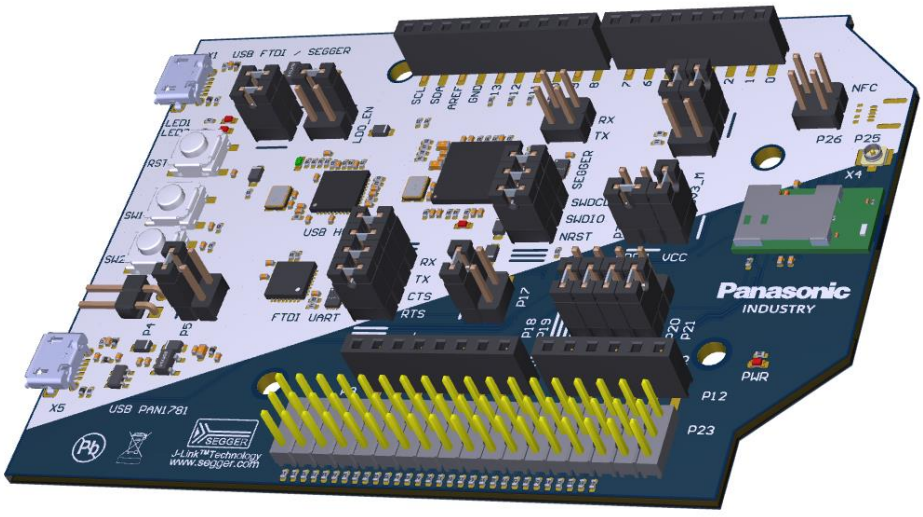
Panasonic
INDUSTRY

PAN1781 EVB

Evaluation Tool

User Guide

Rev. 1.1



Wireless Connectivity

Overview

The PAN1781 EVB (evaluation board) is an evaluation board for the PAN1781 Bluetooth® 5.1 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 5.1 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 OB (on-board debug probe)
- 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

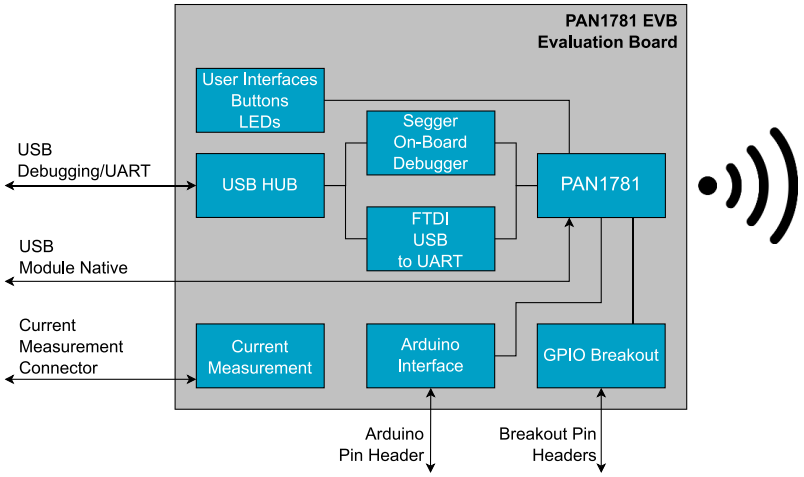


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Table of Contents

1 About This Document

1.1 Purpose and Audience

This User Guide is intended to give an detailed description of the evaluation board (EVB) components and functionalities.

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

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

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	2021-06-24	First version
1.1	2021-11-12	Changed “ETU” to “EVB”. Updated chapter “Current Measurement”: Added more details.

1.3 Use of Symbols

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

Symbol	Description
Menu > **Menu item**	**Path** Indicates a path, e.g. to access a dialog. **Example:** In the menu, select **File** > **Setup page**.
`This font`	**File names** Indicates file names displayed on the screen or to be selected by the user. **Examples:** `pan1760.c` contains the actual module initialization.

`This font`	**Messages, user input, code**
	Indicates messages, information, and code displayed on the screen or to be entered by the user.
	Examples:
	The message `Failed to save your data` is displayed.
	Enter the value `Product 123`.
	Copy firmware binaries to firmware library:
	`$> cd ${TOP}/…`
	`$> …`

Key	**Key** Indicates a key on the keyboard. **Example:** Press **F10**.

1.4 Related Documents

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

2 Overview

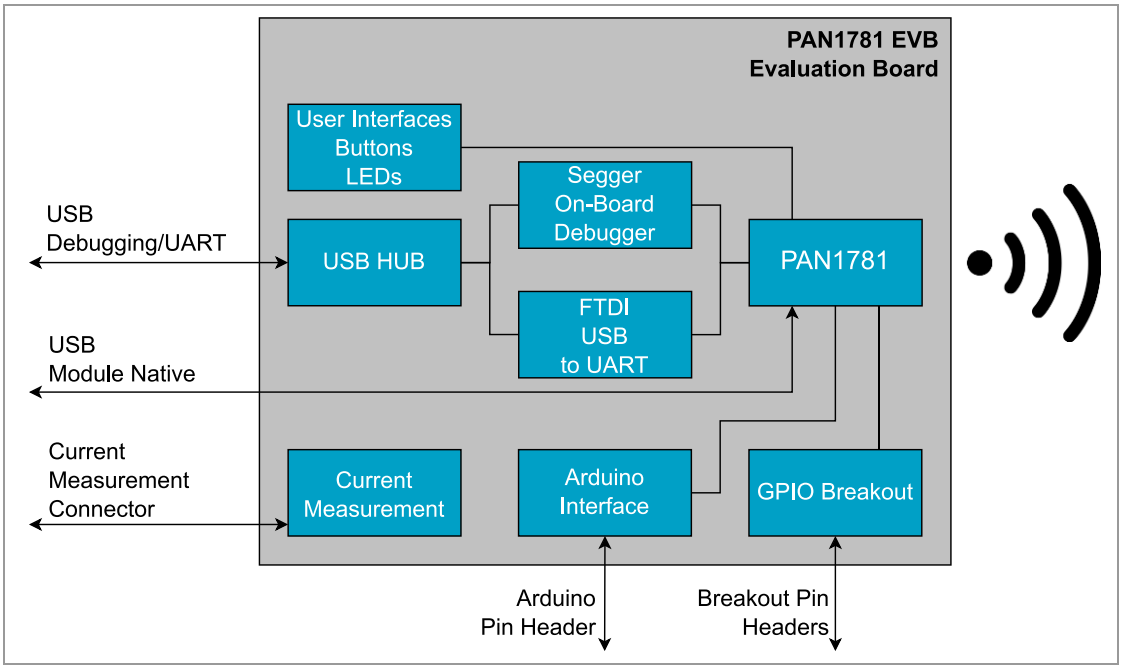
The PAN1781 EVB is an evaluation board for the PAN1781 Bluetooth 5.1 LE module, based on the Nordic nRF52820 single chip controller.

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

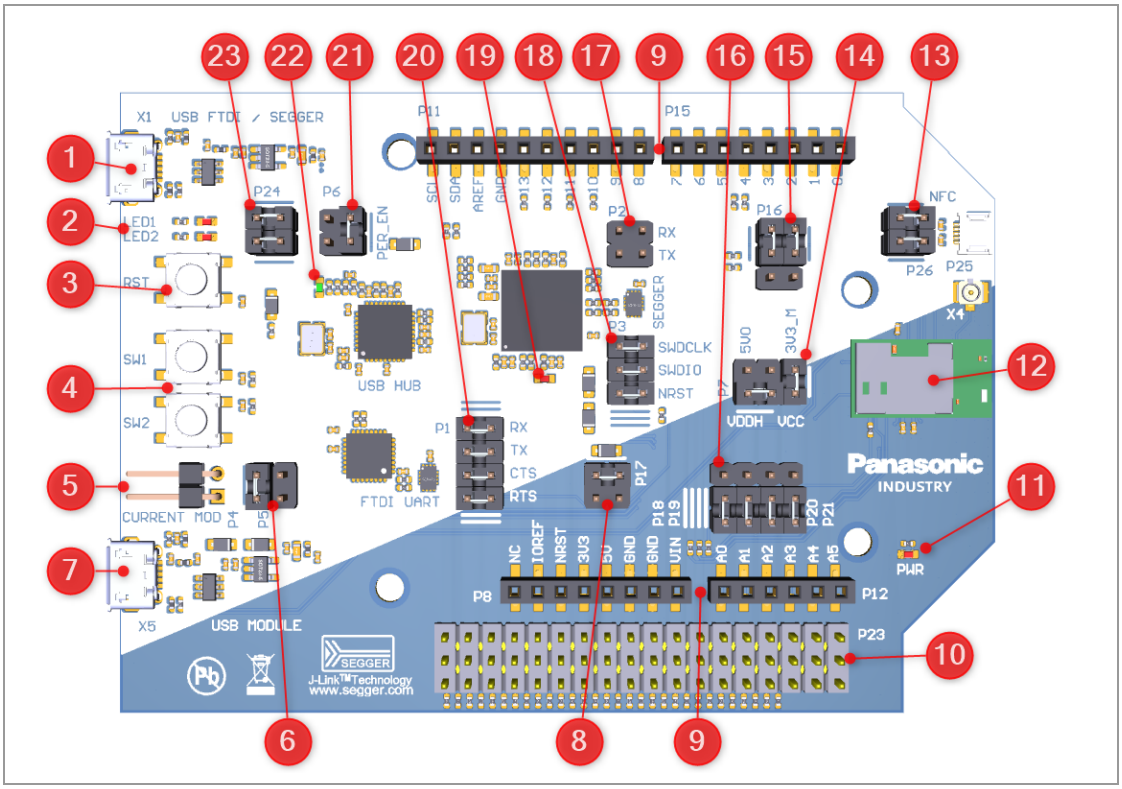
For related documents please refer to ⇨ 4.2 Product Information.

3 PAN1781 EVB

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”. ⇨ 3.10 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. ⇨ 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 OB debugger has an additional UART interface which can be connected to the module. ⇨ 3.11 Activating the Segger OB Debugger UART Port
18	Debug connector	Gives access to the PAN1781 SWD debug interface for external debugger.
19	Segger J-Link OB 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.

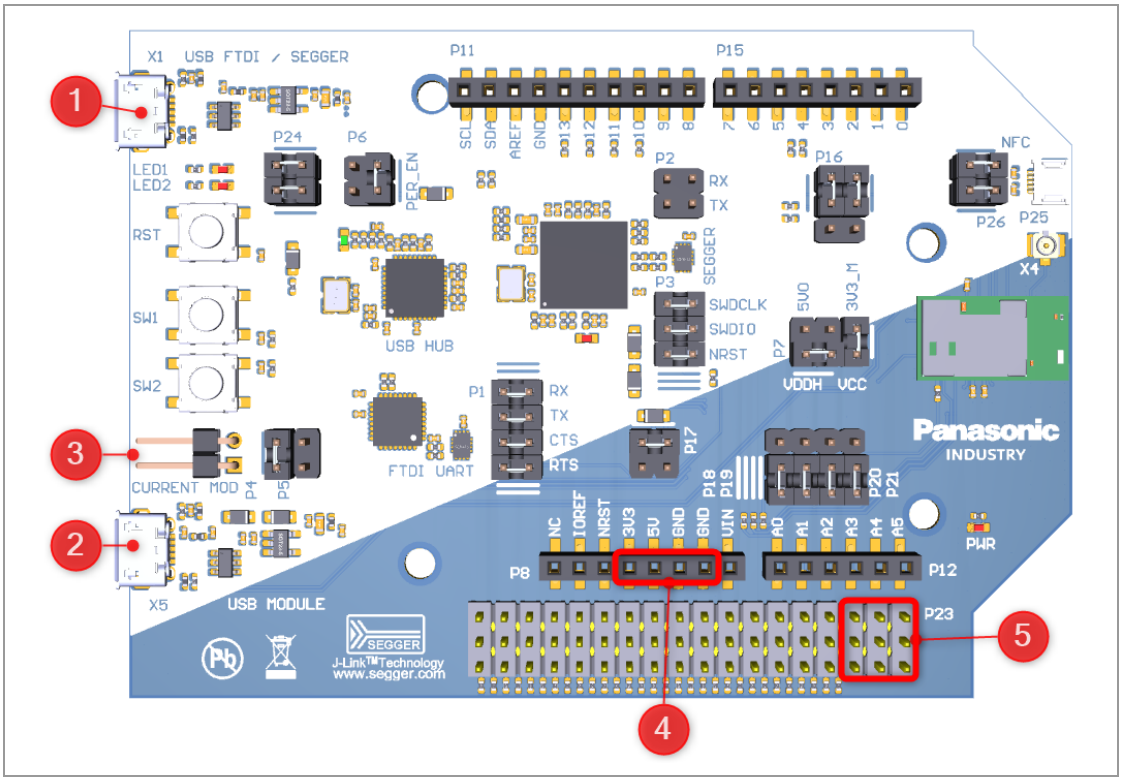
3.3 Pin Map for Pin Headers and Buttons

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

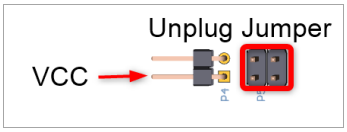
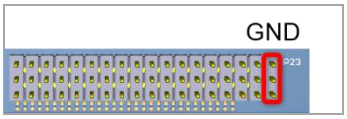
3.4 Powering Options

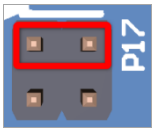
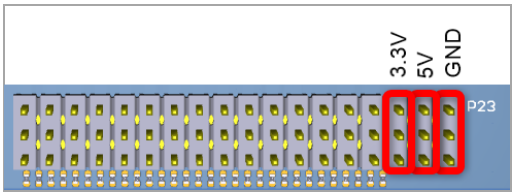
The EVB can be powered by the following different sources:



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

Do not supply 5 V on the pin “3.3 V” (“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. To use the pin “5 V” as input, the jumper position P17 must be changed to following position: 
5	Breakout pins	For power supply the pin “3.3 V” and the pin “5 V” can be used. 

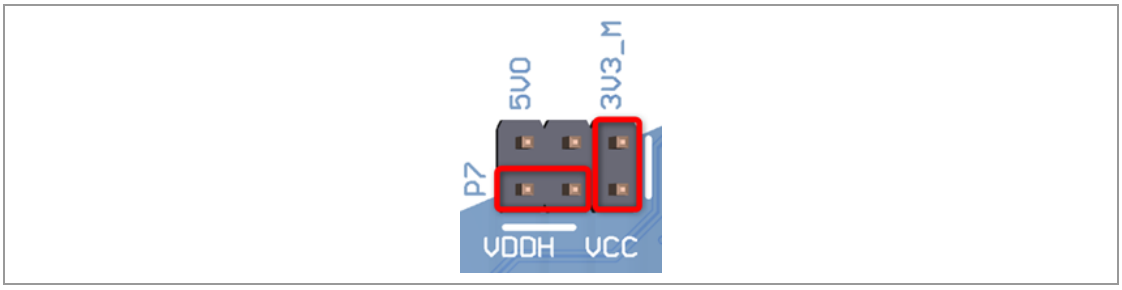
3.5 PAN1781 Power Options

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 pin “VCC” and pin “VDDH” of the module.

The EVB has the pin header “P7” to configure these voltage modes.

3.5.1 Normal Voltage Mode

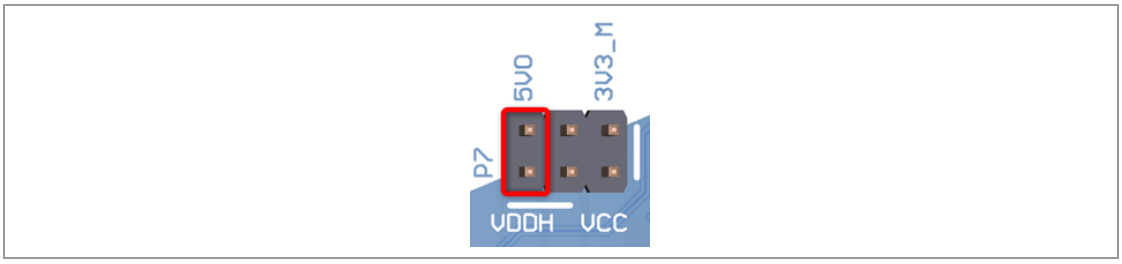
The system enters Normal Voltage Mode when the supply voltage of 3.3 V is connected to both the pin “VCC” and pin “VDDH” of the module (module pin “VDD” shorted to pin “VDDH”).



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.

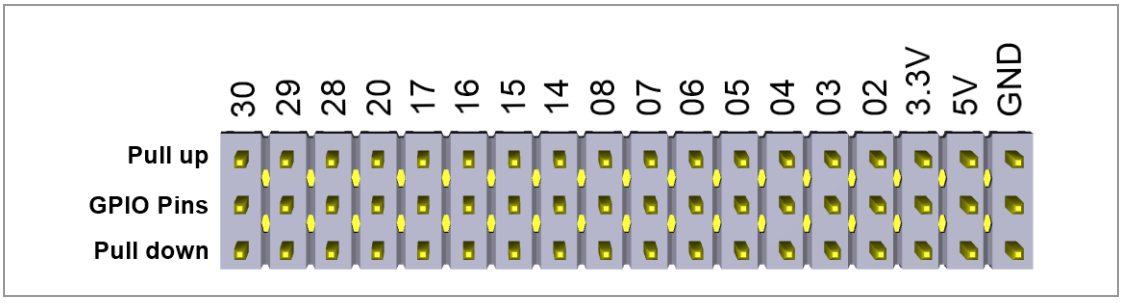


For further information please refer to the Nordic Infocenter:
https://infocenter.nordicsemi.com/topic/ps_nrf52820/power.html?cp=4_3_0_4_2.

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 EVB, PAN1781, and nRF52820.

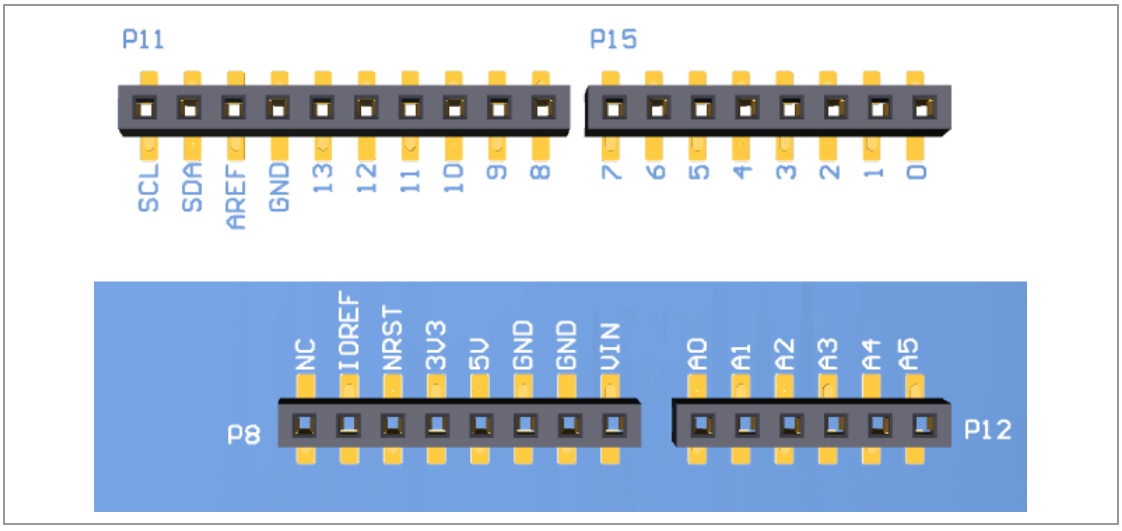


EVB Pin	PAN1781 Footprint	PAN1781 Pin	nRF52820 Footprint	nRF52820 Pin
02	F5	P0.02	36	P0.02
03	A2	P0.03	35	P0.03
04	B2	P0.04	4	P0.04
05	C3	P0.05	5	P0.05
06	F7	P0.06	6	P0.06
07	B6	P0.07	7	P0.07

EVB 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

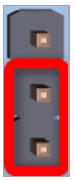
The Arduino interface can be used to stack the EVB with other boards and shields with Arduino connectors.



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.			

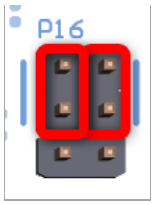
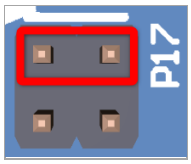
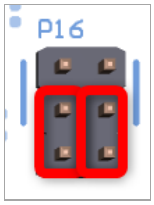
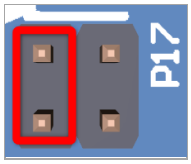
Arduino Pin	Function	PAN1781 Footprint	PAN1781 Pin	nRF52820 Footprint	nRF52820 Pin
GND	Ground				
GND	Ground				
VIN	Not Connected				
A0	Analog Input	P0.02	F5	P0.02	36
A1	Analog Input	P0.03	A2	P0.03	35
A2	Analog Input	P0.04	B2	P0.04	4
A3	Analog Input	P0.05	C3	P0.05	5
A4	Not connected				
A5	Not connected				
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 UART RX/TX Depending on P16 Setup	P0.08/ P0.06	E6/F7	P0.08/ P0.06	31/6
0	GPIO UART TX/RX (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

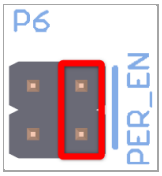
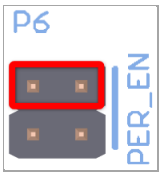
3.8 Arduino Board/Shield Configuration

The EVB 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 (Flipping Pins “RX” and “TX”)	P17 (Blocks the input power direction by a diode)
Board		
Shield		

3.9 Disabling Peripherals

The EVB 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 EVB components when “P6” is in “Disabled” configuration:

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

3.10 Current Measurement

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

Unplug Jumper on “P5"

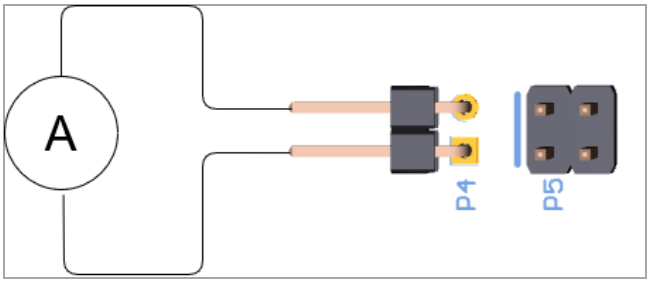
To cut the direct power supply to the PAN1781, the jumper on “P5” must be unplugged. Otherwise, a current measurement will not work.

If a power profiling is needed, the “nRF Power Profiler Kit II” from Nordic can be used. It can be used as ammeter and source meter.

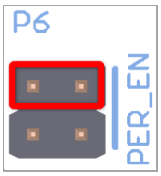
3.10.1 With an Ammeter

The following setup can be used for the current measurement with an ammeter:

1. Unplug the jumper from **P5**.
2. Connect the ammeter to **P4**.



3. Plug in the jumper on **P6** to deactivate peripherals.

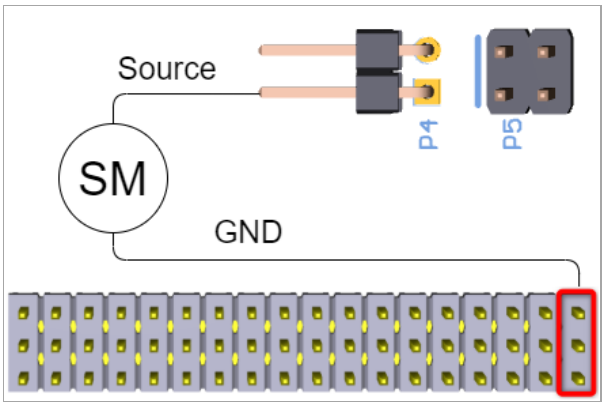


4. Power the board on **X1 USB FTDI/SEGGER**.

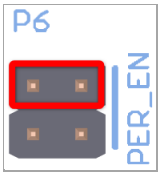
3.10.2 With a Source Meter

The following setup can be used for the current measurement with a source meter:

1. Unplug the jumper from **P5**.
2. Connect the source meter to **P4**.



3. Plug in the jumper on **P6** to deactivate peripherals.



4. Power the board on **X1 USB FTDI/SEGGER**.

> It is necessary to power the board over “X1”. Jumper “P6” deactivates the peripherals by switching off multiple analog switches which disconnect the peripherals from the PAN1781 module.
>
> For this to work, the analog switches itself must be powered through the connector “X1”. If not, signal lines, connected to the analog switches, may float which can result in unexpected behavior and incorrect current measurements.

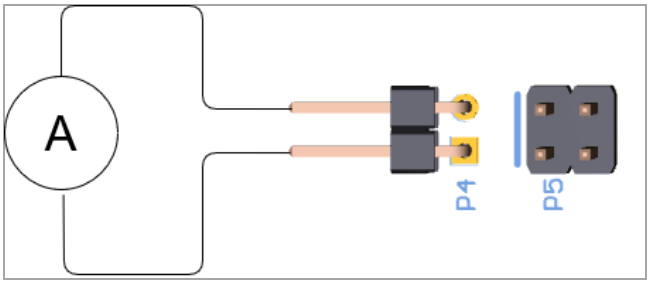
3.10.3 With a variable Voltage Power Supply

Often a current measurement with variable voltage supply is needed for example to simulate different battery voltage levels.

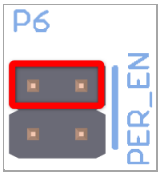
The following setup can be used for the current measurement with a variable voltage power supply:

1. Unplug the jumper from **P5**.

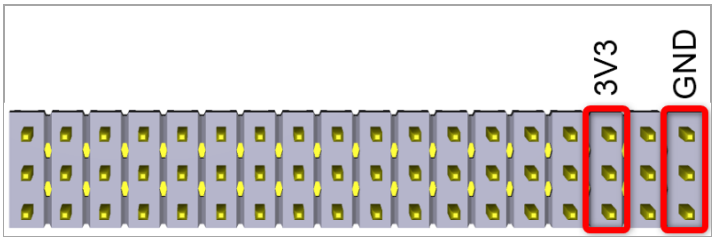
2. Connect the source meter to **P4**.



3. Plug in the jumper on **P6** to deactivate peripherals.



4. Power the board over **GND** and **3V3** of the breakout pin header **P23**.

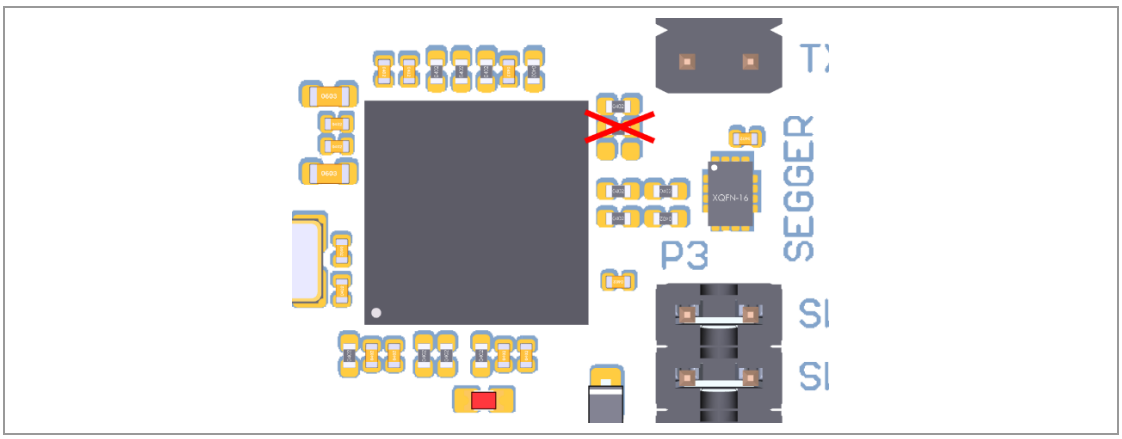


3.11 Activating the Segger OB Debugger UART Port

The Segger J-Link OB debugger has an optional UART port which is connected to the PAN1781. It can be activated by unsoldering a resistor from the EVB.

> The additional Segger J-Link OB debugger UART port **does not** provide flow control functionality with RTS and CTS.

Unsolder the following resistor 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 EVB.

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 EVB.

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