

Preliminary

Panasonic
INDUSTRY

PAN1780

Bluetooth® Low Energy Module Product Specification

Rev. 0.4



Wireless Connectivity

Overview

The PAN1780 is a Bluetooth 5 Low Energy (LE) module based on the Nordic nRF52840 single chip controller.

Features

- Surface mount type dimensions: 15.6 mm x 8.7 mm x 2 mm
- Same form factor as PAN1026A and PAN1762 but smaller pitch and more pins
- Nordic nRF52840 featuring ARM® Cortex®-M4F with 64 MHz
- Bluetooth 5 LE including LE 2M and LE Coded PHY
- Embedded 1 MB flash memory and 256 kB internal RAM
- Includes ARM TrustZone® CryptoCell® 310 and supports secure boot including Root of Trust (RoT)
- Up to 48 general purpose I/Os (GPIO), which are shared by up to 4 SPI, 2 I²C, 2 UART, 4 PWM, 8 ADC, 1 NFC-A, 32 kHz IN/OUT, nRESET
- USB 2.0 full-speed device interface
- Built in temperature sensor

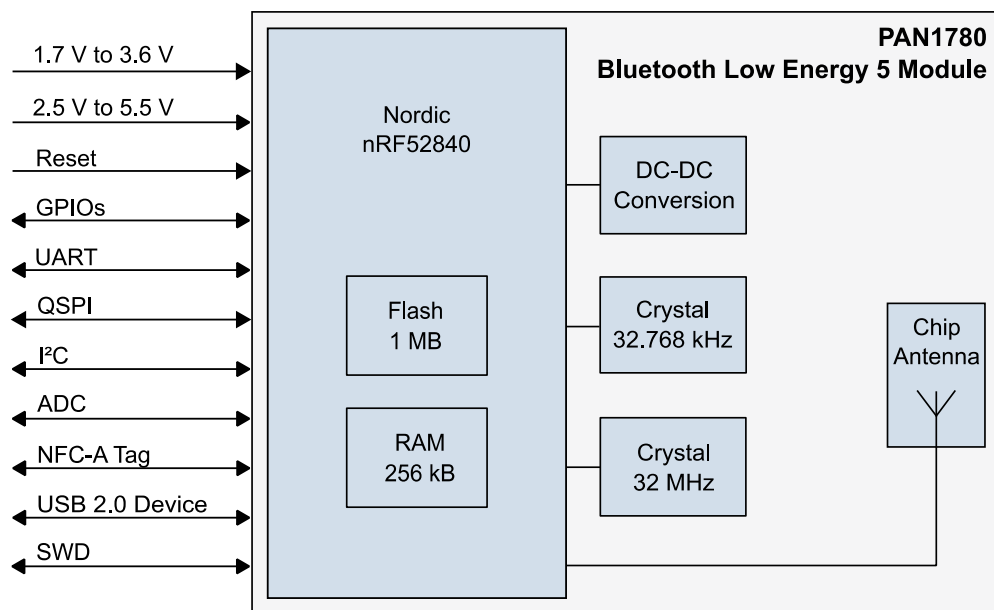
Bluetooth

- LE 2 Mbps high speed PHY, LE long range coded PHY
- LE advertising extensions (advertising on 40 channels total)
- Channel selection algorithm #2
- LE secure connections
- Over-the-air update of application software
- Qualified Bluetooth mesh profile stack

Characteristics

- Typical sensitivity: -95 dBm @ 1 Mb/s and -103 dBm @ 125 kb/s
- Typical max. output power: 8 dBm, configurable from -20 dBm in 4 dB steps and -40 dBm in whisper mode
- Typical current consumption: 4.8 mA in Tx (@ 0 dBm) and 4.8 mA in Rx mode
- Typical current consumption: 0.4 µA in System OFF mode, 1.5 µA with RTC wake up
- On-module DC/DC and LDO regulators with automated low current modes
- Voltage range: 1.7 V to 5.5 V
- Temperature range: -40 °C to 85 °C

Block Diagram



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1 About This Document



1.1 Purpose and Audience

This Product Specification provides details on the functional, operational, and electrical characteristics of the Panasonic module. It is intended for hardware design, application, and Original Equipment Manufacturers (OEM) engineers. The product is referred to as “the PAN1780” or “the module” within this document.

1.2 Revision History

| Revision | Date | Modifications/Remarks |
|----------|------------|--|
| 0.1 | 2019-10-30 | First preliminary version |
| 0.2 | 2019-10-30 | Updated picture “Block Diagram”. Corrected “Typical sensitivity”. Updated table in chapter “Pin Configuration”. Updated chapter “Bluetooth”. |
| 0.3 | 2019-11-20 | Corrected chapter “Current Consumption”. Corrected “Typical max. output power” and “Typical current consumption” in Product Overview. |
| 0.4 | 2020-01-08 | New layout |

1.3 Use of Symbols

| Symbol | Description |
|---|---|
|  | <p>Note</p> <p>Indicates important information for the proper use of the product. Non-observance can lead to errors.</p> |
|  | <p>Attention</p> <p>Indicates important notes that, if not observed, can put the product’s functionality at risk.</p> |
| ⇒ [chapter number] [chapter title] | <p>Cross reference</p> <p>Indicates cross references within the document.</p> <p>Example:</p> <p>Description of the symbols used in this document ⇒ 1.3 Use of Symbols.</p> |

1.4 Related Documents

Please refer to the Panasonic website for related documents ⇒ [6.2.2 Product Information](#).

2 Overview

The PAN1780 is a Bluetooth 5 Low Energy (LE) module based on the Nordic nRF52840 single-chip controller.

The Bluetooth 5 features additionally a higher symbol rate of 2 Mbps using the high-speed LE 2M PHY or a significantly longer range using the LE coded PHY at 500 kb/s or 125 kb/s. The new channel selection algorithm (CSA#2) improves the performance in high interference environments. Furthermore, the new LE advertising extensions allow for much larger amounts of data to be broadcasted in connectionless scenarios.

An output power of up to 8 dBm and the high sensitivity of the nRF52840 in combination with the LE coded PHY make the module very attractive in applications, where a long range is required.

In addition the ultra-low current consumption of the PAN1780 makes the module an ideal choice for battery powered devices.

With the Cortex[®] M4F processor, 256 kB RAM and the build-in 1 MB flash memory the PAN1780 can easily be used in standalone mode, thereby eliminating the need for an external processor, saving complexity, space, and cost.

The rich set of security features from the ARM TrustZone CryptoCell 310 security subsystem provide the necessary means for secure device operation in the IoT space.

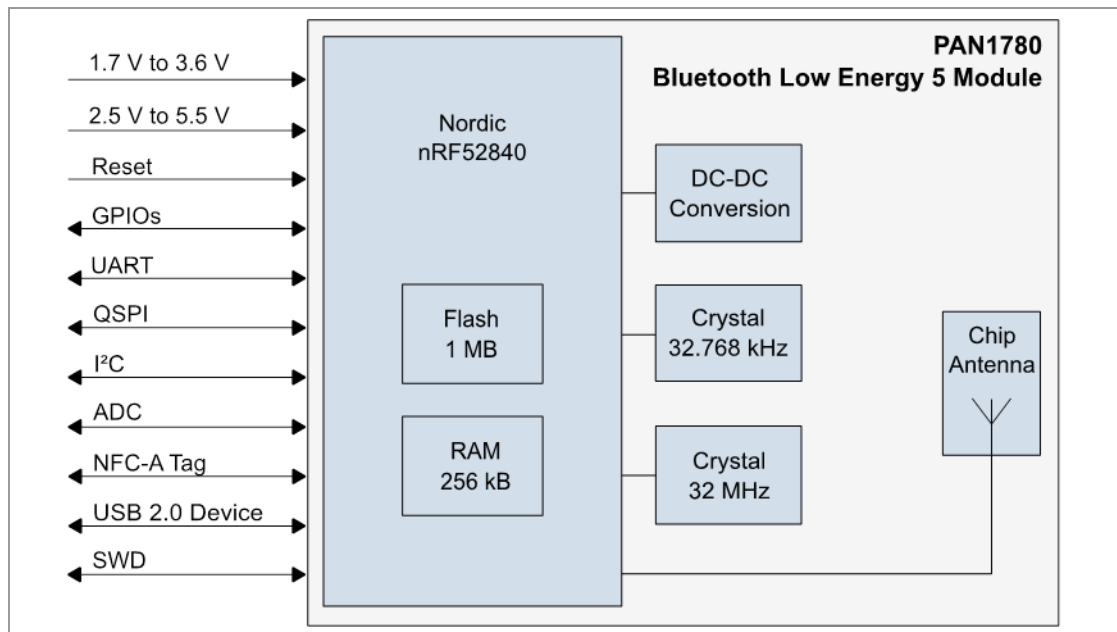
The PAN1780 also supports Type 2 Near Field Communication (NFC-A) for use in simplified pairing and payment solutions (external antenna required).

FCC, IC, and CE approval are in preparation.

For related documents please refer to ⇒ [6.2.2 Product Information](#).

For further information on the variants and versions please refer to ⇒ [6.1 Ordering Information](#).

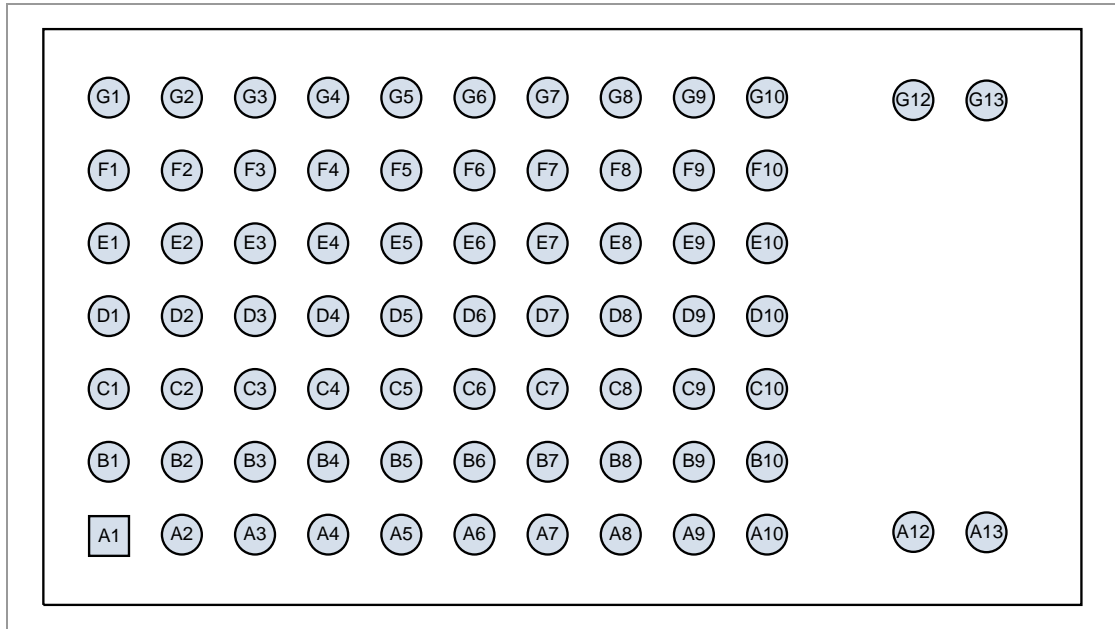
2.1 Block Diagram



2.2 Pin Configuration

Pin Assignment

Top View



Pin Functions

| No. | Pin Name | Pin Type | Description |
|-----|------------|-----------------------------|------------------------|
| A1 | P0.27 | Digital BI | GPIO |
| A2 | P0.26 | Digital BI | GPIO |
| A3 | P0.04/AIN2 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| A4 | P0.05/AIN3 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| A5 | P0.03/AIN1 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| A6 | P0.02/AIN0 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| A7 | P0.29/AIN5 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| A8 | NFC2 | RF NFC BI | Connect to NFC Antenna |
| A9 | NFC1 | RF NFC BI | Connect to NFC Antenna |
| A10 | GND | Ground | Connect to Ground |
| A12 | GND | Ground | Connect to Ground |
| A13 | GND | Ground | Connect to Ground |

| No. | Pin Name | Pin Type | Description |
|-----|--------------|-----------------------------|------------------------|
| B1 | P0.06 | Digital BI | GPIO |
| B2 | X32k_OUT | 32 kHz | Leave open |
| B3 | P0.30/AIN6 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| B4 | P0.31/AIN7 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| B5 | P0.28/AIN4 | Digital BI/ Analog Input | GPIO/Sensor to ADC |
| B6 | P1.13 | Digital BI | GPIO |
| B7 | P1.10 | Digital BI | GPIO |
| B8 | P1.06 | Digital BI | GPIO |
| B9 | P1.15 | Digital BI | GPIO |
| B10 | GND | Ground | Connect to Ground |
| C1 | P0.08 | Digital BI | GPIO |
| C2 | X32k_IN | 32 kHz | Leave open |
| C3 | P1.03 | Digital BI | GPIO |
| C4 | GND | Ground | Connect to Ground |
| C5 | GND | Ground | Connect to Ground |
| C6 | P1.14 | Digital BI | GPIO |
| C7 | P1.11 | Digital BI | GPIO |
| C8 | P1.12 | Digital BI | GPIO |
| C9 | P1.05 | Digital BI | GPIO |
| C10 | GND | Ground | Connect to Ground |
| D1 | GND | Ground | Connect to Ground |
| D2 | P1.08 | Digital BI | GPIO |
| D3 | P0.07/TRCCLK | Digital BI | GPIO or Trace IF Clock |
| D4 | GND | Ground | Connect to Ground |
| D5 | GND | Ground | Connect to Ground |
| D6 | P0.24 | Digital BI | GPIO |
| D7 | P1.02 | Digital BI | GPIO |
| D8 | P1.07 | Digital BI | GPIO |
| D9 | GND | Ground | Connect to Ground |
| D10 | GND | Ground | Connect to Ground |
| E1 | LV Mode | Supply Voltage | 1.7 V to 3.6 V |

| No. | Pin Name | Pin Type | Description |
|-----|---------------|----------------|----------------------------|
| E2 | P1.09/TRCDAT3 | Digital BI | GPIO or Trace IF D3 |
| E3 | GND | Ground | Connect to Ground |
| E4 | P0.17 | Digital BI | GPIO |
| E5 | P0.23 | Digital BI | GPIO |
| E6 | P0.20 | Digital BI | GPIO |
| E7 | P0.21 | Digital BI | GPIO |
| E8 | SWDCLK | Digital BI | Serial Wire Debug IF Clock |
| E9 | P1.04 | Digital BI | GPIO |
| E10 | RF_PIN | Analog BI | Normally leave unconnected |
| F1 | P0.12/TRCDAT1 | Digital BI | GPIO or Trace IF D1 |
| F2 | P0.11/TRCDAT2 | Digital BI | GPIO or Trace IF D2 |
| F3 | P0.13 | Digital BI | GPIO |
| F4 | P0.14 | Digital BI | GPIO |
| F5 | P0.15 | Digital BI | GPIO |
| F6 | P0.19 | Digital BI | GPIO |
| F7 | P1.01 | Digital BI | GPIO |
| F8 | P0.25 | Digital BI | GPIO |
| F9 | P0.22 | Digital BI | GPIO |
| F10 | GND | Ground | Connect to Ground |
| G1 | P0.16 | Digital BI | GPIO |
| G2 | HV Mode | Supply Voltage | 2.5 V to 5.5 V (optional) |
| G3 | GND | Ground | Connect to Ground |
| G4 | USB Mode | Supply Voltage | 4.35 V to 5.5 V |
| G5 | DP | USB D+ | Use for USB only |
| G6 | DM | USB D- | Use for USB only |
| G7 | nRESET | Digital I | Reset Signal Low Active |
| G8 | P1.00/TRCDAT0 | Digital BI | GPIO or Trace IF D0 |
| G9 | SWDIO | Digital BI | Serial Wire Debug IF Data |
| G10 | GND | Ground | Connect to Ground |
| G12 | GND | Ground | Connect to Ground |
| G13 | GND | Ground | Connect to Ground |

2.3 Peripherals

- Full-speed USB 2.0 device controller
- 2 UART (2 or 4 wire with CTS/RTS, 1 200 up to 1 M baud)
- I²C, I²S, SPI (32 MHz)
- QSPI (32 MHz)
- PWM
- PDM
- AES and CRYPTOCELL
- 8 channel 12 bit ADC
- Comparator
- Quadrature decoder
- Temperature sensor
- Real time counter
- Watchdog timer
- 48 PIOs
- Integrated 32 kHz crystal

2.4 Bluetooth Features

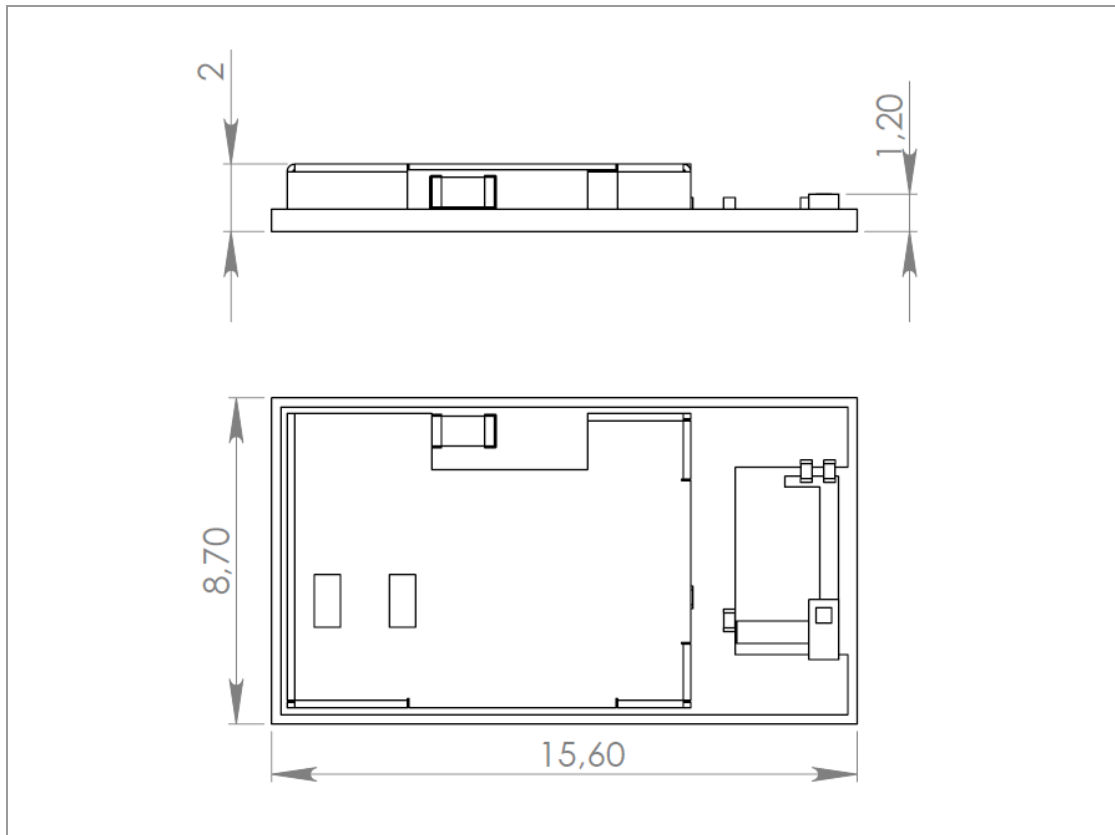
- Bluetooth LE 5
- Supports Bluetooth LE 5 high speed and long range modes

3 Detailed Description

3.1 Dimensions



All dimensions are in millimeters.



| No. | Item | Dimension | Tolerance | Remark |
|-----|--------|-----------|-----------|-----------|
| 1 | Width | 8.70 | ±0.3 | |
| 2 | Length | 15.60 | ±0.3 | |
| 3 | Height | 2.00 | ±0.3 | With case |

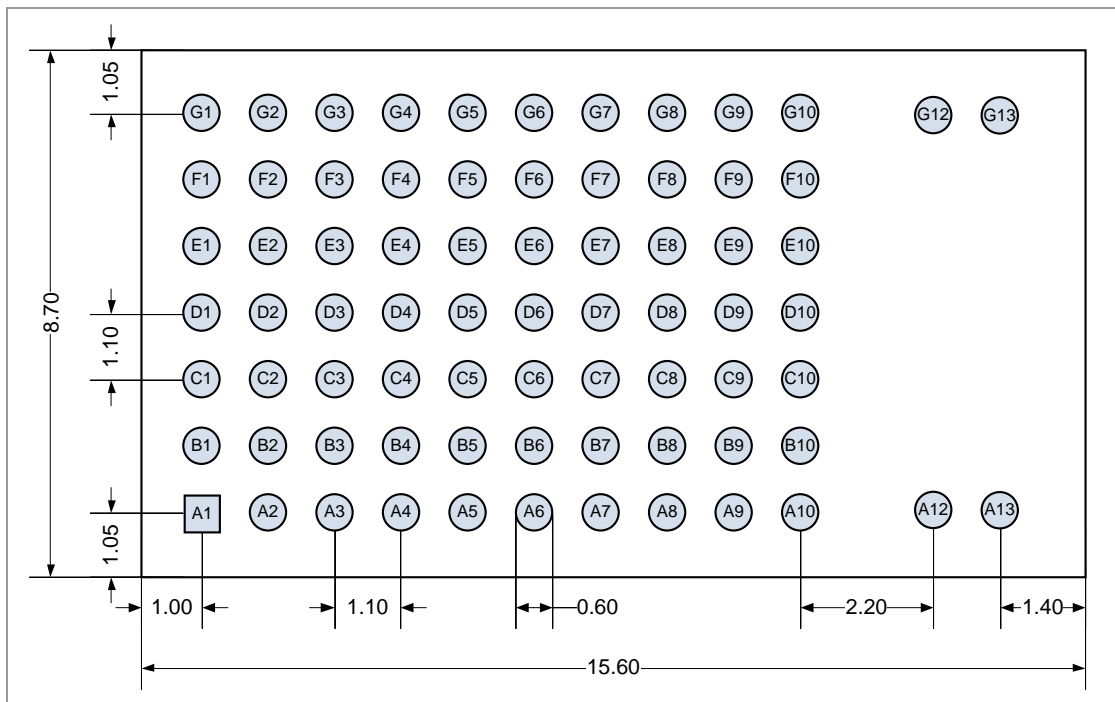
3.2 Footprint



All dimensions are in millimeters.

The outer dimensions have a tolerance of ± 0.3 mm.

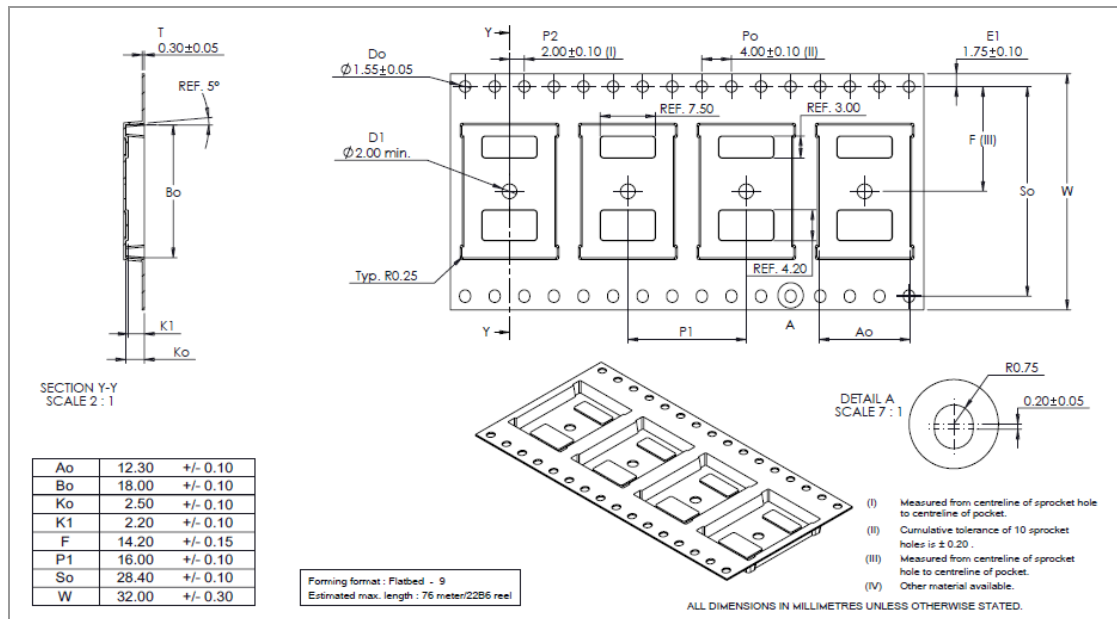
Top View



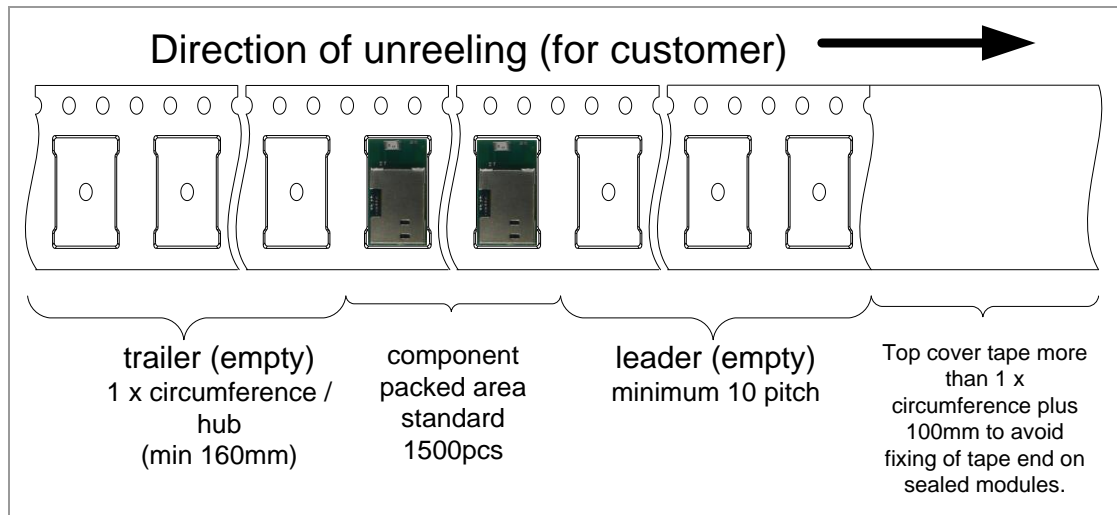
3.3 Packaging

The module is a mass production status product and will be delivered in the package described below.

3.3.1 Tape Dimensions



3.3.2 Packing in Tape

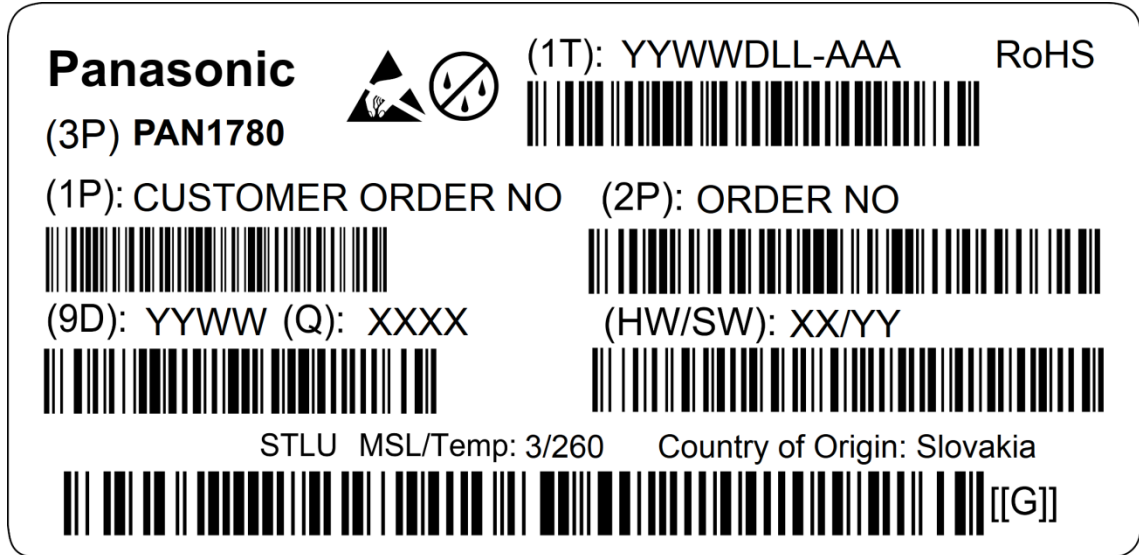


Empty spaces in the component packed area shall be less than two per reel and those spaces shall not be consecutive.

The top cover tape shall not be found on reel holes and it shall not stick out from the reel.

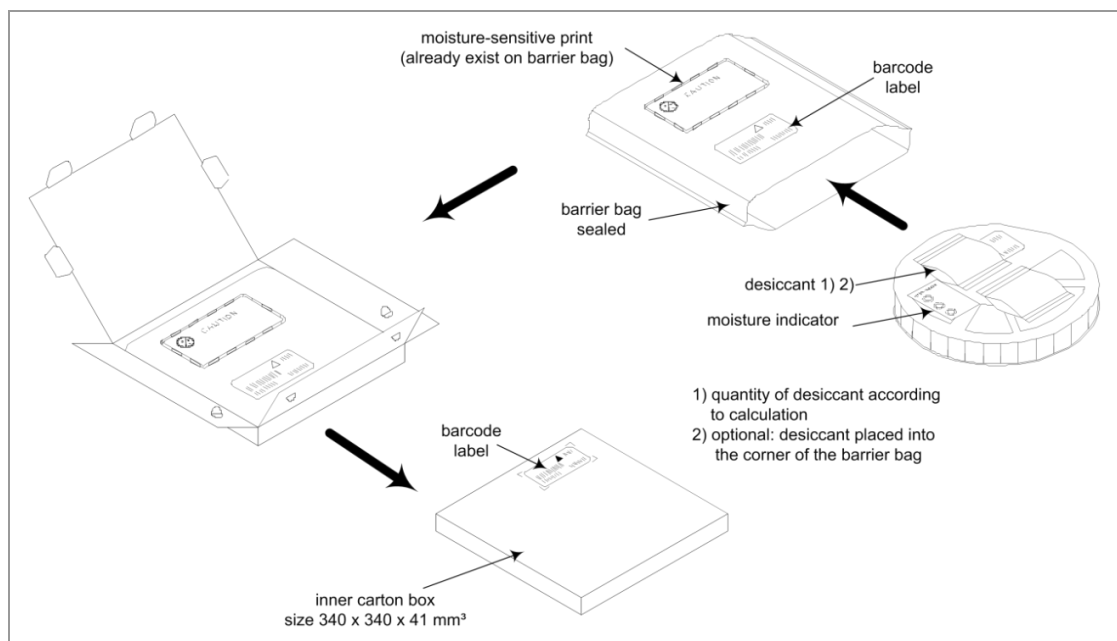
3.3.5 Package Label

Example:



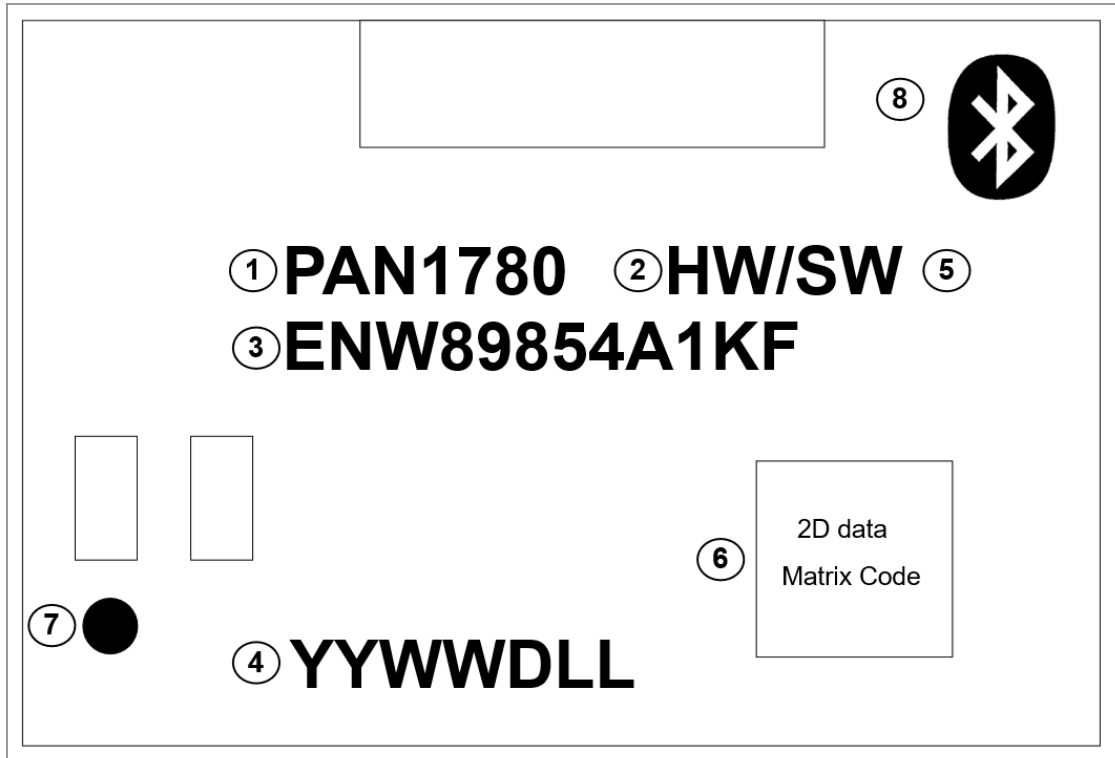
| | |
|---------|--------------------------------------|
| (1T) | Lot code |
| (1P) | Customer order number, if applicable |
| (2P) | Order number |
| (9D) | Date code |
| (Q) | Quantity |
| (HW/SW) | Hardware/software version |

3.3.6 Total Package



3.4 Case Marking

Example:



- 1 Brand name
- 2 Hardware/software version
- 3 Order number
- 4 Lot code
- 5 Status: ES or empty for MP
- 6 2D barcode, for internal usage only
- 7 Marking for Pin 1

4 Specification



All specifications are over temperature and process, unless indicated otherwise.

4.1 Default Test Conditions



Temperature: 25 °C ± 10 °C
Humidity: 40 % to 85 % RH
Supply Voltage: 3.3 V

4.2 Recommended Operating Conditions



The maximum ratings may not be exceeded under any circumstances, not even momentarily or individually, as permanent damage to the module may result.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------|-----------------------------|------|------|-----------------------|------|
| V _{DD} (LV Mode) | Supply Voltage | | 1.7 | | 3.6 | V |
| t _{R_VDD} | Supply Rise Time | 0 V to 1.7 V | | | 60 | ms |
| V _{DD-POR} | Supply Voltage | Power On Reset active | 1.75 | | | |
| V _{DDH} (HV Mode) | Supply Voltage | V _{DDH} - Optional | 2.5 | | 5.5 | V |
| t _{R_VDDH} | Supply Rise Time | 0 V to 3.7 V | | | 100 | ms |
| V _{BUS} | VBUS USB Supply Voltage | V _{BUS} - Optional | 4.35 | | 5.5 | V |
| V _{IO} | Max I/O Pin Voltage | V _{DD} ≤ 3.6 V | -0.3 | | V _{DD} + 0.3 | V |
| | | V _{DD} ≥ 3.6 V | | | V _{DD} + 3.9 | |
| TA | Operating Temperature | | -40 | 25 | 85 | °C |

4.3 Current Consumption



The current consumption depends on the user scenario and on the setup and timing in the power modes.

Assume $V_{DD}=3.3\text{ V}$, $T_{amb}=25\text{ }^{\circ}\text{C}$, if nothing else stated, DC/DC enabled

| Parameter | Condition | Min. | Typ. | Max. | Unit |
|------------------------|---|------|------|------|---------------|
| Sleep Mode | No RAM retention, Wake on Reset, SYS OFF | | 0.4 | | μA |
| | Full RAM retention, Wake on Reset, SYS OFF | | 1.86 | | μA |
| | No RAM retention, Wake on any event, SYS ON | | 0.97 | | μA |
| | Full RAM retention, Wake on any event, SYS ON | | 2.35 | | μA |
| | No RAM retention, Wake on RTC, SYS ON | | 1.5 | | μA |
| CPU executing CoreMark | Running from RAM | | 2.8 | | mA |
| | Running from Flash | | 3.3 | | mA |
| Rx Current | | | 4.8 | | mA |
| Tx Current | 8 dBm | | 14.8 | | mA |
| | 4 dBm | | 9.6 | | mA |
| | 0 dBm | | 4.8 | | mA |
| | -4 dBm | | 3.1 | | mA |
| | -8 dBm | | 3.3 | | mA |
| | -12 dBm | | 3.0 | | mA |
| | -16 dBm | | 3.8 | | mA |
| | -20 dBm | | 2.7 | | mA |
| | -40 dBm | | 2.3 | | mA |

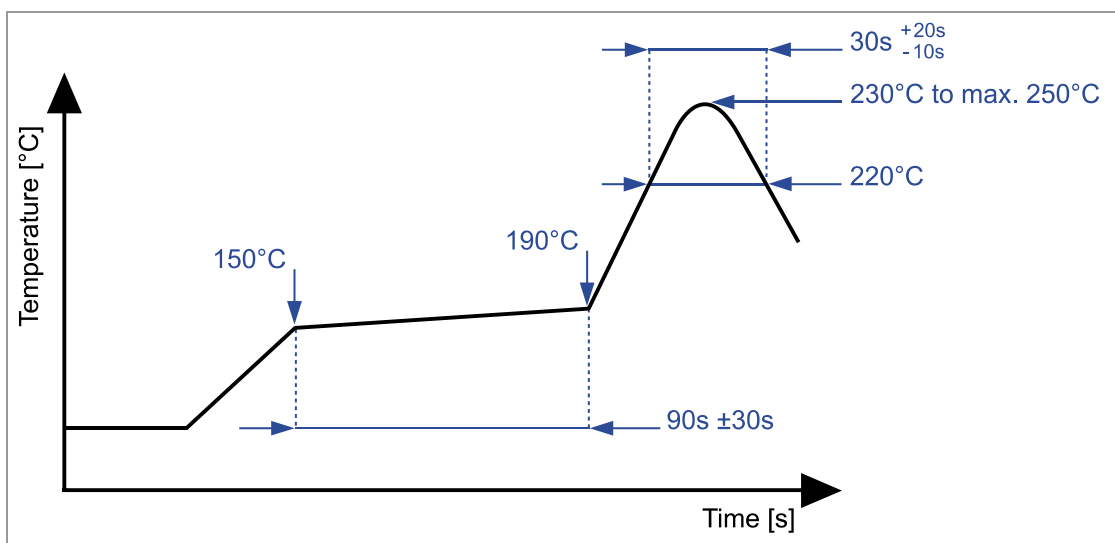
4.4 Bluetooth

| Parameter | Specification |
|---------------------|---|
| Frequency | 2 402 MHz to 2 480 MHz |
| Data Rate | 2 Mbps, 1 Mbps, 500 kbps, 125 kbps |
| Number of Channels | 40: 37 data/3 advertising (0, 12, 39) |
| Receive Sensitivity | -103 dBm (125 kbps Bluetooth LE Mode), -95 dBm (1 Mbps Bluetooth LE Mode), -92 (2 Mbps Bluetooth LE Mode) |
| Output Power | -40 dBm to +8 dBm |
| Link Budget | Up to 111 dB |

4.5 Recommended Soldering Profile



- Reflow permissible cycles: 2
- Opposite side reflow is prohibited due to module weight
- More than 75 percent of the soldering area shall be coated by solder
- The soldering profiles should be adhered to in order to prevent electrical or mechanical damage
- Soldering profile assumes lead-free soldering



5 Cautions



Failure to follow the guidelines set forth in this document may result in degrading of the module functions and damage to the module.

5.1 Design Notes

1. Follow the conditions written in this specification, especially the control signals of this module.
2. The supply voltage must be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47 μ F directly at the module).
3. This module should not be mechanically stressed when installed.
4. Keep this module away from heat. Heat is the major cause of decreasing the life time of these modules.
5. Avoid assembly and use of the target equipment in conditions where the module temperature may exceed the maximum tolerance.
6. Keep this module away from other high frequency circuits.
7. Refer to the recommended pattern when designing a board.

5.2 Installation Notes

1. Reflow soldering is possible twice based on the conditions set forth in [⇒ 4.5 Recommended Soldering Profile](#). Set up the temperature at the soldering portion of this module according to this reflow profile.
2. Carefully position the module so that the heat will not burn into printed circuit boards or affect other components that are susceptible to heat.
3. Carefully locate the module, to avoid an increased temperature caused by heat generated by neighboring components.
4. If a vinyl-covered wire comes into contact with the module, the wire cover will melt and generate toxic gas, damaging the insulation. Never allow contact between a vinyl cover and these modules to occur.
5. This module should not be mechanically stressed or vibrated when reflowed.
6. To repair the board by hand soldering, follow the conditions set forth in this chapter.
7. Do not wash this product.
8. Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the module.

5.3 Usage Condition Notes

1. Take measures to protect the module against static electricity.
If pulses or transient loads (a large load, which is suddenly applied) are applied to the modules, check and evaluate their operation before assembly of the final products.
2. Do not use dropped modules.
3. Do not touch, damage, or soil the pins.
4. Follow the recommended condition ratings about the power supply applied to this module.
5. Electrode peeling strength: Do not apply a force of more than 4.9 N in any direction on the soldered module.
6. Pressing on parts of the metal cover or fastening objects to the metal cover will cause damage.
7. These modules are intended for general purpose and standard use in general electronic equipment, such as home appliances, office equipment, information, and communication equipment.

5.4 Storage Notes

1. The module should not be stressed mechanically during storage.
2. Do not store these modules in the following conditions or the performance characteristics of the module, such as RF performance will be adversely affected:
 - Storage in salty air or in an environment with a high concentration of corrosive gas, such as Cl₂, H₂S, NH₃, SO₂, or NO_x,
 - Storage in direct sunlight,
 - Storage in an environment where the temperature may be outside the range of 5 °C to 35 °C, or where the humidity may be outside the 45 % to 85 % range,
 - Storage of the modules for more than one year after the date of delivery storage period: Please check the adhesive strength of the embossed tape and soldering after 6 months of storage.
3. Keep this module away from water, poisonous gas, and corrosive gas.
4. This module should not be stressed or shocked when transported.
5. Follow the specification when stacking packed crates (max. 10).

5.5 Safety Cautions

These specifications are intended to preserve the quality assurance of products and individual components.

Before use, check and evaluate the operation when mounted on your products. Abide by these specifications without deviation when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, provide the following failsafe functions as a minimum:

1. Ensure the safety of the whole system by installing a protection circuit and a protection device.
2. Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a single fault causing an unsafe status.

5.6 Other Cautions

1. Do not use the module for other purposes than those listed in section ⇒ [5.3 Usage Condition Notes](#).
2. Be sure to provide an appropriate fail-safe function on your product to prevent any additional damage that may be caused by the abnormal function or the failure of the module.
3. This module has been manufactured without any ozone chemical controlled under the Montreal Protocol.
4. These modules are not intended for use under the special conditions shown below. Before using these modules under such special conditions, carefully check their performance and reliability under the said special conditions to determine whether or not they can be used in such a manner:
 - In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash,
 - In direct sunlight, outdoors, or in a dusty environment,
 - In an environment where condensation occurs,
 - In an environment with a high concentration of harmful gas (e. g. salty air, HCl, Cl₂, SO₂, H₂S, NH₃, and NO_x).
5. If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these modules with new modules, because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.



Please refer to the Panasonic website for further information ⇒ [6.2.2 Product Information](#).

5.7 Restricted Use

5.7.1 Life Support Policy

This Panasonic Industrial Devices Europe GmbH product is not designed for use in life support appliances, devices, or systems where malfunction can reasonably be expected to result in a significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Panasonic customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Panasonic Industrial Devices Europe GmbH for any damages resulting.

5.7.2 Restricted End Use

This Panasonic Industrial Devices Europe GmbH product is not designed for any restricted activity that supports the development, production, handling usage, maintenance, storage, inventory or proliferation of any weapons or military use.

Transfer, export, re-export, usage or reselling of this product to any destination, end user or any end use prohibited by the European Union, United States or any other applicable law is strictly prohibited.

6 Appendix

6.1 Ordering Information

Variants and Versions

| Order Number | Brand Name | Description | MOQ ¹ |
|---------------------------|------------|--|------------------|
| ENW89854A1KF ² | PAN1780 | Bluetooth Low Energy Single Mode with Antenna Empty Flash | 1 500 |

¹ Abbreviation for Minimum Order Quantity (MOQ). The default MOQ for mass production is 1 500 pieces, fewer only on customer demand. Samples for evaluation can be delivered at any quantity via the distribution channels.

² Samples are available on customer demand.

6.2 Contact Details

6.2.1 Contact Us

Please contact your local Panasonic Sales office for details on additional product options and services:

For Panasonic Sales assistance in the **EU**, visit

<https://eu.industrial.panasonic.com/about-us/contact-us>

Email: wireless@eu.panasonic.com

For Panasonic Sales assistance in **North America**, visit the Panasonic website “Sales & Support” to find assistance near you at

<https://na.industrial.panasonic.com/distributors>

Please visit the **Panasonic Wireless Technical Forum** to submit a question at

<https://forum.na.industrial.panasonic.com>

6.2.2 Product Information

Please refer to the Panasonic Wireless Connectivity website for further information on our products and related documents:

For complete Panasonic product details in the **EU**, visit

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