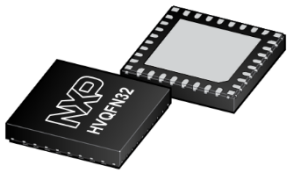
FS2400_SDS

Fail-safe system basis chip with SMPS and LDO, CAN FD transceiver

Rev. 1 — 30 January 2024 **Product short data sheet**



Document information

Information	Content
Keywords	Fail-safe system basis chip, SMPS, LDO, CAN FD transceiver, ultra-wide band (UWB), Near Field Communication (NFC), Bluetooth Low Energy (BLE) devices, small applications, low power
Abstract	The FS2400 is a family of automotive safety system basis chip devices with multiple power supplies designed to support secure car-access applications while maintaining flexibility to fit other small applications requiring low power and CAN FD communication.

1 General description

FS2400 is a family of automotive safety system basis chip (SBC) devices with multiple power supplies designed to support secure car access application using ultra-wide band (UWB), near-field communication (NFC), and Bluetooth Low Energy (BLE) devices. The FS2400 can also fit other small applications requiring low power and CAN FD communication.

This family of devices supports a wide range of applications, offering a choice of output voltage settings, physical interface, integrated system-level features to address low-power and noise-sensitive applications with automotive safety integrity levels (ASIL) up to ASIL B.

The FS2400 integrates a battery-connected switched-mode regulator (V1) and a battery-connected linear regulator (V3) to supply microcontroller, communication devices, and others. V1 offers a high-performance switching regulator capable of operating in Pulse Frequency Modulation (PFM) mode and Force Pulse Width Modulation (FPWM) mode. The mode of operation can be changed using wake pins to optimize noise management.

The FS2400 is developed in compliance with the ISO 26262:2018 standard. It includes enhanced safety features, with fail-safe output, becoming part of a full safety-oriented system, covering ASIL B safety integrity level.

The FS2400 is offered in a 5 mm x 5 mm, 32-Ld HVQFN package with wettable flanks.

2 Features and benefits

Operating range

- 40 V DC maximum input voltage
- Low-power off mode with low sleep current and multiple wake-up sources
- Low-power on mode with HVBUCK (V1) active, HVLDO (V3) selectable by OTP and multiple wake-up sources

Power supplies

- V1: High-voltage synchronous buck converter with integrated FETs. Configurable output voltage (1.9 V to 5 V) and switching frequency, output DC current capability up to 400 mA and PFM mode for Low-power on mode operation
- V3: High-voltage LDO regulator for microcontroller I/O support with selectable output voltage between 3.3 V or 5 V and up to 150 mA current capability

System support

- One CAN FD supporting up to 5 Mbps communication following ISO 11898-2:2016 and SAE J2284 standards
- Four wake-up inputs (40 V capable): WAKEx pins, HVIO1 pin, CAN FD or SPI command
- Hardware ID detection capability
- One high-voltage I/O with wake-up capability (40 V capable): HVIO1
- Device control via 32 bits SPI interface, with CRC
- Integrated long duration timer (LDT) for system shutdown and wake-up control, programmable up to 194 days
- 12-channel analog multiplexer (AMUX) for system monitoring (temperature, battery voltage, internal voltages)

Functional safety

- Developed following ISO 26262:2018 standard to fit for ASIL B applications
- Internal monitoring circuitry with its own reference
- Additional input for external voltage monitoring
- Window or timeout watchdog function to monitor the MCU software failure
- Analog built-in self-test (ABIST) on demand
- Safety outputs (RSTB, LIMP0)
- Safety input to monitor external IC state (ERRMON)

Configuration and enablement

- HVQFN32EP: QFN, 32 pins with exposed pad for optimized thermal management, wettable flanks, 5 mm x 5 mm x 0.85 mm, 0.5 mm pitch
- Permanent device customization via one time programmable (OTP) fuse memory
- OTP emulation mode for system development and evaluation

3 Ordering information

This section describes the part numbers available to be purchased along with their main differences. It also describes how the part number reference is built.

3.1 Part numbers definition

Figure 1 describes how the FS24 part numbers are built.

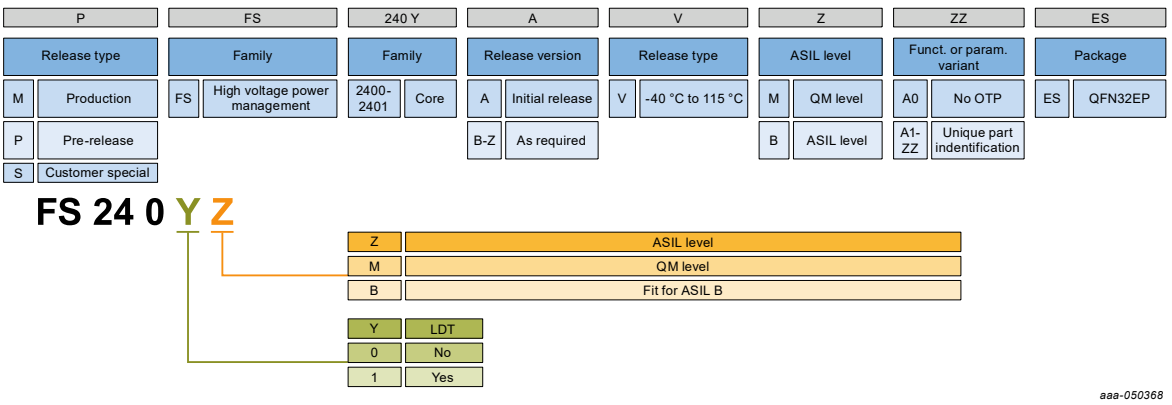


Figure 1. FS24 product numbering scheme

3.2 Part numbers list

Table 1. Device segmentation

Generic part number	Description	Fit for ASIL	LDT	RSTB	LIMP0	VMON (1, 3)	VMON_EXT (VMON0)	Watchdog	Cyclic INIT CRC check	RSTB 8 sec timer	ABIST	Package
FS2400M[1]	QM without LDT	QM	No	Yes	Option	Yes	No	Option	No	No	No	HVQFN32
FS2401M[1]	QM with LDT	QM	Yes	Yes	Option	Yes	No	Option	No	No	No	HVQFN32
FS2400B[1]	ASIL B without LDT	B	No	Yes	Option	Yes	Option	Yes	Yes	Yes	Yes	HVQFN32
FS2401B[1]	ASIL B with LDT	B	Yes	Yes	Option	Yes	Option	Yes	Yes	Yes	Yes	HVQFN32

[1] Exact orderable part numbers are defined in Table 2.

Table 2. Orderable part numbers

Part number[1]	Description	Package
MFS2400AVMA0ES[2]	Superset covering FS2400M devices.	HVQFN32EP
MFS2401AVMA0ES[2]	Superset covering FS24001M devices.	
MFS2400AVBA0ES[2]	Superset covering FS2400B devices.	
MFS2401AVBA0ES[2]	Superset covering FS2401B devices.	
MFS2400AVMA1ES	Configuration given as an example for Ranger 5 attach, V1 at 3.3 V and V3 at 5 V. QM, LDT disabled.	
MFS2401AVBA1ES	Configuration given as an example for Ranger 5 attach, V1 at 3.3 V and V3 at 5 V. ASIL B, LDT enabled.	
MFS2401AVMAFES	Configuration given as an example for S32K1xx + NCF3321 attach, V1 at 5 V and V3 at 3.3 V. QM, LDT enabled.	

[1] To order parts in tape and reel, add the R2 suffix to the full part number reference.
[2] A0 parts are non-programmed OTP configurations. Preprogrammed OTP configurations are managed through part number extension. For a custom OTP configuration, contact a local NXP sales representative.

4 Block diagram

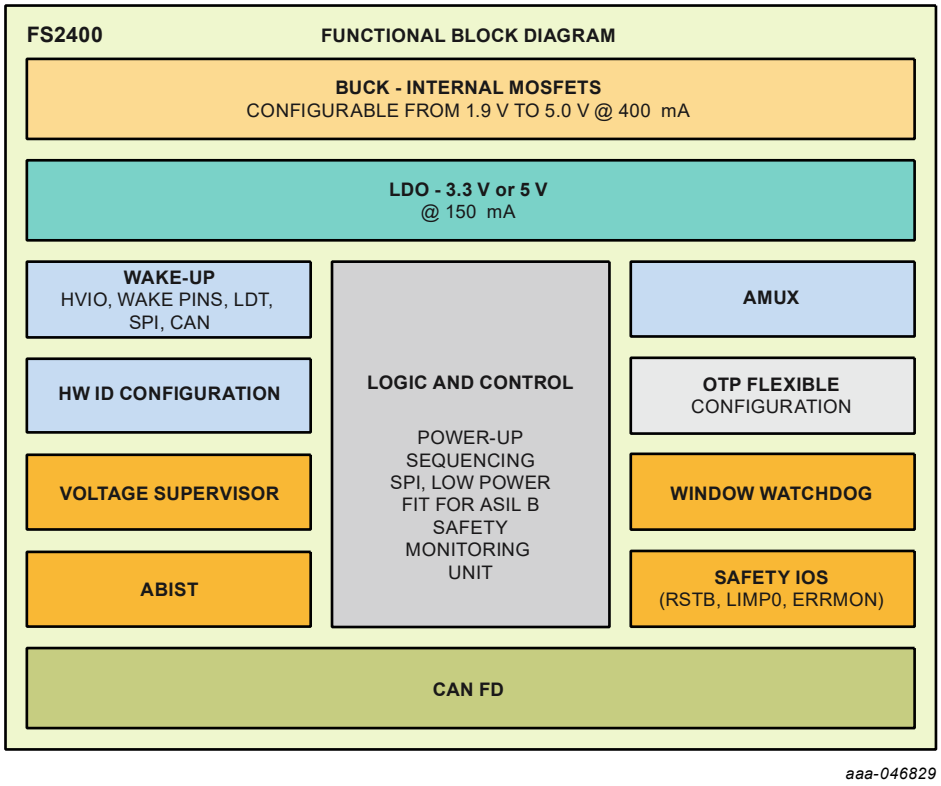


Figure 2. Functional block diagram

4.1 Internal block diagram

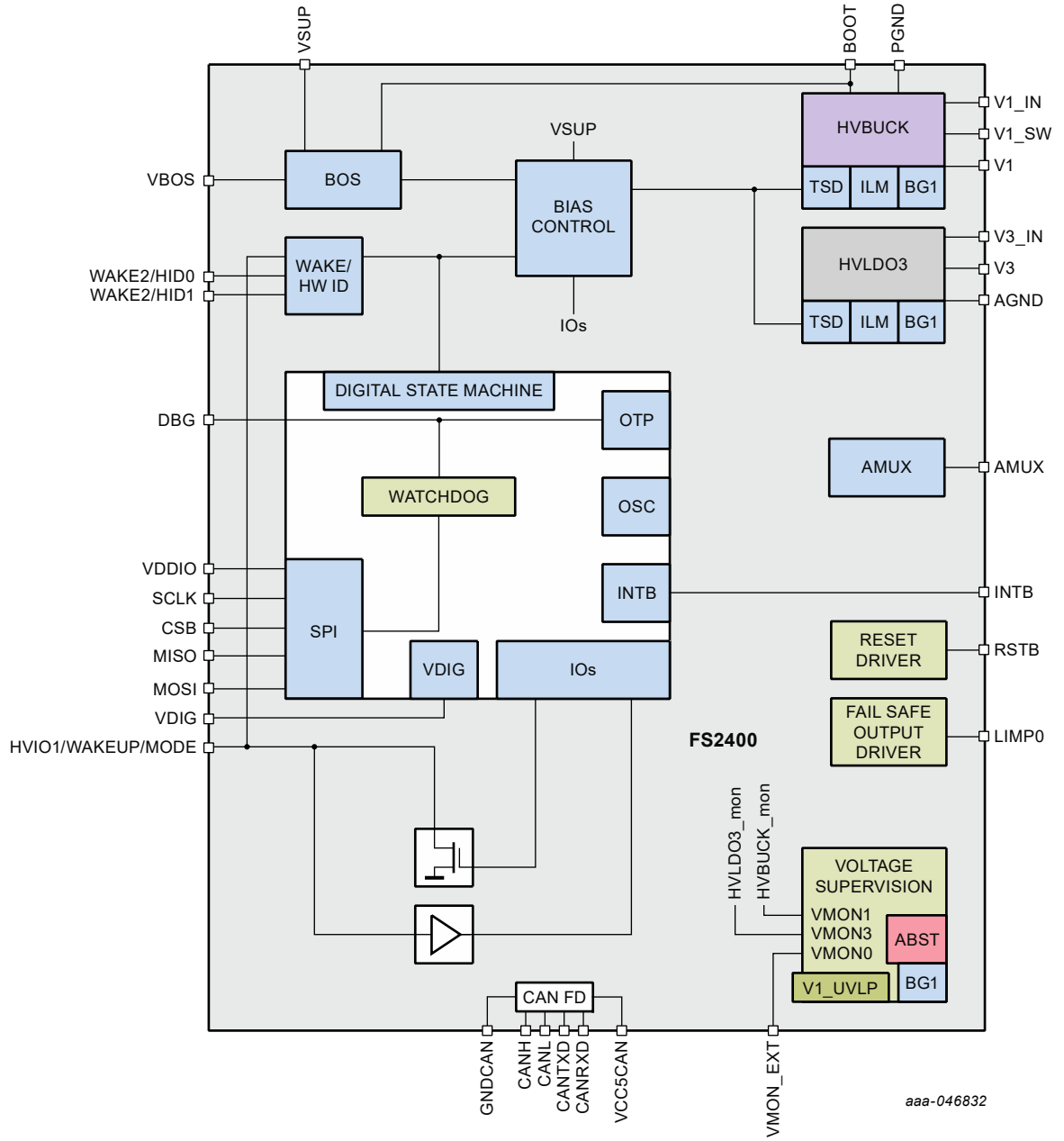


Figure 3. FS2400 block diagram

4.2 Simplified application diagram

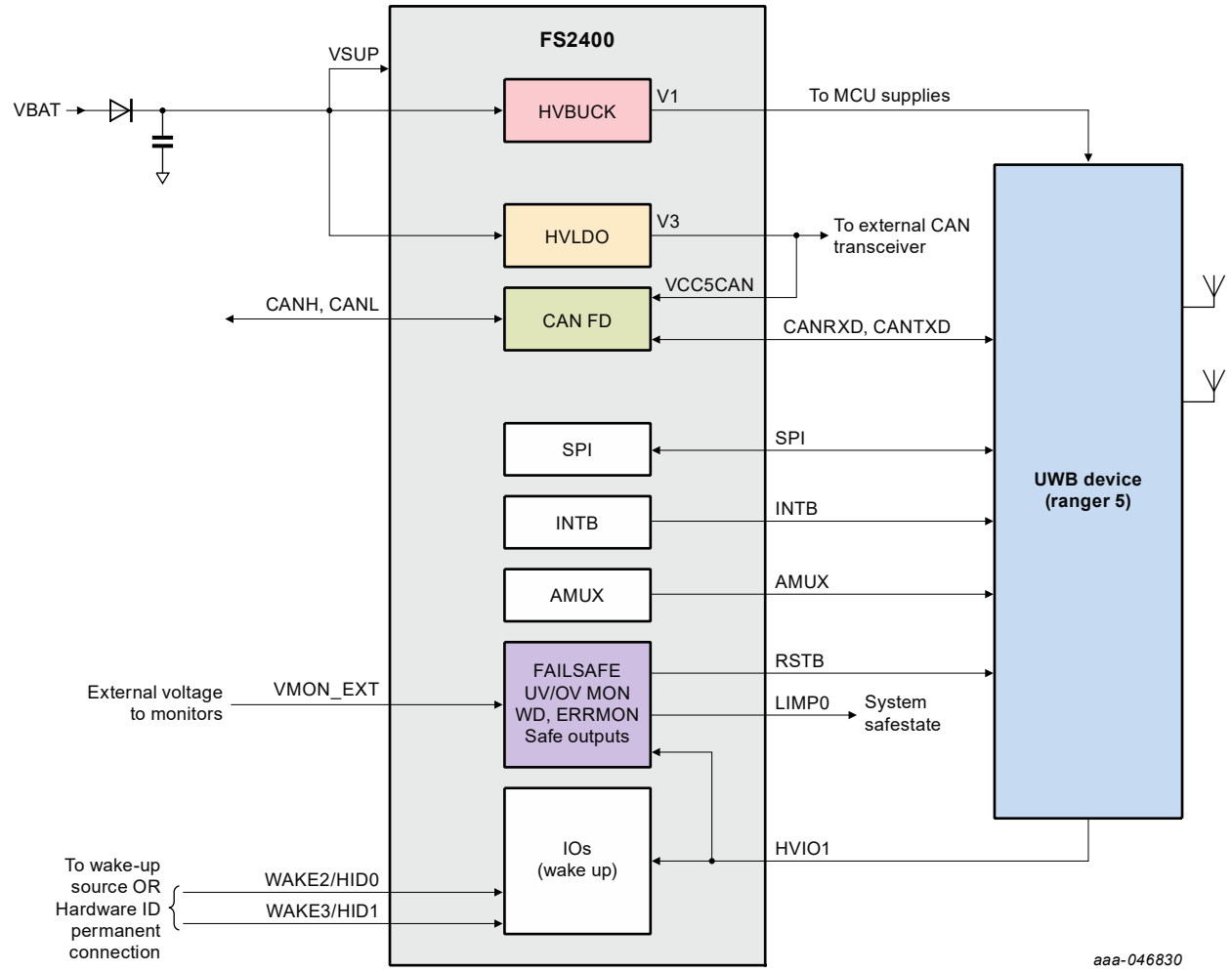


Figure 4. FS24 for UWB Simplified application diagram

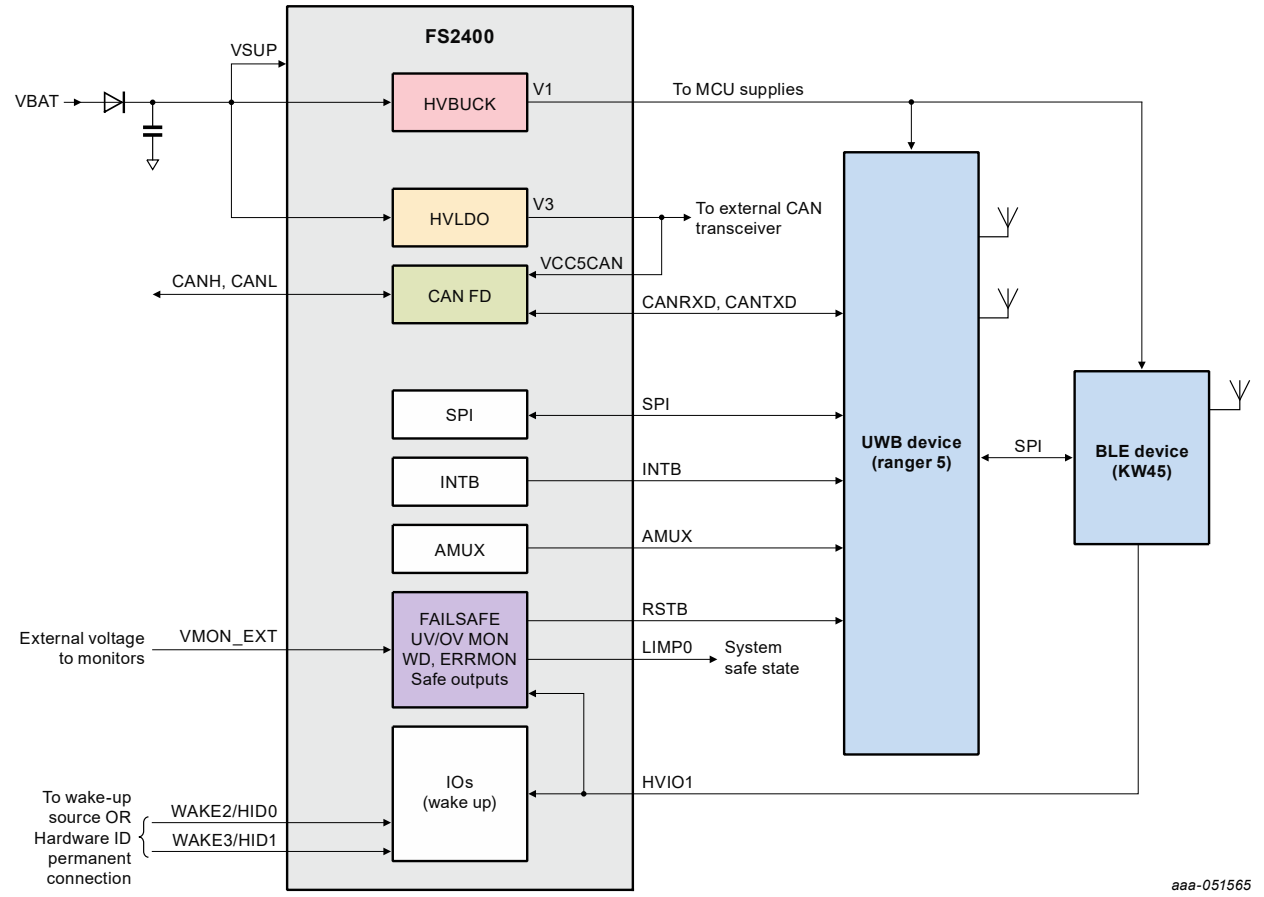


Figure 5. FS24 for UWB and BLE Simplified application diagram

5 Limiting values

Minimum and maximum ratings

Table 3. Limiting values

T_A = -40 °C to 115 °C, unless otherwise specified. VSUP = 5.5 V to 40 V, unless otherwise specified. VDDIO = 1.8 V to 5 V, unless otherwise specified. All voltages referenced to ground, unless otherwise noted. Exceeding these ratings may cause a malfunction or permanent damage to the device.

Symbol	Description (Rating)	Min	Max	Unit
Voltage ratings				
WAKE2/HID0, WAKE3/HID1, LIMP0, HVIO1	Global pins	-0.3	40	V
V1_IN, VSUP, V3_IN	Global supply input pins	-1	40	V
CANH, CANL	Global communication pins	-33	40	V
BOOT	High-voltage pin/local pin	-0.3	45	V
V1_SW, VMON_EXT	High-voltage pins/local pins	-0.3	40	V
DEBUG	Debug pin to enter in Debug mode; should be grounded in the application	-0.3	10	V
V1,V3, VCC5CAN	Local pins	-0.3	5.6	V
VDDIO, VBOS, AMUX	Local pins	-0.3	5.5	V
CANRXD, CANTXD, MISO, MOSI, SCK, CSB, RSTB, INTB	Local pins	-0.3	VDDIO + 0.3	V
VDIG	Local pin	-0.3	2	V
GND_IO, PGND, GNDCAN	Ground pins	-0.3	0.3	V

6 Package outline

FS24 package is a QFN, thermally enhanced, wettable flanks, 5 mm x 5 mm x 0.85 mm, 0.5 mm pitch, 32 pins.

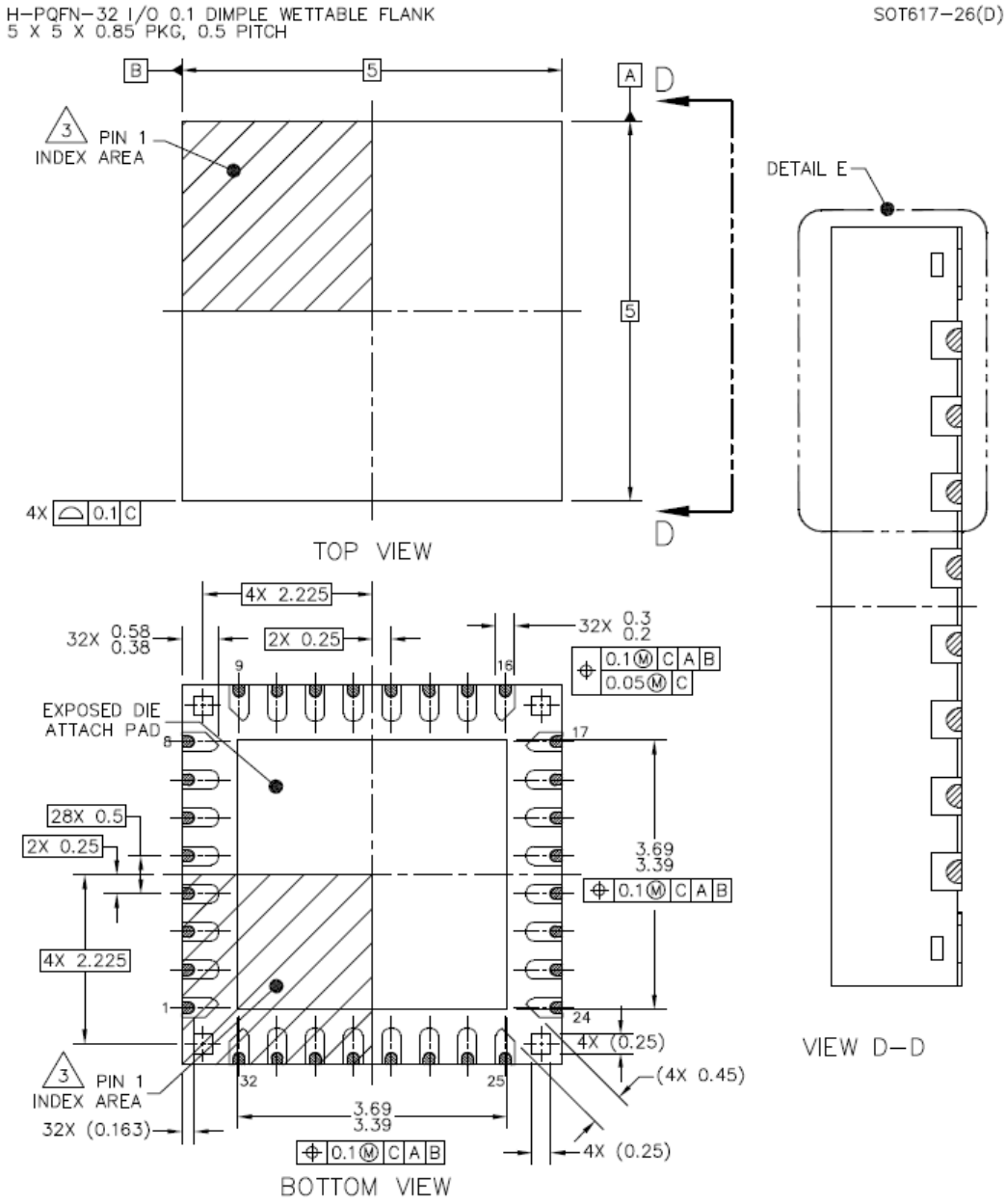


Figure 6. Top and bottom view

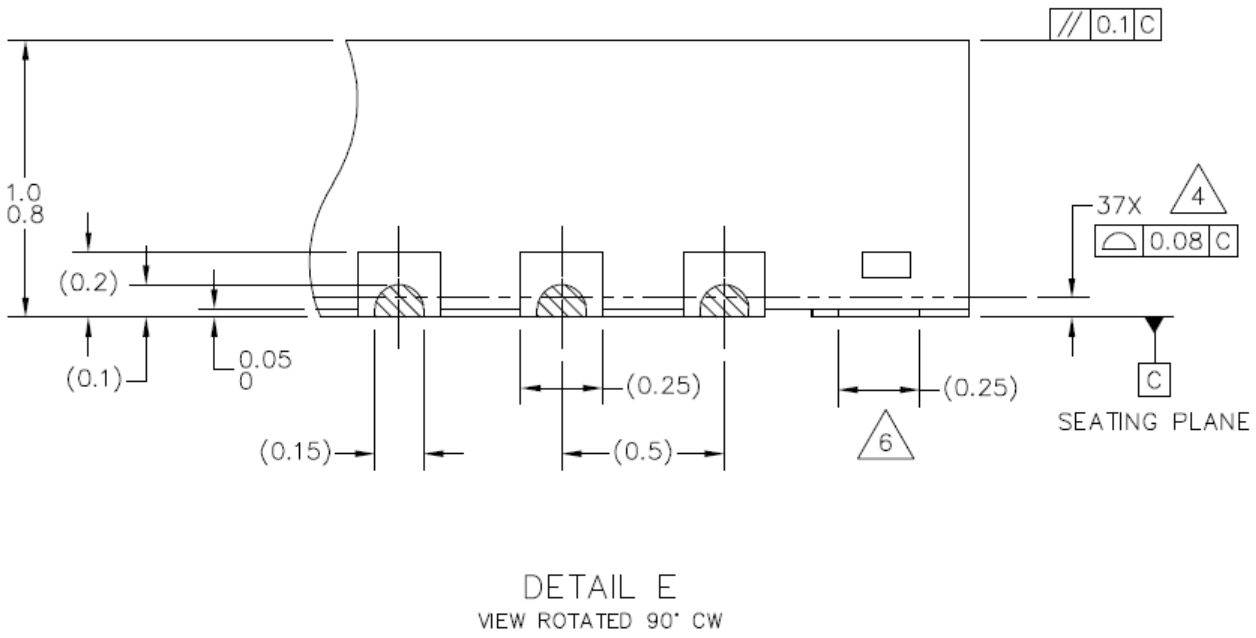


Figure 7. Detail

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.
3. PIN 1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. COPLANARITY APPLIES TO LEADS AND DIE ATTACH FLAG.
5. MIN. METAL GAP FOR LEAD TO EXPOSED PAD SHALL BE 0.2 MM.
6. ANCHORING PADS.

Figure 8. Notes

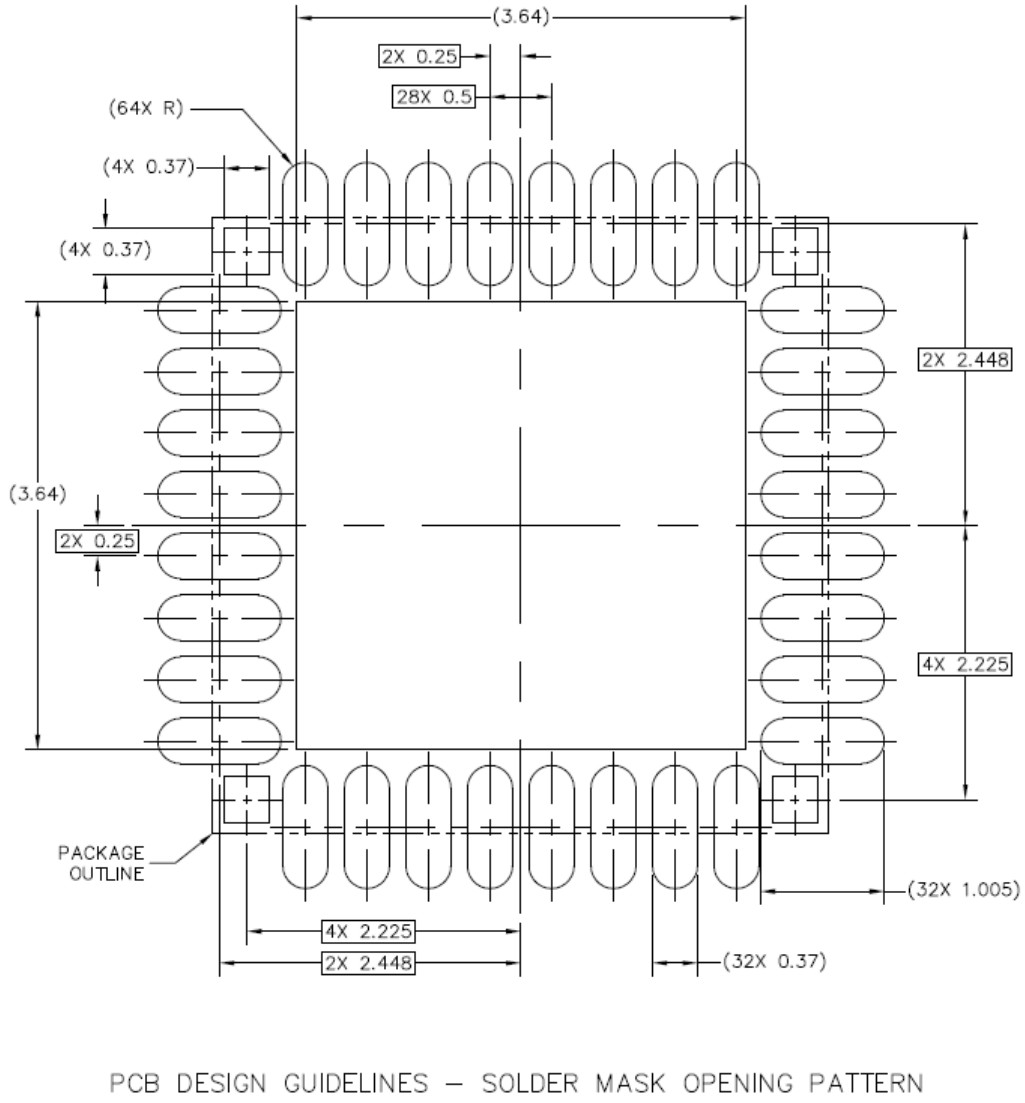


Figure 9. Solder mask opening pattern

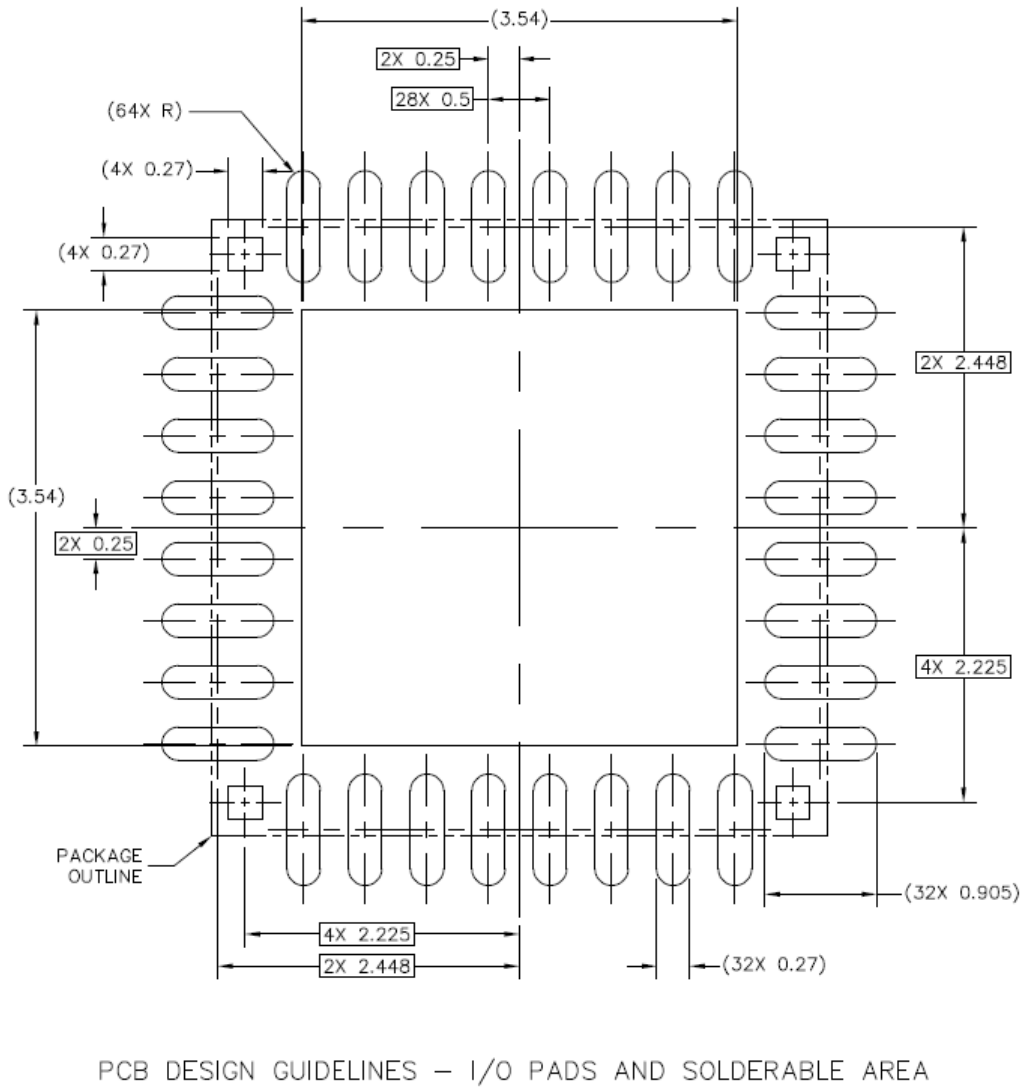


Figure 10. I/O pads solderable area

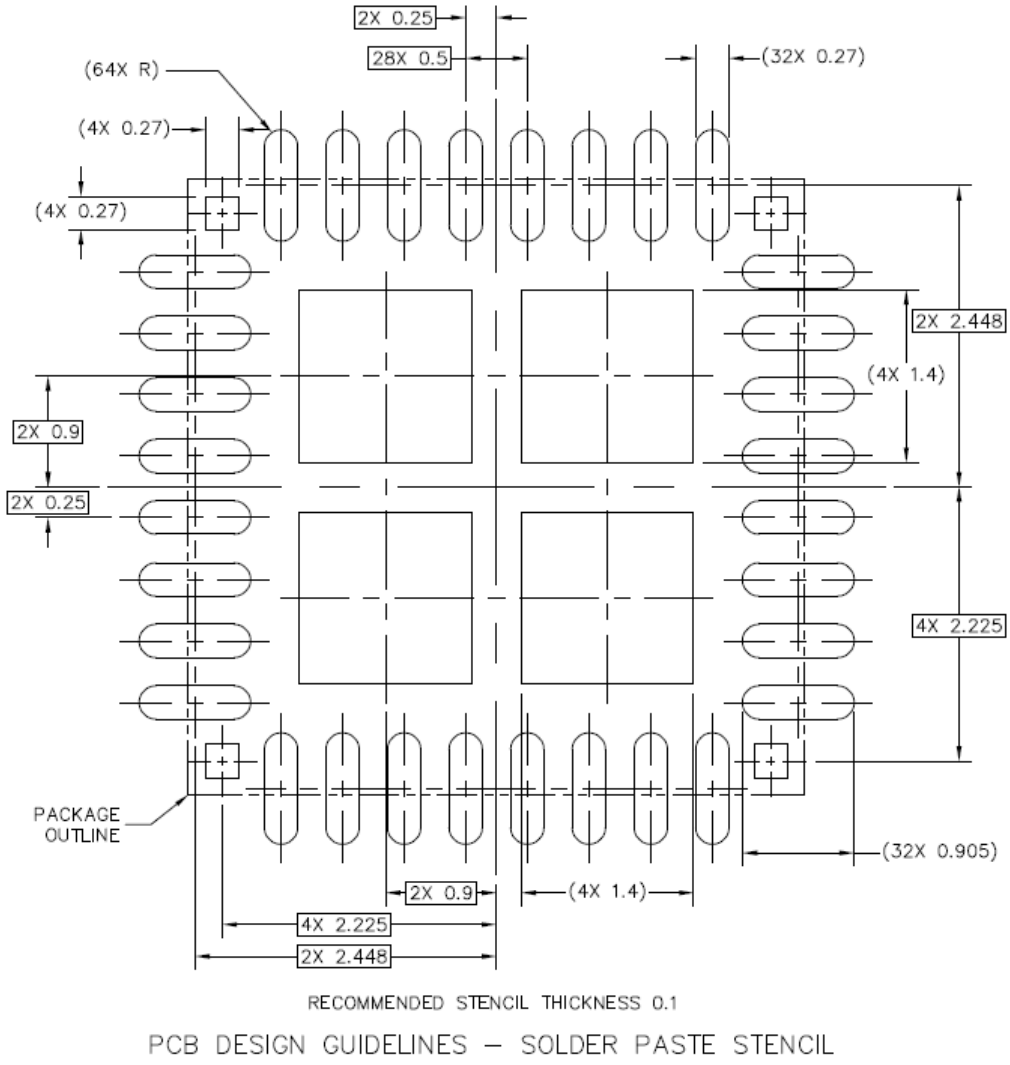


Figure 11. Solder paste stencil

7 Revision history

Table 4. Revision history

Document ID	Release date	Description
FS2400_SDS v.1.0	30 January 2024	Initial version

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".
[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 https://www.nxp.com.

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

Product specification — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at https://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Quick reference data — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately.

Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

Suitability for use in automotive applications (functional safety) — This NXP product has been qualified for use in automotive applications. It has been developed in accordance with ISO 26262, and has been ASIL classified accordingly. If this product is used by customer in the development of, or for incorporation into, products or services (a) used in safety critical applications or (b) in which failure could lead to death, personal injury, or severe physical or environmental damage (such products and services hereinafter referred to as "Critical Applications"), then customer makes the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, safety, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. As such, customer assumes all risk related to use of any products in Critical Applications and NXP and its suppliers shall not be liable for any such use by customer. Accordingly, customer will indemnify and hold NXP harmless from any claims, liabilities, damages and associated costs and expenses (including attorneys' fees) that NXP may incur related to customer's incorporation of any product in a Critical Application.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

Tables

Figures

Contents

For more information, please visit: https://www.nxp.com

Date of release: 30 January 2024
Document identifier: FS2400_SDS