NPIC6C4894

Power logic 12-bit shift register; open-drain outputs

Rev. 1 — 17 April 2014 Product data sheet

1. General description

The NPIC6C4894 is a 12-stage serial shift register. It has a storage latch associated with each stage for strobing data from the serial input (D) to the parallel open-drain outputs (QP0 to QP11). Data is shifted on positive-going clock (CP) transitions. The data in each shift register stage is transferred to the storage register when the latch enable (LE) input is HIGH. Data in the storage register drives the gate of the output extended-drain NMOS transistor whenever the output enable input (OE) is HIGH. A LOW on OE causes the outputs to assume a high-impedance OFF-state. Operation of the OE input does not affect the state of the registers. Two serial outputs (QS1 and QS2) are available for cascading a number of NIC6C4894 devices. Serial data is available at QS1 on positive-going clock edges to allow high-speed operation in cascaded systems with a fast clock rise time. The same serial data is available at QS2 on the next negative going clock edge. It is used for cascading NPIC6C4894 devices when the clock has a slow rise time. 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. This protection makes 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}
- 12 Power EDNMOS transistor outputs of 100 mA continuous current
- 250 mA current limit capability
- Output clamping voltage 33 V
- 30 mJ avalanche energy capability
- Low power consumption
- Latch-up performance exceeds 100 mA per JESD 78 Class II level A
- ESD protection:
  - HBM JS-2011 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
NPIC6C4894D	−40 °C to +125 °C	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
NPIC6C4894PW	−40 °C to +125 °C	TSSOP20	plastic thin shrink small outline package; 20 leads; body width 4.4 mm	SOT360-1

5. Functional diagram

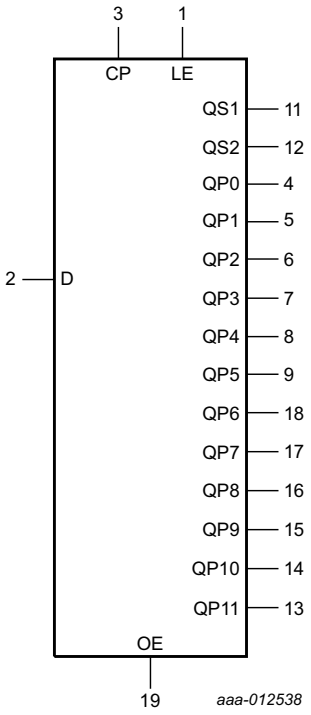


Fig 1. Logic symbol

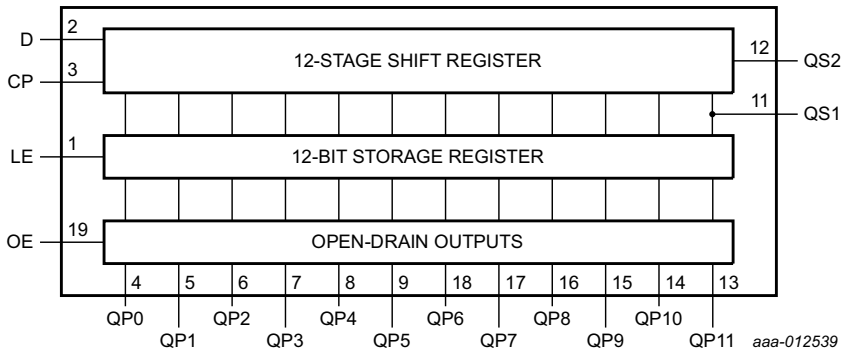


Fig 2. Functional diagram

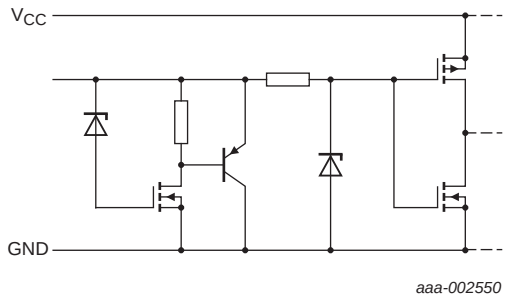


Fig 3. Schematic of all inputs

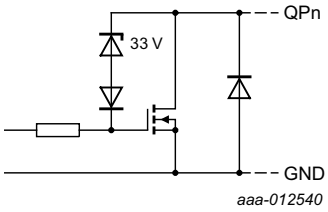


Fig 4. Schematic of open-drain outputs (QPn)

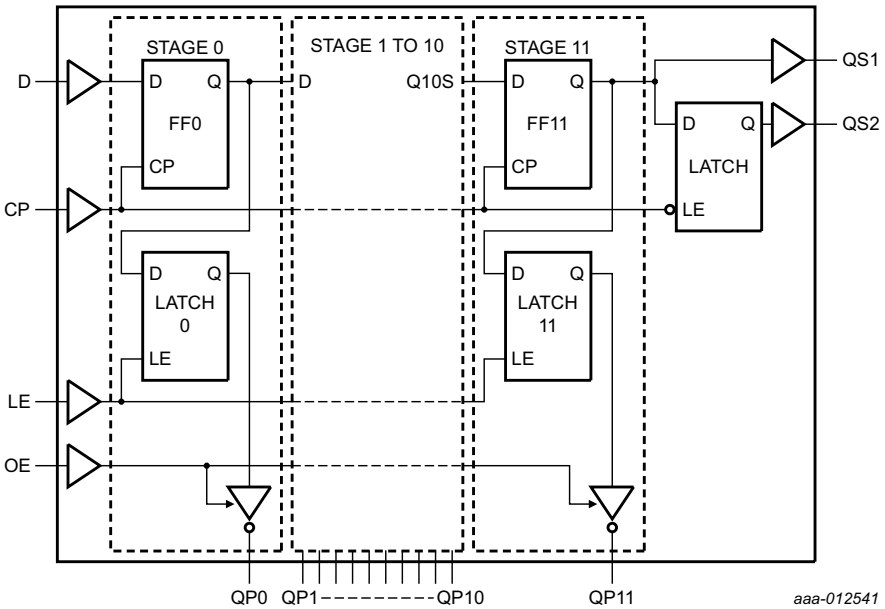


Fig 5. Logic diagram

6. Pinning information

6.1 Pinning

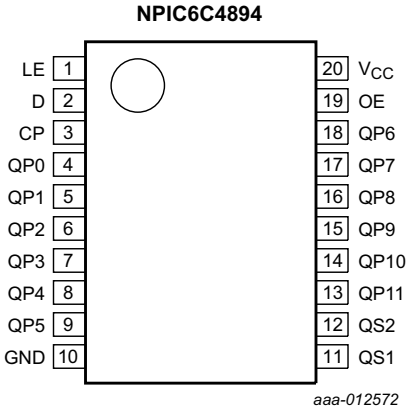


Fig 6. Pin configuration SO20 and TSSOP20

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
LE	1	latch enable input
D	2	serial data input
CP	3	clock input
QP0 to QP11	4, 5, 6, 7, 8, 9, 18, 17, 16, 15, 14, 13	parallel output
GND	10	ground (0 V)
QS1	11	serial output
QS2	12	serial output
OE	19	output enable input
V_{CC}	20	supply voltage

7. Functional description

Table 3. Function table[1]

At the positive clock edge, the information in the 10th register stage is transferred to the 11th register stage and the QS output

Control			Input	Parallel output		Serial output	
CP	**OE**	**LE**	**D**	**QP0**	**QPn**	**QS1[2]**	**QS2[3]**
↑	L	X	X	Z	Z	Q10S	no change
↓	L	X	X	Z	Z	no change	Q11S
↑	H	L	X	no change	no change	Q10S	no change
↑	H	H	L	Z	QPn–1	Q10S	no change
↑	H	H	H	L	QPn–1	Q10S	no change
↓	H	H	H	no change	no change	no change	Q11S

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = LOW-to-HIGH clock transition; ↓ = HIGH-to-LOW clock transition; Z = high-impedance OFF-state.

[2] Q10S = the data in register stage 10 before the LOW to HIGH clock transition.

[3] Q11S = the data in register stage 11 before the HIGH to LOW clock transition.

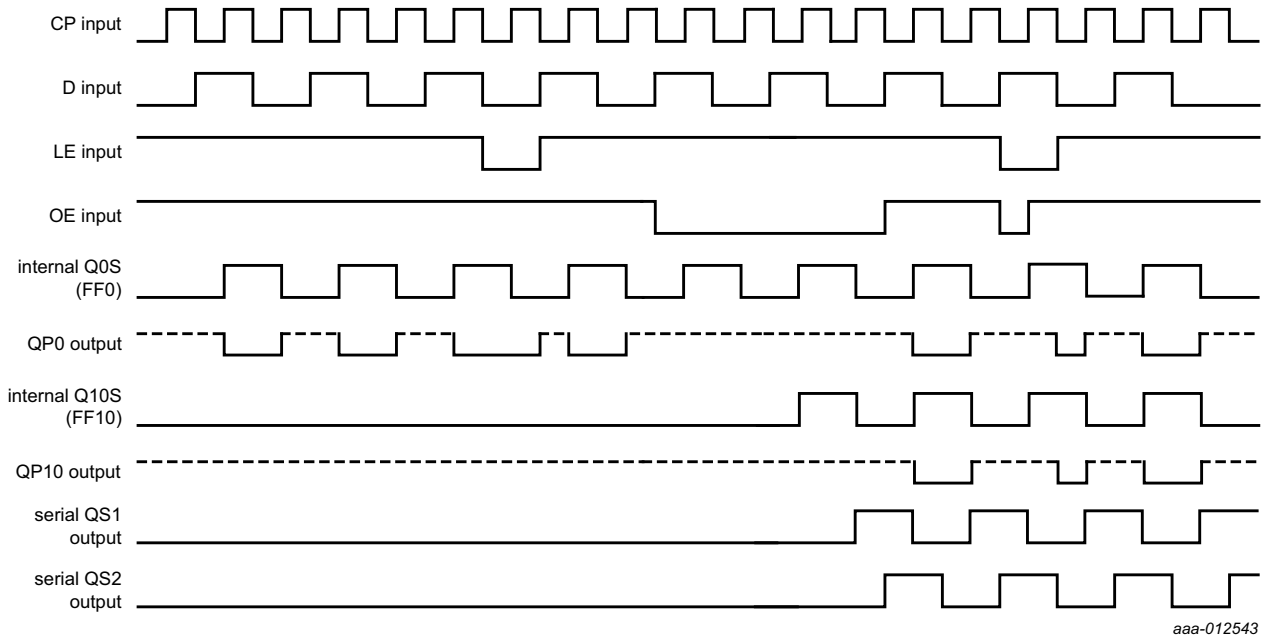


Fig 7. Timing diagram

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	+7.0	V
V_I	input voltage		−0.3	+7.0	V
V_{DS}	drain-source voltage	QPn [1]	-	+33	V
V_O	output voltage	QSn	−0.5	+7.0	V
I_{IK}	input clamping current	$V_I < 0.5$ V or $V_I > V_{CC} + 0.5$ V	-	±50	mA
I_{OK}	output clamping current	QSn; $V_O < 0.5$ V or $V_O > V_{CC} + 0.5$ V	-	±100	mA
$I_{d(SD)}$	source-drain diode current	continuous	-	250	mA
		pulsed [2]	-	500	mA
I_D	drain current	T_{amb} = 25 °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 °C [2]	-	250	mA
E_{AS}	non-repetitive avalanche energy	single pulse; see Figure 8 and Figure 16 [3]	-	30	mJ
I_{AL}	avalanche current	see Figure 8 and Figure 16 [3]	-	200	mA
T_{stg}	storage temperature		−65	+150	°C
P_{tot}	total power dissipation	T_{amb} = 25 °C [4]			
		SO20	-	1500	mW
		TSSOP20	-	1250	mW
		T_{amb} = 125 °C [4]			
		SO20	-	300	mW
		TSSOP20	-	250	mW

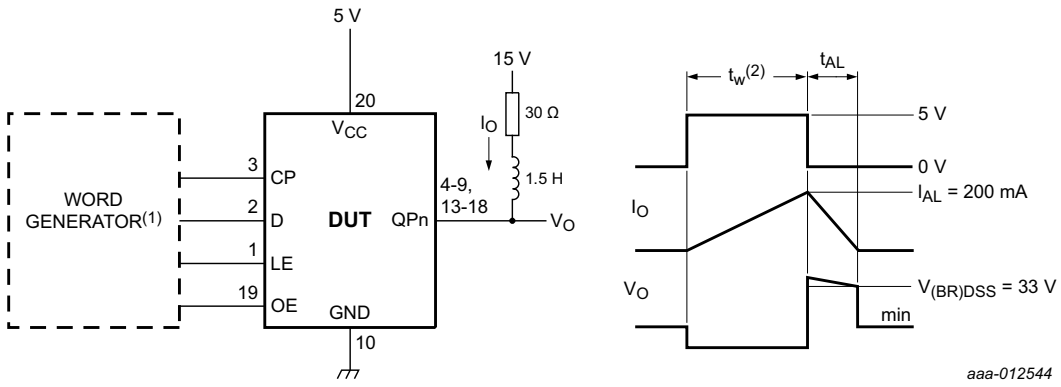
[1] Each power EDNMOS source is internally connected to GND.

[2] Pulse duration ≤ 100 μs and duty cycle ≤ 2 %.

[3] V_{DS} = 15 V; starting junction temperature (T_j) = 25 °C; L = 1.5 H; avalanche current (I_{AL}) = 200 mA.

[4] For SO20 package: above 25 °C the value of P_{tot} derates linearly with 12 mW/°C.
For TSSOP20 package: above 25 °C the value of P_{tot} derates linearly with 10 mW/°C.

8.1 Test circuit and waveform



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

(2) The input pulse duration (t_W) is increased until peak current $I_{AL} = 200$ mA. Energy test level is defined as: $E_{AS} = I_{AL} \times V_{(BR)DSS} \times t_{AL}/2 = 30$ mJ.

Fig 8. Test circuit and waveform for measuring single-pulse avalanche energy

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		4.5	5.0	5.5	V
V_I	input voltage		0	-	5.5	V
I_D	drain current	pulsed drain output current; [1][2] $V_{CC} = 5$ V; $T_{amb} = 25$ °C; all outputs on	-	-	250	mA
T_{amb}	ambient temperature		–40	-	+125	°C

[1] Pulse duration ≤ 100 μs and duty cycle ≤ 2 %.

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

10. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = –40 °C to 125 °C			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{IH}	HIGH-level input voltage		$0.85V_{CC}$	-	-	-	-	-	V
V_{IL}	LOW-level input voltage		-	-	$0.15V_{CC}$	-	-	-	V
V_{OH}	HIGH-level output voltage	QSn; $V_I = V_{IH}$ or V_{IL}							
		I_O = –20 μA; V_{CC} = 4.5 V	4.4	4.49	-	-	-	-	V
		I_O = –4 mA; V_{CC} = 4.5 V	4.0	4.2	-	-	-	-	V
V_{OL}	LOW-level output voltage	QSn; $V_I = V_{IH}$ or V_{IL}							
		I_O = 20 μA; V_{CC} = 4.5 V	-	0.005	0.1	-	-	-	V
		I_O = 4 mA; V_{CC} = 4.5 V	-	0.3	0.5	-	-	-	V
I_I	input leakage current	V_{CC} = 5.5 V; $V_I = V_{CC}$ or GND	-	-	±1	-	-	-	μA
$V_{(BR)DSS}$	drain-source breakdown voltage	QPn; I_O = 1 mA	33	37	-	-	-	-	V
V_{SD}	source-drain voltage	QPn; I_O = 100 mA	–1.2	–0.85	-	-	-	-	V
I_{CC}	supply current	V_{CC} = 5.5 V; $V_I = V_{CC}$ or GND							
		OE = LOW	-	0.006	200	-	-	-	μA
		OE = HIGH	-	0.01	500	-	-	-	μA
		OE = LOW; CP = 5 MHz; see Figure 15 and Figure 17	-	1	5	-	-	-	mA
I_O	output current	QPn; V_O = 0.5 V [1][2][3]	-	140	-	-	-	-	mA
I_{OZ}	OFF-state output current	QPn; V_{CC} = 5.5 V; V_{DS} = 30 V	-	0.002	0.2	-	0.15	0.3	μA
R_{DSon}	drain-source on-state resistance	see Figure 18 and Figure 19 [1][2]							
		V_{CC} = 4.5 V; I_O = 50 mA	-	2.7	9	-	4.3	12	Ω
		V_{CC} = 4.5 V; I_O = 100 mA	-	2.8	10	-	-	-	Ω

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

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

[3] The 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.

11. Dynamic characteristics

Table 7. Dynamic characteristics

At recommended operating conditions unless otherwise specified; Voltages are referenced to GND (ground = 0 V); For test circuit, see Figure 15.

Symbol	Parameter	Conditions	T_{amb} = 25 °C			Unit
			Min	Typ	Max	
t_{pd}	propagation delay	CP to QSn; see Figure 9 [1]	-	5	-	ns
t_{TLH}	LOW to HIGH output transition time	QPn; see Figure 12	-	60	-	ns
		QSn; see Figure 9	-	6	-	ns
t_{THL}	HIGH to LOW output transition time	QPn; see Figure 12	-	18	-	ns
		QSn; see Figure 9	-	6	-	ns
t_{PLZ}	LOW to OFF-state propagation delay	CP, LE and OE to QPn; I_O = 75 mA; see Figure 10, Figure 11, Figure 12 and Figure 20	-	105	-	ns
t_{PZL}	OFF-state to LOW propagation delay	CP, LE and OE to QPn; I_O = 75 mA; see Figure 10, Figure 11, Figure 12 and Figure 20	-	10	-	ns
$f_{clk(max)}$	maximum clock frequency	CP; see Figure 9 [2]	10	-	-	MHz
t_{su}	set-up time	D to CP; see Figure 13	20	-	-	ns
t_h	hold time	D to CP; see Figure 13	20	-	-	ns
t_W	pulse width	CP, LE; see Figure 9 and Figure 11	40	-	-	ns
t_{rr}	reverse recovery time	I_O = −100 mA; dI/dt = 10 A/μs; see Figure 14 [3][4]	-	120	-	ns
t_a	reverse recovery current rise time	I_O = −100 mA; dI/dt = 10 A/μs; see Figure 14 [3][4]	-	100	-	ns

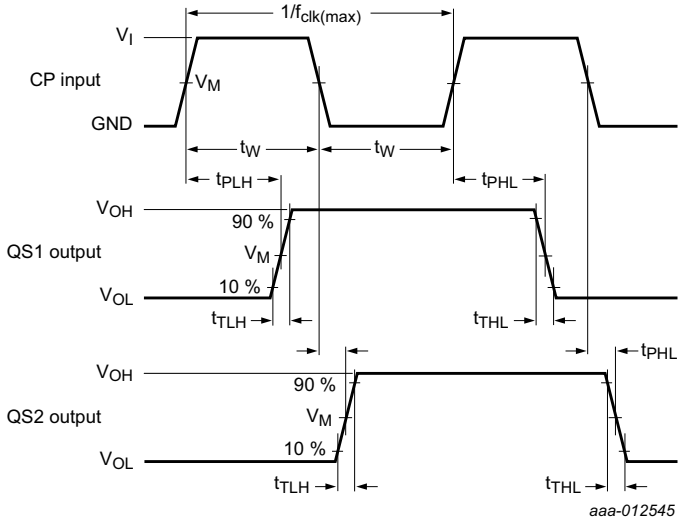
[1] t_{pd} is the same as t_{PLH} and t_{PHL}.

[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 CP → QSn 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.

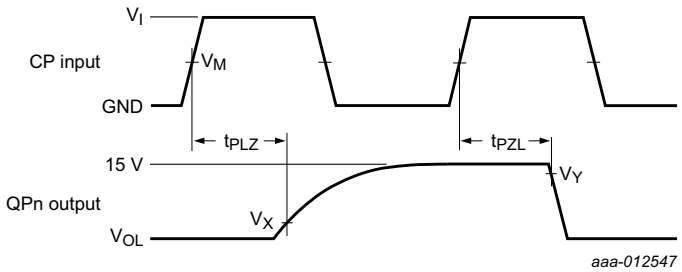
11.1 Waveforms and test circuits



Measurement points are given in Table 8.

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

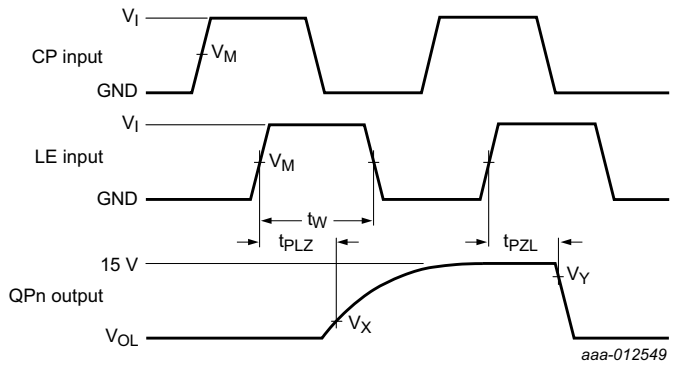
Fig 9. Propagation delay clock (CP) to output (QS1, QS2), clock pulse width, maximum clock frequency and output transition time



Measurement points are given in Table 8.

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

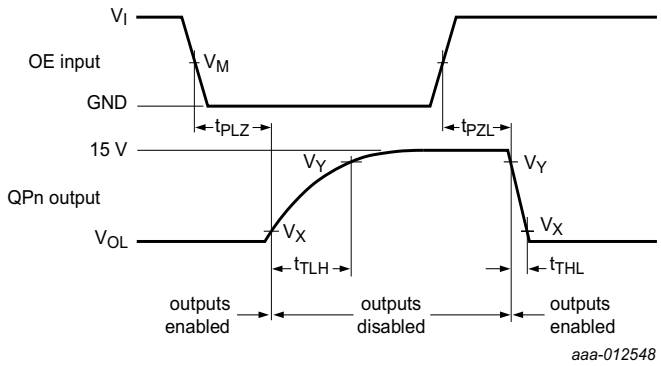
Fig 10. Propagation delay clock (CP) to output (QPn)



Measurement points are given in Table 8.

V_{OL} is the typical output voltage level that occurs with the output load.

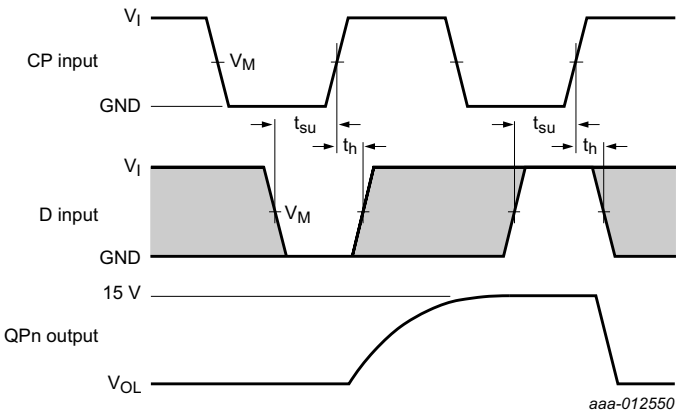
Fig 11. Latch enable (LE) to output (QPn) propagation delays and the latch enable pulse width



Measurement points are given in Table 8.

V_{OL} is the typical output voltage level that occurs with the output load.

Fig 12. Output enable (OE) to output (QPn) and output transition time



Measurement points are given in Table 8.

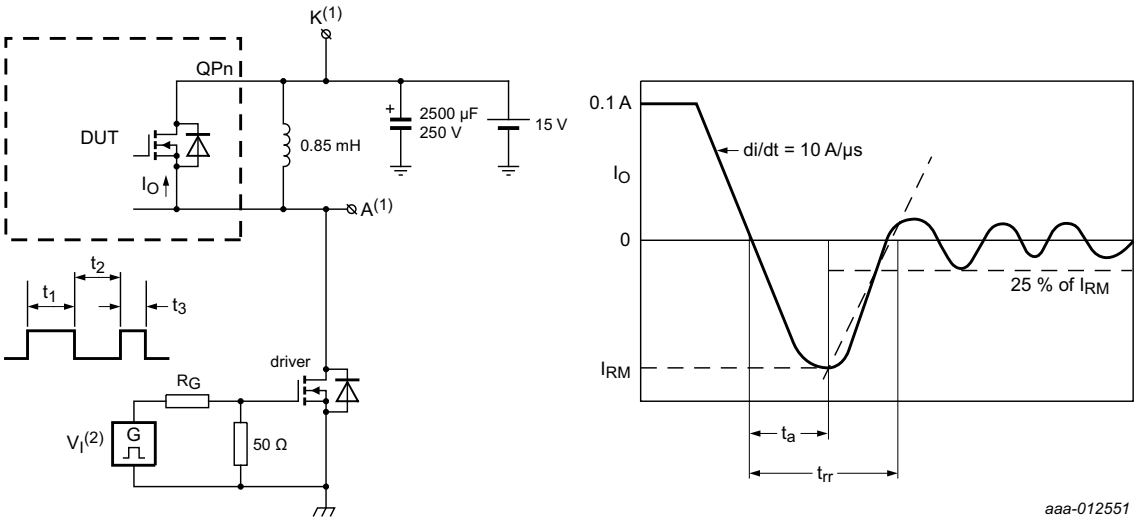
The shaded areas indicate when the input is permitted to change for predictable output performance.

V_{OL} is the typical output voltage level that occurs with the output load.

Fig 13. Set-up and hold times

Table 8. Measurement points

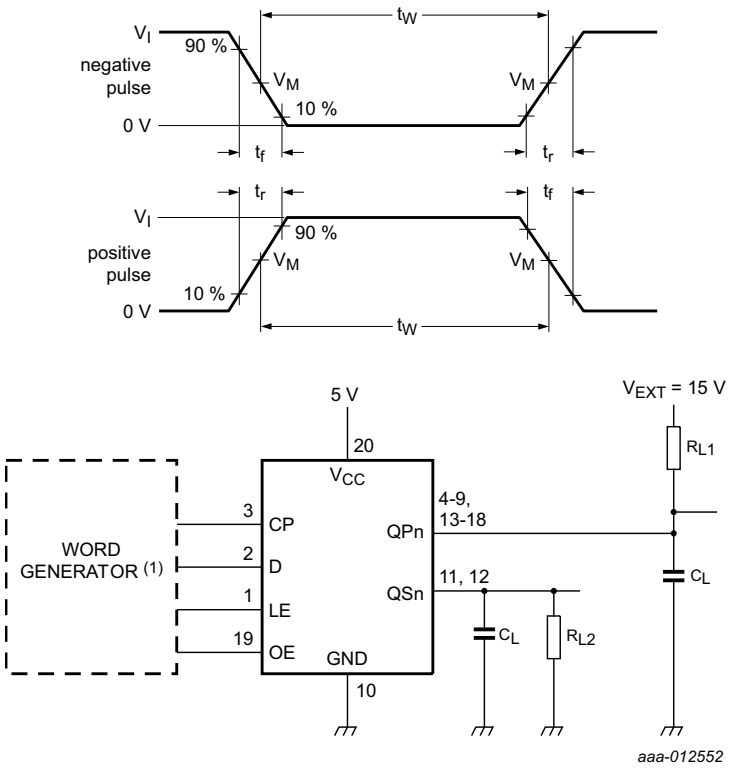
Supply voltage	Input	Output		
V_{CC}	V_M	V_M	V_X	V_Y
5 V	$0.5V_{CC}$	$0.5V_{DS}$	$0.1V_{DS}$	$0.9V_{DS}$



(1) The open-drain QPn terminal under test is connected to testpoint K. All other terminals are connected together and connected to testpoint A.

(2) The V_I amplitude and R_G are adjusted for dI/dt = 10 A/µs. A V_I double-pulse train is used to set I_O = 0.1 A, where t_1 = 10 µs, t_2 = 7 µs and t_3 = 3 µs.

Fig 14. Test circuit and waveform for measuring reverse recovery current



(1) The word generator has the following characteristics: t_r, $t_f \leq 10$ ns; $t_W = 300$ ns; pulsed repetition rate (PRR) = 5 kHz; $Z_O = 50\ \Omega$.

(2) C_L includes probe and jig capacitance.

Test data is given in Table 9. Definitions for test circuit:

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

R_L = Load resistance.

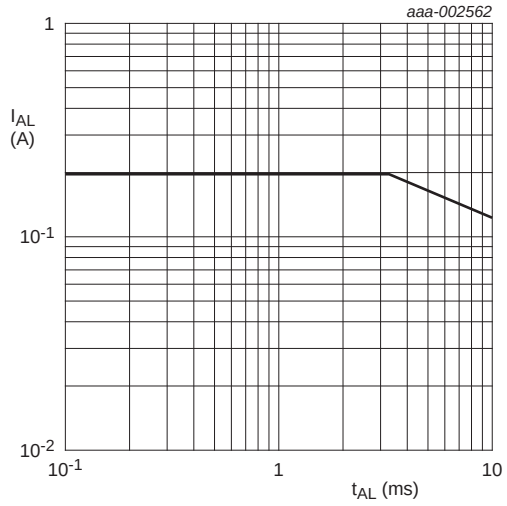
C_L = Load capacitance including jig and probe capacitance.

Fig 15. Test circuit for measuring switching times

Table 9. Test data

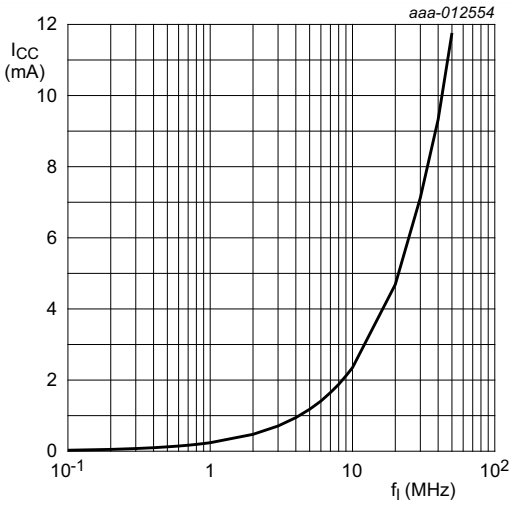
Supply voltage	Input			Load		
	V_I	t_r, t_f	V_M	C_L	R_{L1}	R_{L2}[1]
5 V	5 V	≤ 10 ns	50%	30 pF	200 Ω	2 kΩ

[1] Do not connect R_{L2} when measuring the supply current (I_{CC}).



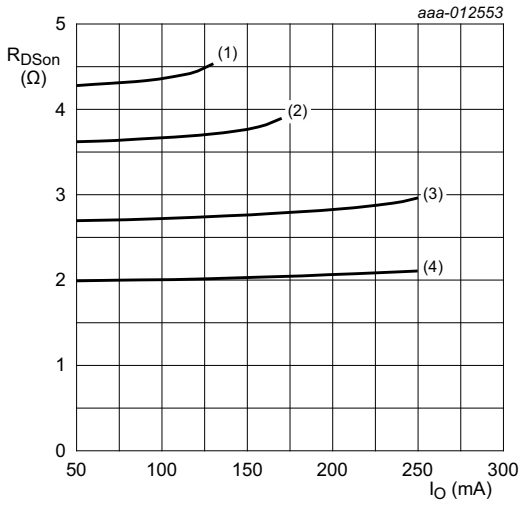
T_{amb} = 25 °C; V_{CC} = 5 V.

Fig 16. Avalanche current (peak) versus time duration of avalanche



T_{amb} = −40 °C to 125 °C; V_{CC} = 5 V.

Fig 17. Supply current versus frequency



V_{CC} = 4.5 V; V_I = V_{CC} or GND.

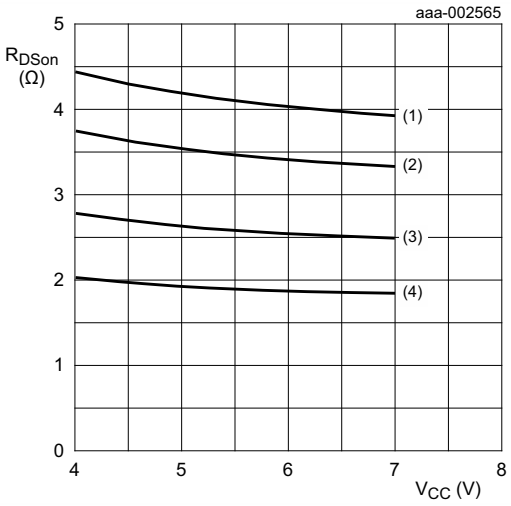
(1) T_{amb} = 125 °C

(2) T_{amb} = 85 °C

(3) T_{amb} = 25 °C

(4) T_{amb} = −40 °C

Fig 18. Drain-source on-state resistance versus drain current



V_I = V_{CC} or GND; I_O = 50 mA.

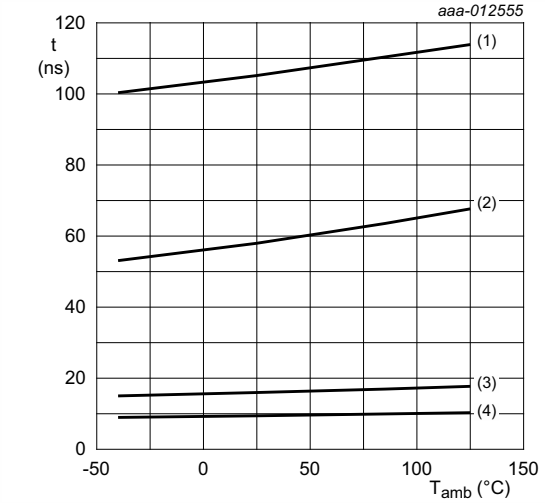
(1) T_{amb} = 125 °C

(2) T_{amb} = 85 °C

(3) T_{amb} = 25 °C

(4) T_{amb} = −40 °C

Fig 19. Static drain-source on-state resistance versus supply voltage



V_{CC} = 5 V; I_O = 75 mA, this technique should limit $T_j - T_{amb}$ to 10 °C maximum.

(1) t_{PLZ}.

(2) t_{TLH}.

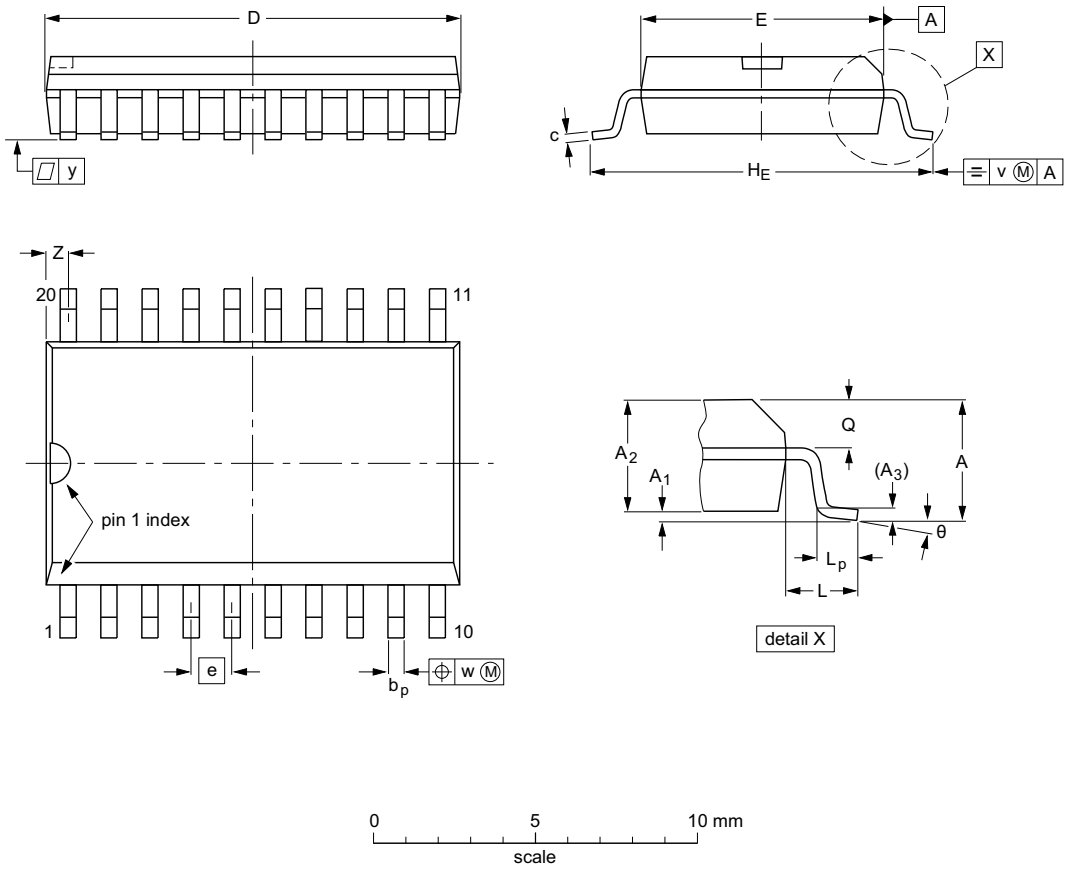
(3) t_{THL}.

(4) t_{PZL}.

Fig 20. Switching time versus temperature

12. Package outline

SO20: plastic small outline package; 20 leads; body width 7.5 mm **SOT163-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	2.65	0.3 0.1	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.1	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.05	0.419 0.394	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

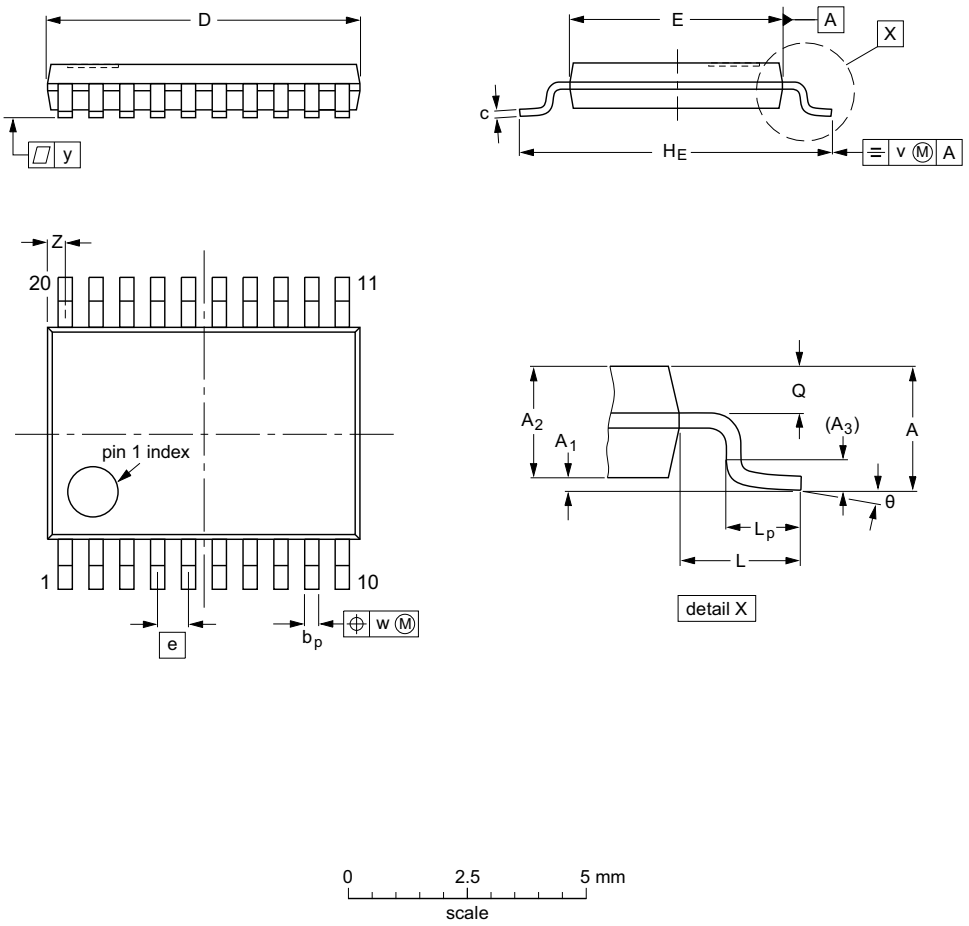
Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT163-1	075E04	MS-013				~~99-12-27~~ 03-02-19

Fig 21. Package outline SOT163-1 (SO20)

TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm **SOT360-1**



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	6.6 6.4	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	0.5 0.2	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			
SOT360-1		MO-153				~~99-12-27~~ 03-02-19

Fig 22. Package outline SOT360-1 (TSSOP20)

13. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
EDNMOS	Extended Drain Negative Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
TTL	Transistor-Transistor Logic

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NPIC6C4894 v.1	20140417	Product data sheet	-	-

15. Legal information

15.1 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 URL http://www.nxp.com.

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17. Contents

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