# NX5P2924B

# Logic controlled high-side power switch Rev. 1 — 24 February 2014

**Product data sheet** 

#### 1. **General description**

The NX5P2924B is a high-side load switch which features a low ON resistance N-channel MOSFET with controlled slew rate that supports 2.5 A of continuous current. Designed for operation from 0.8 V to 5.5 V, it is used in power domain isolation applications to reduce power dissipation and extend battery life. The enable logic includes integrated logic level translation making the device compatible with lower voltage processors and controllers. The NX5P2924B is ideal for portable, battery operated applications due to low ground current.

#### **Features and benefits** 2.

- Wide supply voltage range from 0.8 V to 5.5 V
- Very low ON resistance:
  - 14 mΩ (typical) at a supply voltage of 1.2 V
  - 14 mΩ (typical) at a supply voltage of 1.8 V
- High noise immunity
- High current handling capability (2.5 A continuous current)
- Turn-on slew rate limiting
- ESD protection:
  - ♦ HBM JESD22-A114F Class 3A exceeds 4000 V
  - CDM AEC-Q100-011 revision B exceeds 1000 V
- Specified from -40 °C to +85 °C

#### **Applications** 3.

- Cell phone
- Digital cameras and audio devices
- Portable and battery-powered equipment



#### Logic controlled high-side power switch

# 4. Ordering information

#### Table 1. Ordering information

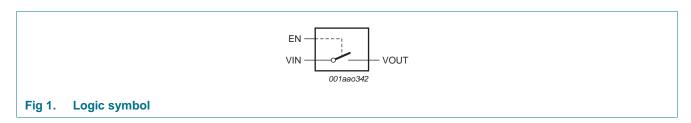
Type number	Package							
	Temperature range	Name	Description	Version				
NX5P2924BUK	–40 °C to +85 °C	WLCSP6	wafer level chip-scale package; 6 bumps; 0.87 x 1.37 x 0.5 mm	NX5P2924B				

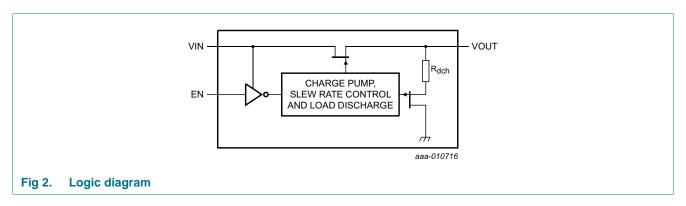
# 5. Marking

#### Table 2. Marking codes

Type number	Marking code
NX5P2924BUK	4B

# 6. Functional diagram

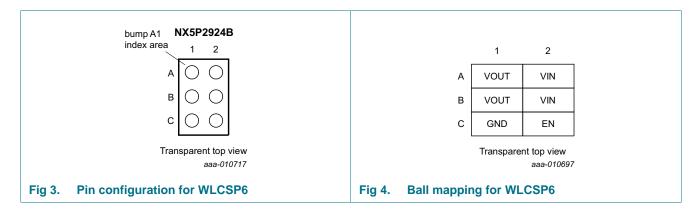




Logic controlled high-side power switch

# 7. Pinning information

## 7.1 Pinning



#### 7.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
VIN	A2, B2	input voltage
GND	C1	ground (0 V)
EN	C2	enable input (active HIGH)
VOUT	A1, B1	output voltage

## 8. Functional description

Table 4. Function table [1]

Input EN	Switch
L	switch OFF
Н	switch ON

<sup>[1]</sup> H = HIGH voltage level; L = LOW voltage level.

#### Logic controlled high-side power 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
$V_{I}$	input voltage	input EN	[ <u>1</u> ] -0.5	+6.0	V
		input VIN	[2] -0.5	+6.0	V
V <sub>SW</sub>	switch voltage	output VOUT	[2] -0.5	$V_{I(VIN)}$	V
I <sub>IK</sub>	input clamping current	input EN: $V_{I(EN)} < -0.5 \text{ V}$	-50	-	mA
I <sub>SK</sub>	switch clamping current	input VIN: $V_{I(VIN)} < -0.5 \text{ V}$	-50	-	mA
		output VOUT: $V_{O(VOUT)} < -0.5 \text{ V}$	-50	-	mA
		output VOUT: $V_{O(VOUT)} > V_{I(VIN)} + 0.5 \text{ V}$	-	50	mA
I <sub>SW</sub>	switch current	V <sub>SW</sub> > -0.5 V	-	±2500	mA
T <sub>j(max)</sub>	maximum junction temperature		-40	+125	°C
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation		[3] _	470	mW

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

## 10. Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
VI	input voltage		0.8	5.5	V
T <sub>amb</sub>	ambient temperature		-40	+85	°C

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

<sup>[3]</sup> The (absolute) maximum power dissipation depends on the junction temperature T<sub>j</sub>. Higher power dissipation is allowed with lower ambient temperatures. The conditions to determine the specified values are T<sub>amb</sub> = 85 °C and the use of a two layer PCB.

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## 11. Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions	Тур	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient		<u>[1]</u> 139	K/W

<sup>[1]</sup> R<sub>th(j-a)</sub> is dependent upon board layout. To minimize R<sub>th(j-a)</sub>, ensure that all pins have a solid connection to larger copper layer areas. In multi-layer PCBs, the second layer should be used to create a large heat spreader area below the device. Avoid using solder-stop varnish under the device.

## 12. Static characteristics

Table 8. Static characteristics

 $V_{I(VIN)} = 1.0 \text{ V}$  to 5.5 V, unless otherwise specified; Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Ta	<sub>mb</sub> = 25	°C	$T_{amb} = -40$ °C	C to +85 °C	Unit
			Min	Typ[1]	Max	Min	Max	
$V_{IH}$	HIGH-level input	EN input; $V_{I(VIN)} = 0.8 \text{ V}$	-	0.7	-	-	-	V
	voltage	EN input; $V_{I(VIN)} = 1.0 \text{ V}$ to 1.2 V	0.9	-	-	0.9	-	V
		EN input; $V_{I(VIN)} = 1.2 \text{ V}$ to 2.5 V	1.2	-	-	1.2	-	V
		EN input; $V_{I(VIN)} = 2.5 \text{ V}$ to 5.5 V	1.2	-	-	1.2	-	V
$V_{IL}$	LOW-level input	EN input; $V_{I(VIN)} = 0.8 \text{ V}$	-	0.25	-	-	-	V
	voltage	EN input; $V_{I(VIN)} = 1.0 \text{ V}$ to 1.2 V	-	-	0.3	-	0.3	V
		EN input; $V_{I(VIN)} = 1.2 \text{ V}$ to 2.5 V	-	-	0.4	-	0.4	V
		EN input; V <sub>I(VIN)</sub> = 2.5 V to 5.5 V	-	-	0.6	-	0.6	V
I <sub>I</sub>	input leakage current	EN input; $V_{I(EN)} = 0.9 \text{ V to } 5.5 \text{ V}$	-	-	-	-	0.1	μΑ
R <sub>dch</sub>	discharge	VOUT output; $V_{I(VIN)} = 0.8 \text{ V}$	-	4.00	-	-	-	kΩ
	resistance	VOUT output; V <sub>I(VIN)</sub> = 1.0 V	-	1.40	-	-	-	kΩ
		VOUT output; V <sub>I(VIN)</sub> = 1.2 V	-	1.30	-	-	-	kΩ
		VOUT output; V <sub>I(VIN)</sub> = 1.8 V	-	1.27	1.50	-	-	kΩ
		VOUT output; V <sub>I(VIN)</sub> = 3.3 V	-	1.25	1.50	-	-	kΩ
		VOUT output; $V_{I(VIN)} = 5.5 \text{ V}$	-	1.25	1.50	-	-	$k\Omega$

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Table 8. Static characteristics ...continued

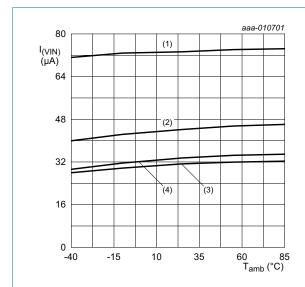
 $V_{I(VIN)} = 1.0 \text{ V to } 5.5 \text{ V}$ , unless otherwise specified; Voltages are referenced to GND (ground = 0 V). ...continued

Symbol	Parameter	Conditions	Ta	<sub>mb</sub> = 25	°C	T <sub>amb</sub> = -40 °	C to +85 °C	Unit
			Min	Typ[1]	Max	Min	Max	
$I_{(VIN)}$	supply current	VOUT open				'		•
		EN = HIGH; $V_{I(VIN)}$ = 1.0 V; see <u>Figure 5</u> and <u>Figure 6</u>	-	25	-	-	35	μА
		EN = HIGH; $V_{I(VIN)}$ = 1.8 V; see <u>Figure 5</u> and <u>Figure 6</u>	-	30	-	-	50	μΑ
		EN = HIGH; $V_{I(VIN)}$ = 3.6 V; see <u>Figure 5</u> and <u>Figure 6</u>	-	45	-	-	65	μΑ
		EN = HIGH; $V_{I(VIN)}$ = 5.5 V; see <u>Figure 5</u> and <u>Figure 6</u>	-	75	-	-	105	μΑ
		EN = LOW; $V_{I(VIN)} = 1.0 \text{ V}$ ; see <u>Figure 7</u> and <u>Figure 8</u>	-	0.1	-	-	8.0	μΑ
		EN = LOW; $V_{I(VIN)}$ = 1.8 V; see Figure 7 and Figure 8	-	0.1	-	-	1.0	μА
		EN = LOW; $V_{I(VIN)}$ = 3.6 V; see Figure 7 and Figure 8	-	0.1	-	-	1.2	μΑ
		EN = LOW; $V_{I(VIN)}$ = 5.5 V; see Figure 7 and Figure 6	-	0.1	-	-	1.5	μА
I <sub>S(OFF)</sub>	OFF-state leakage current	EN = LOW; $V_{I(VIN)}$ = 1.8 V; $V_{I(VOUT)}$ = 0 V; see <u>Figure 9</u> and <u>Figure 10</u>	-	-0.5	-	-3.5	-	μА
		EN = LOW; $V_{I(VIN)}$ = 3.6 V; $V_{I(VOUT)}$ = 0 V; see <u>Figure 9</u> and <u>Figure 10</u>	-	-0.5	-	-5.0	-	μА
		EN = LOW; $V_{I(VIN)}$ = 5.5 V; $V_{I(VOUT)}$ = 0 V; see <u>Figure 9</u> and <u>Figure 10</u>	-	-0.5	-	<b>−7.5</b>	-	μА
C <sub>I</sub>	input capacitance	EN	-	3	-	-	-	pF
C <sub>S(ON)</sub>	ON-state capacitance	VIN; VOUT	-	-	0.5	-	0.5	nF

<sup>[1]</sup> All typical values are measured at  $V_{I(VIN)}$  = 3.6 V and  $T_{amb}$  = 25 °C unless otherwise specified.

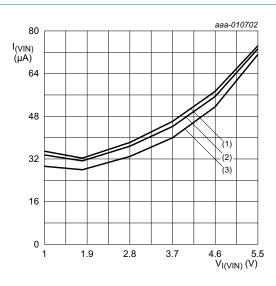
#### Logic controlled high-side power switch

## 12.1 Graphs



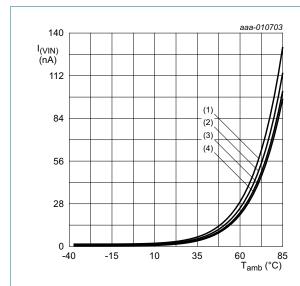
- $V_{I(EN)} = V_{I(VIN)}$
- (1)  $V_{I(VIN)} = 5.5 \text{ V}.$
- (2)  $V_{I(VIN)} = 3.6 \text{ V}.$
- (3)  $V_{I(VIN)} = 1.8 \text{ V}.$
- (4)  $V_{I(VIN)} = 1.0 \text{ V}.$

Fig 5. Typical supply current versus temperature



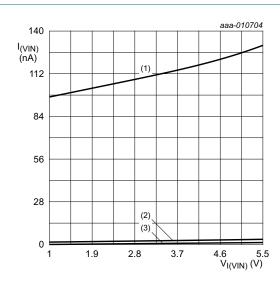
- $V_{I(EN)} = V_{I(VIN)}$ .
- (1)  $T_{amb} = 85 \, ^{\circ}C$ .
- (2)  $T_{amb} = 25 \, ^{\circ}C$ .
- (3)  $T_{amb} = -40 \, ^{\circ}C$ .

Fig 6. Typical supply current versus input voltage on pin VIN



- $V_{I(EN)} = GND.$
- (1)  $V_{I(VIN)} = 5.5 \text{ V}.$
- (2)  $V_{I(VIN)} = 3.6 \text{ V}.$
- (3)  $V_{I(VIN)} = 1.8 \text{ V}.$
- (4)  $V_{I(VIN)} = 1.0 \text{ V}.$

Fig 7. Typical supply current versus temperature



- $V_{I(EN)} = GND.$
- (1)  $T_{amb} = 85 \, ^{\circ}C$ .
- (2)  $T_{amb} = 25 \, {}^{\circ}C$ .
- (3)  $T_{amb} = -40 \, ^{\circ}C$ .

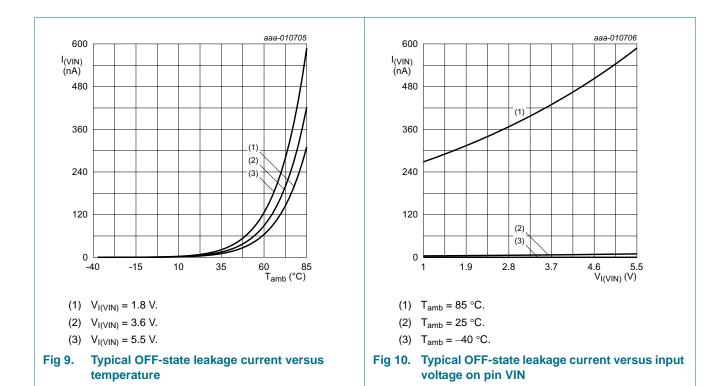
Fig 8. Typical supply current versus input voltage on pin VIN

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#### Logic controlled high-side power switch



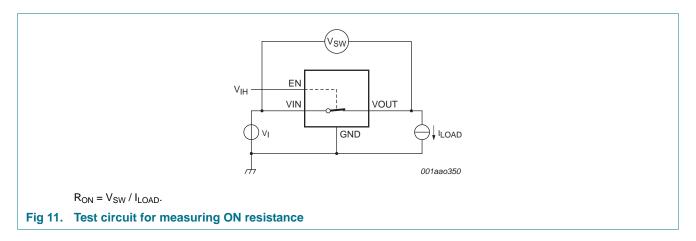
#### 12.2 ON resistance

Table 9. ON resistance

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

Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C		$T_{amb}$ = -40 °C to +85 °C		Unit	
			Min	Тур	Max	Min	Max	
R <sub>ON</sub> ON resistance	$V_{I(EN)} = 1.5 \text{ V}; I_{LOAD} = 200 \text{ mA};$ see <u>Figure 11</u> , <u>12</u> and <u>13</u>			•				
		$V_{I(VIN)} = 0.8 \text{ V to } 5.5 \text{ V}$	-	14	-	-	20	$m\Omega$

## 12.3 ON resistance test circuit and graphs

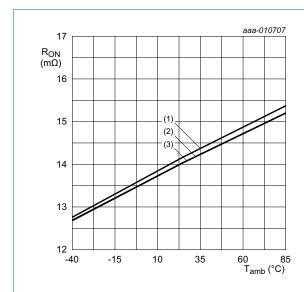


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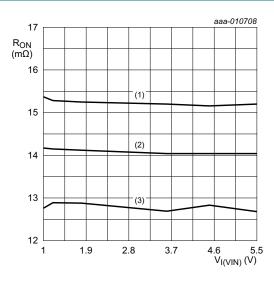
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- (1)  $V_{I(VIN)} = 1.0 \text{ V}.$
- (2)  $V_{I(VIN)} = 3.6 \text{ V}.$
- (3)  $V_{I(VIN)} = 5.5 \text{ V}.$

Fig 12. ON resistance versus temperature



- (1)  $T_{amb} = 85 \, ^{\circ}C$ .
- (2)  $T_{amb} = 25 \, ^{\circ}C$ .
- (3)  $T_{amb} = -40 \, ^{\circ}C$ .

Fig 13. ON resistance versus input voltage

## Logic controlled high-side power switch

# 13. Dynamic characteristics

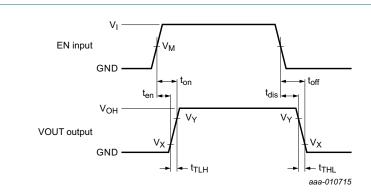
Table 10. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 15.

Symbol	Parameter	Conditions	Ta	<sub>amb</sub> = 25	°C	T <sub>amb</sub> = -40 °C	C to +85 °C	Unit
			Min	Тур	Max	Min	Max	
t <sub>en</sub> e	enable time	EN to VOUT; see <u>Figure 14</u> , <u>16</u> , <u>17</u> , <u>18</u> and <u>20</u>			'		'	
		$V_{I(VIN)} = 0.8 V$	-	600	-	-	-	μS
		$V_{I(VIN)} = 1.0 V$	-	240	-	-	-	μS
		$V_{I(VIN)} = 3.6 \text{ V}$	-	90	-	-	-	μS
		$V_{I(VIN)} = 5.5 V$	-	90	-	-	-	μS
t <sub>dis</sub>	disable time	EN to VOUT; see Figure 14, 19 and 21						
		$V_{I(VIN)} = 0.8 \text{ V}$	-	210	-	-	-	μS
		$V_{I(VIN)} = 1.0 \text{ V}$	-	20	-	-	-	μS
		$V_{I(VIN)} = 3.6 \text{ V}$	-	5	-	-	-	μS
		V <sub>I(VIN)</sub> = 5.5 V	-	4	-	-	-	μS
t <sub>on</sub> tu	turn-on time	EN to VOUT; see <u>Figure 14</u> , <u>16</u> , <u>17</u> , <u>18</u> and <u>20</u>						
		$V_{I(VIN)} = 0.8 \text{ V}$	-	1000	-	-	-	μS
		V <sub>I(VIN)</sub> = 1.0 V	-	350	-	-	-	μS
		V <sub>I(VIN)</sub> = 3.6 V	-	240	-	-	-	μS
		V <sub>I(VIN)</sub> = 5.5 V	-	290	-	-	-	μS
t <sub>off</sub>	turn-off time	EN to VOUT; see Figure 14, 19 and 21						μS
		$V_{I(VIN)} = 0.8 \text{ V}$	-	220.0	-	-	-	μS
		$V_{I(VIN)} = 1.0 \text{ V}$	-	22.3	-	-	-	μS
		$V_{I(VIN)} = 3.6 \text{ V}$	-	7.2	-	-	-	μS
		$V_{I(VIN)} = 5.5 \text{ V}$	-	6.0	-	-	-	μS
t <sub>TLH</sub>	LOW to HIGH	VOUT; see Figure 14						
	output transition time	V <sub>I(VIN)</sub> = 0.8 V	-	400	-	-	-	μS
	transition time	$V_{I(VIN)} = 1.0 \text{ V}$	-	110	-	20	-	μS
		$V_{I(VIN)} = 3.6 \text{ V}$	-	150	-	50	-	μS
		$V_{I(VIN)} = 5.5 V$	-	200	-	70	-	μS
t <sub>THL</sub>	HIGH to LOW	VOUT; see Figure 14						
	output transition time	V <sub>I(VIN)</sub> = 0.8 V	-	10.0	-	-	-	μS
	uansiuon ume	$V_{I(VIN)} = 1.0 \text{ V}$	-	2.3	-	-	-	μS
		$V_{I(VIN)} = 3.6 \text{ V}$	-	2.2	-	-	-	μS
		$V_{I(VIN)} = 5.5 \text{ V}$	-	2.0	-	-	-	μS

#### Logic controlled high-side power switch

## 13.1 Waveforms, graphs and test circuit



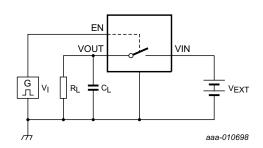
Measurement points are given in Table 11.

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

Fig 14. Switching times

Table 11. Measurement points

Supply voltage	EN Input	Output			
V <sub>I(VIN)</sub>	V <sub>M</sub>	V <sub>X</sub>	V <sub>Y</sub>		
1.0 V to 5.5 V	$0.5 \times V_{I(EN)}$	$0.1 \times V_{OH}$	$0.9 \times V_{OH}$		



Test data is given in Table 12.

Definitions test circuit:

R<sub>L</sub> = Load resistance.

 $C_L$  = Load capacitance including jig and probe capacitance.

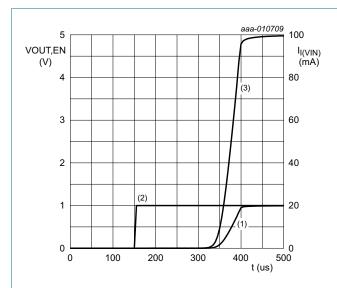
 $V_{\text{EXT}}$  = External voltage for measuring switching times.

Fig 15. Test circuit for measuring switching times

Table 12. Test data

Supply voltage	Input	Load	
V <sub>EXT</sub>	V <sub>I(EN)</sub>	CL	R <sub>L</sub>
1.0 V to 5.5 V	1.5 V	0.1 μF	10 Ω

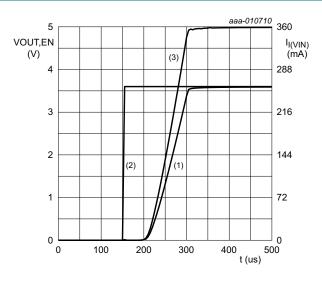
#### Logic controlled high-side power switch



 $V_{I(VIN)}$  = 1 V;  $R_L$  = 10  $\Omega;$   $C_L$  = 0.1  $\mu F;$   $T_{amb}$  = 25  $^{\circ}C.$ 

- (1) VOUT
- (2) EN
- (3)  $I_{I(VIN)}$

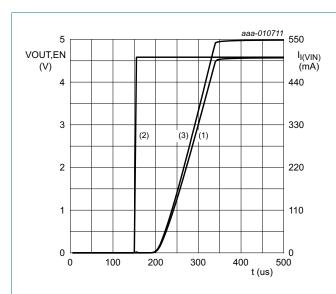
Fig 16. Typical enable time at  $V_{I(VIN)}$  = 1 V;  $C_L$  = 0.1  $\mu F$ 



 $V_{I(VIN)}$  = 3.6 V;  $R_L$  = 10  $\Omega;$   $C_L$  = 0.1  $\mu F;$   $T_{amb}$  = 25 °C.

- (1) VOUT
- (2) EN
- (3) I<sub>I(VIN)</sub>

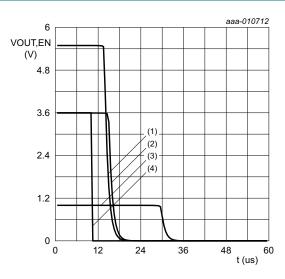
Fig 17. Typical enable time at  $V_{I(VIN)}$  = 3.6 V;  $C_L$  = 0.1  $\mu F$ 



 $V_{I(VIN)} = 5.5 \text{ V}; R_L = 10 \Omega; C_L = 0.1 \mu\text{F}; T_{amb} = 25 \text{ }^{\circ}\text{C}.$ 

- (1) VOUT
- (2) EN
- (3) I<sub>I(VIN)</sub>

Fig 18. Typical enable time at  $V_{I(VIN)}$  = 5.5 V;  $C_L$  = 0.1  $\mu F$ 

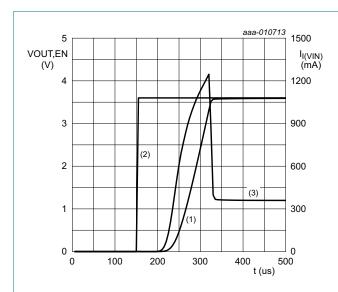


$$R_L = 10 \Omega$$
;  $C_L = 0.1 \mu F$ ;  $T_{amb} = 25 ^{\circ}C$ 

- (1)  $V_{I(VIN)} = 5.5 \text{ V}$
- (2)  $V_{I(VIN)} = 3.6 \text{ V}$
- (3)  $V_{I(VIN)} = 1.0 \text{ V}$
- (4) EN

Fig 19. Typical disable time

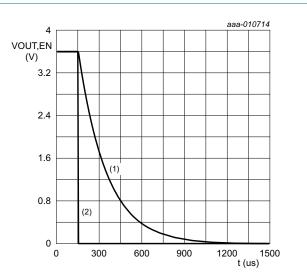
#### Logic controlled high-side power switch



 $V_{I(VIN)}$  = 3.6 V;  $R_L$  = 10  $\Omega;$   $C_L$  = 20  $\mu F;$   $T_{amb}$  = 25  $^{\circ}C.$ 

- (1) VOUT
- (2) EN
- (3) I<sub>I(VIN)</sub>

Fig 20. Typical enable time at  $V_{I(VIN)}$  = 3.6 V;  $C_L$  = 20  $\mu F$ 



 $V_{I(VIN)}$  = 3.6 V;  $R_L$  = 10  $\Omega;$   $C_L$  = 20  $\mu F;$   $T_{amb}$  = 25  $^{\circ}C$ 

- (1) VOUT
- (2) EN

Fig 21. Typical disable time at  $V_{I(VIN)}$  = 3.6 V;  $C_L$  = 20  $\mu F$ 

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## 14. Package outline

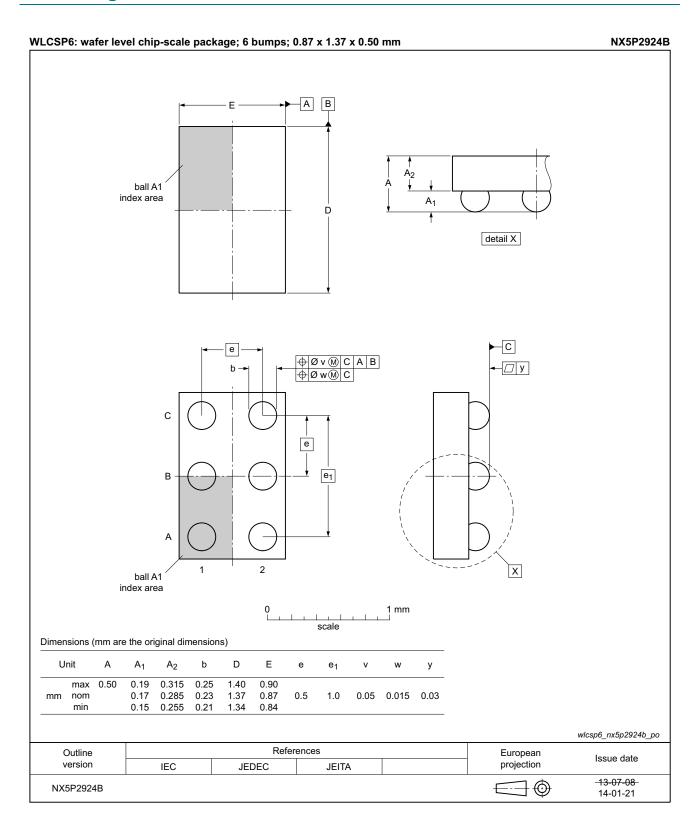


Fig 22. Package outline NX5P2924B

NX5P2924B

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## Logic controlled high-side power switch

## 15. Abbreviations

#### Table 13. Abbreviations

Acronym	Description
CDM	Charged Device Model
DUT	Device Under Test
ESD	ElectroStatic Discharge
НВМ	Human Body Model
IEC	International Electrotechnical Commission
MOSFET	Metal-Oxide Semiconductor Field Effect Transistor

# 16. Revision history

#### Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NX5P2924B v.1	20140224	Product data sheet	-	-

#### Logic controlled high-side power switch

## 17. Legal information

#### 17.1 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.

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#### Logic controlled high-side power switch

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## Logic controlled high-side power switch

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