



# NXQ1TXL5

Low-cost one-chip 5 V Qi compliant transmitter

Rev. 1 — 8 April 2016

Product short data sheet

## 1. General description

The NXQ1TXL5 is a controller and driver IC for a low-cost 5 V Qi-compliant low-power wireless charger. It offers a fully integrated solution that includes a 5 V full-bridge power stage, as defined in Wireless Power Consortium (WPC) 5 V Qi standards A5, A11, A12 and A16.

The NXQ1TXL5 uses a dedicated analog ping circuitry to detect devices. With this analog ping circuitry, an extremely low standby (wait state) power consumption is achieved. When a Qi-compliant receiver is placed, the NXQ1TXL5 starts to communicate with it. After the receiver is recognized, it safely initiates wireless power transfer from the transmitter to the receiver. The device is optimized to operate from a 5 V USB power supply and uses Smart Power Limiting (SPL) to adjust the output power automatically to compensate for power-limited supplies. This low-cost version of the fully integrated NXP Qi-compliant wireless power transmitter does not support Foreign Object Detection (FOD).

To indicate the charging status or standby status, the NXQ1TXL5 has two LED outputs for the user interface.

The NXQ1TXL5 is available in a 5 mm × 5 mm, 32-pin HVQFN package.

## 2. Features and benefits

- Single-chip WPC Qi-compliant device for A5/A11/A12/A16 5 V single-coil low-power transmitter
- Operates from 5 V supply
- Integrated high efficiency full-bridge power stage with low EMI radiation meeting EN55022 radiated and conducted emission limits
- Very few external components required, minimizing cost and board space
- Extremely low-power receiver detection circuitry by integrating an analog ping circuit; standby (wait state) power 10 mW (typical)
- Power stage protected against overcurrents and overtemperature
- Dual-channel ASK demodulation
- Demodulates communication packets from Qi-compliant receivers
- PID regulation for power drive and control
- Internal 1.8 V digital supply generation
- Two LED outputs



- On-chip thermal protection
- Small HVQFN 32-pin package (5 mm × 5 mm) with 0.5 mm pitch
- Peak efficiency > 75 %
- Excellent low power (< 2 W) transfer efficiency. Ideal for charging wearables

### 3. Applications

- Wireless Power Consortium (WPC) Qi-compliant wireless power transmitters
- Wireless charger for (smart)phones, toys, shavers, pads, and other handheld devices
- High-efficiency low-power wireless charger for smartwatches and other wearables

### 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DDP</sub>	power supply voltage	on pins VDDP1 and VDDP2	3.4	-	5.25	V
I <sub>DDP</sub>	power supply current	on pins VDDP1 and VDDP2				
		wait state (average current)	-	2	-	mA
		power transfer state (no load)	-	15	-	mA
		power transfer state (with load)	-	1.5	5 <sup>[1]</sup>	A

[1] The maximum average current is 2 A. However, when removing the receiver, the power stage current protection limits the peak current at 5 A.

### 5. Ordering information

Table 2. Ordering information

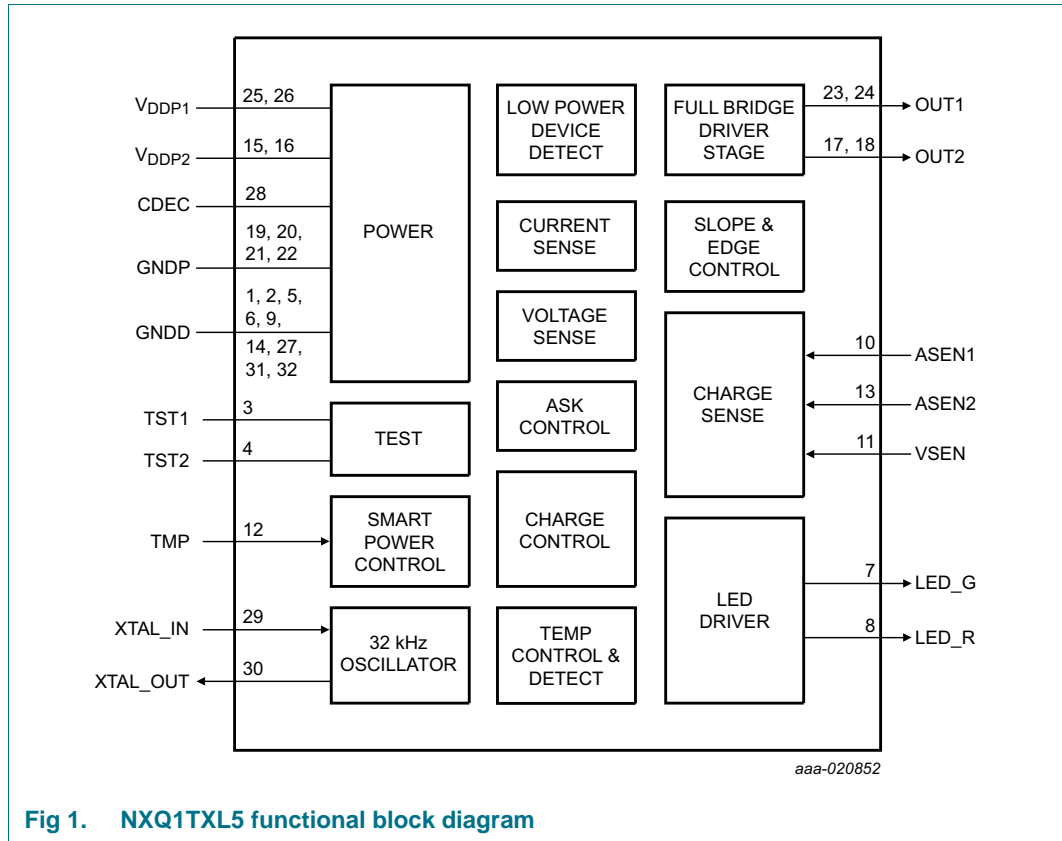
Type number	Package		Version
	Name	Description	
NXQ1TXL5	HVQFN32	plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 × 5 × 0.85 mm	SOT617-3

#### 5.1 Ordering options

Table 3. Ordering options

Type number	Orderable part number	Package	Packing method	Minimum ordering quantity	Temperature
NXQ1TXL5	NXQ1TXL5/101J	HVQFN32	reel 13" Q1/T1, *standard mark SMD non-dry-pack	6000	T <sub>amb</sub> = -20 °C to +85 °C

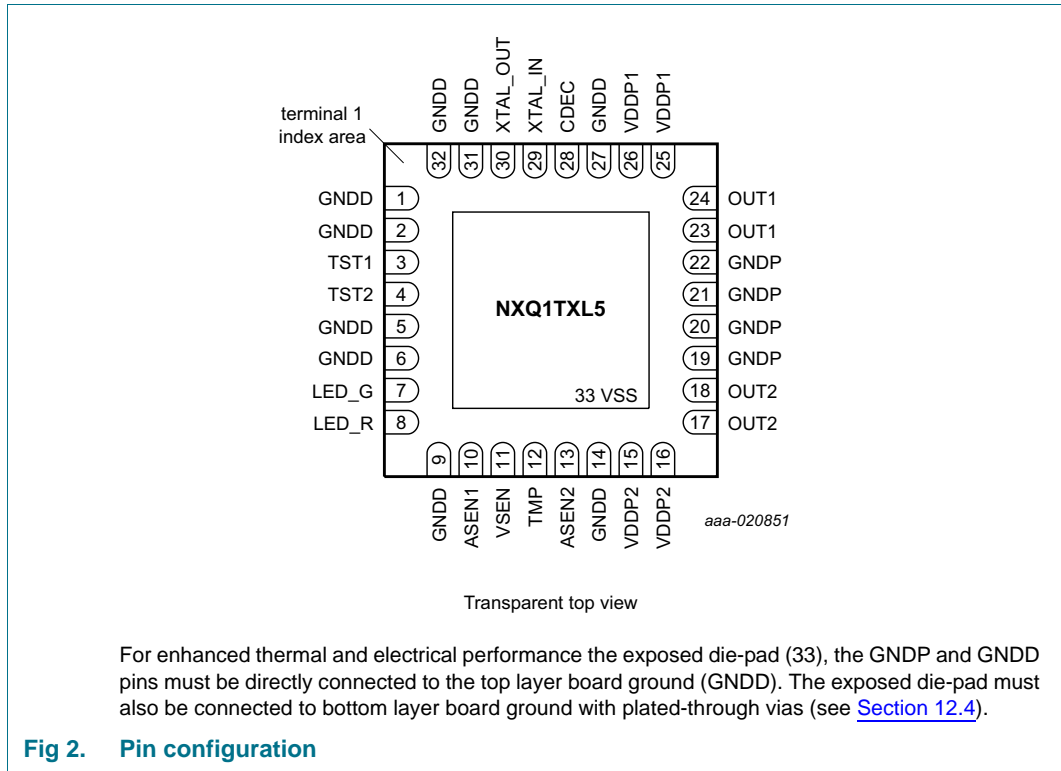
## 6. Block diagram



**Fig 1. NXQ1TXL5 functional block diagram**

## 7. Pinning information

### 7.1 Pinning



### 7.2 Pin description

**Table 4. Pin description**

Symbol	Pin	Type	Description
GNDD	1	I	digital ground
GNDD	2	I	digital ground
TST1	3	I	test pin 1
TST2	4	I	test pin 2
GNDD	5	O	digital ground
GNDD	6	I	digital ground
LED_G	7	O	green LED output
LED_R	8	O	red LED output
GNDD	9	I	digital ground
ASEN1	10	I	analog sense input 1
VSEN	11	I	coil voltage sense
TMP	12	I	enable/disable temperature reduction
ASEN2	13	I	analog sense input 2
GNDD	14	I	digital ground
VDDP2	15, 16	P	power supply pin 2

Table 4. Pin description ...continued

Symbol	Pin	Type	Description
OUT2	17, 18	O	transmitter output 2
GNDP	19, 20, 21, 22	P	power ground
OUT1	23, 24	O	transmitter output 1
VDDP1	25, 26	P	power supply pin 1
GNDD	27	P	digital ground
CDEC	28	P	decoupling connection for internal LDO
XTAL_IN	29	I	crystal input
XTAL_OUT	30	O	crystal output
GNDD	31	I/O	digital ground
GNDD	32	O	digital ground

## 8. Functional description

The NXQ1TXL5 is a fully integrated 5 V wireless charger with an internal full-bridge power stage. It efficiently integrates all the functions required to control the power transfer with a Qi-compliant receiver. It can deliver up to 8 W continuous power into the Qi-compliant type A5, A11, A12 or A16 transmitter coil.

[Figure 1](#) shows a block diagram of the NXQ1TXL5. It is operational when a 5 V supply is connected and pin STBY is LOW. The NXQ1TXL5 starts checking for a device on the transmitter base station. When a receiver is detected, power transfer is initiated for the detected receiver.

### 8.1 NXQ1TXL5 operating states

The NXQ1TXL5 supports a number of operating states:

- **Power-on state:**  
The NXQ1TXL5 generates a power-on LED blinking sequence after which it is operational.
- **Wait state (analog and digital ping):**  
The NXQ1TXL5 performs extremely low-power device detection using analog circuitry in analog ping mode. The NXQ1TXL5 performs standard device detection using the DSP in digital ping mode.
- **ID and config state:**  
The NXQ1TXL5 communicates with and begins to supply power to a Qi-compliant receiver.
- **Power transfer state:**  
The NXQ1TXL5 charges the Qi-compliant receiver in power transfer state.
- **Charged state:**  
The NXQ1TXL5 switches to charged state when it receives a 'charge complete' message from the receiver.
- **Fault state:**  
The NXQ1TXL5 switches to a fault state when:
  - A receiver error is reported
  - A receiver/transmitter overtemperature condition occurs

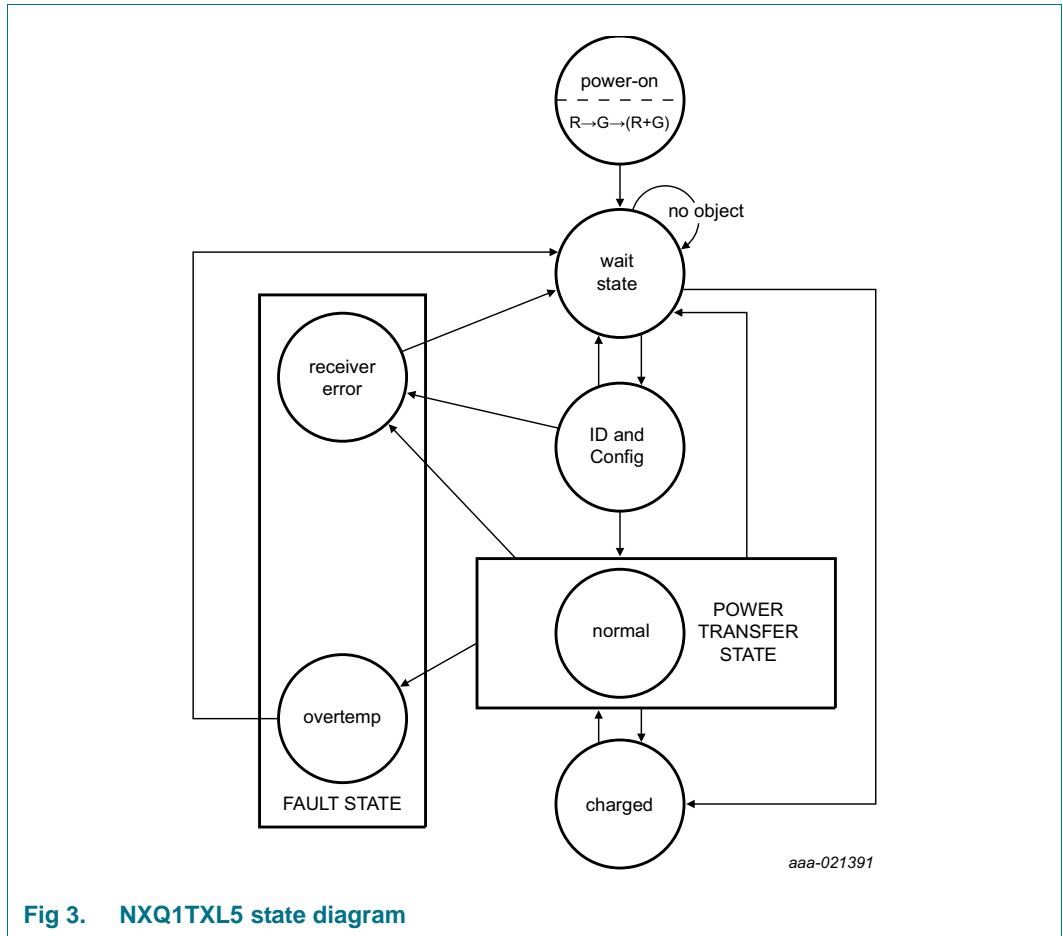


Fig 3. NXQ1TXL5 state diagram

## 8.2 Protections

The NXQ1TXL5 incorporates two built-in protections.

- Temperature reduction and temperature protection mechanism
- OverCurrent Protection (OCP)

## 9. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to ground. See Limiting Values disclaimer in [Section 15.3](#).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DDP</sub>	power supply voltage	on pin VDDP1 and VDDP2	-0.3	+6.0	V
T <sub>j</sub>	junction temperature		-	+150	°C
T <sub>stg</sub>	storage temperature		-55	+150	°C
T <sub>amb</sub>	ambient temperature		-20	+85	°C
V <sub>ESD</sub>	electrostatic discharge voltage	according to the Human Body Model (HBM)	-2	+2	kV
		according to the Charge Device Model (CDM)	-500	+500	V

## 10. Thermal characteristics

**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	2-layer application board positioned horizontally in free air; dimensions 45 mm × 45 mm × 0.8 mm; natural convection; copper coverage on each layer > 95 %; copper thickness each layer 70 μm	30	K/W

## 11. Characteristics

**Table 7. DC characteristics**

T<sub>amb</sub> = 25 °C, default settings unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DDP</sub>	power supply voltage	on pin VDDP1 and VDDP2 <a href="#">[1]</a>	3.4	-	5.25	V
I <sub>DDP</sub>	power supply current	on pins VDDP1 and VDDP2:				
		wait state (peak current) <a href="#">[2]</a>	-	1	-	A
		wait state (average current) <a href="#">[2]</a>	-	2	-	mA
		standby state (STBY HIGH)	-	15	50	μA
		power transfer state (no-load)	-	15	-	mA
		power transfer state (average current with load) <a href="#">[2]</a>	-	-	2	A
power transfer state (absolute peak current with load)	-	-	5	A		

- [1] The maximum DC V<sub>DDP</sub> input voltage is 5.25 V. However, at the maximum load, spikes can occur due to high di/dt. With the proper decoupling circuitry and snubbers at the outputs, these spikes must never exceed 7 V (see [Section 12.2](#) and [Section 12.3](#)).
- [2] The current consumption depends on the load impedance of the LC tank connected to the output stage at 175 kHz. Assumed typical value: L = 6.3 μF, 60 mΩ and C = 384 nF.



**Table 8. AC characteristics** $T_{amb} = 25\text{ }^{\circ}\text{C}$ , default settings unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Full-bridge power stage</b>						
$f_{sw}$	switching frequency	start-up and power transfer states	110	-	205	kHz
$f_{sw(step)}$	switching frequency step size	start-up and power transfer states	-	500	-	Hz
$\delta$	duty cycle	start-up and power transfer states	10	-	50	%
$\delta_{step}$	duty cycle step size	start-up and power transfer states	-	0.1	-	%
<b>Pins CNF_IN, ASEN1, ASEN2, VSEN, and TMP</b>						
$V_I$	input voltage	operating range	[1] 0	-	1.5	V
<b>LED_G, LED_R</b>						
$V_O$	output voltage	set externally	400	-	$V_{DDP}$	mV
$I_{load}$	load current	open-drain output	[2] -	-	20	mA
<b>Test pins (TST1 and TST2)</b>						
$V_{IH}$	HIGH-level input voltage		1	-	3.6	V
$V_{IL}$	LOW-level input voltage		-	-	0.6	V
<b>Oscillator: pins XTAL_IN and XTAL_OUT</b>						
$V_I$	input voltage		-	-	1.8	V
<b>External crystal requirements</b>						
$f_{nom}$	nominal frequency		32	32.768	33.5	kHz
$D_L$	drive level		-	-	1	$\mu\text{W}$
$C_L$	load capacitance		[3] 8	12	14	pF

[1] The nominal operating range is from 0 V to 1.5 V. However, any level between 1.5 V and  $V_{DDP}$  has the same effect (as 1.5 V).

[2] The output voltage at maximum load current is guaranteed not to exceed 400 mV.

[3] The load capacitors are embedded in the NXQ1TXL5.

## 12. Application information

### 12.1 Crystal oscillator

The NXQ1TXL5 uses an external low-cost 32.768 kHz crystal, with a 1 % accuracy. The crystal should support a load capacitance of  $\approx 12$  pF (the load capacitance is embedded in the NXQ1TXL5). Do not connect the crystal to the NXQ1TXL5 using vias, but directly on the top layer of the PCB. If possible, shield the crystal by connecting the casing to ground. The crystal is connected to the oscillator input pin (XTAL\_IN) via a 2.2 pF series capacitor.

### 12.2 Supply decoupling

Effective supply decoupling is required. The decoupling capacitors must be chosen such that the effective capacitance is at least 10  $\mu$ F at a DC bias voltage of 5.5 V. The frequency must be 205 kHz for each supply pin. X5R capacitors of 22  $\mu$ F normally fulfill this requirement. To prevent spikes that are too high on the VDDP pins and to improve HF behavior and reduce EMI, use smaller (10 nF) high-quality capacitors. These capacitors must be mounted as close as possible to the VDDP pins of the NXQ1TXL5 in parallel with the 22  $\mu$ F capacitors (see [Figure 4](#)).

### 12.3 Snubber network

Snubber RC networks are connected to outputs OUT1 and OUT2. Each snubber network consists of a 6.8 nF capacitor in series with a 1  $\Omega$  resistor to ground (see [Figure 4](#)). The snubber network must be connected as close as possible to the NXQ1TXL5 OUT1 and OUT2 pins.

### 12.4 Exposed die-pad ground and thermal connection

For optimal thermal and electrical performance, the device bottom exposed VSS pin (pin 33) MUST be soldered to a PCB solder land under the exposed die-pad. For good electrical contact and thermal flow from the device to the bottom copper layer, the PCB solder pad under the device must be connected with plated-through vias to the copper bottom layer of the PCB. In this way, the PCB bottom copper layer can provide heat sinking for the device dissipation.

In the NXQ1TXL5 application note examples are provided for recommended layouts with good thermal and electrical performance.

### 12.5 Support interface

For NXP Semiconductors support purposes, connecting interface wires must be made possible to check DSP operation. To connect the interface wires, the NXQ1TXL5 the test interface pins (pins 3 and 4) must be made available on the PCB layout as exposed test-pads with minimum 2 mm<sup>2</sup> solder area. A test pad for ground connection must also be placed close to these test-pad connections. Do not connect pull-up resistors to VDDP for the test interface pins.



### 12.7 Efficiency

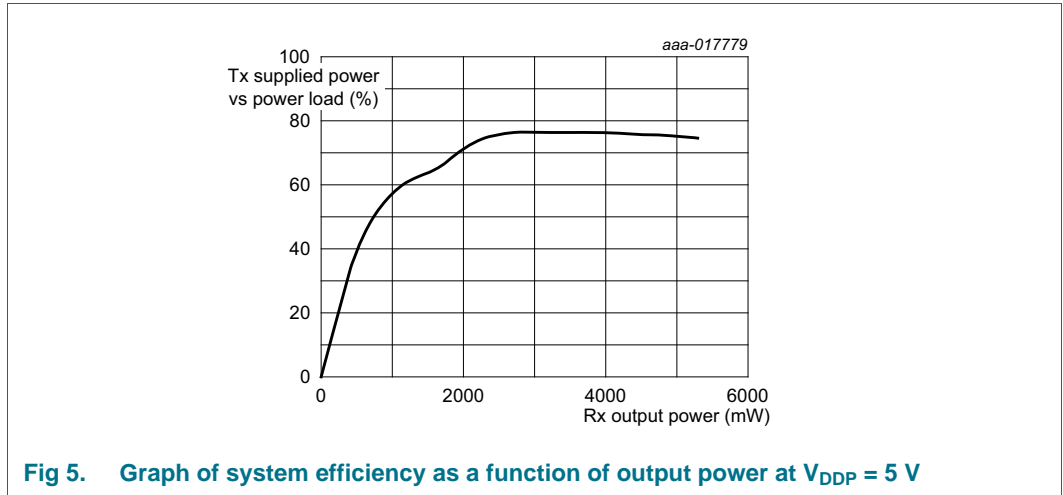


Fig 5. Graph of system efficiency as a function of output power at  $V_{DDP} = 5\text{ V}$

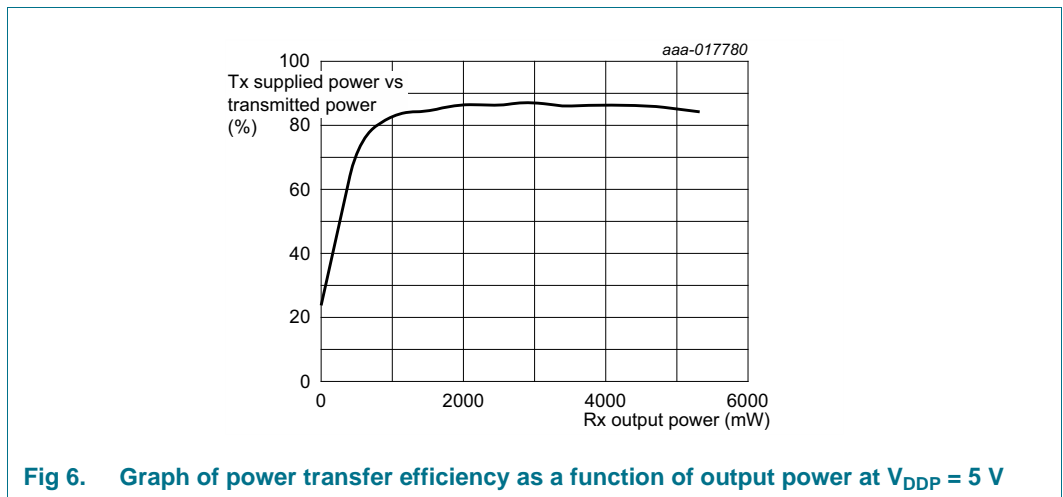


Fig 6. Graph of power transfer efficiency as a function of output power at  $V_{DDP} = 5\text{ V}$

**Remark:** The curves in [Figure 5](#) and [Figure 6](#) are measured on the NXP Semiconductors DB1340 boards with:

- Coil: Elec&Eltek (E&E); Y31-60055F
- Capacitors:
  - 82 nF; 5 %; 50 V; C0G; 1206; Murata; GRM31C5C1H823JA01L
  - 100 nF; 5 %; 50 V; C0G; 1206; TDK; CGA5L2C0G1H104J160AA

13. Package outline

HVQFN32: plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 x 5 x 0.85 mm

SOT617-3

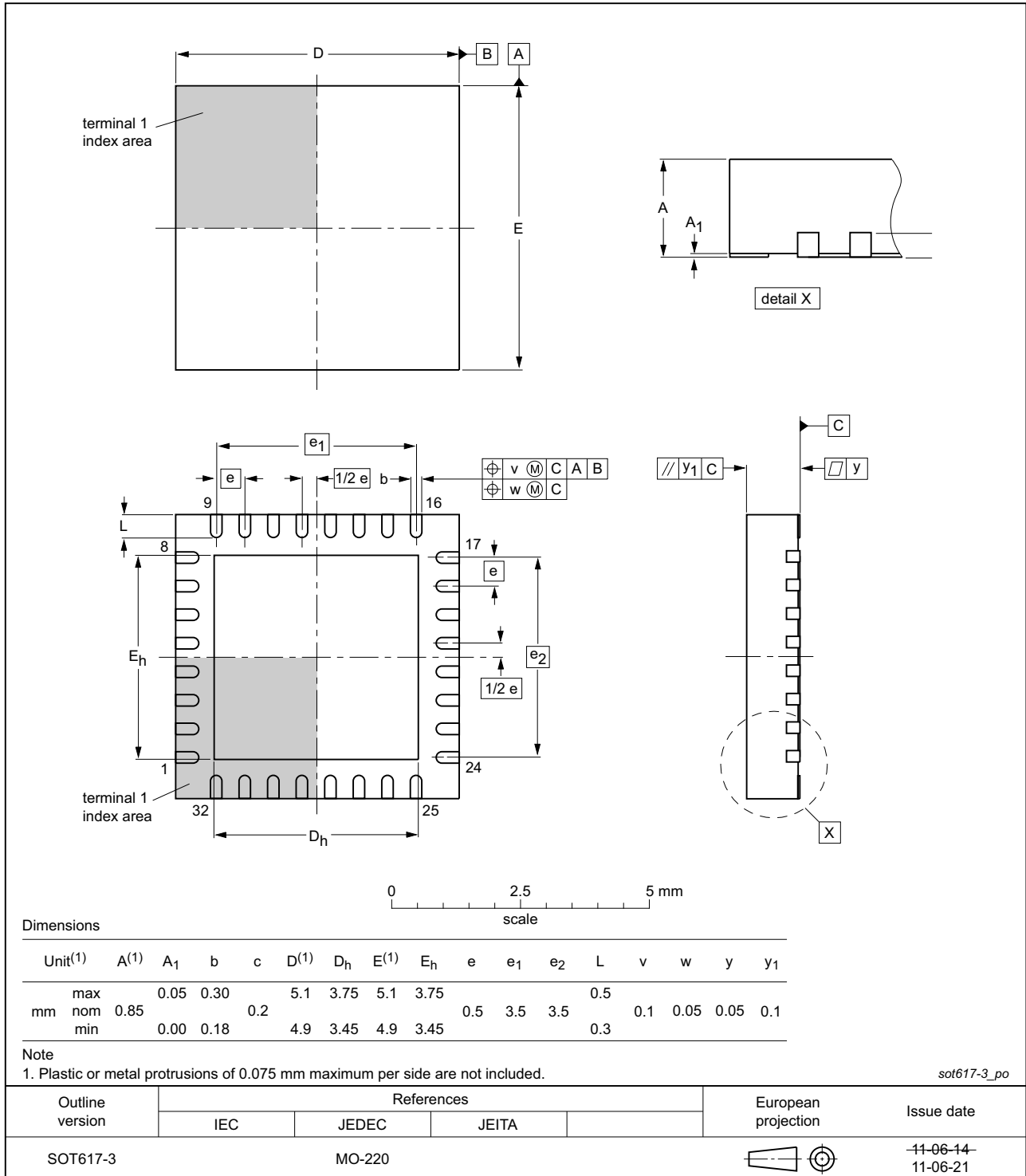


Fig 7. Package outline SOT617-3 (HVQFN32)

## 14. Revision history

Table 9. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NXQ1TXL5 v.1	20160408	Product short data sheet	-	-

## 15. Legal information

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Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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**17. Contents**

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

**2 Features and benefits . . . . . 1**

**3 Applications . . . . . 2**

**4 Quick reference data . . . . . 2**

**5 Ordering information . . . . . 2**

5.1 Ordering options . . . . . 2

**6 Block diagram . . . . . 3**

**7 Pinning information . . . . . 4**

7.1 Pinning . . . . . 4

7.2 Pin description . . . . . 4

**8 Functional description . . . . . 6**

8.1 NXQ1TXL5 operating states . . . . . 6

8.2 Protections . . . . . 7

**9 Limiting values . . . . . 8**

**10 Thermal characteristics . . . . . 8**

**11 Characteristics . . . . . 8**

**12 Application information . . . . . 10**

12.1 Crystal oscillator . . . . . 10

12.2 Supply decoupling . . . . . 10

12.3 Snubber network . . . . . 10

12.4 Exposed die-pad ground and thermal connection . . . . . 10

12.5 Support interface . . . . . 10

12.6 Application diagram . . . . . 11

12.7 Efficiency . . . . . 12

**13 Package outline . . . . . 13**

**14 Revision history . . . . . 14**

**15 Legal information . . . . . 15**

15.1 Data sheet status . . . . . 15

15.2 Definitions . . . . . 15

15.3 Disclaimers . . . . . 15

15.4 Trademarks . . . . . 16

**16 Contact information . . . . . 16**

**17 Contents . . . . . 17**

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