

## Ultra-compact, low-power NB-IoT industrial module series with optional GNSS



### Features

- LTE, category NB2, release 15
- Worldwide regional band coverage
- Single-tone/multi-tone/extended TBS and 2 HARQ
- Up to DL: 127 kbps, UL: 159 kbps
- eDRX and PSM support
- Ultralow power mode 1.2 uA typical (0.5 uA typical in power-off)
- Ultra-compact size, weight: 660mg
- Embedded IoT internet protocols
- Differential FOTA support
- Up to +23 dBm power-out
- Multiple I/F and GPIO
- GCF certified
- RED certified
- RED-DA certified
- Optional embedded GSMA-compliant SIM
- Optional GNSS and A-GNSS
- Optional wireless M-Bus mode
- Optional Wi-Fi positioning for IEEE 802.11b hot spots

#### Product label



#### Product label



### Application

- Asset tracking
- Smart city
- Street lighting
- Smart metering
- Smart industry

### Description

The **ST87M01** is a high-performance, fully programmable, ultra-compact, and low-power LTE Cat NB2 NB-IoT industrial module series, offering comprehensive worldwide band coverage and advanced security features. Designed to meet diverse application requirements, the ST87M01 family provides multiple configurable options including GNSS, Wi-Fi positioning, embedded SIM, and Wireless M-Bus (WBUS).

The integrated GNSS functionality enables precise location tracking via GPS constellation, while the Wi-Fi positioning feature offers fast, low-power location services using nearby 802.11b networks in conjunction with third-party geocoding providers. Wireless M-Bus serves as a reliable backup communication channel in environments with limited cellular network coverage. The embedded SIM option optimizes board space and reduces BOM complexity.

Supporting a wide range of IoT protocols, the ST87M01 modules include PDU SMS services and internet protocols such as TCP/IP, TLS/DTLS, CoAP, LwM2M, MQTT, and HTTP/HTTPS, enabling versatile connectivity and application scenarios.

The ultra-compact LGA package (10.6 mm x 12.8 mm, 51 pins) makes the ST87M01 family an ideal choice for space-constrained designs, facilitating device miniaturization without compromising performance.

## 1 Product description

This section provides an overview of the principal technical data describing the ST87M01 narrow-band Internet-of-Things (NB-IoT) and GNSS cellular module family. This ultra-compact, ultra-low-power, cost-efficient, certified NB-IoT and GNSS module family, offering multi-band data transmission, is introduced here along with its super compact form factor.

### 1.1 Overview

The ST87M01 is a high-performance module with ultralow power consumption, NB-IoT (LTE Cat NB2) 3GPP Release 15, and GNSS certified module family.

The ST87M01 module family supports multi-frequency bands with extended multi-regional coverage, enabling almost complete worldwide NB-IoT data communication.

Moreover, the ST87M01 supports additional communication standards, i.e. the GNSS receiver enables support of multiple satellite constellations to address high-accuracy localization applications, the wireless M-BUS mode allows support of a backup/service communication channel typically used in metering communications, and the Wi-Fi positioning feature enables fast, low-consumption location services using nearby 802.11b when used with a third-party geocoding provider.

In addition, the ultra-compact module form factor makes the ST87M01 family the perfect choice for size-critical applications, allowing for miniaturization. In fact, ultra-compactness is a crucial characteristic addressed by the ST87M01 family, which is presented in an LGA package of only 10.6 mm x 12.8 mm with 51 pins.

Furthermore, thanks to its ultralow power consumption and industrial qualification grade over the industrial temperature range, the ST87M01 family represents the best choice for a wide range of IoT applications, ranging from smart grids, energy smart metering, smart city, factory automation, industrial IoT and asset tracking to any smart monitoring application meeting Low Power Wide Area Network (LPWAN) communication requirements.

ST may update the firmware provided with the modules at any time. The pre-loaded version by ST must be checked by the customer before going to production, to verify if a newer version is available. The available version to load may be requested directly from the ST sales office or found at [www.st.com/en/wireless-connectivity/st87m01.html](http://www.st.com/en/wireless-connectivity/st87m01.html).

ST recommends that users regularly check for documentation and the current firmware version available at [www.st.com/en/wireless-connectivity/st87m01.html](http://www.st.com/en/wireless-connectivity/st87m01.html).

Additionally, the ST87M01 family embeds PDU SMS service and internet protocols for NB-IoT products, including TCP/IP, TLS/DTLS, Co-AP, LwM2M, MQTT and HTTP/HTTPS, which enable a broad set of multiple IoT applications.

Lastly, full support of Power Saving Mode (PSM) and Extended Discontinuous Reception (eDRX) mechanisms, along with ultralow power silicon technology adoption and a dedicated interface to wake up module on interrupt basis, allow the ST87M01 family to achieve extra-long battery life on a single-cell primary battery.

The ST87M01 family is designed and qualified according to industrial grade. Each manufactured module is fully tested, traced and satisfies STMicroelectronics' stringent reliability and quality requirements.

### 1.2 Safety information

ST87M01 is typically used in well-defined applications such as metering equipment. However, it can be used in any application requiring NB-IoT connectivity, so an assessment of the human risk associated with the usage of an RF cellular terminal should be done, and precautions must be taken in all phases of the operation of the terminal incorporating ST87M01 by the terminal manufacturer.

The terminal manufacturer must notify users and personnel of this safety information. ST is not liable in case the terminal manufacturer does not properly communicate the precautions.

The ST87M01 is compliant with the normative requirements regarding EMC, RF exposure and electrical safety listed in the [Table 6](#). However, the terminal manufacturer should verify the compliance with specific norms related to the specific application, considering the following general precautions as well:

- Mobile communication equipment should not be used while driving according to specific laws and regulations.
- Wireless devices must be switched off on aircraft during flight to prevent interference. More specific restrictions should be verified by airline staff.
- Wireless devices could create interference with some medical equipment.

- Cellular communication cannot be guaranteed in all network conditions. Emergency communication is possible only with adequate cellular signal strength.
- RF interference can occur if the terminal is used close to a radio, computer, or other electric equipment.
- In areas with risk of explosion, specific indications and signs must be followed.

## 1.3

### Key features

#### Module Family Name

ST87M01

#### Cellular Radio Access Technology

LTE Cat NB2, 3GPP Release 15

#### Hardware

Module form factor: metallic shielded LGA package (51 pin)

Dimensions [mm]: 10.6 x 12.8 x 2.4

Optional embedded SIM

#### LTE FDD Certified Frequency Bands

B1, B3, B5, B8, B20, B28 selected for GCF certification

Over hardware capability for almost worldwide coverage

[B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26/B28/B65/B66/B70/B71/B85, supported by the same HW]

#### Transmit Power

Class-3: +23 dBm

#### Data Transmission

Single-Tone: DL: 26 kbps, UL: 16 kbps

Multi-Tone: DL: 26 kbps, UL: 66 kbps

Extended TBS and 2 HARQ (Cat NB2): DL: 127 kbps, UL: 159 kbps

#### Embedded Protocol Stacks

IPv4, IPv6, TCP/UDP, CoAP/LWM2M, MQTT, HTTP/HTTPS, DTLS

#### Firmware Upgrade

Host via UART and DFOTA over LWM2M, ext. SPI flash (for production only)

#### SMS

PDU mode

#### AT Commands

3GPP & STMicroelectronics Extended AT Commands

#### Interfaces

Control: Reset and Wake-Up

Peripherals: 1xUSIM (1.8 V only), 2xUART, 2xI<sup>2</sup>C, 1xSPI, up to 2xADC and 24xGPIO

RF ports: 5 0Ω antennas for NB-IoT and GNSS

#### Localization services (Only for some specific p/n)

LTE network-based positioning support

Optional A-GNSS: GPS, Galileo, optimized concurrent mode

Optional Wi-Fi positioning for IEEE 802.11b hot spots

#### Secondary data communication service (Only specific p/n)

Wireless M-BUS physical layer EN-13757-4 Rel. 2019

Modes: T1 – 868.95 MHz, C1 – 868.95 MHz

#### Typical Power Supply range

VIO: 1.8 V to 3.3 V

VPMU\_x/VDCDC/VPA: 2.2 to 3.0 V

**Industrial grade:** -40°C to +85°C

## 1.4

### Product variants

**ST87M01-ABCD** is the product family name that is specified for each single part number as described below:

“A” indicates the subset of FDD-certified frequency bands addressed by the specific part number.

“B” indicates the secondary mode of operation addressed by the specific part number.

“C” indicates the presence or absence of the embedded SIM for the specific part number.

“D” indicates specific application features.

**Table 1. Ordering codes table**

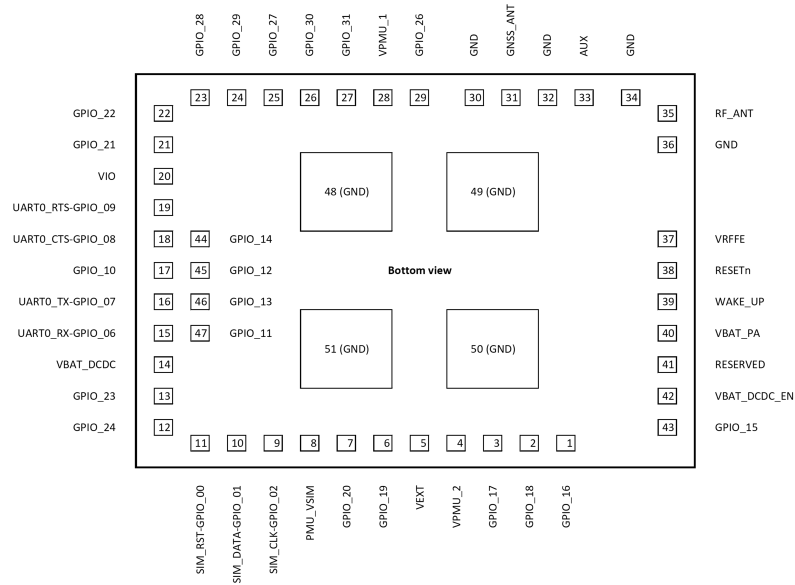
Commercial product	Description					
	NB-IoT bands supported	GNSS localization	Wi-Fi localization	WMBUS	Extra ADC	eSIM
ST87M01-1001	B1, B3, B5, B8, B20, B28				✓	
ST87M01-1301	B1, B3, B5, B8, B20, B28	✓	✓		✓	
ST87M01-1000	B1, B3, B5, B8, B20, B28					
ST87M01-1100	B1, B3, B5, B8, B20, B28	✓				
ST87M01-1101	B1, B3, B5, B8, B20, B28	✓			✓	
ST87M01-1111	B1, B3, B5, B8, B20, B28	✓			✓	✓
ST87M01-1400	B1, B3, B5, B8, B20, B28			✓		

Parts marked as “ES” are not yet qualified and therefore not approved for use in production. STMicroelectronics is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. STMicroelectronics’ Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 2 Module pad

### 2.1 Pad assignment overview

**Figure 1. ST87M01 pin assignment**



### 2.2 Pin definition

**Table 2. ST87M01 pin definition**

Pin no.	Pin name	Pin Type <sup>(1)</sup>	Reset State <sup>(2)</sup>	Power Domain	Description	GPIO Alternate Function		
						0	1	2
1	GPIO_16	D	I, PD	VIO	General-Purpose I/O	I2C0_SCL <sup>(8)</sup>	---	---
2	GPIO_18	D	I, PD	VIO	General-Purpose I/O	---	HST_D <sup>(6)</sup>	---
3	GPIO_17	D	I, PD	VIO	General-Purpose I/O	---	HST_CLK <sup>(6)</sup>	---
4	VPMU_2	S			Input power for PMU2	---	---	---
5	PMU_VEXT	S			General-Purpose LDO	---	---	---
6	GPIO_19	D	I, PD	VIO	General-Purpose I/O	---	---	---
7	GPIO_20	D	I, PD	VIO	General-Purpose I/O	---	---	---
8	PMU_VSIM	S			SIM/eSIM LDO	---	---	---
9	GPIO_02	D	Hi-Z <sup>(3)</sup>	VSIM	General-Purpose I/O	SIM_CLK <sup>(4)</sup>	---	---
10	GPIO_01	D	Hi-Z <sup>(3)</sup>	VSIM	General-Purpose I/O	SIM_DATA <sup>(4)</sup>	---	---
11	GPIO_00	D	Hi-Z <sup>(3)</sup>	VSIM	General-Purpose I/O	SIM_RST <sup>(4)</sup>	---	---
12	GPIO_24	D	I, PD	VIO	General-Purpose I/O	SWDIO <sup>(4)</sup>	HST_D <sup>(6)</sup>	---
13	GPIO_23	D	I, PD	VIO	General-Purpose I/O	SWCLK <sup>(4)</sup>	HST_CLK <sup>(6)</sup>	---
14	VDCDC	S			Input power for DC-DC	---	---	---

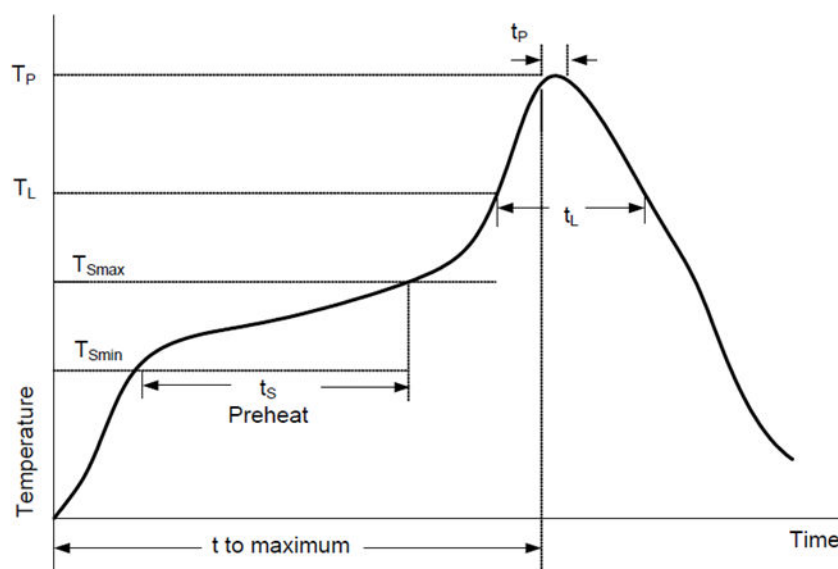
15	GPIO_06	D	I, PU	VIO	General-Purpose I/O	UART0_RX <sup>(4) (9)</sup>	---	---
16	GPIO_07	D	I, PU	VIO	General-Purpose I/O	UART0_TX <sup>(4) (9)</sup>	---	---
17	GPIO_10	D	I, PD	VIO	General-Purpose I/O	---	---	PWM_0
18	GPIO_08	D	I, PD	VIO	General-Purpose I/O	UART0_CTS	PWM_0	---
19	GPIO_09	D	I, PD	VIO	General-Purpose I/O	UART0_RTS	PWM_1	---
20	VIO	S			Power domain GPIO	---	---	---
21	GPIO_21	D	I, PD	VIO	General-Purpose I/O	UART1_RX <sup>(8)</sup>	I2C1_SDA <sup>(8)</sup>	---
22	GPIO_22	D	I, PD	VIO	General-Purpose I/O	UART1_TX <sup>(8)</sup>	I2C1_SCL <sup>(8)</sup>	---
23	GPIO_28	D	I, PD	VIO	General-Purpose I/O	HST_D0 <sup>(6)</sup>	---	SPI0_CS <sup>(5)</sup>
24	GPIO_29	D	I, PD	VIO	General-Purpose I/O	HST_D1 <sup>(6)</sup>	---	SPI0_DO <sup>(5)</sup>
25	GPIO_27	D	I, PD	VIO	General-Purpose I/O	HST_CLK <sup>(6)</sup>	---	SPI0_CLK <sup>(5)</sup>
26	GPIO_30	D	I, PD	VIO	General-Purpose I/O	HST_D2 <sup>(6)</sup>	---	SPI0_DI <sup>(5)</sup>
27	GPIO_31	D	I, PD	VIO	General-Purpose I/O	HST_D3 <sup>(6)</sup>	ADC2 <sup>(7)</sup>	---
28	VPMU_1	S			Input power for PMU1	---	---	---
29	GPIO_26	D	I, PD	VIO	General-Purpose I/O	ADC1	---	---
30	GND_RF1	-			Ground RF	---	---	---
31	GNSS_ANT	A			RF input	---	---	---
32	GND_RF2	-			Ground RF	---	---	---
33	RF_AUX	A			RF pin	---	---	---
34	GND_RF3	-			Ground RF	---	---	---
35	RF_ANT	A			RF input	---	---	---
36	GND_RF5	-			Ground RF	---	---	---
37	PMU_VRFFE	-			Add capacitor footprint to GND	---	---	---
38	RESETn	D	I, PU	VIO	Reset input (active low)	---	---	---
39	WAKE_UP	D	I, PU	VIO	Wake-up input (active low <sup>(10)</sup> )	---	---	---
40	VPA	S			Input power for power amplifier	---	---	---
41	RESERVED	-			(Keep the pad open)	---	---	---
42	DCDC_EN	D	O	VIO	DC-DC Enable indicator	---	---	---
43	GPIO_15	D	I, PD	VIO	General Purpose I/O	I2C0_SDA <sup>(8)</sup>	---	---
44	RESERVED	-			(Keep the pad open)	---	---	---
45	RESERVED	-			(Keep the pad open)	---	---	---
46	RESERVED	-			(Keep the pad open)	---	---	---
47	RESERVED	-			(Keep the pad open)	---	---	---
48	GND_PAD1	-			Ground	---	---	---
49	GND_PAD2	-			Ground	---	---	---
50	GND_PAD3	-			Ground	---	---	---
51	GND_PAD4	-			Ground	---	---	---

- Note:
- (1) D=digital, S=supply, A=analog.
  - (2) I, PD=input pull-down, I,PU=input pull-up, O=output, Hi-Z=high impedance.
  - (3) VSIM is off at power-up.
  - (4) Default configuration after boot.
  - (5) SPI is used by the bootloader for firmware programming and in standalone mode.
  - (6) Three options for HST interface: two wires on pins 2 and 3, two wires on pins 12 and 13, five wires on pins from 23 to 27.
  - (7) ADC2 not available on ST87M01-xxx0
  - (8) Available only in standalone mode. Disabled by default.
  - (9) Only UART function available for AT commands. The pin cannot be used as a GPIO.
  - (10) Factory configuration. Note that the WAKE\_UP pin active level and pullup up/down option can be configured via AT#WAKEUPEVENT command

## 3 SMT production guide

### 3.1 Reflow profile

**Figure 2. JEDEC STD020 reflow profile**



**Table 3. Reflow profile parameters**

Profile parameter	Value
Preheat time ( $t_s$ )	60 – 120 seconds
Preheat temperatures ( $T_{smin}$ - $T_{smax}$ )	150 – 200°C
$T_L$	217°C
Total time above $T_L$	60 – 150 seconds
Peak temperature ( $T_p$ )	245 – 250°C
Time within 5°C of peak	30 – 40 seconds
Ramp-up (from 217°C to peak)	0.0 – 3.0 degrees / seconds
Ramp-down (from peak to 217°C)	-6.0 – -1.0 degrees / seconds
Time from 25°C to peak	5 – 8 minutes

### 3.2 Baking requirements

The module is rated MSL3 as defined in JEDEC J-STD-020 and it is shipped in a sealed bag reporting the sealing date.



### 3.3 Module marking information

Figure 3. Module marking information (RED)



## 4 Environmental and certifications

### 4.1 Environmental specifications

**Table 4. Operating condition**

Parameter	Min.	Typ.	Max.	Unit
Extended operating temperature	-40		+85	°C

*Note:* In the operating temperature range, the module meets the 3GPP 36.521-1 specification.

**Table 5. Storage condition**

Parameter	Min.	Typ.	Max.	Unit
Storage temperature	-40		+85	°C

*Note:* The module is delivered in tape-and-reel carriers, and must be stored in sealed, moisture-barrier, antistatic bags.

*Note:* The module is not powered.

### 4.2 Regulatory

The ST87M01 is designed to comply with the directives and standards listed in the following sections.

#### 4.2.1 RED

RED certification covers the bands FDD 1, FDD 3, FDD 8, FDD 20, and FDD 28.

**Table 6. RED information**

EMC [Radio]	EMC testing according to: <ul style="list-style-type: none"> <li>· EN 301 489-1 V2.2.3: Common technical requirements</li> <li>· EN 301 489-19 V2.2.1: GNSS</li> <li>· EN 301 489-52 V1.2.1: LTE NB-IoT</li> </ul>
RF [NB-IoT]	LTE NB-IoT RF conducted testing according to EN 301 908-13 V13.2.1
RF [NB-IoT]	LTE NB-IoT Radiated Spurious Emissions (RSE) testing according to EN 301 908-1 V15.1.1
RF [NB-IoT]	LTE NB-IoT RF conducted assessment according to EN 301 908-13 V13.2.1
RF [GNSS]	GNSS RF testing according to EN 303 413 V1.2.1 for the following constellations: <ul style="list-style-type: none"> <li>· GPS: L1</li> </ul>
RF SRD 868.95MHz [Wireless M-BUS]	SRD 433 MHz RF partial testing according to: <ul style="list-style-type: none"> <li>· EN 300 220-1 V3.1.1</li> <li>· EN 300 220-2 V3.1.1</li> </ul> Clause 4.2.2 - Unwanted emissions in the spurious domain (Tx Mode)
MPE	RF exposure report according to EN 62311:2020 standard
Safety	Electrical safety testing according to EN 62368-1:2014/AC:2015

The full text of the EU declaration of conformity is available online at the following address:

<https://www.st.com/>

#### 4.2.2

#### RED-DA

Certification has been carried out in consideration of the cybersecurity requirements of the RED Directive Delegated Act (articles 3.3.d and 3.3.e).

**Table 7. RED information**

Cybersecurity	Testing according to: <ul style="list-style-type: none"> <li>EN 18031-1:2024 for requirements 3.3.d</li> <li>EN 18031-2:2024 for requirements 3.3.e</li> </ul>
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#### 4.2.3

#### GCF

GCF certification covers the bands FDD 1, FDD 3, FDD 5, FDD 8, FDD 20, and FDD 28.

**Table 8. GCF information**

RSE	LTE: 3GPP TS 36.124
LTE NB-IoT	RF: 3GPP TS 36.521-1 RRM: 3GPP TS 36.521-3 Protocol: 3GPP TS 36.523-2
UICC	USIM: 3GPP TS 31.121
USIM/USAT	UICC (Electrical SIM): ETSI TS 102 230-1

#### 4.3

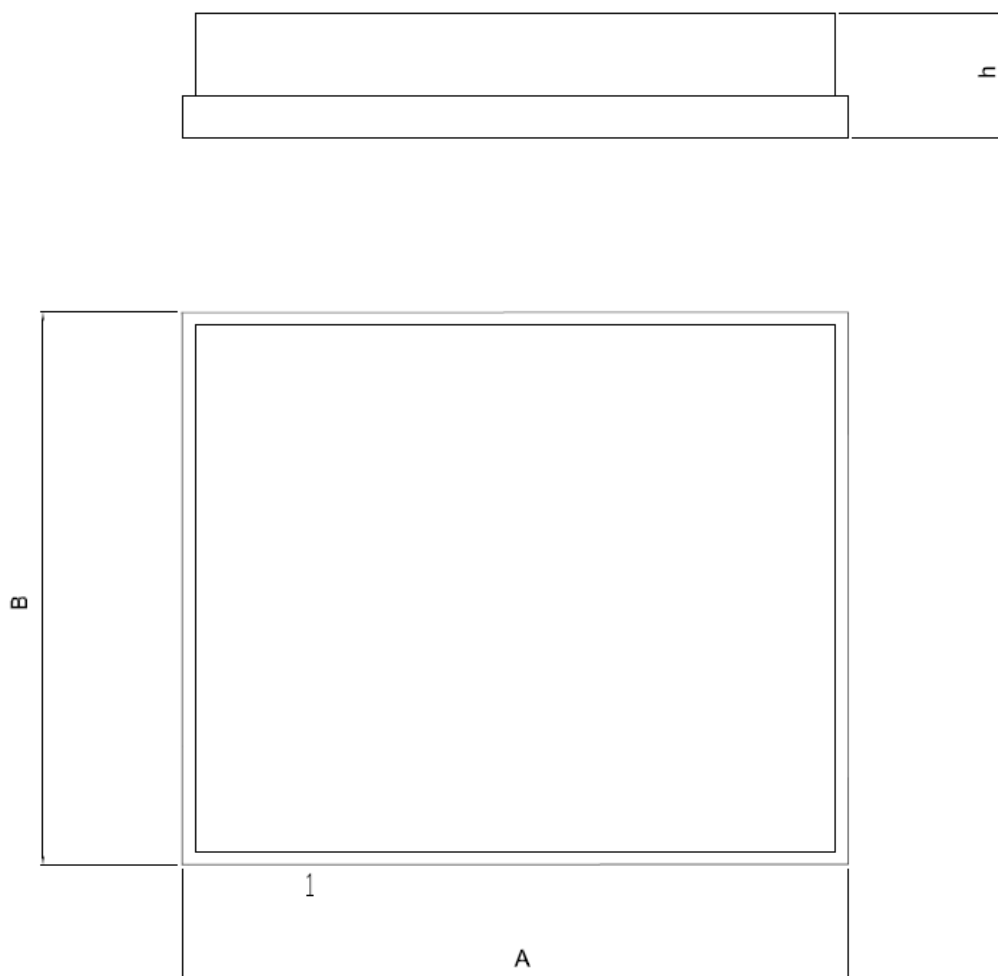
#### RoHS directive compliance

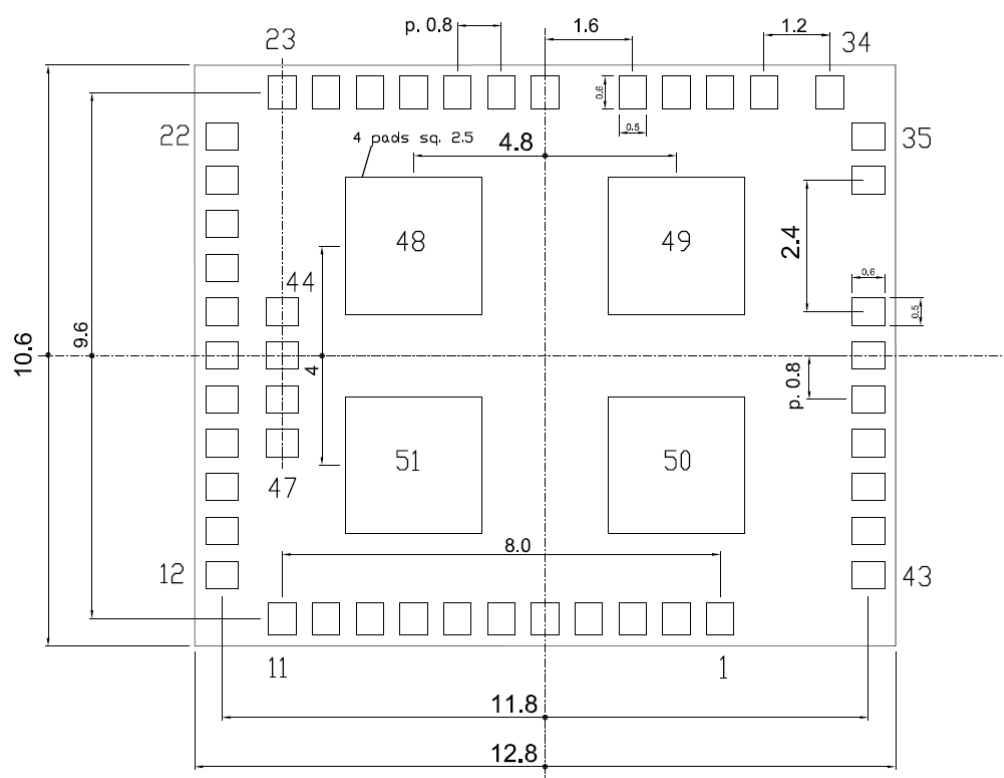
Product meets EU RoHS requirement (RoHS Directive 2011/65/EU - 8 June 2011 – Annex II amended by delegated directive 2015/863 - 31 March 2015) without any exemptions.

## 5 Package information

### 5.1 Mechanical information

Figure 4. POA (side and top view)



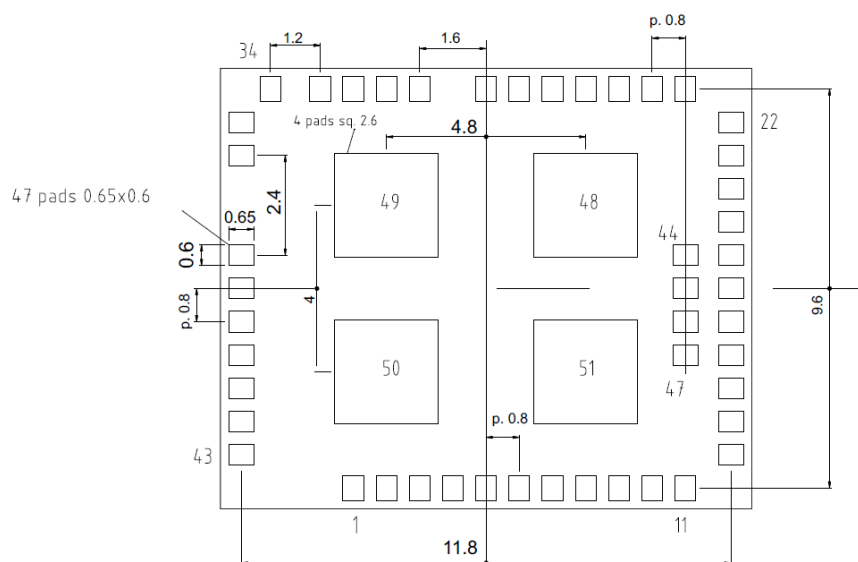
**Figure 5. POA (bottom view)**

**Table 9. Mechanical dimensions**

Item	Dimensions (mm)	Tolerance (mm)
A	12.8	+/- 0.15
B	10.6	+/- 0.15
h (height)	2.4 nom.	+/- 0.2
Pad size	n 47 x (0.5x0.6)	
Pad size	n 4 x Sq. 2.5	
Pitch	See Figure 5. POA (bottom view)	

## 5.2 Footprint recommendation (land pattern)

**Figure 6. Land pattern (top view)**

### Recommended land pattern top view



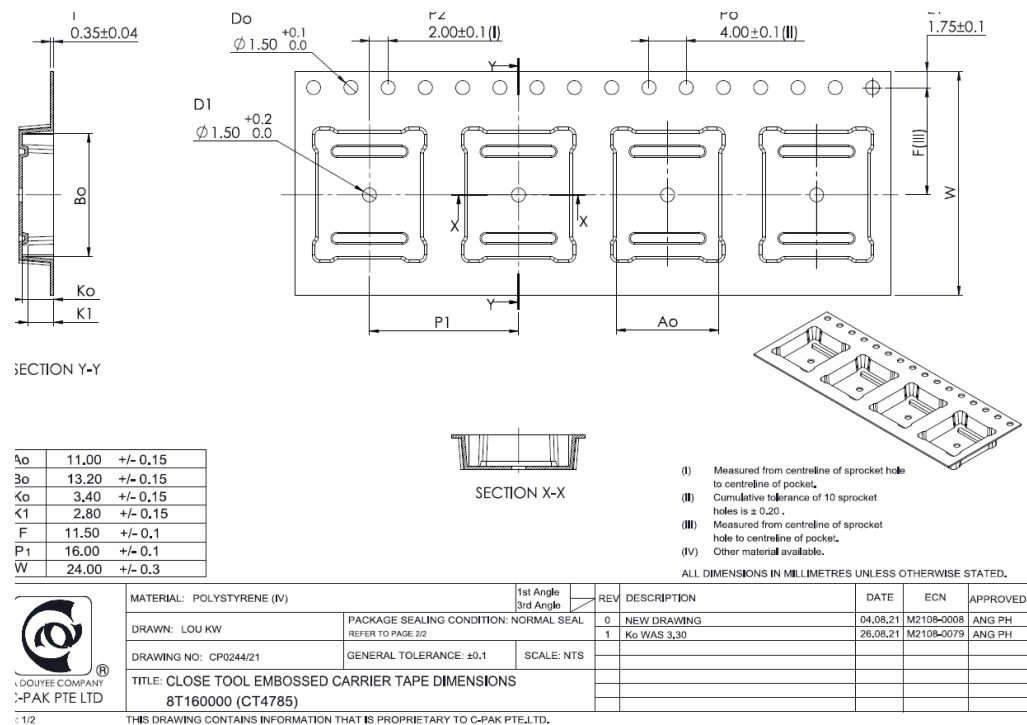
All dimensions are in millimeters

## 6 Packaging

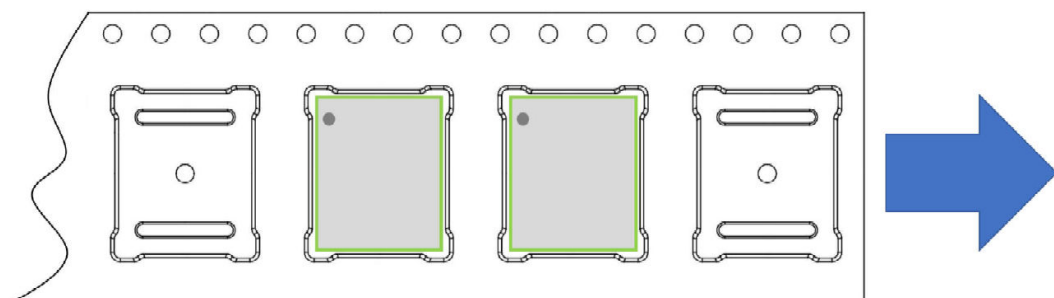
The module is shipped in an ESD protected vacuum-sealed bag. The bag should be opened respecting the moisture sensitivity level specified in [Section 3.2: Baking requirements](#).

### 6.1 Tape and reel packaging

**Figure 7. Tape dimensions (mm)**



**Figure 8. Module orientation in tape**



## 7 General information

### 7.1 Acronyms and terms

**Table 10. Definitions of terms**

Term	Definition
PSM	Power Saving Mode
eDRX	Extended Discontinuous Reception
PA	Power Amplifier
SIM / eSIM	Subscriber Identity Module / embedded Subscriber Identity Module
LDO regulator	Low Dropout regulator
MCU	Microcontroller Unit
RF	Radio Frequency
DFOTA	Differential FOTA

### 7.2 Reference documents

The documents listed in [Table 11](#) provide further information.

**Table 11. Reference documents**

Reference	Document
[1]	3GPP TS 36.521-1



## Revision history

**Table 12. Document revision history**

Date	Version	Changes
17-Jun-2024	1	Initial release.
09-May-2025	2	Added ST87M01-1400
25-Sep-2025	3	Added ST87M01-1001 and ST87M01-1301

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