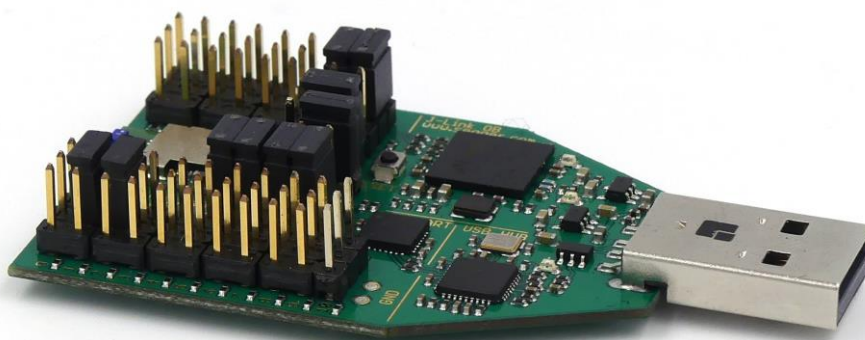


PAN1762

Current Consumption in Low Power Modes

Application Note

Rev. 1.0



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1 About This Document

1.1 Purpose and Audience




This Application Note is intended to explain how to measure the current consumption in low power modes on the PAN1762 USB stick.

The document is intended for hardware and software engineers.

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	2019-04-25	Initial release

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 PAN1762.
⇒ [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
This font	File names, messages, user input Indicates file names or messages and information displayed on the screen or to be selected or entered by the user. Examples: pan1762.c contains the actual module initialization. The message Failed to save your data is displayed. Enter the value Product 123.
Key	Key Indicates a key on the keyboard, e.g. F10 .

1.4 Related Documents

[1] PAN1762 Design Guide

[2] PAN1762 Software Guide

Please refer to the Panasonic website for more information as well as related documents

⇒ [12.2 Product Information](#).

2 Introduction

The PAN1762 USB stick is a development platform for the Bluetooth® Low Energy (LE) PAN1762 module. It is based on the Bluetooth Low Energy chipset TC35680 from Toshiba. For further information please visit <https://toshiba.semicon-storage.com/eu/product/wireless-communication/bluetooth/tc35680.html>.

Toshiba provides a Bluetooth software development kit (SDK) that is available after registration. For further information please visit <https://apps.toshiba.de/web/SDKRegistration/>.

Panasonic provides the PAN1762 Software Guide.
Please refer to the Panasonic website for more information ⇒ [12.2 Product Information](#).

Low power handling is inherent to all applications for the PAN1762 USB stick. However, it may be difficult to measure the current consumption for the different available low power modes, because the selected low power mode affects the function of the application.

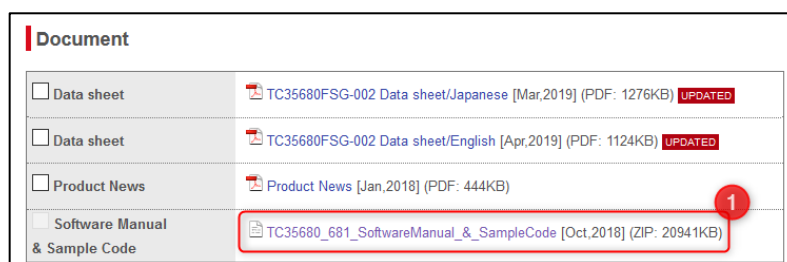
This Application Note explains a way to consistently measure the current consumption in the different low power modes using the PAN1762 USB stick.

3 Chip Support Package

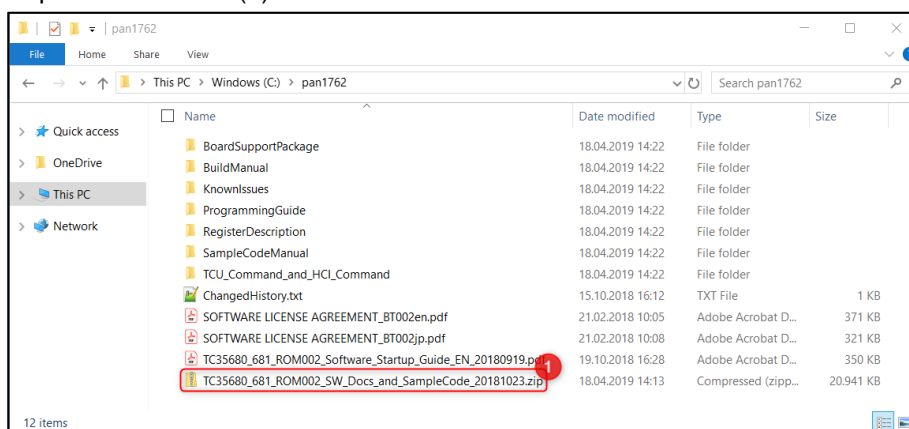
Besides the Bluetooth software development kit (SDK) Toshiba provides a separate chip support package. The chip support package also includes test applications, which can be utilized for low power current consumption measurements.

3.1 Download

The chip support package (1) includes in-depth information about the TC35680 chipset.



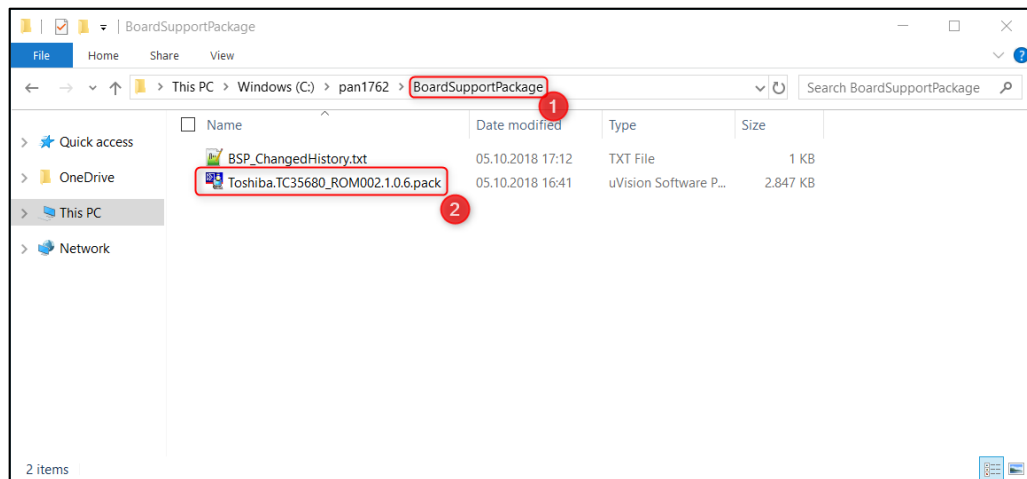
1. Download the chip support package from <https://toshiba.semicon-storage.com/eu/product/wireless-communication/bluetooth/detail.TC35680FSG-002.html>.
2. Unpack the ZIP file (1) to a destination folder.



Board Support Package

The ZIP file also includes a pack-file “board support package” (2) in the subdirectory BoardSupportPackage.

This pack-file includes low-level CMSIS drivers for the TC35680 chipset, as well as general sample and test applications, which can be utilized for low power current consumption measurements.



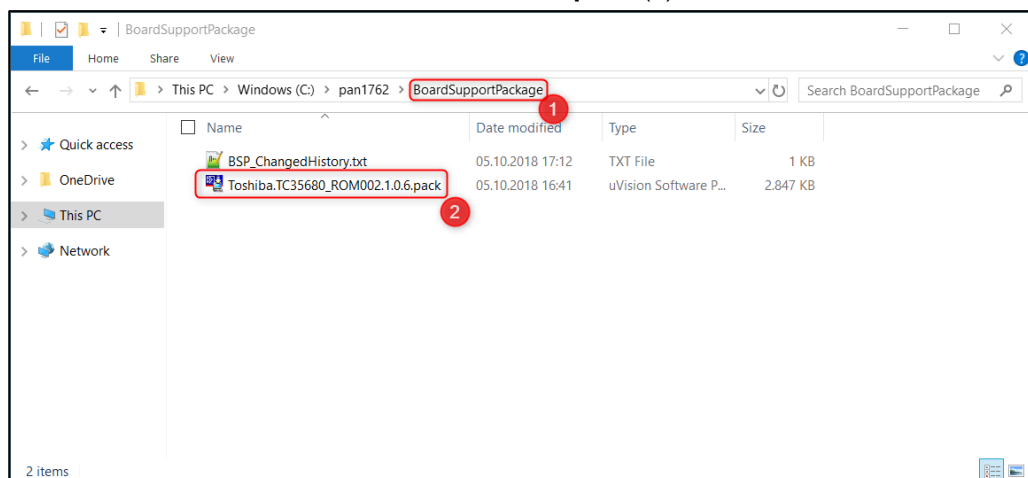
3.2 Installation

The general sample and test applications, included in the “pack”-file, are only provided for the **KEIL µVision® IDE**.



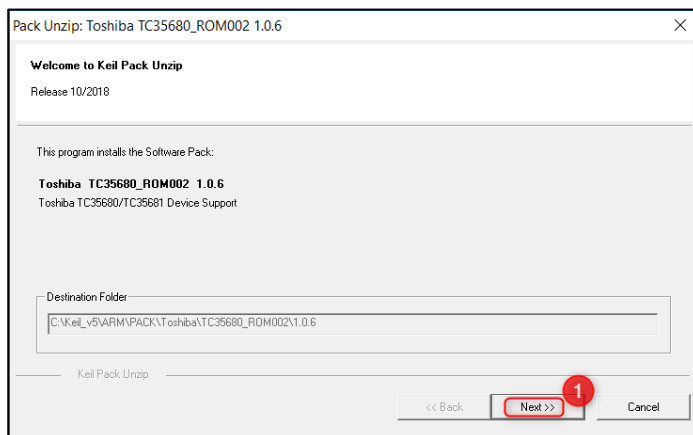
It is sufficient to have the code-size limited version of the **KEIL µVision IDE** installed.

1. Navigate to the subdirectory BoardSupportPackage (1).
2. Double-click **Toshiba.TC35680_ROM002.1.0.6.pack** (2).



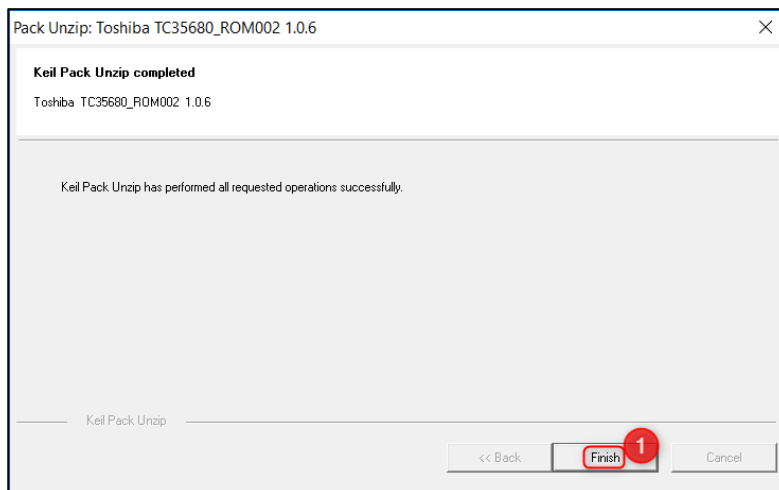
➔ The Keil package unzipper will install the “pack”-file.

3. Click **Next >>** (1).



➔ The installation will start.

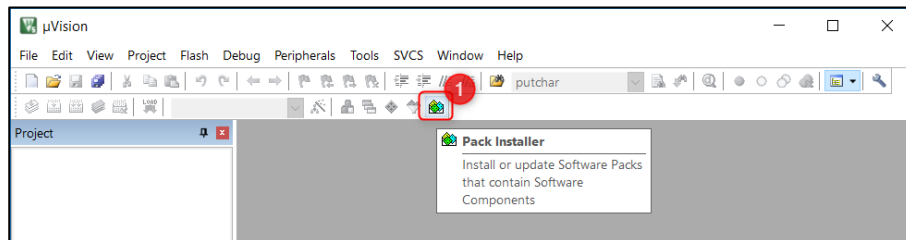
4. Click **Finish** (1).



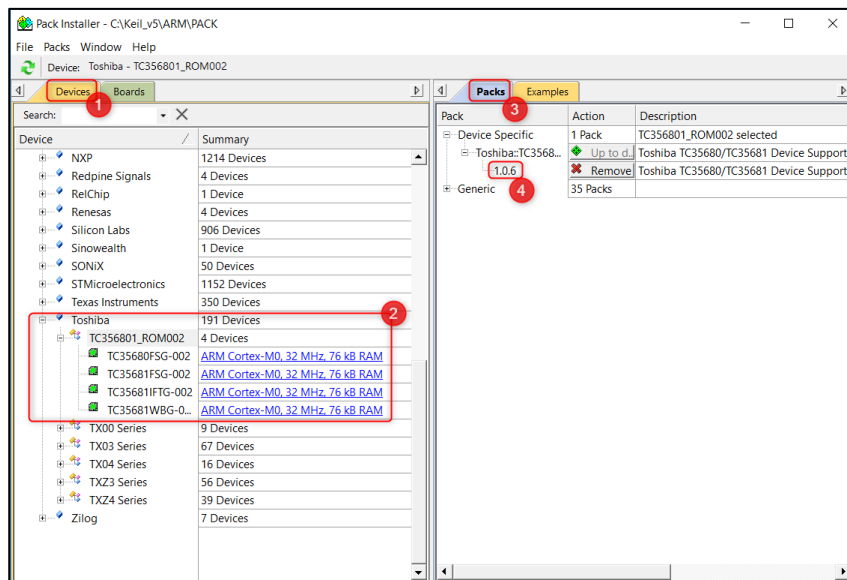
4 Application Setup

4.1 Preparation

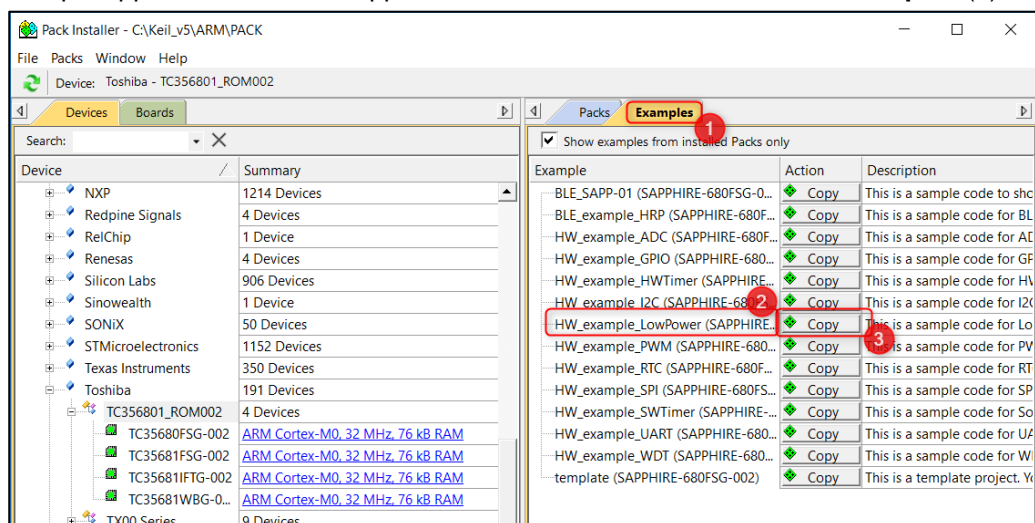
1. Go to the **Start** menu and launch **KEIL µVision IDE**.
2. Click on the icon **Pack Installer** (1).



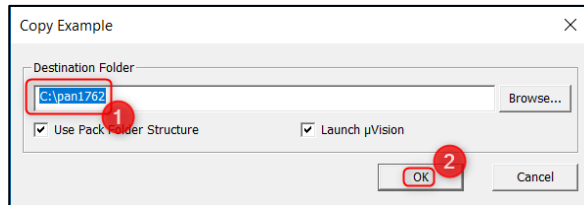
3. Click on the tab **Device** (1).
The newly installed “pack”-file can be found In the section **Toshiba** (2). In the tab **Packs** (3) the version number (4) can be verified.



4. Sample applications and test applications can be chosen from the tab **Examples** (1).



5. Choose the sample application **HW_example_LowPower** (2) and click **Copy** (3).
→ The window **Copy Example** will be displayed.
6. Choose a destination folder (1).



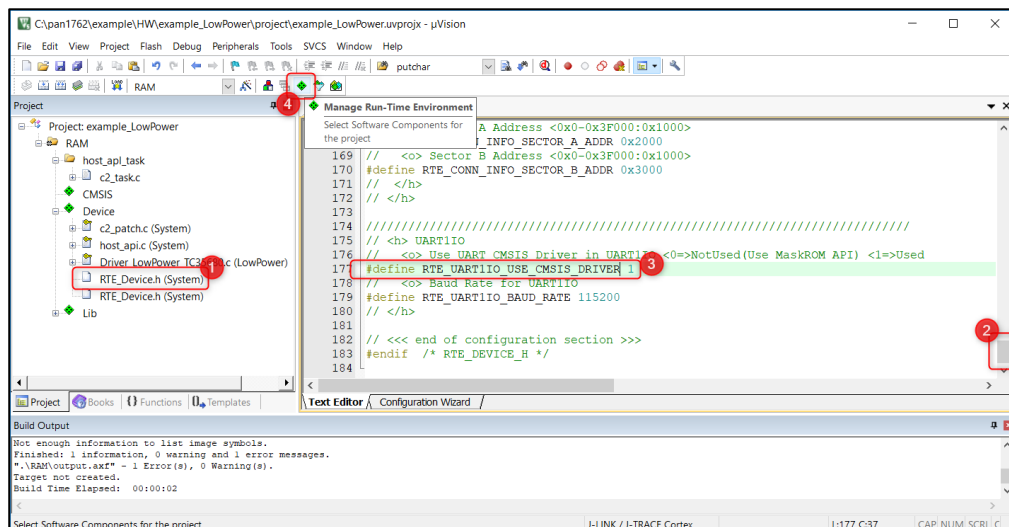
7. Click **OK** (2).

4.2 Modifications

By default the low power sample application uses the UART driver that is built into the TC35680 firmware. This driver does not support proper shutdown and re-initialization of the UART hardware.

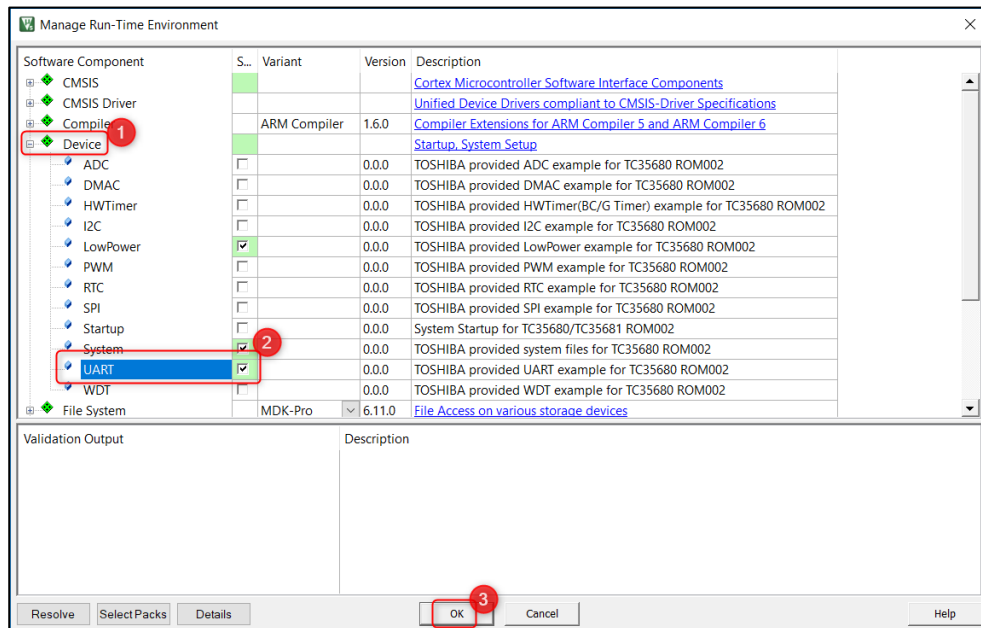
So the UART driver from the CMSIS driver that comes with the “pack”-file must be used instead and proper shutdown and re-initialization of the UART hardware must be added to the application.

1. Choose the first **RTE_Device.h** (1) from the project file list.

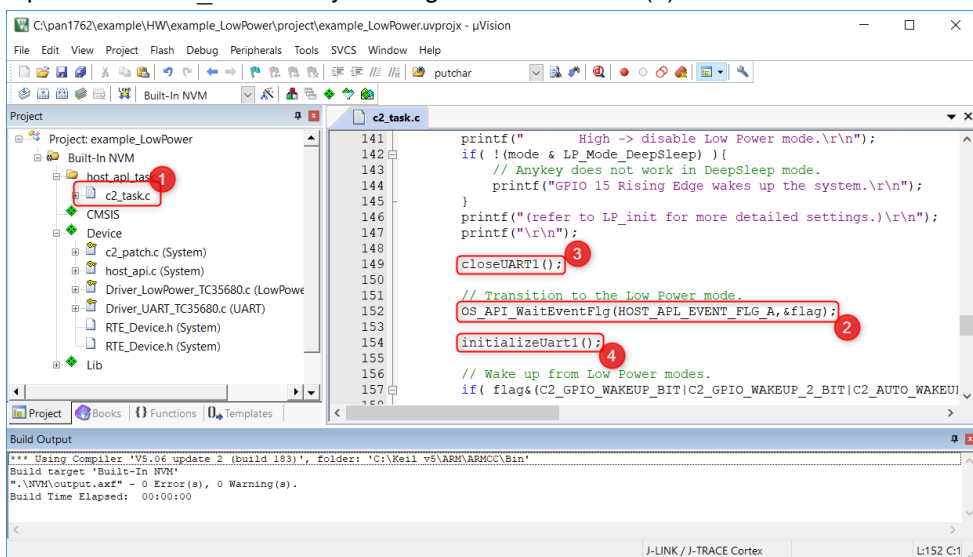


2. Scroll to the end of the file (2).
3. Change the definition **RTE_UART1IO_USE_CMSIS_DRIVER** (3) from 0 to 1.
4. Click on the icon **Manage Run-Time Environment** (4).
→ The window **Manage Run-Time Environment** will be displayed.

- Open the tree view for the software component **Device** (1).

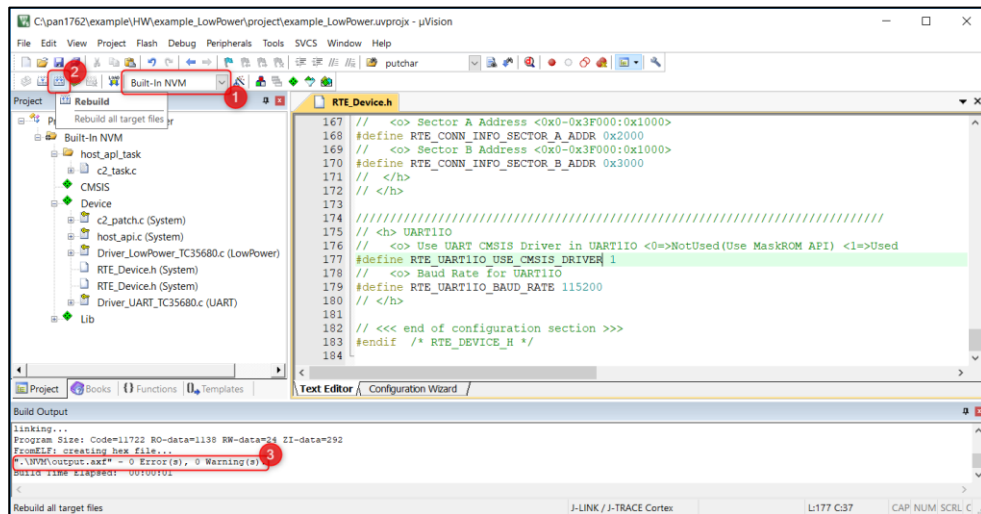


- Enabling the **UART** checkbox (2).
- Click **OK** (3) to confirm the configuration change.
- Open the file `c2_task.c` by clicking on the file name (1).



- Look out for the function call indicated by (2) and add the necessary instructions for properly shutting down and re-initializing of the UART hardware before (3) and afterwards (4).

10. Click on the drop-down menu (1) and select **Built-In NVM**.



11. Click on the icon **Rebuild** (2) to rebuild the project.
12. Check if the build process was successful (3).

5 Bluetooth Device Address Safeguard



If this step is skipped, the Bluetooth device address from the PAN1762 USB stick will be permanently lost.

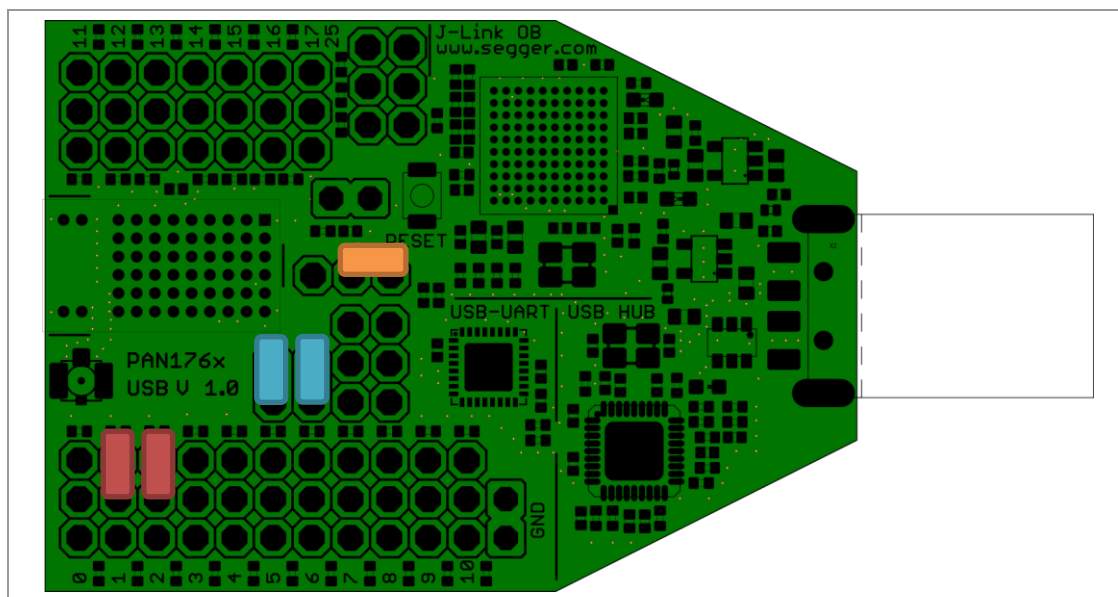
There is no way to recover a lost Bluetooth device address.

The new created application can be programmed directly from within **KEIL µVision IDE**. However, the programming step will erase the Bluetooth device address from the module. Therefore, it is important to remember the Bluetooth device address before programming, so it can be written back later.

The easiest way to remember the Bluetooth device address is to use **EasyStandalone**.

The following requirements must be met:

- ✓ All of the attached PAN1762 USB sticks are removed.
- ✓ The PAN1762 USB stick is jumpered minimally to “host mode”

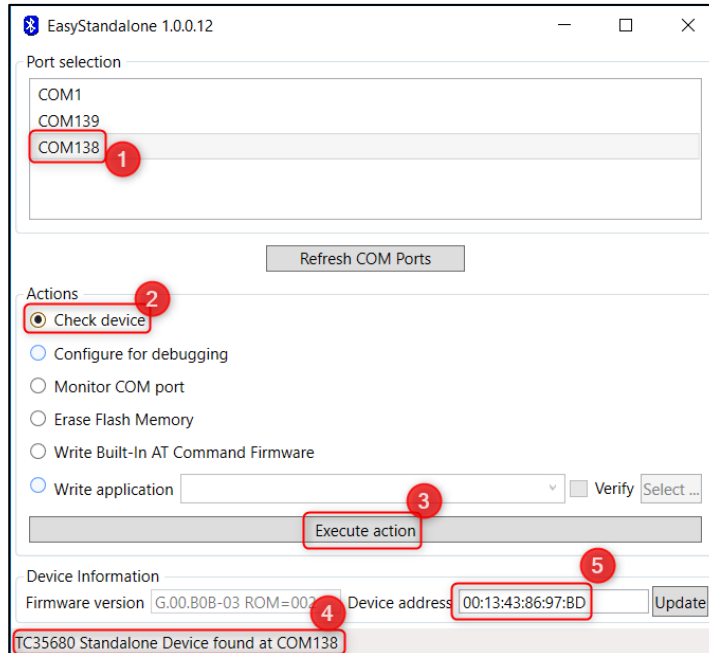


- Configure “boot mode” to “host mode” (red jumpers)
- Connect UART Rx/Tx to USB serial (blue jumper)
- Power module from USB power supply (orange jumper)

1. Attach the PAN1762 USB stick.
2. Go to the **Start menu** and launch **EasyStandalone**.
3. Make sure that the COM port selection is correct, because **EasyStandalone** does not have an automatic detection.

4. Select a COM port (1) from the list of devices in the **Port selection**.

Make sure that the COM port selection is correct, because EasyStandalone does not have an automatic detection.



5. Choose **Check device** (2).
6. Click **Execute action** (3).
 - ➔ A success message will be displayed in the status bar (4).
 - ➔ The firmware version and the Bluetooth device address will be displayed (5).



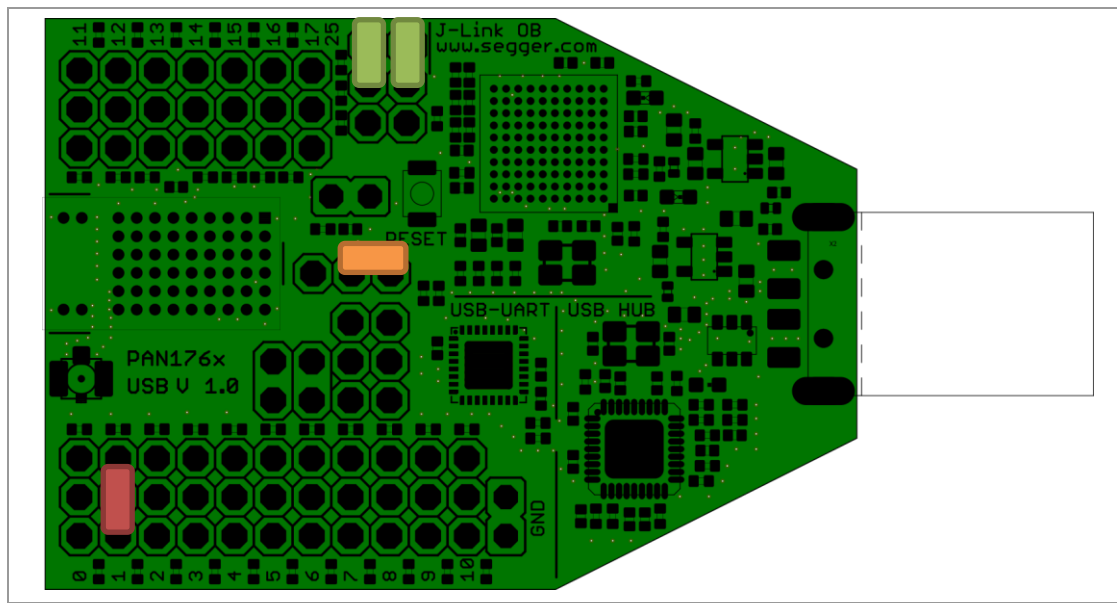
Please note down the Bluetooth device address for later use.

6 Application Programming

The application can be programmed directly from within **KEIL μVision IDE**.

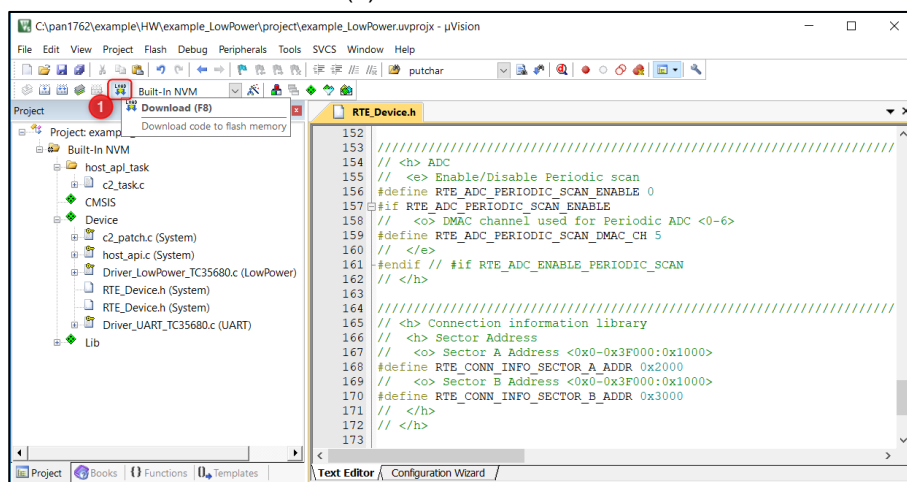
The following requirements must be met:

- ✓ The PAN1762 USB stick is jumpered minimally to “standalone mode”

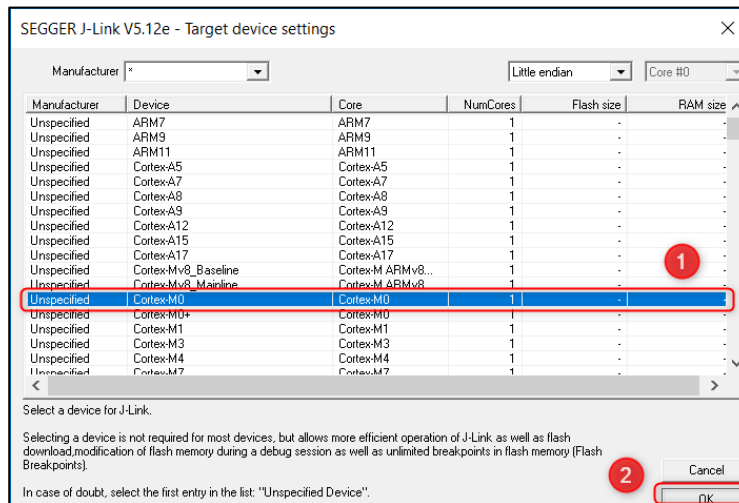


- Configure “boot mode” to “standalone mode” (red jumper)
- Power module from USB power supply (orange jumper)
- Connect SWD pins to on-board debugger (green jumpers)

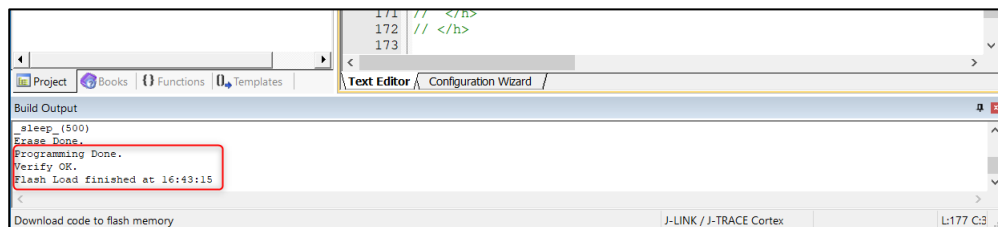
1. Attach the PAN1762 USB stick.
2. Go to the **Start menu** and launch **KEIL μVision IDE**.
3. Click on the icon **Download (1)**.



- If the following dialog will be displayed, select **Cortex-M0** (1) and click **OK** (2).



- After the programming has finished check the output in the window **Build Output**.



Troubleshooting

If something goes wrong during usage or during programming, the PAN1762 USB stick may behave incorrectly afterwards.

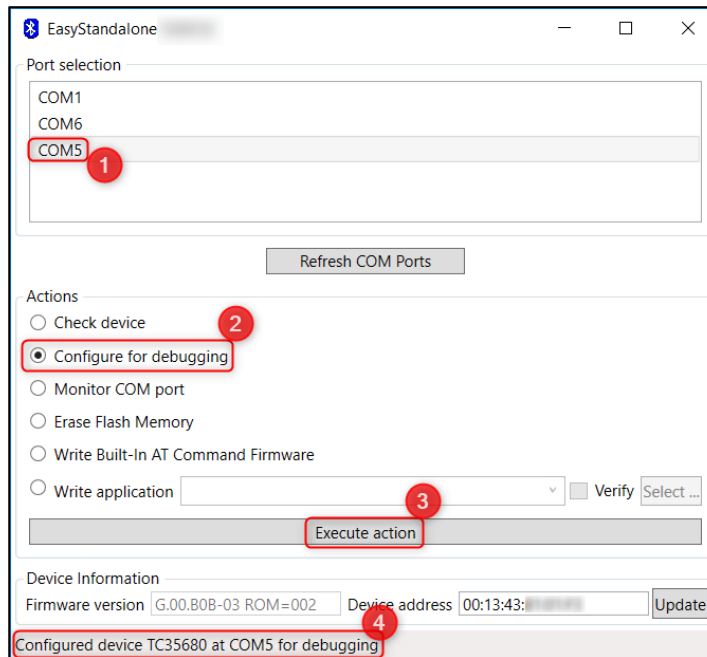
In this case, the PAN1762 USB stick has to be reconfigured to a known good state by using **EasyStandalone**.

The following requirements must be met:

- ✓ All of the attached PAN1762 USB sticks are removed
- ✓ The PAN1762 USB stick to be used should be jumpered minimally to “host mode” as explained in [⇒ 5 Bluetooth Device Address Safeguard](#)

- Attach the PAN1762 USB stick.
- Go to the **Start menu** and launch **EasyStandalone**.

3. Select a COM port (1) from the list of devices in the **Port selection**.
Make sure that the COM port selection is correct, because **EasyStandalone** does not have an automatic detection.



4. Choose **Configure for debugging** (2).
5. Click **Execute action** (3).
→ A success message will be displayed in the status bar (4).

7 Application Setup

The following requirements must be met:

- ✓ Installed terminal application



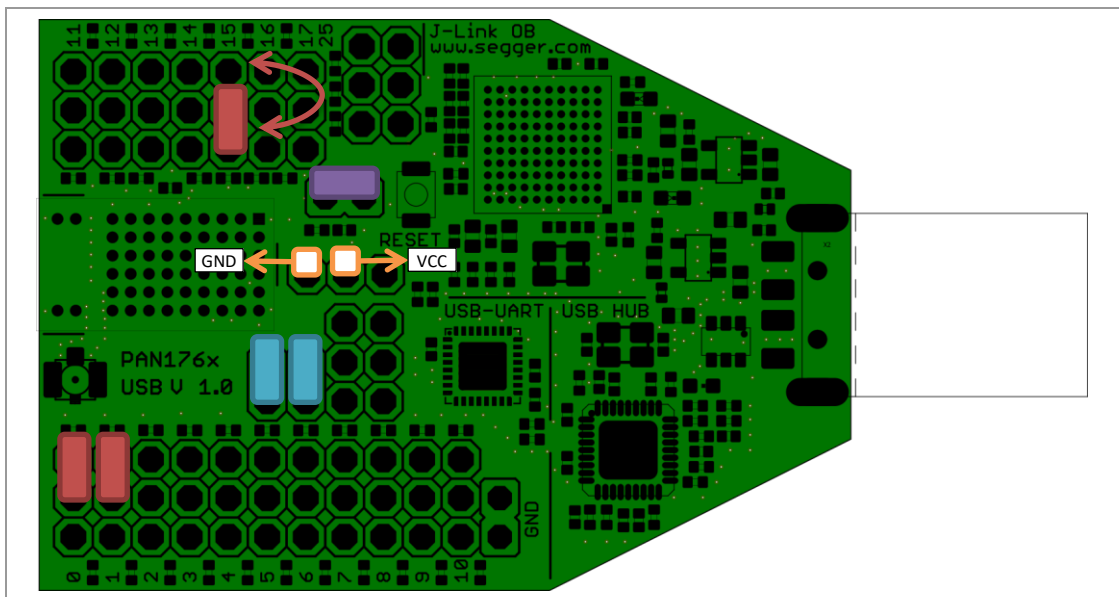
If you do not have any terminal application yet, you can try **Termite** from https://www.compuphase.com/software_termite.htm. In the following steps **Termite** is used.

7.1 Hardware Setup



In order to avoid any leakage current:

- All unnecessary jumpers must be removed from the PAN1762 USB stick.
- The power supply of the module must be connected to the measurement equipment.

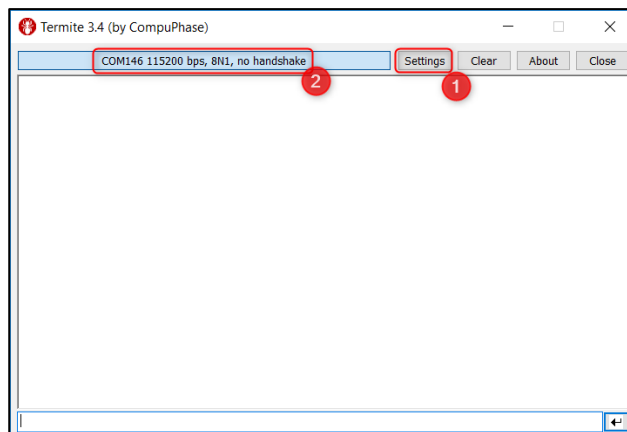


- The **red jumper on GPIO 1** makes sure that the device boots up in standalone mode.
- The **purple jumper** near the reset button makes sure that the reset button is operational.
- The **red jumpers on GPIO 0** is used by the application as a “sleep mode enable” pin and must be set to GND, to allow the device to enter sleep mode.

- The **red jumper on GPIO 15** is used by the demo application as the wake up key to exit a sleep mode.
By default it is set to GND and must be moved to VCC in the “other position” to create a rising edge.
- The **blue jumpers** connect the UART Rx and Tx lines and have to be removed after the demo application has been configured properly.
- The **orange pin headers** need to be connected to GND and VCC of the measurement equipment.

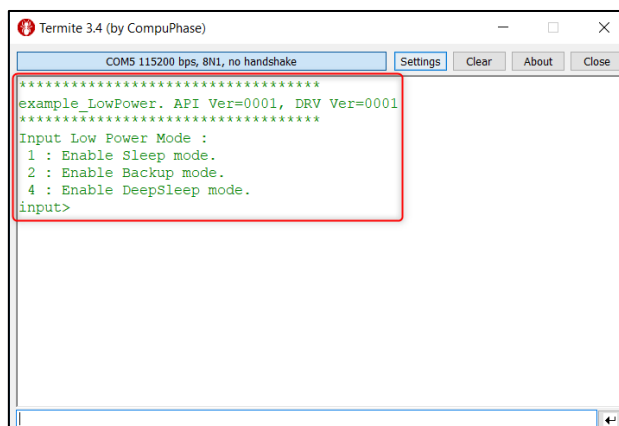
7.2 Application Usage

1. Use any terminal application to connect to the well-known COM port of the PAN1762 USB stick.
2. Click **Settings** (1) to choose the desired COM port.



➔ The chosen COM port will be displayed (2).

3. Make sure that the power supply of the measurement equipment is turned on.
 4. Make sure that the blue jumpers for the UART Rx and Tx lines are connected.
 5. Press the “reset” button on the PAN1762 USB stick.
- ➔ The application will identify itself by printing the following diagnostic message to the terminal window:



8 Sleep Mode Measurement

The following requirements must be met:

- ✓ Successfully started application as explained in ⇒ [7.2 Application Usage](#)

1. Choose option 1 **Enable Sleep mode** via the terminal application.
2. Enter 1 into the text box (1) and press **Enter**.

```

Termit 3.4 (by CompuPhase)
COM5 115200 bps, 8N1, no handshake
example_LowPower. API Ver=0001, DRV Ver=0001
*****
Input Low Power Mode :
1 : Enable Sleep mode.
2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input> 1
1
Enable Sleep mode.
GPIO 0 Low -> enable Low Power mode.
High -> disable Low Power mode.
GPIO 15 Rising Edge wakes up the system.
(refer to LP_init for more detailed settings.)
  
```

⇒ Sleep mode will be enabled (2).

3. Remove the blue jumpers to disconnect the UART Rx and Tx lines.
4. Perform the power measurement on the measurement equipment.
5. Attach the blue jumpers again to reconnect the UART Rx and Tx lines.
6. Move the jumper GPIO 15 to the other position connecting it to VCC to create a rising edge.

⇒ Sleep mode is exited again (1).

```

Termit 3.4 (by CompuPhase)
COM5 115200 bps, 8N1, no handshake
2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input> 1
1
Enable Sleep mode.
GPIO 0 Low -> enable Low Power mode.
High -> disable Low Power mode.
GPIO 15 Rising Edge wakes up the system.
(refer to LP_init for more detailed settings.)
Wake up from Sleep mode.
Wake up because of ANYKEY function.
*****
Input Low Power Mode :
1 : Enable Sleep mode.
2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input>
  
```

7. Move back the jumper on GPIO15.

⇒ The next measurement can be done.

Expected Result



Please note, that this is only a typical value.

The typical power consumption should be close to 2.5 μA if the following conditions are met:

- At room temperature
- In sleep mode
- With a supply voltage of 3.0 V

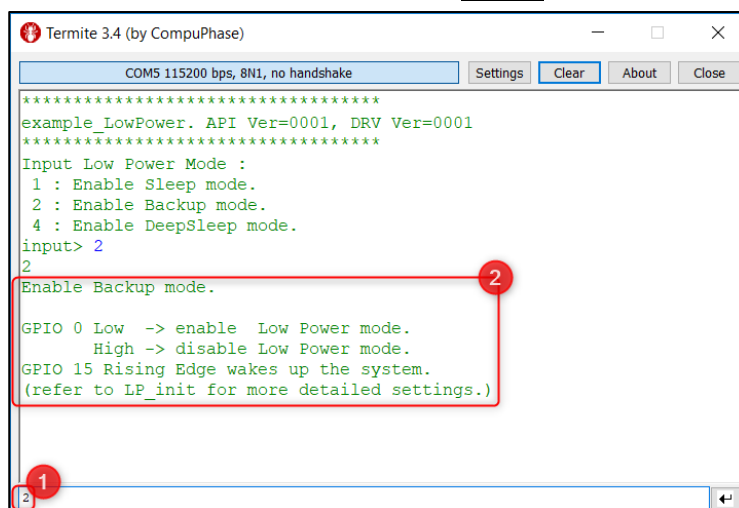


9 Backup Mode Measurement

The following requirements must be met:

- ✓ Successfully started application as explained in ⇒ [7.2 Application Usage](#)

1. Choose option 2 **Enable Sleep mode** via the terminal application.
2. Enter 2 into the text box (1) and press **Enter**.



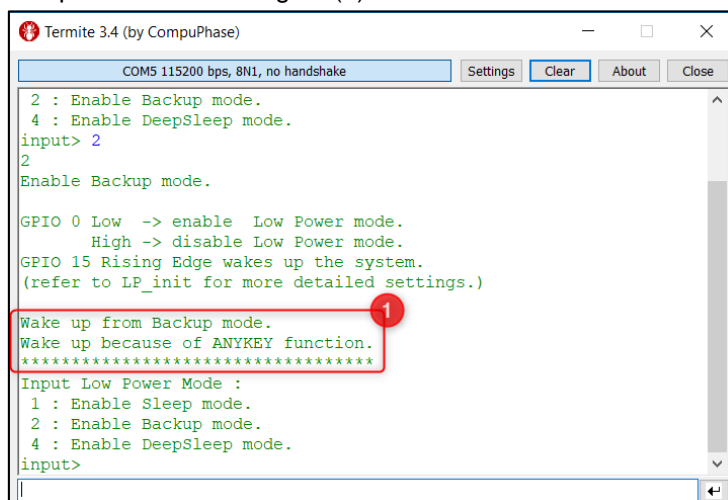
```
Termite 3.4 (by CompuPhase)
COM5 115200 bps, 8N1, no handshake
Settings Clear About Close

*****
example_LowPower. API Ver=0001, DRV Ver=0001
*****
Input Low Power Mode :
1 : Enable Sleep mode.
2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input> 2
2
Enable Backup mode.
GPIO 0 Low -> enable Low Power mode.
      High -> disable Low Power mode.
GPIO 15 Rising Edge wakes up the system.
(refer to LP_init for more detailed settings.)
```

⇒ Backup mode will be enabled (2).

3. Remove the blue jumpers to disconnect the UART Rx and Tx lines.
4. Perform the power measurement on the measurement equipment.
5. Attach the blue jumpers again to reconnect the UART Rx and Tx lines.
6. Move the jumper GPIO 15 to the other position connecting it to VCC to create a rising edge.

⇒ Sleep mode is exited again (1).



```
Termite 3.4 (by CompuPhase)
COM5 115200 bps, 8N1, no handshake
Settings Clear About Close

2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input> 2
2
Enable Backup mode.
GPIO 0 Low -> enable Low Power mode.
      High -> disable Low Power mode.
GPIO 15 Rising Edge wakes up the system.
(refer to LP_init for more detailed settings.)
Wake up from Backup mode.
Wake up because of ANYKEY function.
*****
Input Low Power Mode :
1 : Enable Sleep mode.
2 : Enable Backup mode.
4 : Enable DeepSleep mode.
input>
```

7. Move back the jumper on GPIO15.

⇒ The next measurement can be done.

Expected Result



Please note, that this is only a typical value.

The typical power consumption should be close to 2.5 μA if the following conditions are met:

- At room temperature
- In sleep mode
- With a supply voltage of 3.0 V

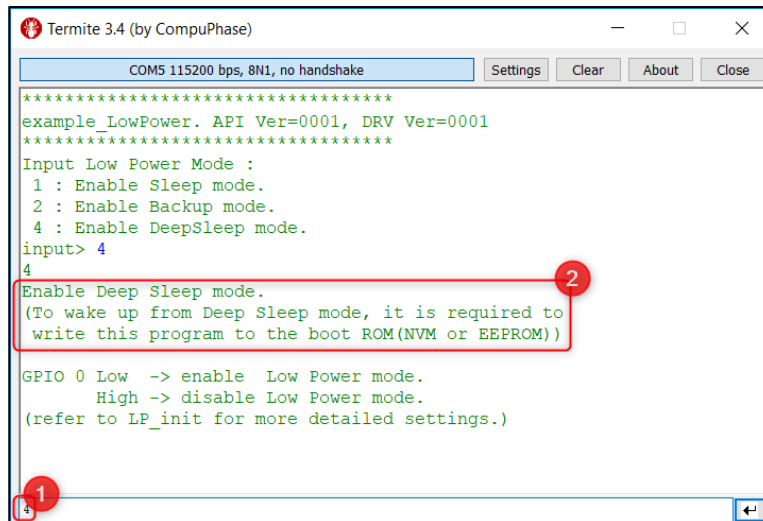


10 Deep Sleep Mode Measurement

The following requirements must be met:

- ✓ Successfully started application as explained in ⇒ [7.2 Application Usage](#)

1. Choose option 4 **Enable Sleep mode** via the terminal application.
2. Enter 4 into the text box (1) and press **Enter**.



```
Termit 3.4 (by CompuPhase)
COM5 115200 bps, 8N1, no handshake
example_LowPower. API Ver=0001, DRV Ver=0001
Input Low Power Mode :
  1 : Enable Sleep mode.
  2 : Enable Backup mode.
  4 : Enable DeepSleep mode.
input> 4
4
Enable Deep Sleep mode.
(To wake up from Deep Sleep mode, it is required to
write this program to the boot ROM(NVM or EEPROM))
GPIO 0 Low -> enable Low Power mode.
High -> disable Low Power mode.
(refer to LP_init for more detailed settings.)
```

⇒ Deep sleep mode will be enabled (2).

3. Remove the blue jumpers to disconnect the UART Rx and Tx lines.
4. Perform the power measurement on the measurement equipment.
5. Attach the blue jumpers again to reconnect the UART Rx and Tx lines.
6. Press the “reset” button in order to do the next measurement.



The deep sleep mode cannot be exited using GPIO 15.

Expected Result



Please note, that this is only a typical value.

The typical power consumption should be close to 50 nA if the following conditions are met:

- At room temperature
- In sleep mode
- With a supply voltage of 3.0 V



11 Bluetooth Device Address Recovery

The easiest way to restore the Bluetooth device address is to use **EasyStandalone**.

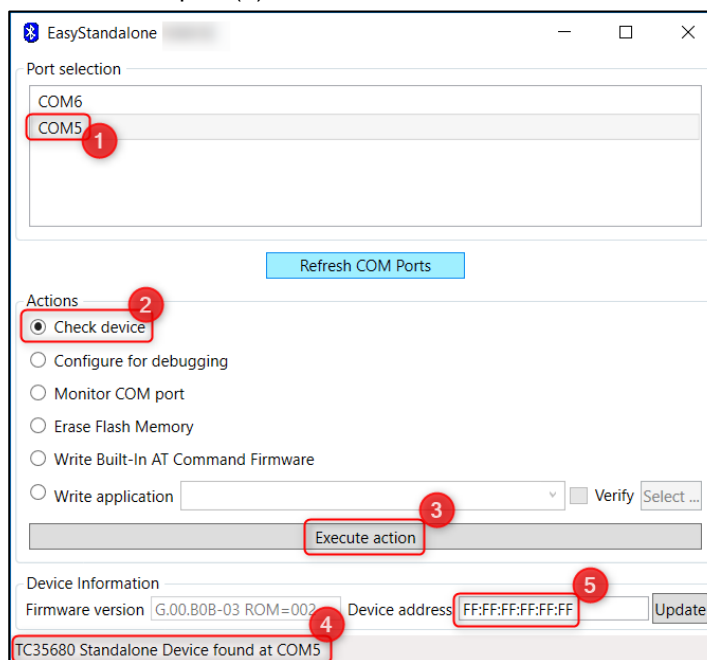


If you forgot to remember the Bluetooth device address as explained in [⇒ 5 Bluetooth Device Address Safeguard](#), the Bluetooth device address is inevitably lost and cannot be restored.

The following requirements must be met:

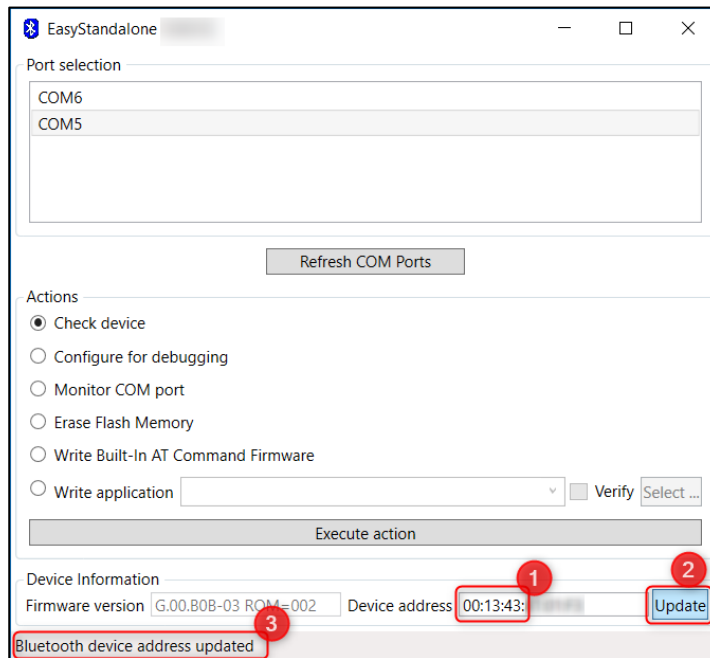
- ✓ All of the attached PAN1762 USB sticks are removed
- ✓ The PAN1762 USB stick to be used is jumpered to “host mode”, as explained in [⇒ 5 Bluetooth Device Address Safeguard](#)

1. Attach the PAN1762 USB stick.
2. Go to the **Start menu** and launch **EasyStandalone**.
3. Make sure that the COM port selection is correct, because **EasyStandalone** does not have an automatic detection.
4. Select a COM port (1) from the list of devices in the **Port selection**.



5. Choose **Check device** (2).
6. Click **Execute action** (3).
 - ➔ A success message will be displayed in the status bar (4).
 - ➔ The Bluetooth device address will be displayed as **FF: FF: FF: FF: FF: FF** (5), because it was overwritten.

7. Enter the previously noted Bluetooth device address into the edit box (1)



8. Click **Update** (2).
 - ➔ A success message will be displayed in the status bar (3).
 - ➔ The Bluetooth device address will be updated to the address that was entered.

12 Contact Details

12.1 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>

12.2 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>