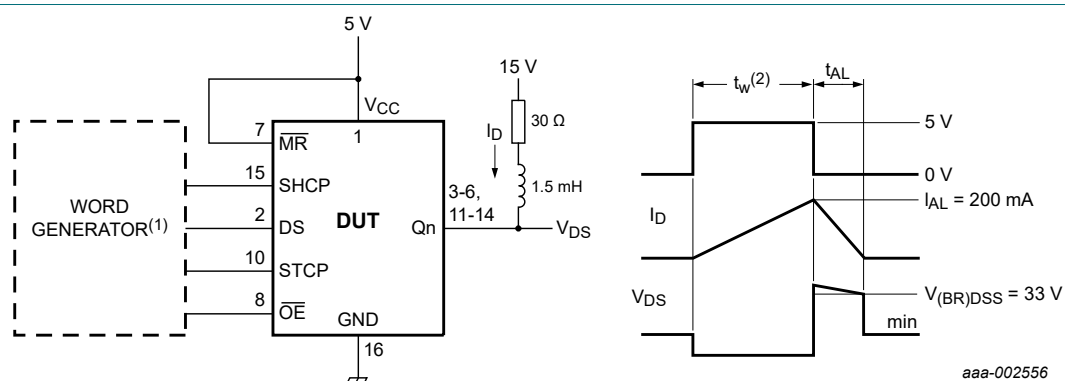
[2] Pulse duration $\leq 100\text{ }\mu\text{s}$ and duty cycle $\leq 2\%$.

[3] $V_{DS} = 15\text{ V}$; starting junction temperature (T_J) = $25\text{ }^{\circ}\text{C}$; $L = 1.5\text{ H}$; avalanche current (I_{AL}) = 200 mA .

[4] For SO16 packages: above $25\text{ }^{\circ}\text{C}$ the value of P_{tot} derates linearly with $6.4\text{ mW}/^{\circ}\text{C}$.

For TSSOP16 packages: above $25\text{ }^{\circ}\text{C}$ the value of P_{tot} derates linearly with $5.8\text{ mW}/^{\circ}\text{C}$.

For DHVQFN16 packages: above $25\text{ }^{\circ}\text{C}$ the value of P_{tot} derates linearly with $14.6\text{ mW}/^{\circ}\text{C}$.



(1) The word generator has the following characteristics: $t_r, t_f \leq 10\text{ ns}$; $Z_O = 50\text{ }\Omega$.

(2) The input pulse duration (t_W) is increased until peak current $I_{AL} = 200\text{ mA}$. Energy test level is defined as:

$$E_{AS} = I_{AL} \times V_{(BR)DSS} \times t_{AL}/2 = 30\text{ mJ}.$$

Fig. 9. Test circuit and waveform for measuring single-pulse avalanche energy

8. Recommended operating conditions

Table 4. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		4.5	-	5.5	V
V_I	input voltage		0	-	5.5	V
I_D	drain current	pulsed drain output current; $V_{CC} = 5\text{ V}$; [1] [2] $T_{amb} = 25\text{ °C}$; all outputs on	-	-	250	mA
T_{amb}	ambient temperature		-40	-	+125	°C

[1] Pulse duration $\leq 100\text{ }\mu\text{s}$ and duty cycle $\leq 2\%$.

[2] Technique should limit $T_J - T_{amb}$ to 10 °C maximum.

9. Static characteristics

Table 5. Static characteristics

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

Symbol	Parameter	Conditions	$V_{CC} = 5.0\text{ V}$; $T_{amb} = 25\text{ °C}$			Unit
			Min	Typ	Max	
V_{IH}	HIGH-level input voltage	$V_{CC} = 4.5\text{ V}$ to 5.5 V	$0.85V_{CC}$	-	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 4.5\text{ V}$ to 5.5 V	-	-	$0.15V_{CC}$	V
V_{OH}	HIGH-level output voltage	serial data output Q7S; $V_I = V_{IH}$ or V_{IL}				
		$I_O = -20\text{ }\mu\text{A}$; $V_{CC} = 4.5\text{ V}$	4.4	4.49	-	V
		$I_O = -4\text{ mA}$; $V_{CC} = 4.5\text{ V}$	4.0	4.2	-	V
V_{OL}	LOW-level output voltage	serial data output Q7S; $V_I = V_{IH}$ or V_{IL}				
		$I_O = 20\text{ }\mu\text{A}$; $V_{CC} = 4.5\text{ V}$	-	0.005	0.1	V
		$I_O = 4\text{ mA}$; $V_{CC} = 4.5\text{ V}$	-	0.3	0.5	V
I_{IH}	HIGH-level input current	$V_{CC} = 5.5\text{ V}$; $V_I = V_{CC}$	-	-	1	μA
I_{IL}	LOW-level input current	$V_{CC} = 5.5\text{ V}$; $V_I = 0\text{ V}$	-1	-	-	μA
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 1\text{ mA}$	33	37	-	V
V_{SD}	source-drain voltage	diode forward voltage; $I_F = 100\text{ mA}$	-	0.85	1.2	V
I_{CC}	supply current	logic supply current; $V_{CC} = 5.5\text{ V}$; $V_I = V_{CC}$ or GND				
		all outputs off	-	0.004	200	μA
		all outputs on [1]	-	0.006	500	μA
		all outputs off; SHCP = 5 MHz; $C_L = 30\text{ pF}$; see Fig. 14 and Fig. 16	-	0.75	5	mA
$I_{O(nom)}$	nominal output current	$V_{DS} = 0.5\text{ V}$; $T_{amb} = 85\text{ °C}$; $I_{out} = I_D$ [2] [3] [4]	-	140	-	mA
I_{DSX}	drain cut-off current	$V_{CC} = 5.5\text{ V}$; $V_{DS} = 30\text{ V}$	-	0.002	0.2	μA
		$V_{CC} = 5.5\text{ V}$; $V_{DS} = 30\text{ V}$; $T_{amb} = 125\text{ °C}$	-	0.15	0.3	μA

Symbol	Parameter	Conditions	V _{CC} = 5.0 V; T _{amb} = 25 °C			Unit
			Min	Typ	Max	
R _{DSon}	drain-source on-state resistance	see Fig. 17 and Fig. 18 [2] [3]				
		V _{CC} = 4.5 V; I _D = 50 mA	-	3.0	9	Ω
		V _{CC} = 4.5 V; I _D = 50 mA; T _{amb} = 125 °C		5.4	12	Ω
		V _{CC} = 4.5 V; I _D = 100 mA	-	3.1	10	Ω

[1] Output currents below 250 mA current limit.

[2] Technique should limit T_j - T_{amb} to 10 °C maximum.

[3] These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

[4] Nominal output current is defined for a consistent comparison between devices from different sources. It is the current that produces a voltage drop of 0.5 V at T_{amb} = 85 °C.

10. Dynamic characteristics

Table 6. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); For test circuit see Fig. 14.

Symbol	Parameter	Conditions	V _{CC} = 5.0 V; T _{amb} = 25 °C			Unit
			Min	Typ	Max	
t _{PLH}	LOW to HIGH propagation delay	OE to Qn; I _D = 75 mA; see Fig. 10 and Fig. 19	-	97	-	ns
t _{PHL}	HIGH to LOW propagation delay	OE to Qn; I _D = 75 mA; see Fig. 10 and Fig. 19	-	9	-	ns
t _r	rise time	OE to Qn; I _D = 75 mA; see Fig. 10 and Fig. 19	-	60	-	ns
t _f	fall time	OE to Qn; I _D = 75 mA; see Fig. 10 and Fig. 19	-	18	-	ns
t _{pd}	propagation delay	SHCP to Q7S; I _D = 75 mA; see Fig. 11 [1]	-	5	-	ns
f _{max}	maximum frequency	SHCP; I _D = 75 mA; see Fig. 11 [2]	-	-	10	MHz
t _{rr}	reverse recovery time	I _F = 100 mA; dI/dt = 10 A/μs; see Fig. 13 [3] [4]	-	120	-	ns
t _a	reverse recovery current rise time	I _F = 100 mA; dI/dt = 10 A/μs; see Fig. 13 [3] [4]	-	100	-	ns
t _{su}	set-up time	DS to SHCP; see Fig. 12	15	-	-	ns
t _h	hold time	DS to SHCP; see Fig. 12	15	-	-	ns
t _W	pulse width		40	-	-	ns

[1] t_{pd} is the same as t_{PLH} and t_{PHL}.

[2] This is the maximum serial clock frequency assuming cascaded operation where serial data is passed from one stage to a second stage. The clock period allows for SHCP → Q7S propagation delay and setup time plus some timing margin.

[3] Technique should limit T_j - T_{amb} to 10 °C maximum.

[4] These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

10.1. Test circuits and waveforms

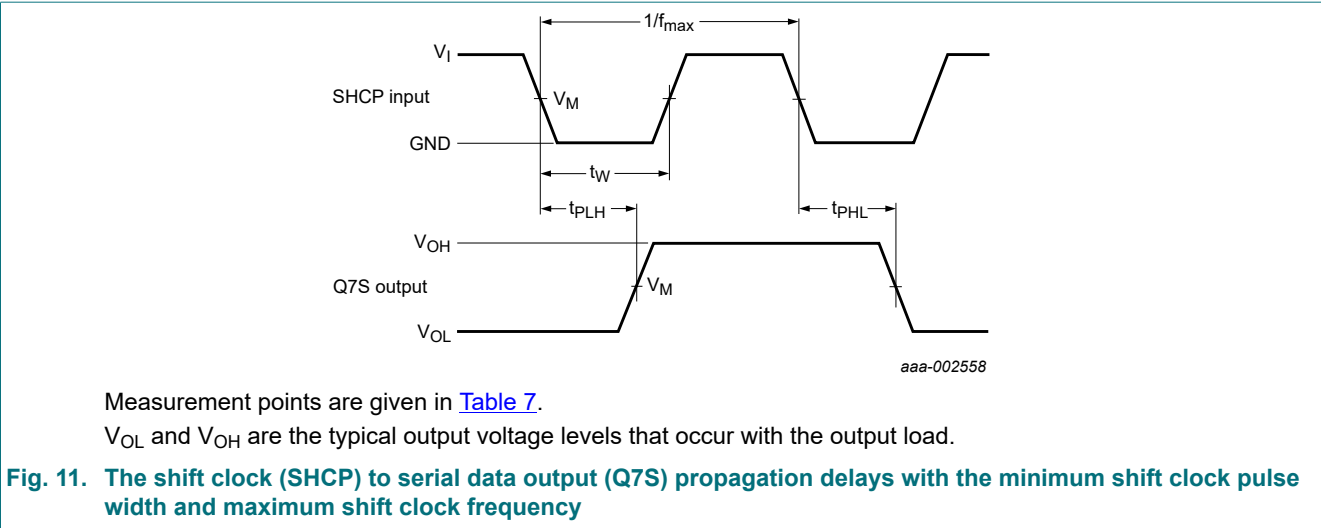
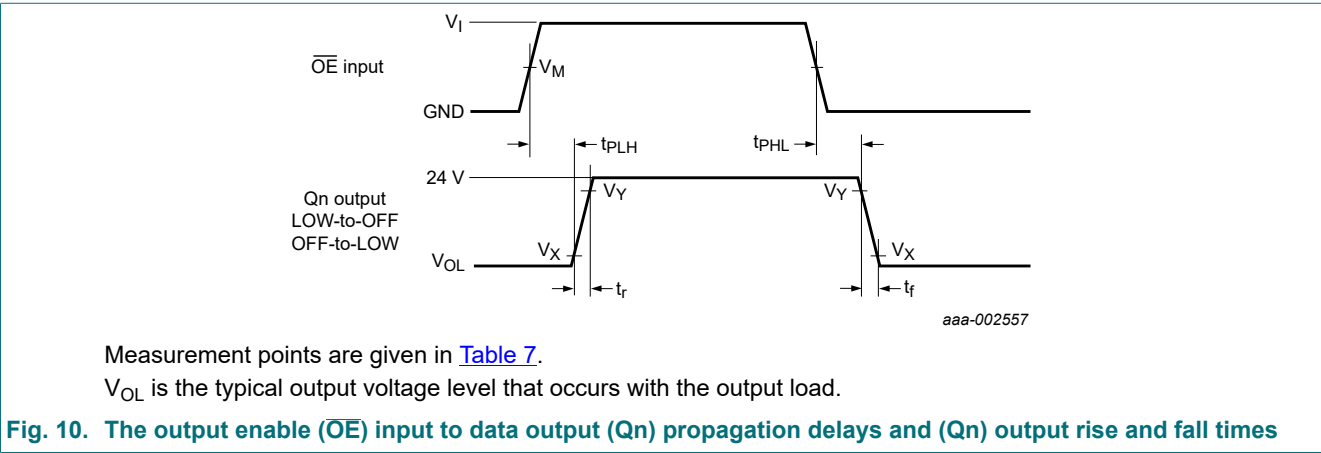
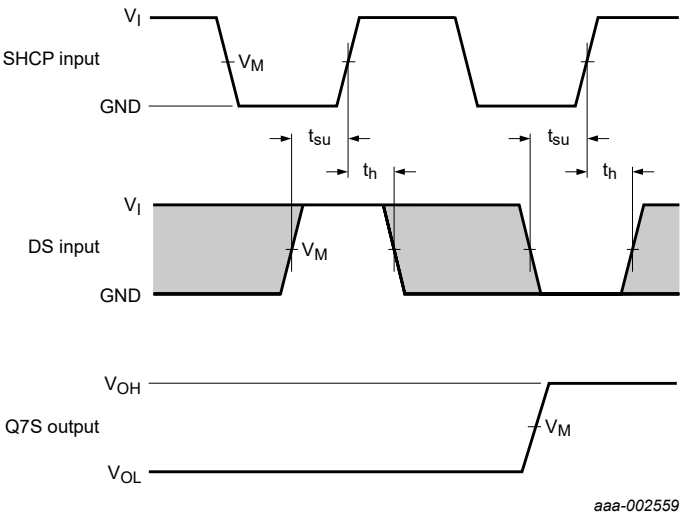


Table 7. Measurement points

Supply voltage	Input	Output		
V_{CC}	V_M	V_M	V_X	V_Y
5 V	$0.5V_{CC}$	$0.5V_{DS}$	$0.1V_{DS}$	$0.9V_{DS}$

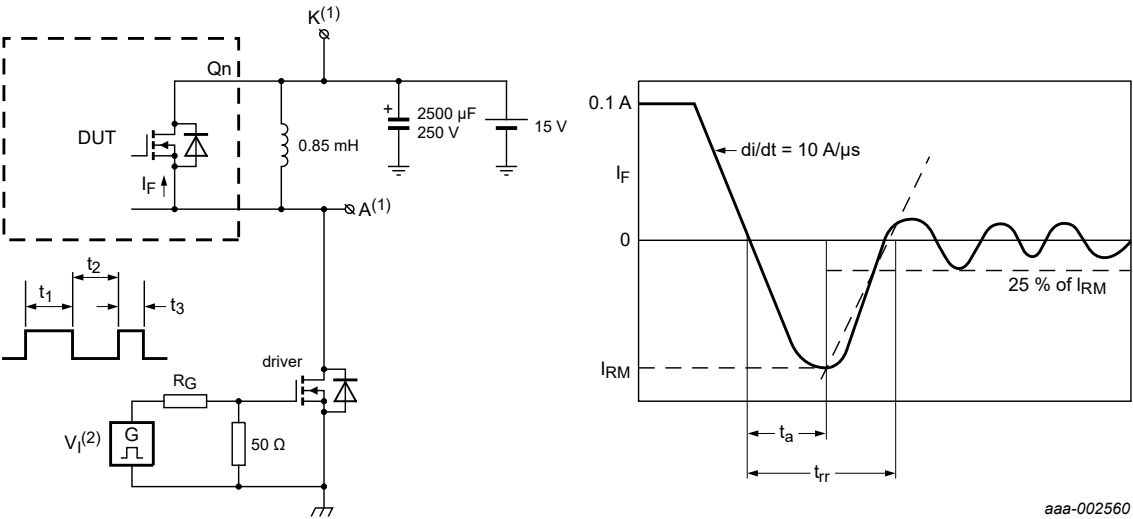


Measurement points are given in [Table 8](#).
The shaded areas indicate when the input is permitted to change for predictable output performance.
 V_{OL} and V_{OH} are the typical output voltage levels that occur with the output load.

Fig. 12. The data set-up and hold times for the serial data input (DS)

Table 8. Measurement points

Supply voltage	Input	Output
V_{CC}	V_M	V_M
5 V	$0.5V_{CC}$	$0.5V_{CC}$



(1) The open-drain Qn terminal under test is connected to test point K. All other terminals are connected together and connected to test point A.
(2) The V_I amplitude and R_G are adjusted for $di/dt = 10 \text{ A}/\mu\text{s}$. A V_I double-pulse train is used to set $I_F = 0.1 \text{ A}$, where $t_1 = 10 \mu\text{s}$, $t_2 = 7 \mu\text{s}$ and $t_3 = 3 \mu\text{s}$.

Fig. 13. Test circuit and waveform for measuring reverse recovery current

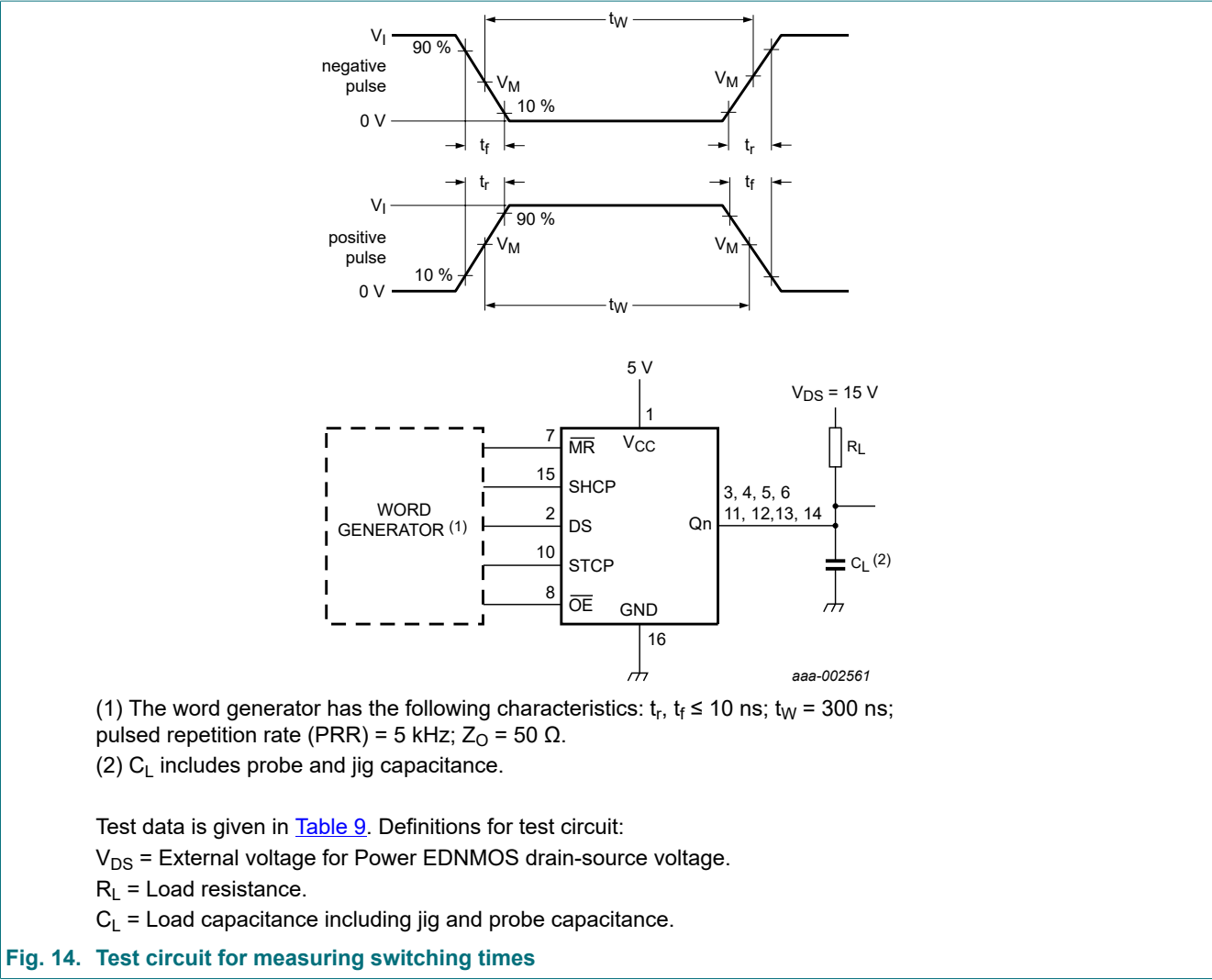


Fig. 14. Test circuit for measuring switching times

Table 9. Test data

Supply voltage	Input			Load	
	V_I	t_r, t_f	V_M	C_L	R_L
5 V	5 V	≤ 10 ns	50 %	30 pF	200 Ω

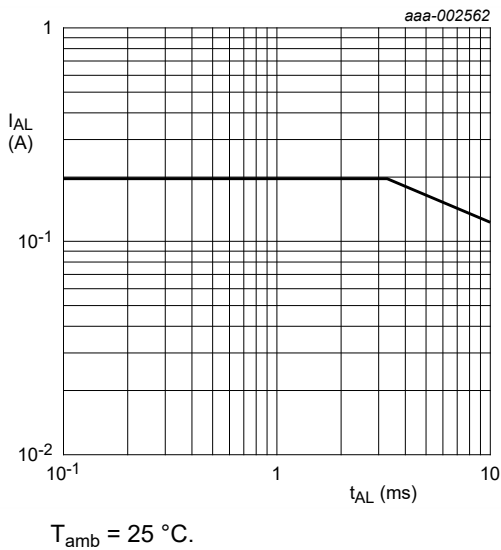


Fig. 15. Avalanche current (peak) versus time duration of avalanche

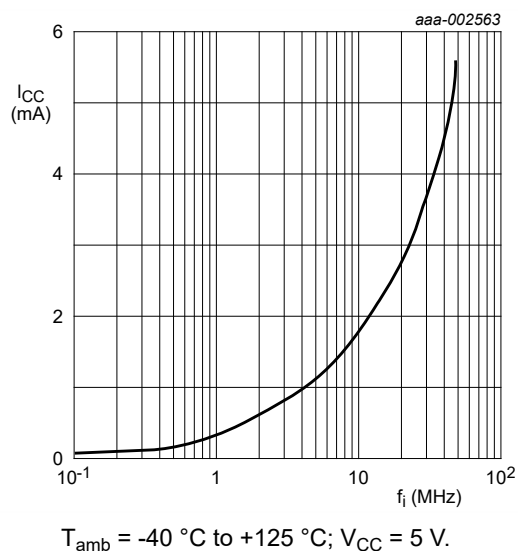


Fig. 16. Supply current versus frequency

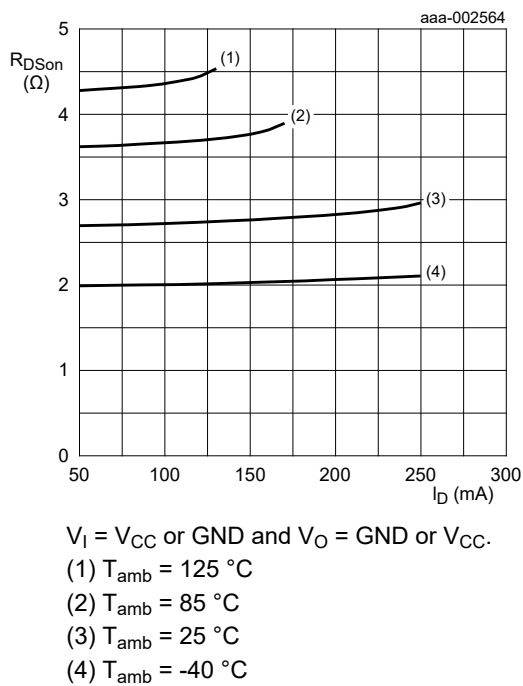


Fig. 17. Drain-source on-state resistance versus drain current

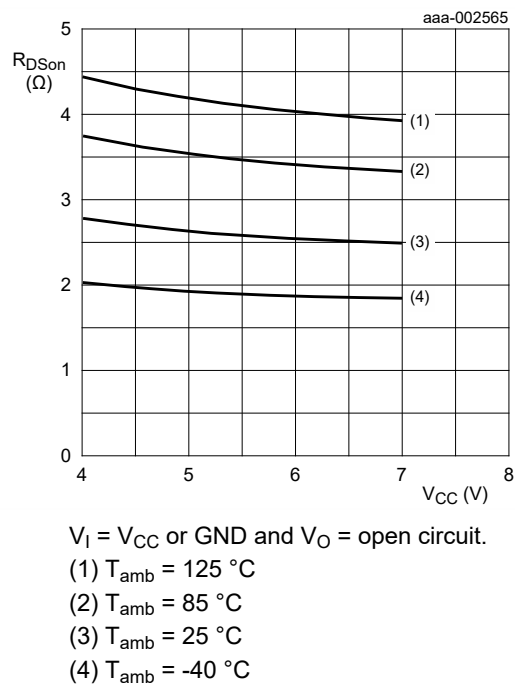
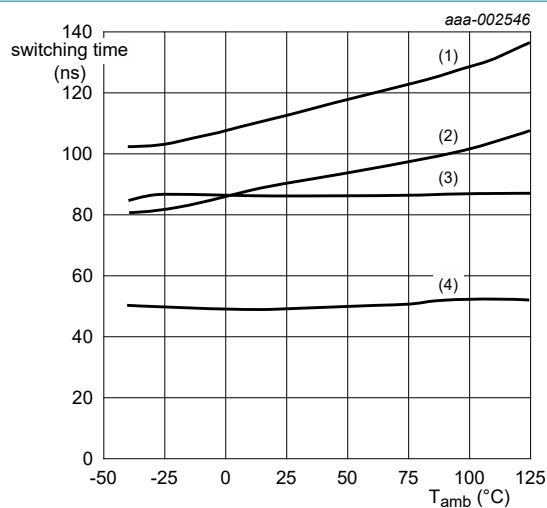


Fig. 18. Static drain-source on-state resistance versus supply voltage



Technique limit $T_J - T_C$ to 10 °C maximum.

(1) t_{PLH} .

(2) t_r .

(3) t_f .

(4) t_{PHL} .

Fig. 19. Switching time versus case temperature

11. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

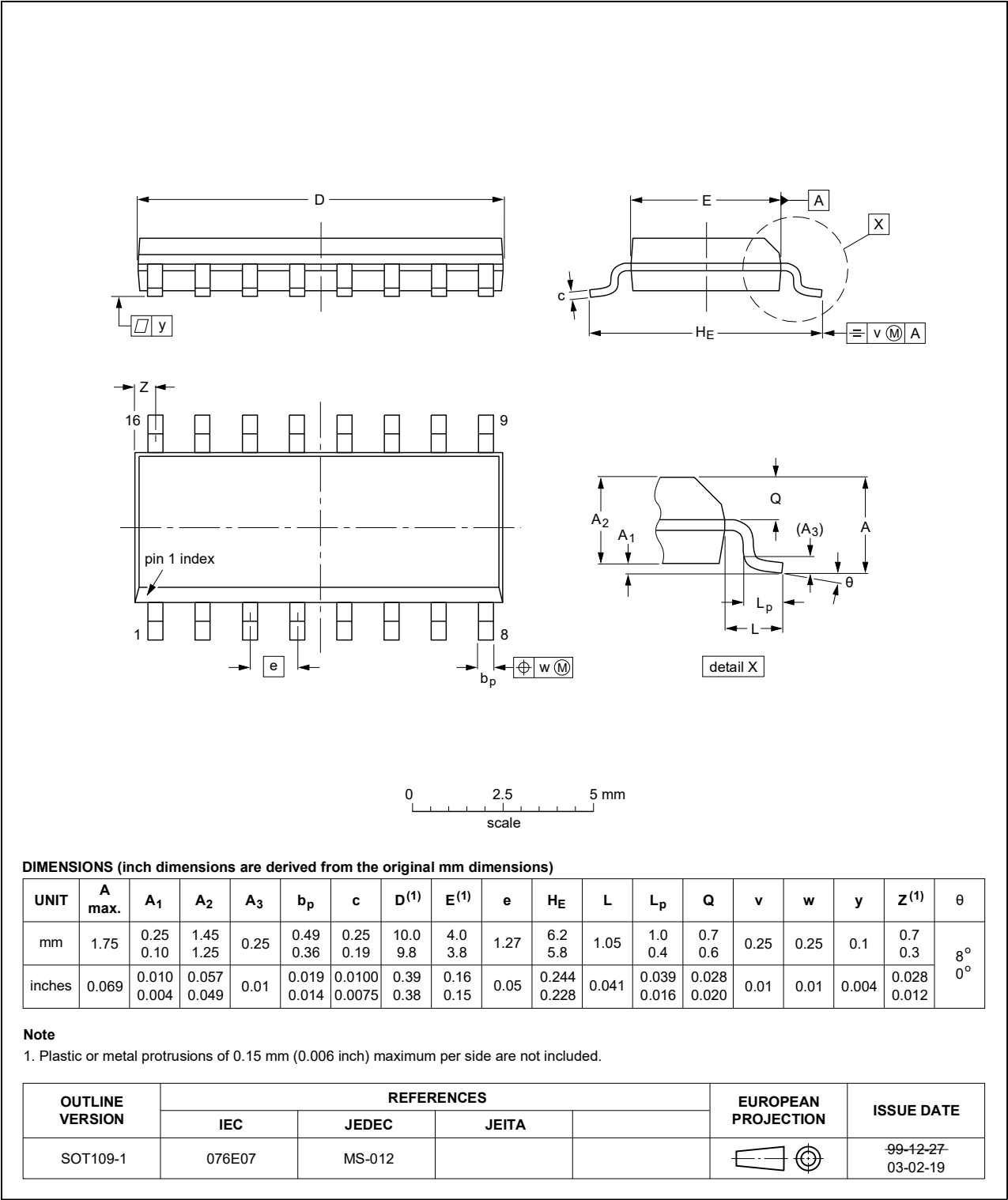


Fig. 20. Package outline SOT109-1 (SO16)

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

SOT403-1

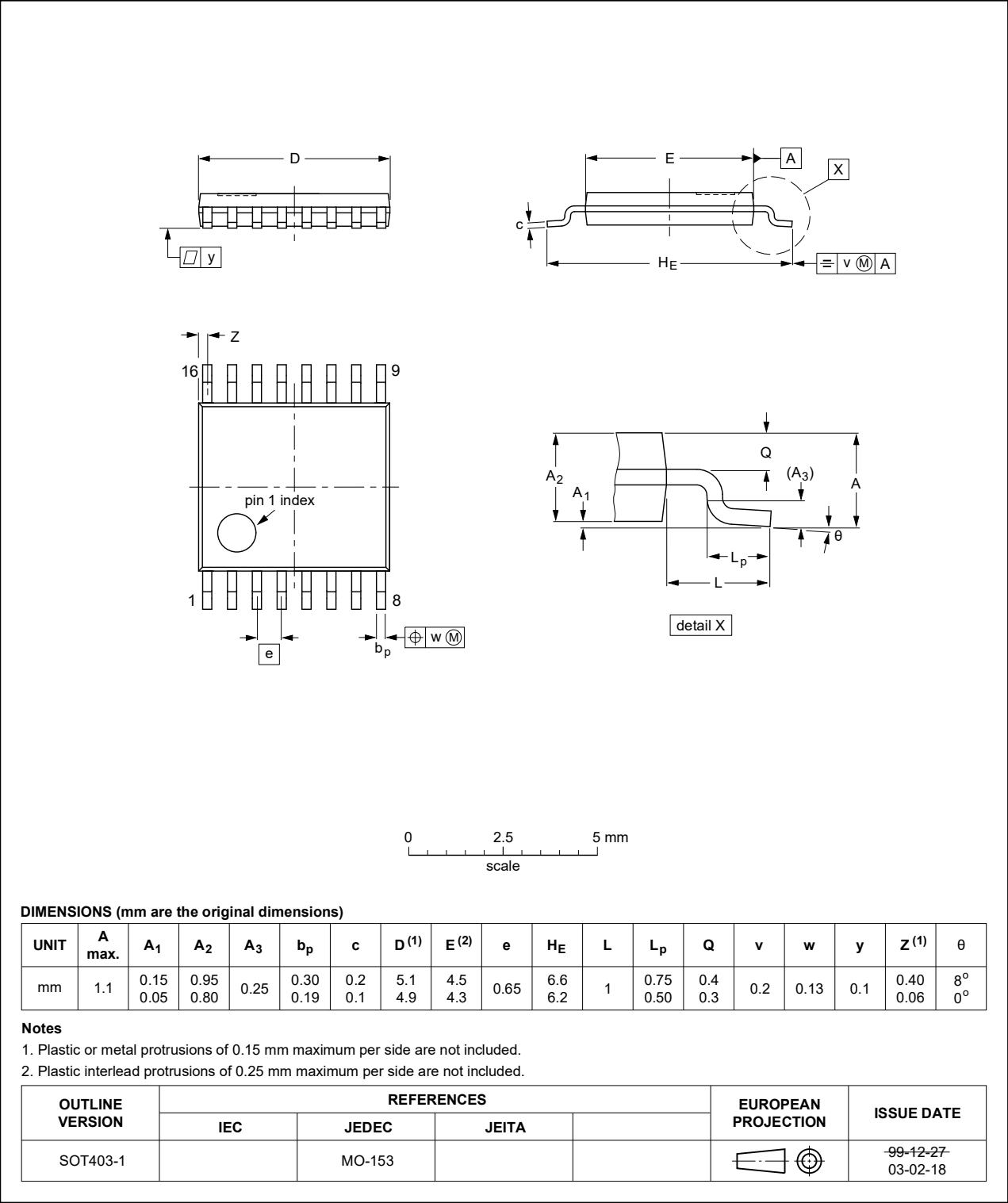


Fig. 21. Package outline SOT403-1 (TSSOP16)

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

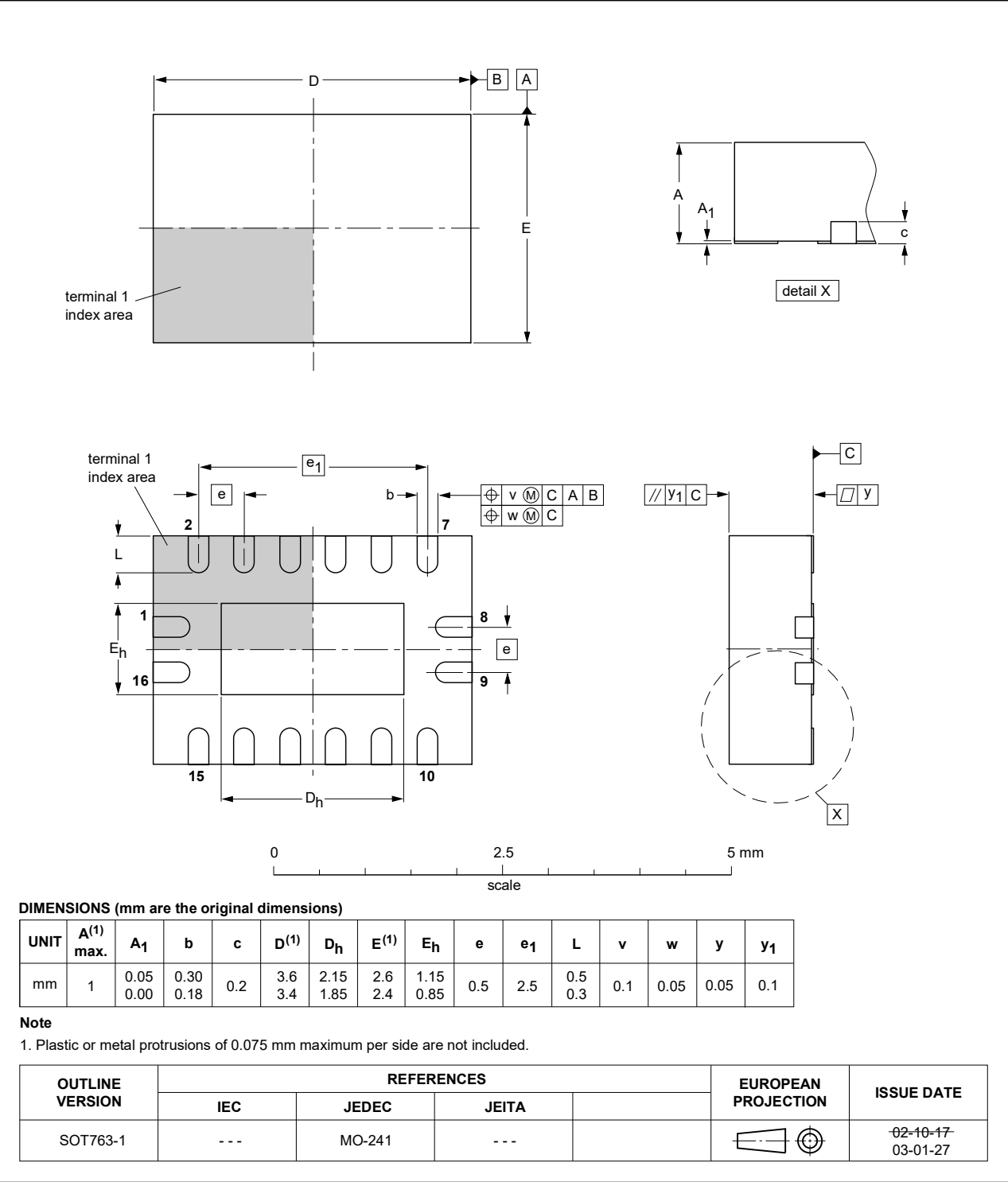


Fig. 22. Package outline SOT763-1 (DHVQFN16)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
DUT	Device Under Test
EDNMOS	Extended Drain Negative Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model

13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NPIC6C596 v.3	20200622	Product data sheet	-	NPIC6C596 v.2
Modifications:	- The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. - Legal texts have been adapted to the new company name where appropriate.			
NPIC6C596 v.2	20130704	Product data sheet	-	NPIC6C596 v.1
Modifications:	Fig. 5 corrected (errata).			
NPIC6C596 v.1	20120821	Product data sheet	-	-

14. 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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Contents

1. General description.....	1
2. Features and benefits.....	1
3. Applications.....	1
4. Ordering information.....	2
5. Functional diagram.....	2
6. Pinning information.....	4
6.1. Pinning.....	4
6.2. Pin description.....	4
7. Limiting values.....	5
8. Recommended operating conditions.....	6
9. Static characteristics.....	6
10. Dynamic characteristics.....	7
10.1. Test circuits and waveforms.....	8
11. Package outline.....	13
12. Abbreviations.....	16
13. Revision history.....	16
14. Legal information.....	17

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