NX30P0121UK

High-voltage back-to-back OVP switch

Rev. 1.0 — 19 June 2019 Product data sheet

1 General description

The NX30P0121UK is an advanced 3A unidirectional power switch. It includes Undervoltage Lockout (UVLO), Overvoltage Lockout (OVLO) in VOUT, OVLO adjustable pin and over-temperature protection circuits. It is designed to automatically isolate the power switch terminals when a fault condition occurs. Both VIN and VOUT pins have 29V tolerance in shutdown mode.

The device has a default internal 14.5V overvoltage protection threshold in VOUT and adjustable OVP threshold by resistor divider from VOUT. ISNS pin is current source output proportional to input current from VIN to VOUT when device is enabled.

The device is enabled by external EN pin. When EN pin is driven LOW, the device is in shutdown mode where all internal circuitries are off and OVP switch is off. When EN pin is driven HIGH and VIN is valid, the OVP switch soft starts after VIN debounce time to limit the inrush current.

NX30P0121UK is offered in a small 12 bumps, 1.65 x 1.25 x 0.525 mm WLCSP package.

2 Features and benefits

- Wide supply voltage range from 2.5V to 20V
- Switch maximum 3A continuous current
- 29V tolerance on both VIN and VOUT pin
- 54mΩ (typical) Low ON resistance
- Adjustable overvoltage protection threshold, internal 14.5V VOUT OVLO
- Built in slew rate control for inrush current limit
- ISNS to monitor input current from VIN to VOUT
- Protection circuitry
  - Over-temperature protection
  - Overvoltage protection
  - Undervoltage lockout
- ESD protection
  - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV
  - CDM (JESD22-C101E)
- Specified from -40°C to +85°C

3 Applications

- Smartphone
- Tablet
- Other portable electronic devices

4 Ordering information

Table 1. Ordering information

Type number	Topside marking	Package		
		Name	Description	Version
NX30P0121UK	N21	WLCSP12	wafer level chip scale package; 12 bumps; 0.4 mm pitch; 1.65 mm x 1.25 mm x 0.525 mm body (backside coating included)	SOT1390-8

4.1 Ordering options

Table 2. Ordering options

Type number	Orderable part number	Package	Packing method	Minimum order quantity	Temperature
NX30P0121UK	NX30P0121UKZ	WLCSP12	REEL 7" Q1 DP CHIPS	4000	T_{amb} = -40 °C to +85 °C

5 Functional diagram

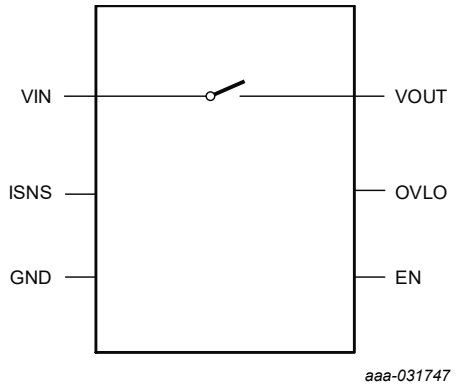

Figure 1. Logic symbol

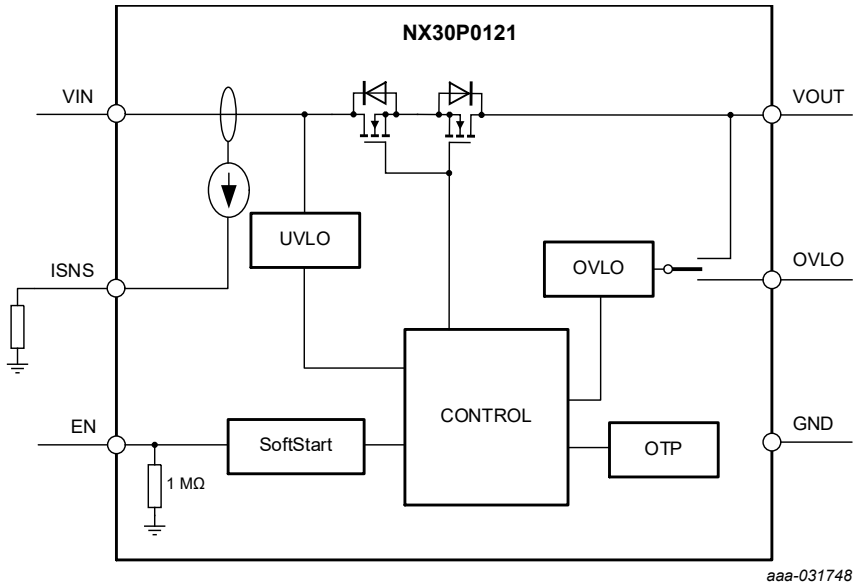

Figure 2. Internal block diagram

6 Pinning information

6.1 Pinning

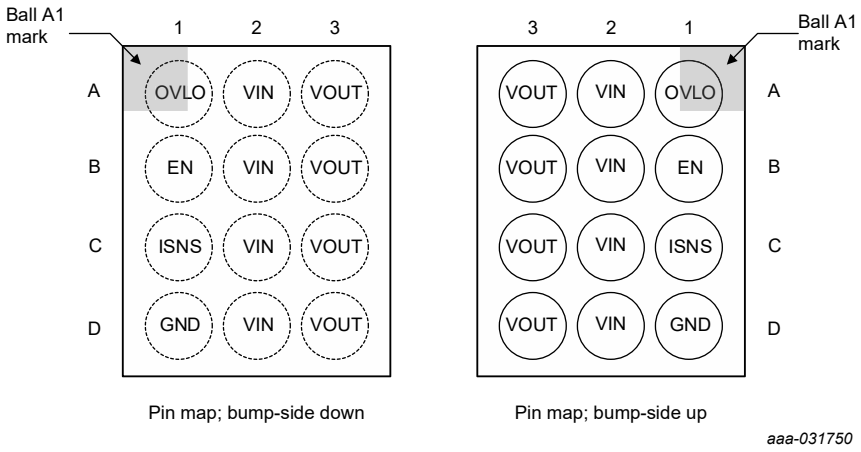

Figure 3. NX30P0121 Pin map, WLCSP12

6.2 Pin description

Table 3.

Pin description			
Symbol	**Pin**	**Type**	**Description**
VIN	A2, B2, C2, D2	P	Input power pin. Connect bypass capacitor 1uF to GND

Pin description			
Symbol	**Pin**	**Type**	**Description**
VOUT	A3, B3, C3, D3	P	Output Power pin, Connect bypass capacitor 1uF to GND
EN	B1	DIN	Enable pin. Drive HIGH to enable device.
ISNS	C1	AO	1,053:1 current mirror of input current from VIN to VOUT. Must connect a resistor on ISNS pin to GND to monitor the input current.
OVLO	A1	AIN	Adjustable OVLO threshold with external Resistor divider
GND	D1	P	Ground

7 Functional description

Table 4. Function table

EN	VIN	VOUT	Switch	ISNS	Operation
L	X	X	OFF	Hi-Z	Shutdown mode
H	< VIN_{UVLO}	X	OFF	Hi-Z	Standby mode, Undervoltage lockout
H	X	> $VOUT_{OVLO}$	OFF	Hi-Z	Standby mode, Overvoltage lockout
H	> VIN_{UVLO}	< $VOUT_{OVLO}$	ON	ON	Switch ON mode

7.1 EN pin

When EN is driven LOW, the device enters shutdown mode regardless of VIN and VOUT voltage. All internal circuitries are off to minimize current consumption and OVP switch is OFF. When EN is driven HIGH, the OVP switch is ready to turn on depending on VIN and VOUT condition. if VIN is above VIN_{UVLO} and VOUT is lower than $VOUT_{OVLO}$, the device soft starts after VIN debounce timer is expired, to reduce in-rush current. There is an internal 1MΩ pull-down resistor in EN pin, which secure EN status in case EN pin is float. This pin has +29V tolerance.

7.2 Undervoltage Lockout (UVLO)

When EN is driven HIGH and VIN < VIN_{UVLO}, the UVLO circuit disables the power MOSFET. Once VIN exceeds VIN_{UVLO} and no other protection circuit is active, the channel MOSFET state is controlled by the EN pin.

7.3 Overvoltage Lockout (OVLO)

When EN is driven HIGH and VOUT is above $VOUT_{OVLO}$, the OVLO circuit disables the power MOSFET within $t_{dis(OVP)}$. Once VOUT drops below $VOUT_{OVLO}$ and no other protection circuit is active, the power MOSFET resumes operation.

OVLO pin is used to adjust the overvoltage protection threshold. The default overvoltage threshold is 14.5V when OVLO pin is shorted to GND. Connecting a resistor divider to the OVLO pin (see Figure 4) adjusts the overvoltage threshold from 4V to 20V using below equation.

$$VOUT_{OVLO} = Vth(OVLO)\ X\ (\ R1 + R2\ )/(R2)$$

Where Vth(OVLO) = 1.227V

R1 is recommended to use 1MΩ resistance.

When the voltage on OVLO pin is below 0.1V, the device defaults to the 14.5V OVP threshold.

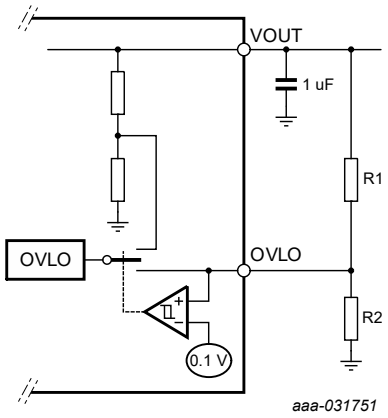

Figure 4. External OVLO adjustment

7.4 Over-temperature protection

When EN is HIGH and the device temperature exceeds 145°C the Over-Temperature Protection (OTP) circuit disables the power MOSFET. Once the device temperature decreases below 115 °C and no other protection circuit is active, the state of the OVP MOSFET is controlled by the EN pin again.

7.5 ISNS pin

The ISNS pin is current source output having 1,053:1 ratio with input current from VIN to VOUT. It requires a resistor from ISNS to GND to monitor input current. When device is disabled, its output is high impedance. The ISNS voltage is determined by below equation. R_{ISNS} is recommended to be +/-1% tolerant.

$V_{ISNS} = (I_{IN} \times R_{ISNS}) / 1{,}053$

7.6 Timing diagram

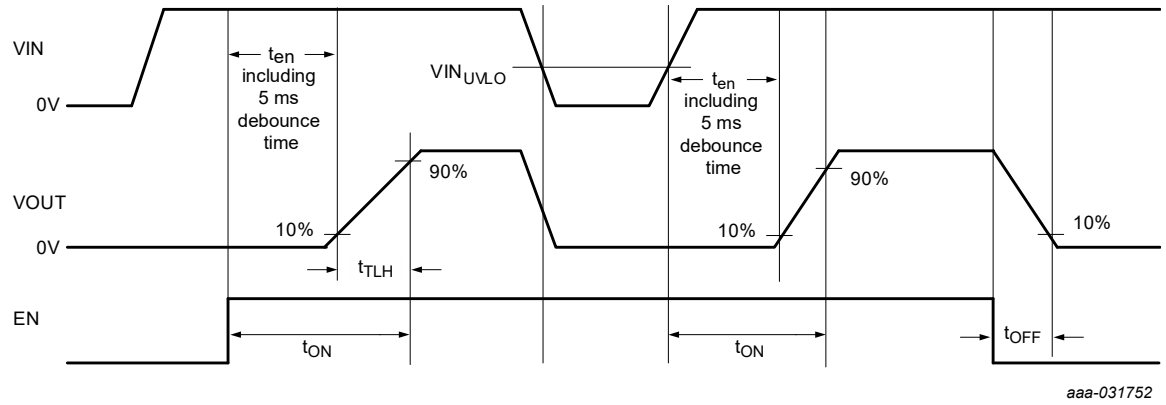

Figure 5. Timing diagram at start up

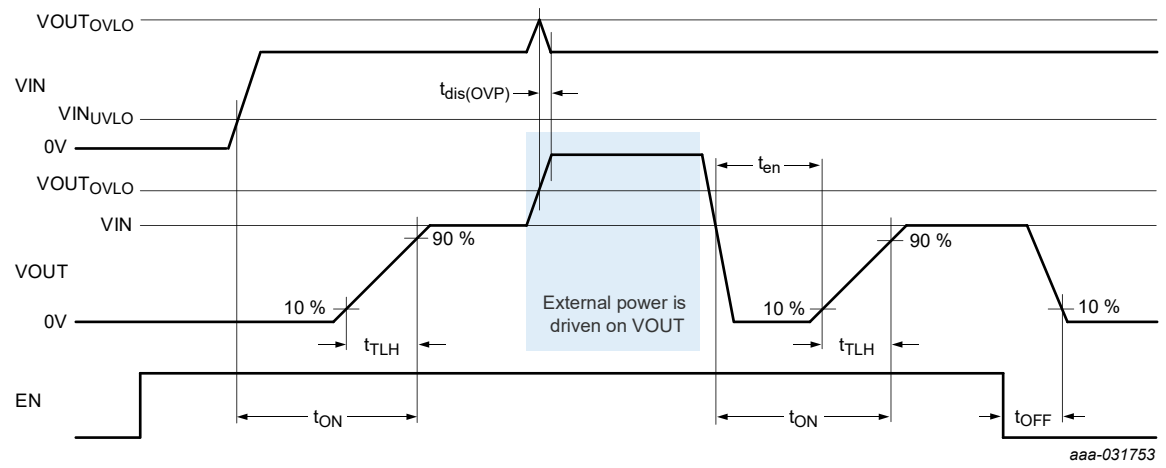

Figure 6. Timing diagram when VOUT is driven by external power

8 Application diagram

The NX30P0121UK is typically used to add wireless charger path in single input switching mode charger application. If wireless charger is used, then NX30P0121UK bridge wireless charger output to the switching mode charger, protecting wireless charger from up to 29V which could be from VBUS.

For best performance, it is recommended to keep input and output traces short and wide, and capacitors as close to the device as possible. Regarding thermal performance, it is recommended to increase the PCB area around VIN and VOUT pins.

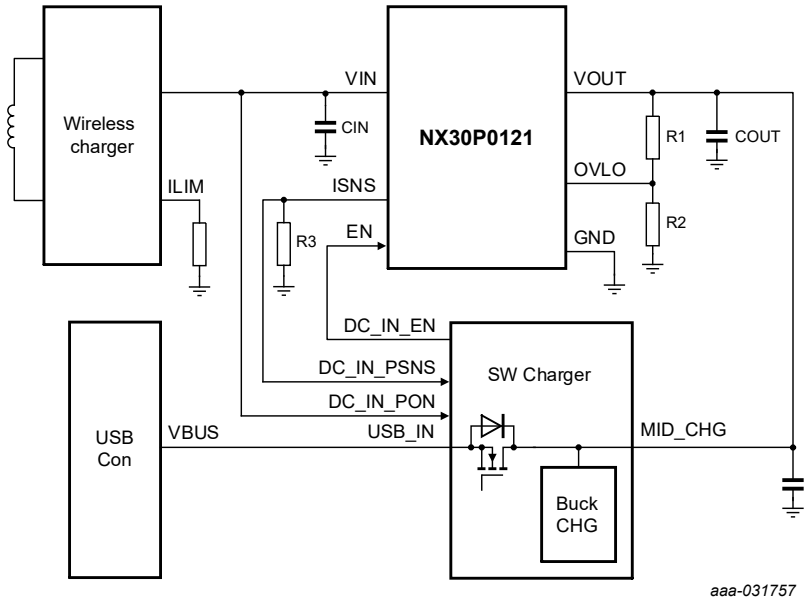

Figure 7. NX30P0121UK application diagram

9 Limiting values

Table 5. Limiting values (absolute maximum ratings)

Symbol	Parameter	Conditions	Min	Max	Unit
V_I	Input voltage (with respect to GND)	VIN	-0.5	+29	V
		VOUT	-0.5	+29	V
		OVLO	-0.5	VOUT	V
		EN	-0.5	+29	V
		ISNS	-0.5	+6	V
I_{IK}	Input clamping current	EN; VI < -0.5 V	-50	-	mA
I_{SK}	Switch clamping current	VIN, VOUT; VI < -0.5 V	-50	-	mA
I_{SW}	Continuous switch current	T_{amb} = 85 °C	-	+3.0	A
		T_{amb} = 105 °C	-	+3.0	A
	Peak switch current	130µs pulse, 5% duty cycle at 85 °C	-	+10	A
T_{stg}	Storage temperature		-65	+150	°C
P_{tot}	Total power dissipation	T_{amb} = 25 °C	-	1.45	W

10 Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_I	input voltage (with respect to GND)	VIN	2.5	20	V
		VOUT	2.5	20	V
		EN	0	20	V

Symbol	Parameter	Conditions	Min	Max	Unit
		ISNS	0	+6	V
$T_{j(max)}$	Maximum junction temperature		-40	+125	°C
T_{amb}	Ambient temperature		-40	+85	°C

11 Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient		[1] [2]	70.8	°C/W

[1] *Determined in accordance to JEDEC JESD51-2A natural convection environment. Thermal resistance data in this report is solely for a thermal performance comparison of one package to another in a standardized specified environment. It is not meant to predict the performance of a package in an application-specific environment*

[2] Thermal test board meets JEDEC specification for this package (JESD51-9).

12 Electrical characteristics

12.1 Static characteristics

Table 8. Static characteristics

At recommended input voltages and T_{amb} = -40°C to +85°C; voltages are referenced to GND (ground = 0 V); unless otherwise specified.

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
I_q	V_{IN} quiescent current	EN = 1.8V, V_{IN} = 5V, IO = 0A	-	110	-	-	170	µA
		EN = 1.8V, V_{IN} = 14V, IO = 0A	-	140	-	-	220	µA
I_{SHDN}	V_{IN} shutdown leakage current	EN = 0V, V_{IN} = 5.0V; V_{OUT} = 0V	-	5	-	2	10	µA
	V_{OUT} shutdown Leakage current	EN = 0V, V_{OUT}= 5.0 V, V_{IN} = 0 V	-	1	3	-	5	µA
I_{OVLO}	OVLO input leakage Current	V_{OVLO}=$V_{th(OVLO)}$	-	0.5	-	-	25	nA
R_{ON}	ON resistance	V_{IN} = 5.0 V	-	54	66	-	79	mΩ
		V_{IN} = 14 V	-	54	66	-	79	mΩ
V_{INUVLO}	V_{IN} UVLO voltage	V_{IN} Rising; EN = 1.8V	2.2	2.37	2.55	2.1	2.6	V
$V_{INhys(UVLO)}$	V_{IN} UVLO hysteresis voltage	V_{IN} Falling	-	110	-	-	140	mV
$V_{OUTOVLO}$	Default overvoltage lockout voltage	V_{OUT} Rising; EN = 1.8V OVLO short to GND	-	14.5	-	13.5	15.3	V

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
		V_{OUT} Falling; EN = 1.8V OVLO short to GND	-	14.2	-	13.2	15.0	V
$V_{th(OVLO)}$	external OVLO set threshold voltage	V_{OUT}= 2.5 V to 20 V; EN = 1.8V	1.163	1.227	1.288	1.16	1.3	V
V_{IH}	HIGH-level input voltage	EN pin; V_{IN} = 2.5 V to 20 V	1.2	-	-	1.2	-	V
V_{IL}	LOW-level input voltage	EN pin; V_{IN} = 2.5 V to 20 V	-	-	0.4	-	0.4	V
R_{pd}	pull-down resistance	EN	-	1	-	0.7	1.4	MΩ
C_I	input capacitance	EN pin; V_{IN} = 5V	-	2	-	-	-	pF
K	Current sensing ratio	I_{IN} / I_{ISNS} , I_{IN} = 1A, V_{IN} = 5V, EN =1.8V		1050		1010	1090	A/A
V_{ISNS}	ISNS voltage	I_{IN} = 2A, R_{ISNS} = 400Ω, V_{IN} = 5V, V_{IN} > 3.0V		0.762				V
V_{ISNS}	ISNS voltage	I_{IN} = 1A, R_{ISNS} = 806Ω, V_{IN} = 5V, V_{IN} > 3.0V		0.767				V
V_{ISNS}	ISNS voltage	I_{IN} = 0.5A, R_{ISNS} = 806Ω, V_{IN} = 5V, V_{IN} > 3.0V		0.384				V
$T_{th(OTP)}$	Over temperature shutdown threshold	EN = 1.8V	-	145	-	-	-	°C
$T_{th(OTP)Hys}$	Over temperature shutdown threshold hysteresis	EN = 1.8V	-	30	-	-	-	°C

12.2 Dynamic characteristics

Table 9. Dynamic characteristics

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
t_{en}	Enable Time	From EN to V_{OUT} = 10% of V_{IN}; V_{IN} = 5 V; C_{OUT} =10µF; R_{Load} = 100Ω includes 2ms V_{IN} debounce time	3.5	5.5	8.0	3.0	11.0	ms
t_{TLH}	V_{OUT} rise time	V_{OUT} from 10% to 90% of V_{IN}; C_{OUT} = 10µF; R_{OUT} = 100Ω						
		V_{IN} = 5 V	-	1.8	-	-	-	ms
		V_{IN} =14 V	-	3.0	-	-	-	ms
$t_{dis(OVP)}$	OVP turn off time	From V_{OUT} > $VOUT_{OVLO}$ to V_{VIN} = 80% of V_{OUT}; Rload_V_{IN} = 100Ω,;C_{IN} = 0uF; V_{IN} = 12V; OVLO pin short to GND	-	70	-	-	-	ns
t_{on}	turn-on time	EN to V_{OUT}= 90% of V_{IN}						

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
		V_{IN}= 5.0 V	-	7.5	-	5.0	10.0	ms
		V_{IN} = 14.0 V	-	9.0	-	-	-	ms
t_{off}	turn-off time	EN to V_{OUT} = 10% V_{IN}						
		V_{IN} = 5.0 V; C_{OUT} = 10µF; R_{OUT} = 100Ω	-	2.6	4.0	-	4.0	ms
		V_{IN} = 14 V; C_{OUT} = 10µF; R_{OUT} = 100Ω	-	2.6	-	-	-	ms

12.3 Graphs

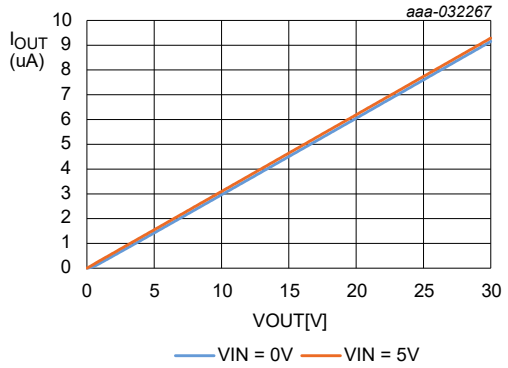

Figure 8. VOUT leakage current (EN = 0V)

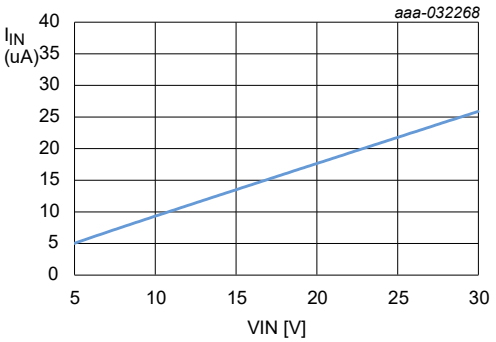

Figure 9. VIN leakage current (EN = 0V)

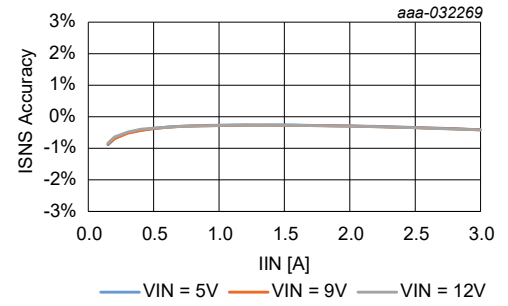

Figure 10. ISNS accuracy (R_{ISNS} = 806Ω)

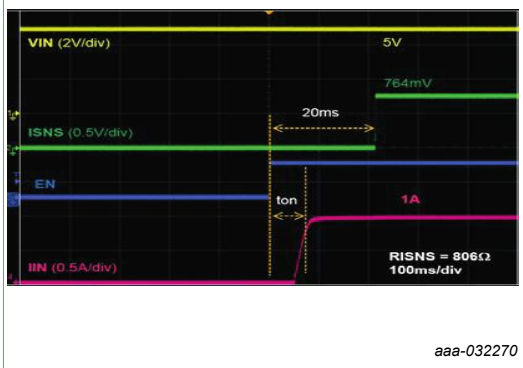

Figure 11. Startup (R_{ISNS} = 806Ω)

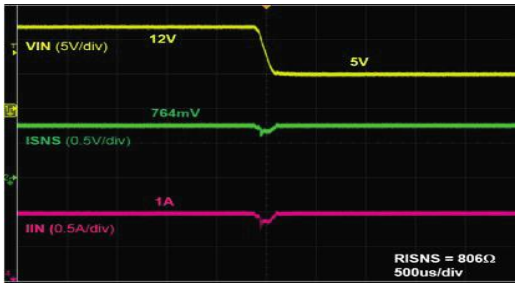

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Figure 12. ISNS response time on VIN change

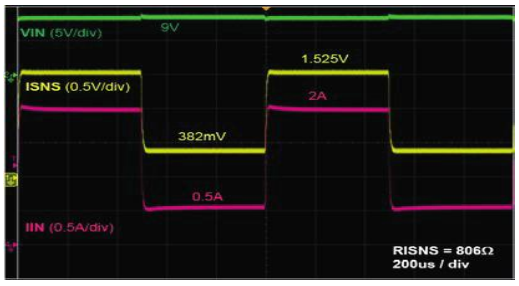

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Figure 13. ISNS response time on load change

13 Package outline

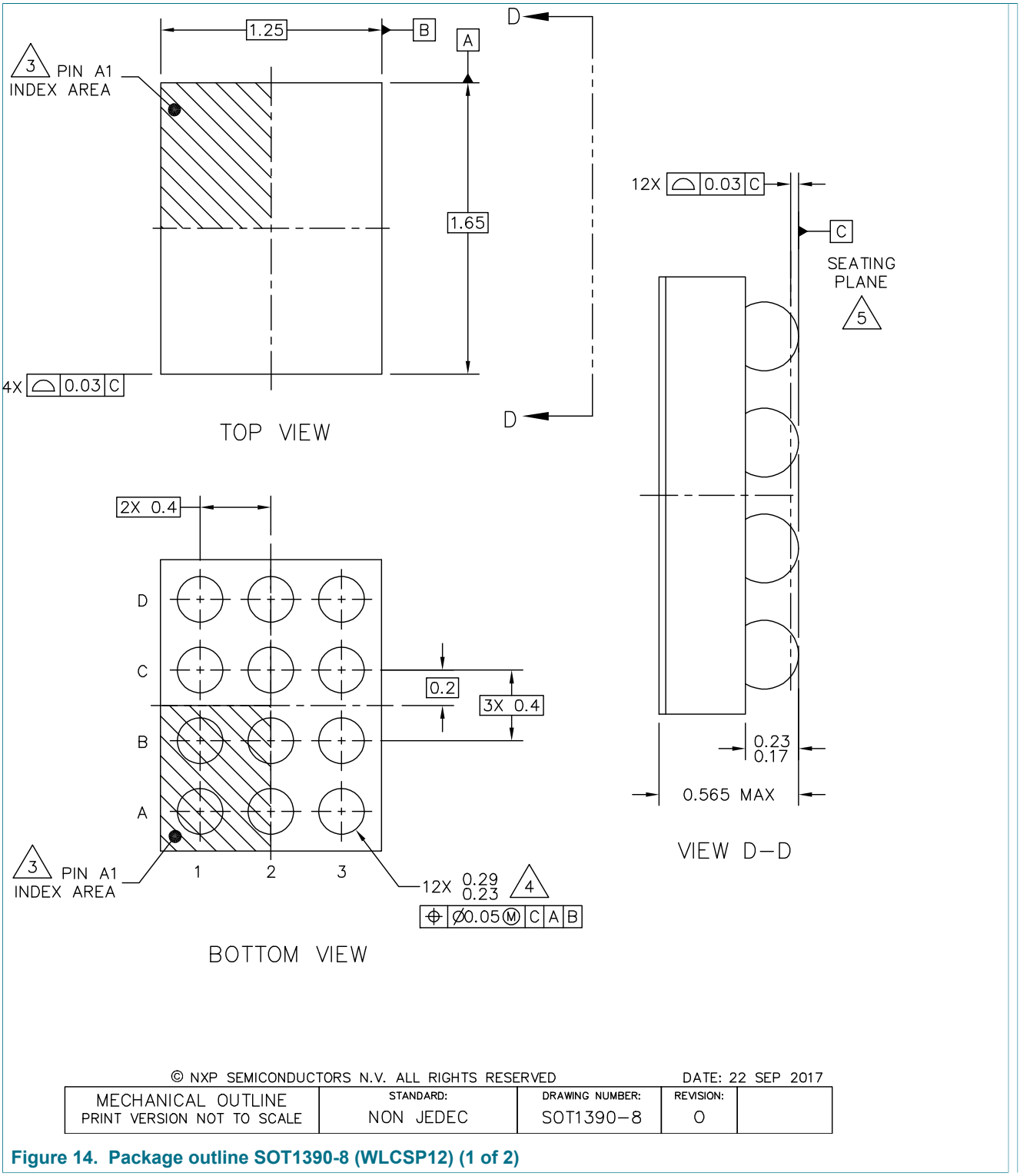


Figure 14. Package outline SOT1390-8 (WLCSP12) (1 of 2)

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.
3. PIN A1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. MAXIMUM SOLDER BALL DIAMETER MEASURED PARALLEL TO DATUM C.
5. DATUM C, THE SEATING PLANE, IS DETERMINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
6. THIS PACKAGE HAS A BACK SIDE COATING THICKNESS OF 0.025.

DATE: 22 SEP 2017

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE	STANDARD: NON JEDEC	DRAWING NUMBER: SOT1390–8	REVISION: O	

Figure 15. Package outline SOT1390-8 (WLCSP12) (2 of 2)

14 Soldering

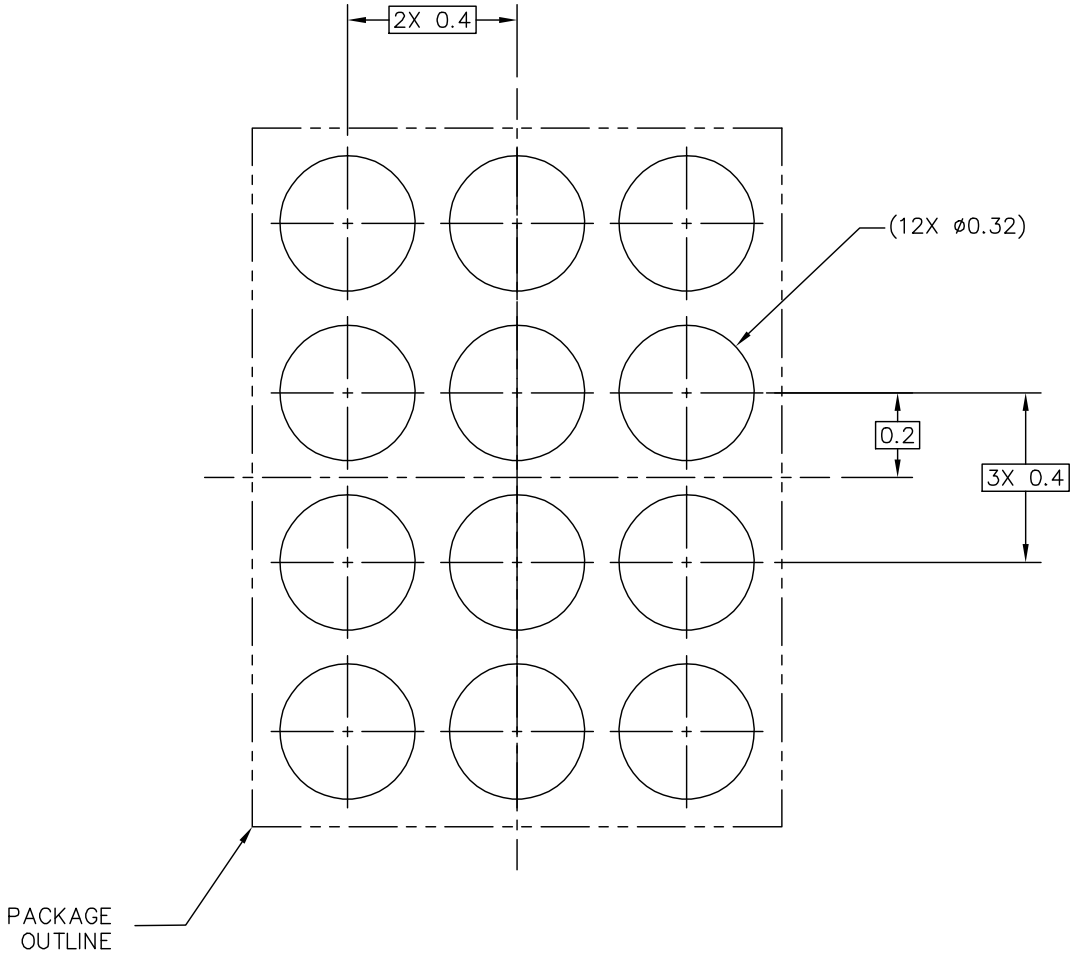
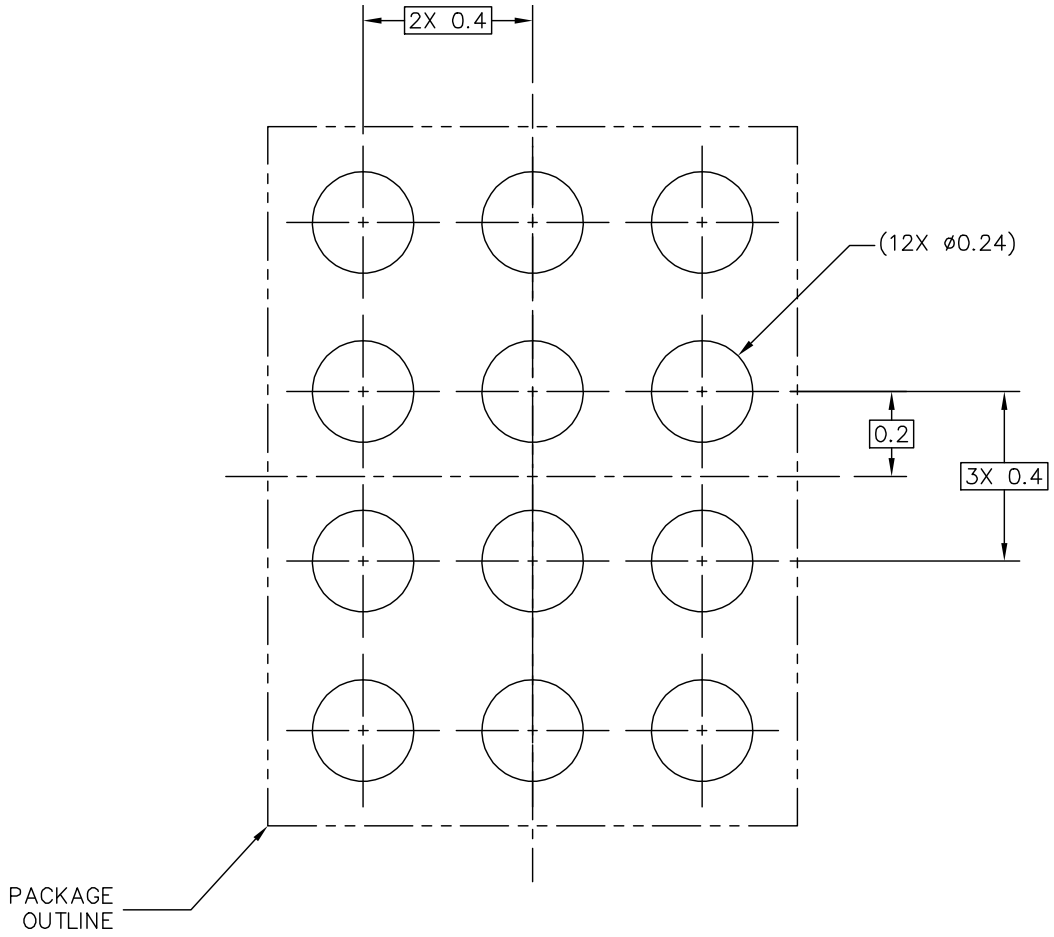


Figure 16. Reflow soldering footprint for SOT1390-8



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 DATE: 22 SEP 2017

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Figure 17. Reflow soldering footprint part2 for WLCSP12 (SOT1390-8)

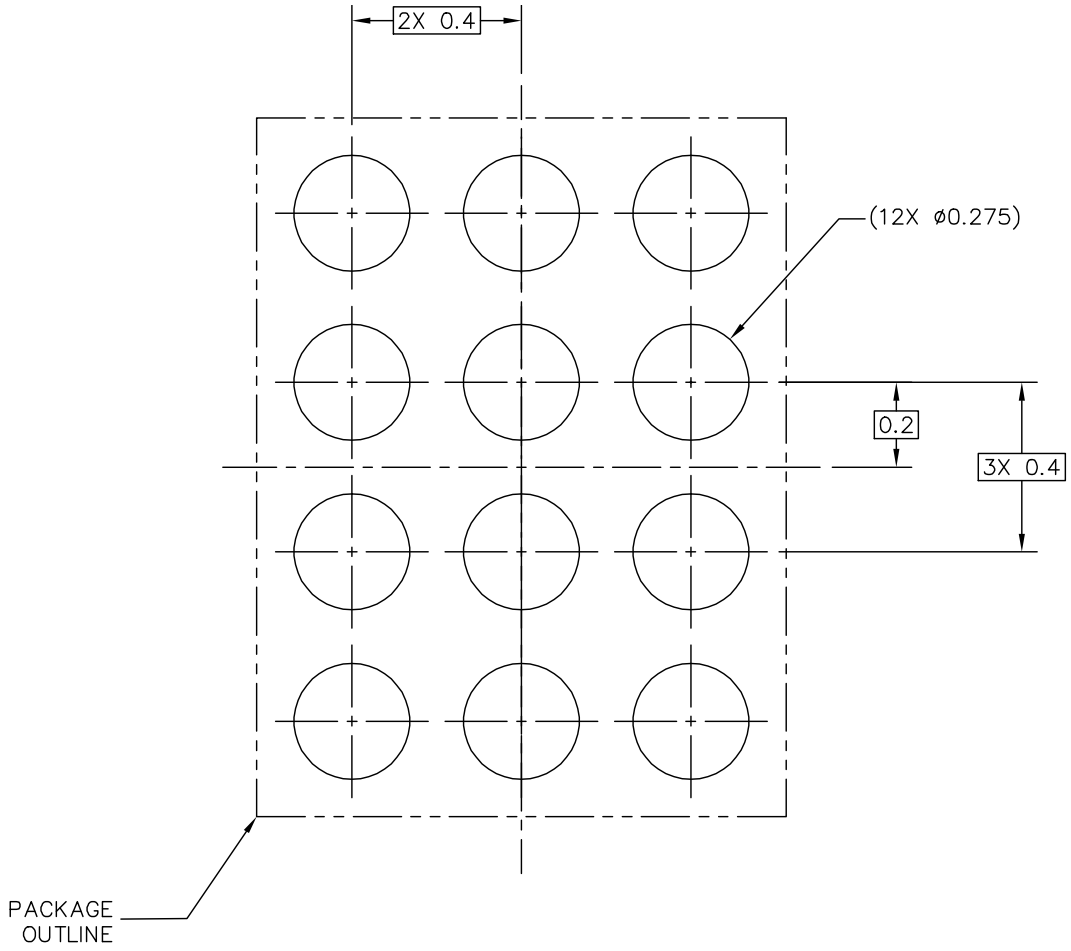

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Figure 18. Reflow soldering footprint part3 for WLCSP12 (SOT1390-8)

15 Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NX30P0121 v.1.0	20190619	Product data sheet	-	-

16 Legal information

16.1 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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