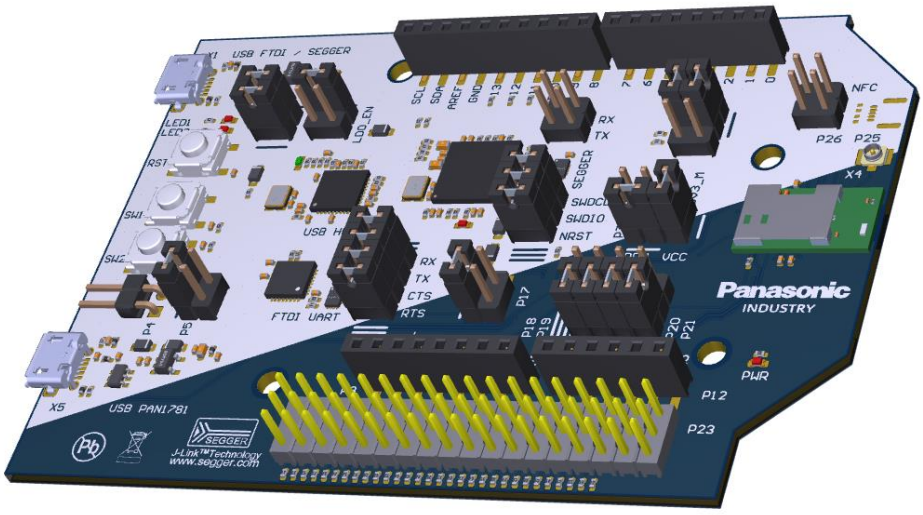
Panasonic
INDUSTRY

# PAN1781 ETU

## Easy-To-Use Evaluation Tool

## User Guide

Rev. 1.0




Wireless Connectivity

## Overview

The PAN1781 ETU is an evaluation board for the PAN1781 Bluetooth® 5 Low Energy (LE) module based on the Nordic nRF52820 single chip controller.

## PAN1781 Features

- Surface mount type dimensions: 15.6 mm × 8.7 mm × 2 mm
- Drop-in replacement for PAN1026A and PAN1762
- Nordic nRF52820 featuring ARM® Cortex®-M4 with 64 MHz
- Bluetooth 5 LE including LE 2M and LE Coded PHY
- Embedded 256 kB flash memory and 32 kB internal RAM
- 128-bit AES/ECB/CCM/AAR co-processor
- Up to 16 General Purpose I/O's (GPIO), which are shared with up to 2× SPI, 2× I²C, UART, COMP, QDEC, 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
- Angle of arrival (AOA) and angle of departure (AOD) direction finding

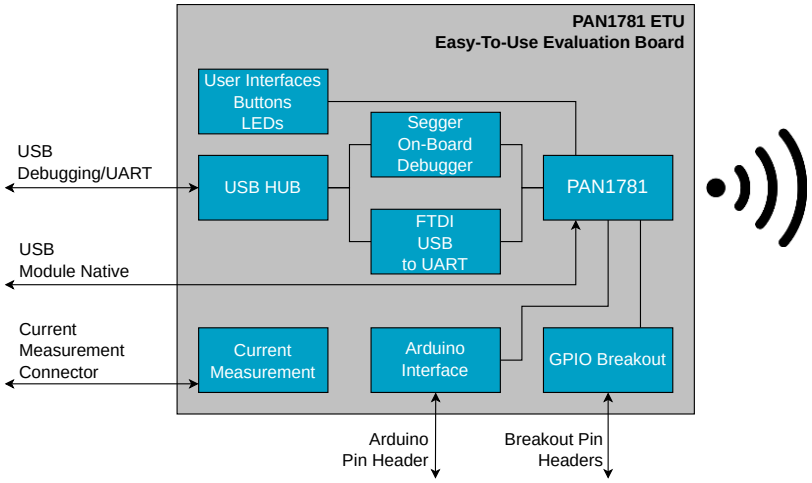
## PAN1781 Characteristics

- Typical sensitivity: -95 dBm at 1 Mb/s and -103 dBm at 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: 4.9 mA in Tx (at 0 dBm) and 4.7 mA in Rx mode
- Typical current consumption: 0.3 µA in System OFF mode, 1.2 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

## Evaluation Tool Features

- Arduino interface configurable as shield or board
- All GPIO break out
- Power measurement interface
- Segger® J-Link On-Board Debugger
- FTDI USB to UART Interface
- Peripherals are deactivable for low power applications
- 2× user buttons, 2× user LEDs
- Module native USB interface
- Compatibility to Nordics nRF5 SDK projects

## Block Diagram



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# Table of Contents

# 1 About This Document

## 1.1 Purpose and Audience

This User Guide is intended to give an detailed description of the Easy-To-Use (ETU) evaluation board components and functionalities.

It is intended for hardware design, application, and Original Equipment Manufacturers (OEM) engineers.

The product is referred to as “the PAN1781 ETU” or “the ETU” within this document.

## 1.2 Revision History

| Revision | Date | Modifications/Remarks |
|---|---|---|
| 1.0 | 2021-06-24 | First version |

## 1.3 Use of Symbols

| Symbol | Description |
|---|---|
|  | **Note**<br>Indicates important information for the proper use of the product. Non-observance can lead to errors. |
|  | **Attention**<br>Indicates important notes that, if not observed, can put the product’s functionality at risk. |
|  | **Tip**<br>Indicates useful information designed to facilitate working with the module and software. |
| ⇨ [chapter number] [chapter title] | **Cross reference**<br>Indicates cross references within the document.<br>**Example:**<br>Description of the symbols used in this document ⇨ 1.3 Use of Symbols. |
| ✓ | **Requirement**<br>Indicates a requirement that must be met before the corresponding tasks can be completed. |
| ➔ | **Result**<br>Indicates the result of a task or the result of a series of tasks. |
| **This font** | **GUI text**<br>Indicates fixed terms and text of the graphical user interface.<br>**Example:**<br>Click **Save**. |

| Symbol | Description |
|---|---|
| **Menu** > **Menu item** | **Path**<br>Indicates a path, e.g. to access a dialog.<br>**Example:**<br>In the menu, select **File** > **Setup page**. |
| `This font` | **File names, messages, user input**<br>Indicates file names or messages and information displayed on the screen or to be selected or entered by the user.<br>**Examples:**<br>`pan1760.c` contains the actual module initialization.<br>The message `Failed to save your data` is displayed.<br>Enter the value `Product 123`. |
| **Key** | **Key**<br>Indicates a key on the keyboard, e.g. **F10**. |

## 1.4 Related Documents

For related documents please refer to the Panasonic website ⇨ 4.2 Product Information.

# 2 Overview

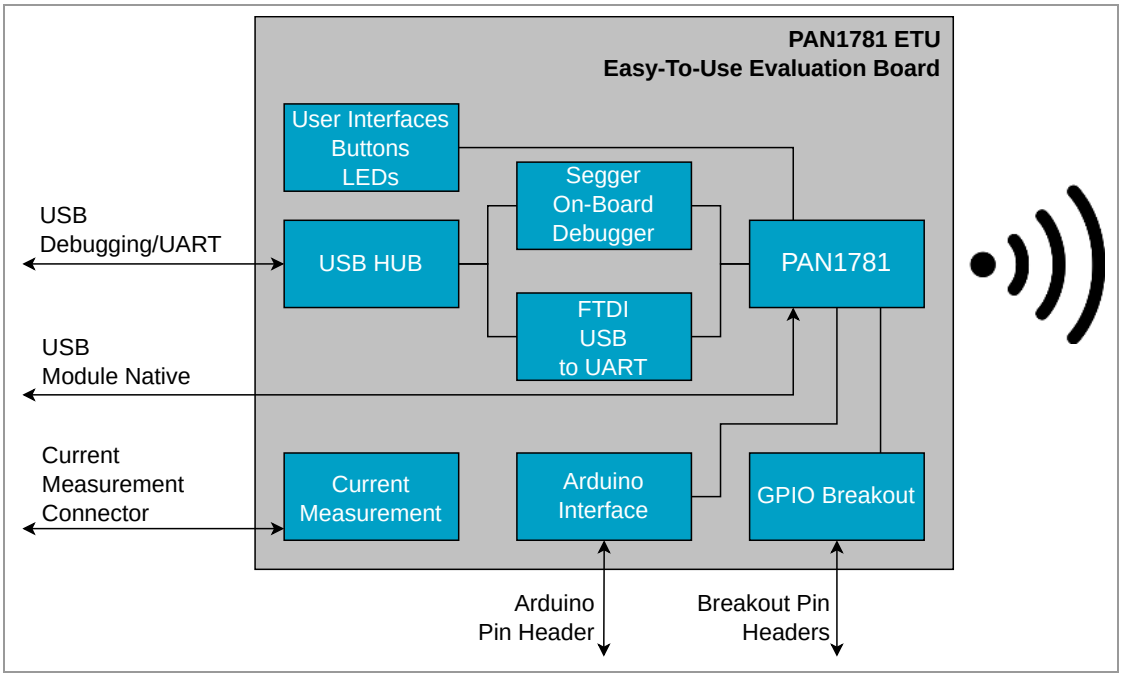
The PAN1781 ETU is an evaluation board for the PAN1781 Bluetooth 5 LE module, based on the Nordic nRF52820 single chip controller.

It gives access to the PAN1781 over several different interfaces like USB, UART, GPIOs, current measurement pins, and Segger J-Link On-Board Debugger. With the PAN1781 ETU, an evaluation of the PAN1781 can be easily done which results in a high reduction of development time.

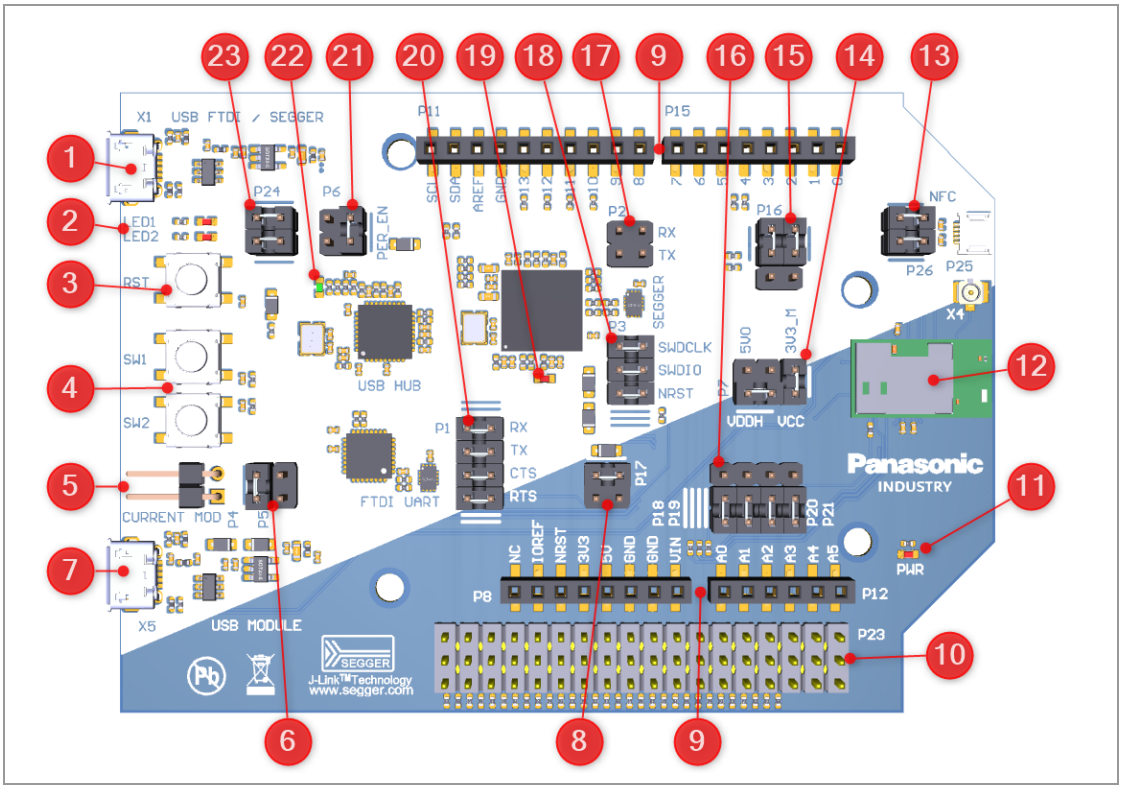
For related documents please refer to ⇨ 4.2 Product Information.

# 3 PAN1781 ETU

## 3.1 Block Diagram




## 3.2 Board Overview



| No. | Name | Function |
|---|---|---|
| 1 | USB connector | Flashing, debugging, and UART communication |
| 2 | User LEDs | Can be used in user application. |
| 3 | Reset button | Resets the PAN1781. |
| 4 | User buttons | Can be used in user application. |
| 5 | Current measurement pin header | If the jumper from pin header P5 (no. 6) is unplugged, a current measurement can be done on pin header P4.<br>⇨ 3.9 Current Measurement |
| 6 | | |
| 7 | Module native USB connector | Connected to the PAN1781 USB interface. |
| 8 | Arduino power direction pin header | Input/output power direction can be chosen.<br>⇨ 3.8 Arduino Board/Shield Configuration |
| 9 | Arduino pin headers | Arduino boards or shields can be stacked here. |
| 10 | Breakout pins | All PAN1781 GPIOs can be accessed here. |
| 11 | PAN1781 power LED | The LED shines red when the PAN1781 is powered. |
| 12 | PAN1781 | Bluetooth module |
| 13 | Pin header | Connects the GPIOs of the module with the breakout pins. |
| 14 | PAN1781 voltage level pin header | The module voltage level 3.3 V or 5 V can be chosen. |
| 15 | Arduino UART direction pin header | UART TX and RX can be swapped here. |
| 16 | Arduino pin configuration pin header | Chose which Arduino interface pin is routed to which GPIO of the module (for a few selected GPIOs). |
| 17 | Segger UART – PAN1781 connector pin header | The Segger J-Link On-Board Debugger has an additional UART interface which can be connected to the module.<br>⇨ 3.11 Activating the Segger OBD UART Port |
| 18 | Debug connector | Gives access to the PAN1781 SWD debug interface for external debugger. |
| 19 | Segger J-Link On-Board Debugger LED | Is shining and could blink red when the On-Board Debugger is powered. |
| 20 | FTDI UART (PAN1781 connector) | Connection between FTDI adapter and the PAN1781. |
| 21 | Peripheral power pin header | The USB hub, FTDI adapter, and On-Board Debugger can be switched off here. |
| 22 | USB hub power LED | The LED shines green when the USB hub is powered. |
| 23 | User LED connection pin header | The LEDs can be separated from the PAN1781 GPIOs here. |

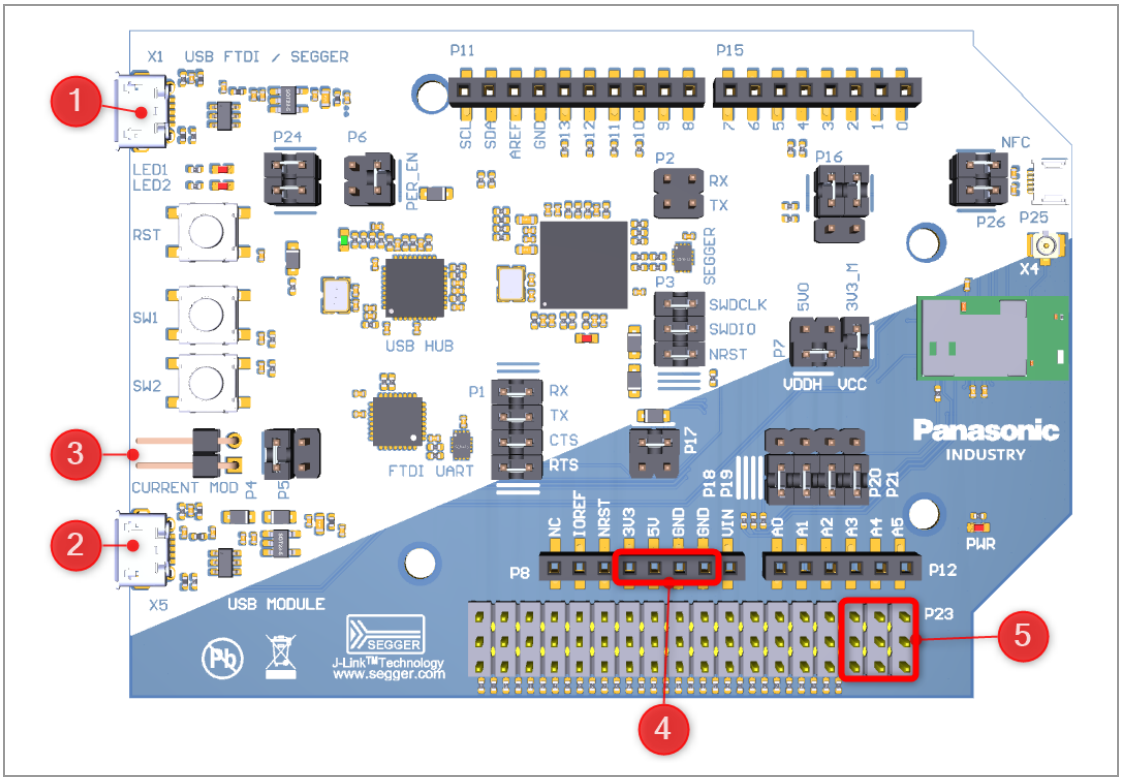
## 3.3 Pin Map for Pin Headers and Buttons

The following table gives information about the connections between pin headers and the PAN1781:

| | Pin | PAN1781 Footprint | PAN1781 Pin | nRF52820 Footprint | nRF52820 Pin |
|---|---|---|---|---|---|
| P1 | RX | E6 | P0.08 | 31 | P0.08 |
| | TX | F7 | P0.06 | 6 | P0.06 |
| | CTS | B6 | P0.07 | 7 | P0.07 |
| | RTS | B5 | P0.30 | 33 | P0.30 |
| P2 | RX | E6 | P0.08 | 31 | P0.08 |
| | TX | F7 | P0.06 | 6 | P0.06 |
| P3 | SWDCLK | C5 | SWDCLK | 20 | SWDCLK |
| | SWDIO | C4 | SWDIO | 19 | SWDIO |
| | NRST | A3 | RESET | 16 | P0.18 |
| P16 | RX/TX | E6/F7 | P0.08/P0.06 | 31/6 | P0.08/P0.06 |
| P18/P19/P20/P21 | ⇨ 3.6 Breakout Pin Header | | | | |
| P23 | | | | | |
| P24 | LED1 | E1 | P0.14 | 14 | P0.14 |
| | LED2 | C6 | P0.15 | 15 | P0.15 |
| P26 | Top | A8 | P0.16 | 22 | P0.16 |
| | Bottom | F6 | P0.17 | 23 | P0.17 |
| SW1 | | B2 | P0.04 | 4 | P0.04 |
| SW2 | | C3 | P0.05 | 5 | P0.05 |

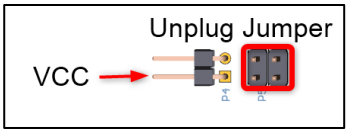
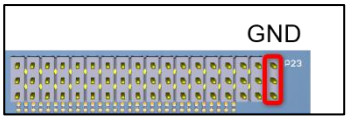
## 3.4 Powering Options

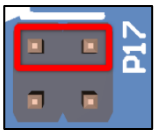
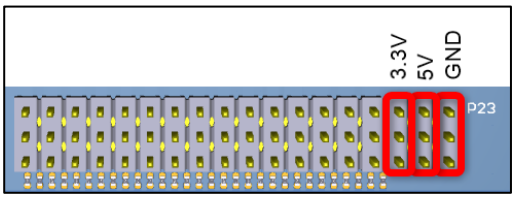
The ETU can be powered by the following different sources:




**Risk of Damage the Board Components (no. 4 and no. 5)**

Do not supply 5 V on the 3.3 V pin (“Arduino pin header” and “breakout pins”). This could lead to damage on board components.

| No. | Powering Option | Description |
|---|---|---|
| 1 | USB connector | The whole board can be powered over the USB connector. The PAN1781 is still powered if the peripherals are deactivated over P6. |
| 2 | Module native USB connector | |
| 3 | Current measurement pin header | Can be used as power entry for PAN1781 only. Power supply can be achieved in following way:     |

| No. | Powering Option | Description |
|---|---|---|
| 4 | Arduino pin header | For power supply, the pin 3.3 V and the pin 5 V can be used.<br>To use the pin 5 V as input, the jumper position P17 must be changed to following position:<br>  |
| 5 | Breakout pins | For power supply the pin 3.3 V and the pin 5 V can be used.<br>  |

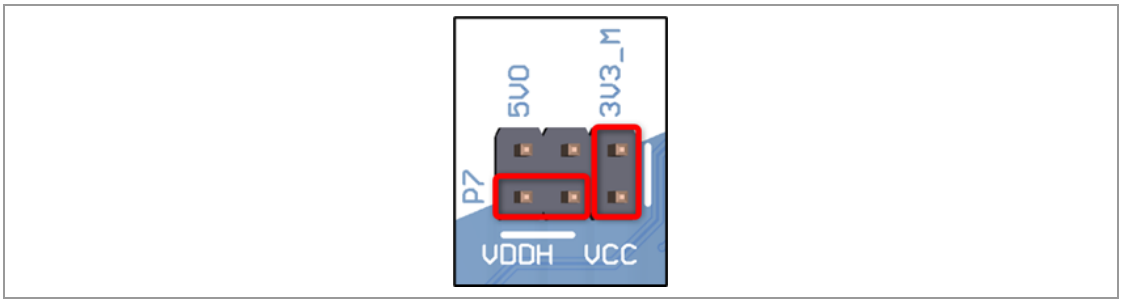
## 3.5 PAN1781 Power Options

The PAN1781 has two different supply voltage modes: Normal Voltage Mode and High Voltage Mode. The mode depends on which voltage levels are connected to the VCC/VDDH pins of the module.

The ETU has the pin header P7 to configure these voltage modes.

### 3.5.1 Normal Voltage Mode

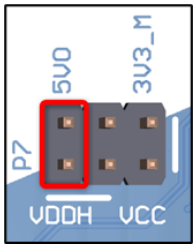
The system enters Normal Voltage Mode when the supply voltage of 3.3 V is connected to both the pin VCC and pin VDDH of the module (module pin VDD shorted to pin VDDH).



### 3.5.2 High Voltage Mode

If the High Voltage Mode is used, a current measurement over the current measurement pin header is not possible. To measure the current, an own power supply must be used and connected directly to the pin VDDH on P7.

The system enters High Voltage Mode when a supply voltage of 5 V is only connected to the pin VDDH and the pin VCC is not connected to any voltage supply.

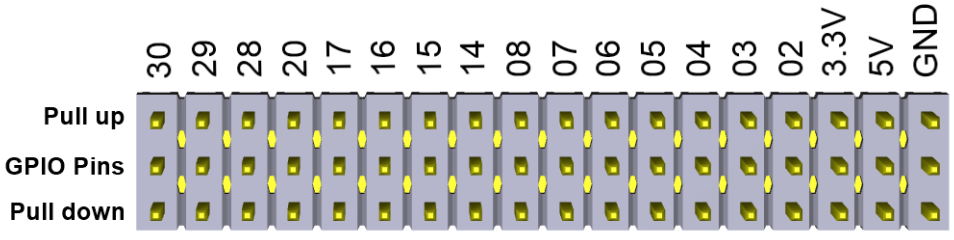



For further information please refer to the Nordic Infocenter:
https://infocenter.nordicsemi.com/topic/ps_nrf52820/power.html?cp=4_3_0_4_2

## 3.6 Breakout Pin Header

Every GPIO of the PAN1781 can be accessed through the breakout pin header P23. Also, for each pin a pull-up pin and a pull-down pin is available which can be bridged by jumper.

The following figure and table gives an overview about the connection between ETU, PAN1781, and nRF52820.

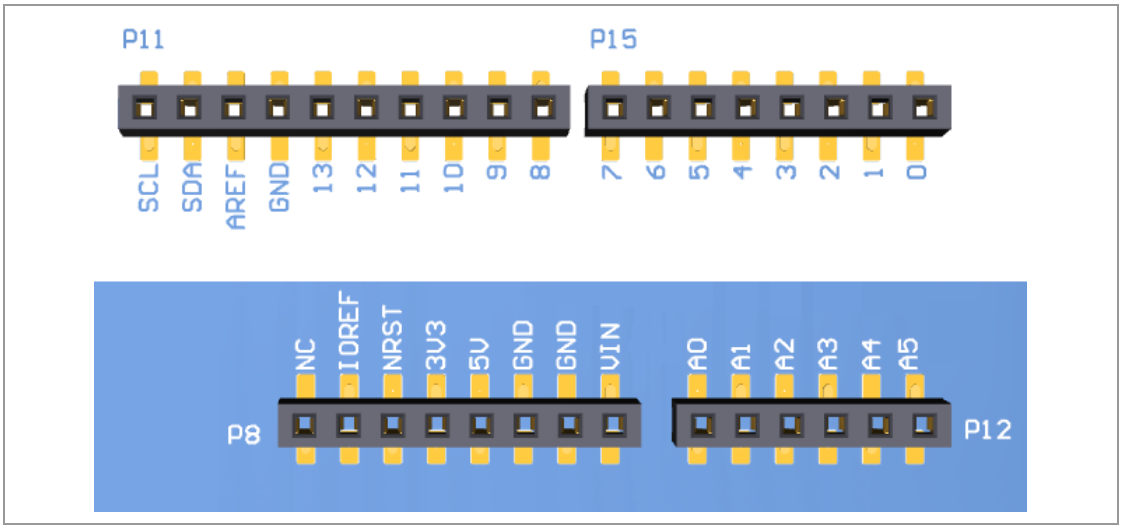



| ETU Pin | PAN1781 Footprint | PAN1781 Pin | nRF52820 Footprint | nRF52820 Pin |
|---|---|---|---|---|
| 02 | F5 | P0.02 | 36 | P0.02 |
| 03 | A2 | P0.03 | 35 | P0.03 |
| 04 | B2 | P0.04 | 4 | P0.04 |
| 05 | C3 | P0.05 | 5 | P0.05 |
| 06 | F7 | P0.06 | 6 | P0.06 |
| 07 | B6 | P0.07 | 7 | P0.07 |

| ETU Pin | PAN1781 Footprint | PAN1781 Pin | nRF52820 Footprint | nRF52820 Pin |
|---|---|---|---|---|
| 08 | E6 | P0.08 | 31 | P0.08 |
| 14 | E1 | P0.14 | 14 | P0.14 |
| 15 | C6 | P0.15 | 15 | P0.15 |
| 16 | A8 | P0.16 | 22 | P0.16 |
| 17 | F6 | P0.17 | 23 | P0.17 |
| 20 | E2 | P0.20 | 17 | P0.20 |
| 28 | F8 | P0.28 | 34 | P0.28 |
| 29 | B1 | P0.29 | 32 | P0.29 |
| 30 | B5 | P0.30 | 33 | P0.30 |
| 3.3 V | The maximum output current 500 mA. | | | |
| 5 V | The maximum output current depends on the USB supply. | | | |
| GND | | | | |

## 3.7 Arduino Interface

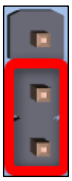
The Arduino interface can be used to stack the ETU with other boards and shields with Arduino connectors.




| Arduino Pin | Function | PAN1781 Footprint | PAN1781 Pin | nRF52820 Footprint | nRF52820 Pin |
|---|---|---|---|---|---|
| IOREF | 3.3 V Ref Voltage Out | | | | |
| NRST | Module Reset | Reset | A3 | P0.18 | 16 |
| 3V3 | 3.3 V input/output | The maximum output current is 500 mA. | | | |
| 5V | 5 V input/output | The maximum output current depends on the USB supply. | | | |

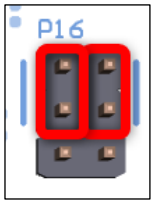
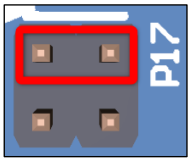
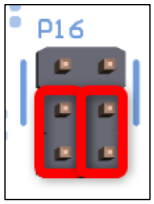
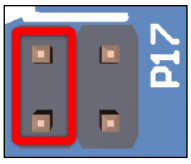
| Arduino Pin | Function | PAN1781 Footprint | PAN1781 Pin | nRF52820 Footprint | nRF52820 Pin |
|---|---|---|---|---|---|
| GND | Ground | | | | |
| GND | Ground | | | | |
| VIN | Not Connected | | | | |
| A0 | Analog Input | P0.02 | F5 | P0.02 | 36 |
| A1 | Analog Input | P0.03 | A2 | P0.03 | 35 |
| A2 | Analog Input | P0.04 | B2 | P0.04 | 4 |
| A3 | Analog Input | P0.05 | C3 | P0.05 | 5 |
| A4 | Not connected | | | | |
| A5 | Not connected | | | | |
| SCL | $I^2C$ Clock | P0.30 | B5 | P0.30 | 33 |
| SDA | $I^2C$ Data | P0.07 | B6 | P0.07 | 7 |
| AREF | | P0.02 | F5 | P0.02 | 36 |
| GND | Ground | | | | |
| 13 | GPIO | P0.28 | F8 | P0.28 | 34 |
| 12 | GPIO | P0.29 | B1 | P0.29 | 32 |
| 11 | GPIO | P0.20 | E2 | P0.20 | 17 |
| 10 | GPIO | P0.03 | A2 | P0.03 | 35 |
| 9 | Not connected | | | | |
| 8 | Not connected | | | | |
| 7 | Not connected | | | | |
| 6 | Not connected | | | | |
| 5 | GPIO | P0.05 | C3 | P0.05 | 5 |
| 4 | GPIO | P0.04 | B2 | P0.04 | 4 |
| 3 | GPIO | P0.15 | C6 | P0.15 | 15 |
| 2 | GPIO | P0.14 | E1 | P0.14 | 14 |
| 1 | GPIO<br>UART RX/TX<br>Depending on P16 Setup | P0.08/<br>P0.06 | E6/F7 | P0.08/<br>P0.06 | 31/6 |
| 0 | GPIO<br>UART TX/RX<br>(depending on P16 setup) | P0.06/P0.08 | F7/E6 | P0.06/P0.08 | 6/31 |

Four GPIOs of the PAN1781 are routed to two Arduino pin header pins each. It can be chosen which one is used by configuring the pin headers P18, P19, P20, and P21.

| Pin Configuration | P18 | P19 | P20 | P21 |
|---|---|---|---|---|
|  | P0.02 → A1 | P0.03 → A1 | P0.04 → A2 | P0.05 → A3 |
|  | P0.02 → AREF | P0.03 → 10 | P0.04 → 4 | P0-05 → 3 |

## 3.8 Arduino Board/Shield Configuration

The ETU can be used either as Arduino board or as Arduino shield. The UART communication and the 5 V Power input/output configuration is different between these both modes. The following jumpers must be set to achieve the specific board/shield configuration.

| Configuration | P16<br>(Flipping RX and TX Pins) | P17<br>(Blocks the input power direction by a diode) |
|---|---|---|
| Board |  |  |
| Shield |  |  |

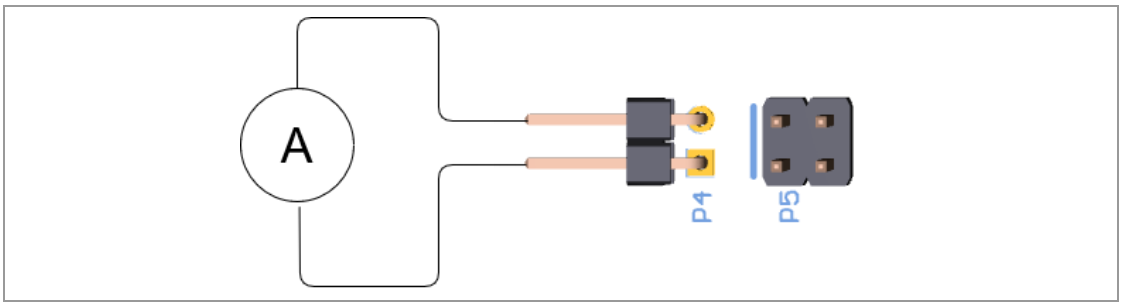
## 3.9 Current Measurement

**Unplug Jumper on P5**

To cut the direct power supply to the PAN1781, the jumper on P5 must be unplugged. Otherwise a current measurement will not work.

The ETU provides the feature to measure the current of the PAN1781, independent from the peripheral components.

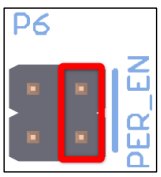
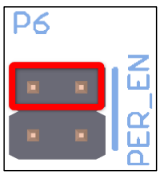
The following setup can be used for the current measurement:




If a power profiling is needed, the “nRF Power Profiler Kit II” from Nordic can be used.

## 3.10 Disabling Peripherals

The ETU peripheral components can be deactivated to save energy when it is powered by battery for example.

| Peripheral Status | Jumper Configuration |
|---|---|
| Enabled |   |
| Disabled |   |

The following table shows the status of the ETU components when P6 is in “Disabled” configuration:

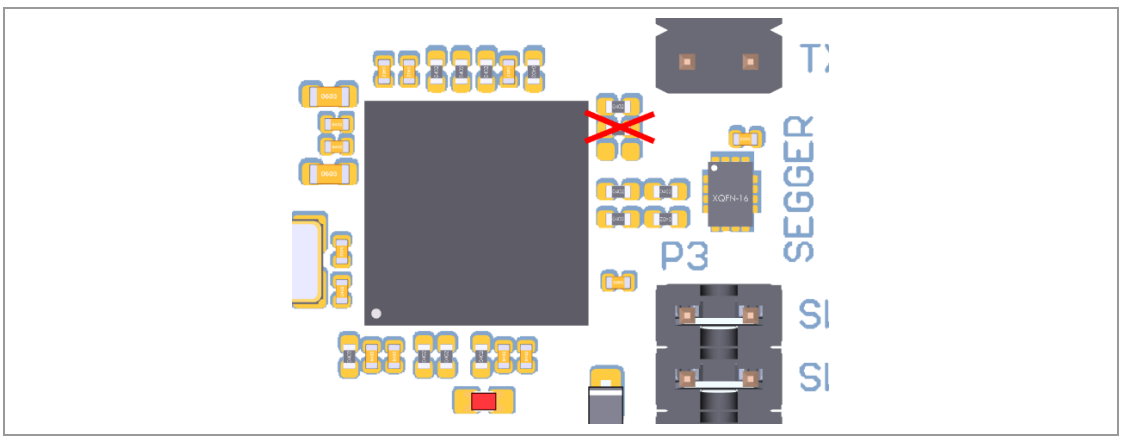
| Peripheral | Status |
|---|---|
| USB hub | Disabled |
| FTDI USB to UART adapter | Disabled |
| Segger J-Link On-Board Debugger | Disabled |
| User buttons | Enabled |
| Reset button | Enabled |
| PAN1781 power mode configuration | Enabled |
| Powering over FTDI/Segger J-Link On-Board Debugger | Enabled |
| User LEDs | Enabled |
| Current measurement | Enabled |
| PAN1781 | Enabled |
| Module native USB interface | Enabled |
| Arduino interface | Enabled |
| Breakout pins | Enabled |

## 3.11 Activating the Segger OBD UART Port

The Segger J-Link On-Board Debugger has an optional UART port which is connected to the PAN1781. It can be activated be unsoldering a resistor from the ETU.

The additional Segger J-Link On-Board Debugger UART port **does not** provide flow control functionality with RTS and CTS.

The following figure shows which resistor must be unsoldered to activate the additional UART port:



## 3.12 Software Development

The PAN1781 is a radio certified module. There are conditions on hardware and software which must be met for a valid usage of the certification.

For further information please refer to “PAN1781 Module Integration Guide”.

Only the Nordics nRF5 SDK sample projects which are labeled with “pca10100e” are working on the ETU.

Nordic provides several SDKs with building tools and sample projects.

For further information please refer to the software documentation:
https://www.nordicsemi.com/Software-and-tools/Software.

## 3.13 Bluetooth Device Address Safeguard

**Beware of Accidental Erase!**

Before starting development, it is necessary to read out the module-specific information so that it can be restored whenever needed.

Special care must be taken that the public Bluetooth Device Address is not accidentally erased and lost, even if the public Bluetooth Device Address is not explicitly used during evaluation of the PAN1781 ETU.

During development it is usually necessary to reset the module to the factory default state (“erase all”). This will also reset all the pre-programmed information in the module.

The PAN1781 is pre-programmed and comes with: a public Bluetooth Device Address and a random Bluetooth Device Address. Both can be easily used, depending on the anticipated use-case.

All applications from the Nordic SDK automatically use the built-in random Bluetooth Device Address and must be modified when the public Bluetooth Device Address shall be used.

### 3.13.1 Background Information

During production of the module, some module-specific information are stored in the user information configuration registers (UICRs) of the PAN1781.

UICRs are non-volatile memory (NVM) registers for configuring user-specific settings and can be modified by the user.

The module-specific information in the UICRs include:

- Public Bluetooth Device Address
- Hardware Revision

This information is also encoded in the 2D barcode on the metal shield box on the PAN1781. The 2D barcode can only be read with a suitable barcode reader.

All module-specific information are stored in the registers CUSTOMER[0] and CUSTOMER[1] of the UICR during production.

The UICRs behave like a single block of flash memory, i.e. they can only be written once, and they can only be erased as a whole.

Whenever the module is reset to the factory default state (“erase all”), this will also reset the UICRs. Thus all module-specific information are deleted that was stored during the production of the module.

### 3.13.2 Saving Production Information

**Bluetooth Device Addresses are unique!**

Please note that every module has a unique Bluetooth Device Address, so this step must be done for every module individually.

To save all module-specific information that is programmed during the production of the module, it is sufficient to read out the UICR registers CUSTOMER[0] and CUSTOMER[1] .

The following requirement must be met:

✓ **nRF-Command Line Tools** is downloaded (from Nordic website https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Command-Line-Tools/Download).

1. Execute `nrfjprog.exe` from the downloaded nRF-Command Line Tools.
2. Execute **`nrfjprog.exe --memrd 0x10001080`** from a command line prompt.
   ➔ `0x10001080: 43 AA BB CC  |....|`
3. Execute **`nrfjprog.exe --memrd 0x10001084`** from a command line prompt.
   ➔ `0x10001084: 01 02 00 13  |....|`

These two values are unique and must be stored safely.

### 3.13.3 Restoring Production Information

It is not possible to modify already written portions of the UICR without erasing the complete UICR area before.

To restore the previously saved module-specific information, it is sufficient to write back the stored information into the UICR registers CUSTOMER[0] and CUSTOMER[1].

The following requirement must be met:

✓ **nRF-Command Line Tools** is downloaded (from Nordic website https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Command-Line-Tools/Download).

1. Execute `nrfjprog.exe` from the downloaded nRF-Command Line Tools.
2. Execute **`nrfjprog.exe --memwr 0x10001080 --val 0x43aabbcc`** from a command line prompt.
   ➔
   ```
   Parsing parameters.
   Writing.
   ```
3. Execute **`nrfjprog.exe --memwr 0x10001084 --val 0x01020013`** from a command line prompt.
   ➔
   ```
   Parsing parameters.
   Writing.
   ```

# 4 Contact Details

## 4.1 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

## 4.2 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
http://pideu.panasonic.de/products/wireless-modules.html

For complete Panasonic product details in **North America**, visit
http://www.panasonic.com/rfmodules