AN14659

MCX W23 Bluetooth Low Energy Power Consumption Analysis

Rev. 2.0 — 4 August 2025 **Application note**

Document information

Information	Content
Keywords	AN14659, MCX W23, MCU link, Bluetooth Low Energy, Bluetooth LE, Average power, Average current, Power consumption, NHS5204, Ultra low power, Small footprint, Integrated flash, Security, IoT, Coin battery, Small body-worn device
Abstract	This document describes the power consumption of the MCX W23 Bluetooth Low Energy device and the procedure to measure the current consumption using the MCXW23_EVK_BB and MCXW236B_RDM boards.

1 Introduction

This document describes the power consumption of the MCX W23 Bluetooth Low Energy (LE) device and the procedure to measure the current consumption using the MCXW23_EVK_BB and MCXW236B_RDM boards.

The MCX W23 is a system-on-chip (SoC), which incorporates the microcontroller unit (MCU) circuitry and an RF circuitry. The total power consumption of the MCX W23 is the sum of the power that each of the system blocks consumes. Therefore, to obtain an efficient low-power system power optimization, these sections must be tweaked individually. In this document, a power measurement test setup with a specific firmware and profile loaded on the MCX W23 is used. The result depends on the firmware and the profile that the user uses. For more information on the Bluetooth LE standard, see *MCX W23 Data Sheet* (document MCXW23) and *Power Management for MCX W23* (document AN14660).

The tests mentioned in this document are performed in a lab. These tests are for customer reference only. The user test results can differ from the results shown in this document as the test equipment, measurement setup, and other system details at the customer end can impact the test results.

2 Bluetooth Smart power metrics

The following are the Bluetooth LE power metrics.

- MCXW23_EVK_BB and MCXW236B_RDM boards are used to measure the current
- Low-power (central and peripheral) reference design application software sets the device to different modes. These modes are used for the current measurements, similar to the temperature sensor in the Low-power mode. The revision software used is the SDK 25.06 Release
- CM33 (core main power domain) and RADIO (core radio power domain) could be active in of the state as follows:
  - Sleep mode
  - Deep-sleep mode
  - Power-down mode
  - Deep-power down mode
- CM33 is woken up (core wake-up power domain) and performs system initialization and some pre-processing
- RADIO woke-up and transceiver are ready to operate. If the software allows, the CM33 can enter in Inactive mode
- The transceiver is performing one or more RX/TX sequences
- CM33 is processing the received or transmitted packets
- The transceiver is put back in Sleep mode
- CM33 enters low-power (Deep-sleep mode)

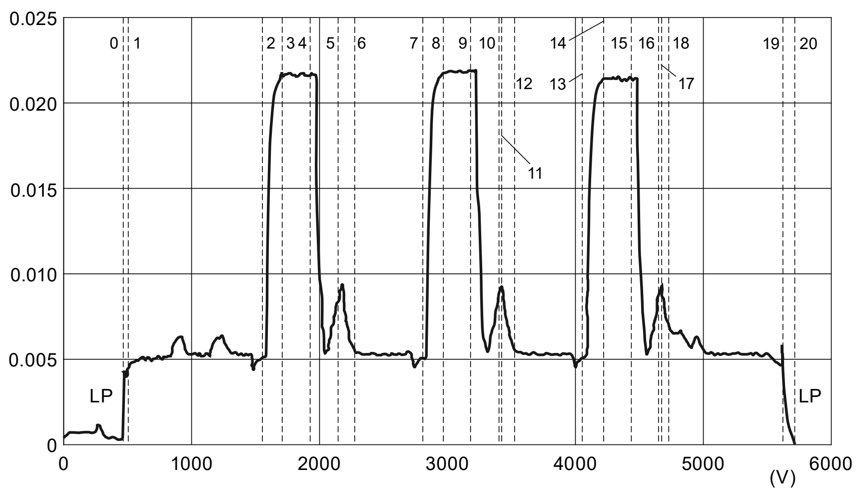


Figure 1. Typical operation cycle of a wireless low-power end device

Figure 1 shows how current consumption, varies over time for each operation cycle of the device.

At power up, the system performs the so-called power-on reset, and after that it performs the system initialization. On completion of initialization, the system enters in the Low-power mode. Several Low-power modes are available for both the MCUs and radio. Usually, the software defines the most suitable combinations of the CM33 and XCVR Low-power modes, for example, Deep-sleep mode for the CM33 and NBU.

The timings shown in Figure 1 are explained in Table 1.

Table 1. Timings of a typical low-power device

Event - Peripheral	Event - Peripheral
LP. SoC in Deep Sleep mode	10. TX to RX transition
0. SoC awakes from Deep Sleep mode	11. XCVR Active RX

Table 1. Timings of a typical low-power device*...continued*

Event - Peripheral	Event - Peripheral
1. CM33 run: Pre-processing	12. XCVR RX warm down
2. XCVR TX warmup	13. CM33 STOP: RX to TX
3. XCVR Active TX	14. XCVR TX warmup
4. TX to RX transition	15. XCVR Active TX
5. XCVR Active RX	16. TX to RX transition
6. XCVR RX warm down	17. XCVR Active RX
7. CM33 STOP: RX to TX	18. XCVR RX warm down
8. XCVR TX warmup	19. CM33 RUN: Post-processing
9. XCVR Active TX	20. SoC going to Deep Sleep mode
-	LP. SoC in Deep Sleep mode

The time the transceiver switches from RX to TX is called RX to TX turnaround time, an essential parameter of the transceiver.

When the radio is operational, the CM33 performs various tasks, like serving interrupts or controlling various peripherals. Therefore, the best metric to be applied is current consumption over time, considering the average current of all implied entities.

2.1 Bluetooth Smart (LE)

The Bluetooth Smart or Bluetooth LE is suitable for low-power communication, automotive applications (key fob and anchor), and IoT deployments. The Bluetooth LE operates at a 2.4 GHz industrial scientific and medical (ISM) band and uses gaussian frequency-shift keying (GFSK) modulation. The bandwidth bit period product is 0.5 and the modulation index is 0.5, that is between 0.45 and 0.55.

The Bluetooth LE transmits data using 40 channels over an 80 MHz bandwidth, from 2400 MHz to 2480 MHz with 2 MHz spacing. Each channel is spaced with 2 MHz. The data rate could be set to 1 bit/s, 2 Mbit/s, long range S2 (500 kbit/s), or S8 (125 kbit/s). These channels are numbered from 0 to 39. Three specific channels are dedicated for advertising packets (data exchange): channel 37, 38, and 39.

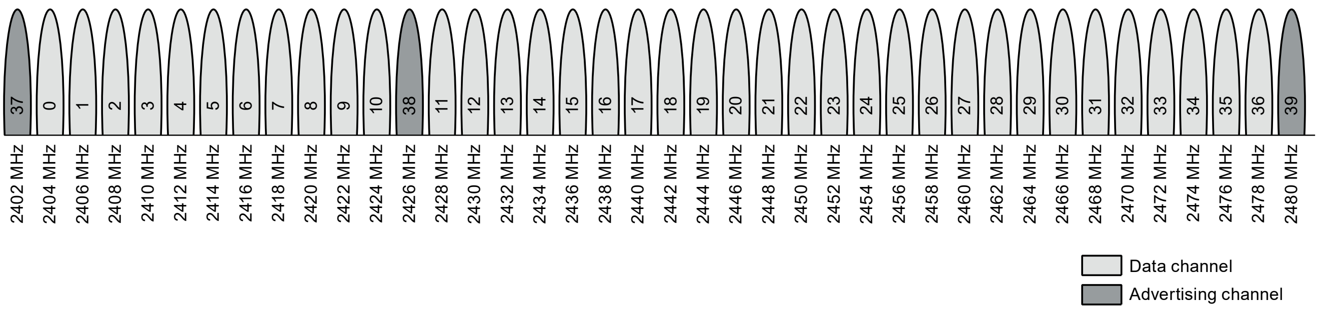


Figure 2. Bluetooth LE radio channels

The LE results from using the low-duty cycle of transmission and/or reception of data, along with short advertising and data packets. An asynchronous and connection-less link-layer ensures low latency and fast transactions.

At the generic access profile (GAP) layer level, the roles of the Bluetooth LE devices are GAP central and GAP peripheral. For more details, see Figure 3.

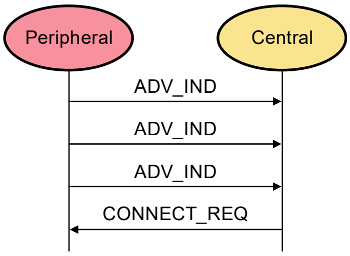


Figure 3. GAP central and GAP peripheral

The peripheral starts sending advertising data to the central. If the central is willing to establish a connection with the peripheral, it sends a connection request to the advertiser. Data exchange starts after the connection is established. For more details, see Figure 4.

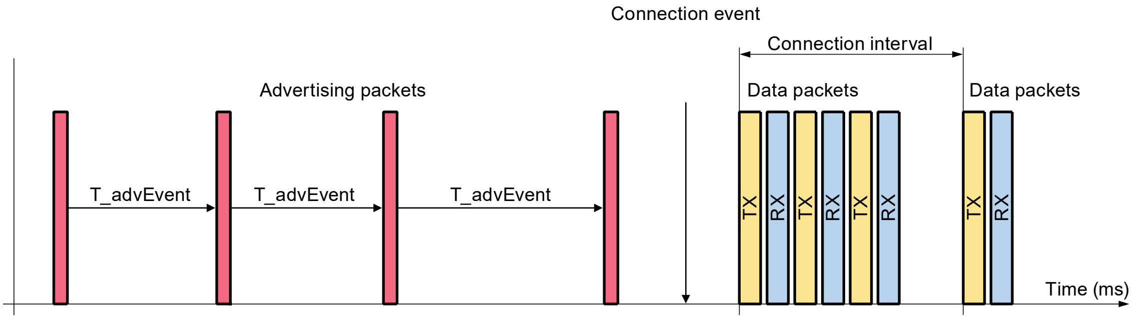


Figure 4. Bluetooth LE advertising and connection events

According to Bluetooth LE specifications, the following are the four types of advertising packets:

1. ADV_IND - Connectable undirected advertising
2. ADV_DIRECT_IND - Connectable directed advertising
3. ADV_NONCONN_IND - Non-connectable undirected advertising
4. ADV_SCAN_IND - Scannable undirected advertising (also known as ADV_DISCOVER_IND)

All the above advertising packets types are using a TX followed with an RX sequence except the non-connectable undirected advertising packets, as shown in Figure 5. After sending the advertising packet, the device is waiting for the scan request or connect request from a peer device, if any.

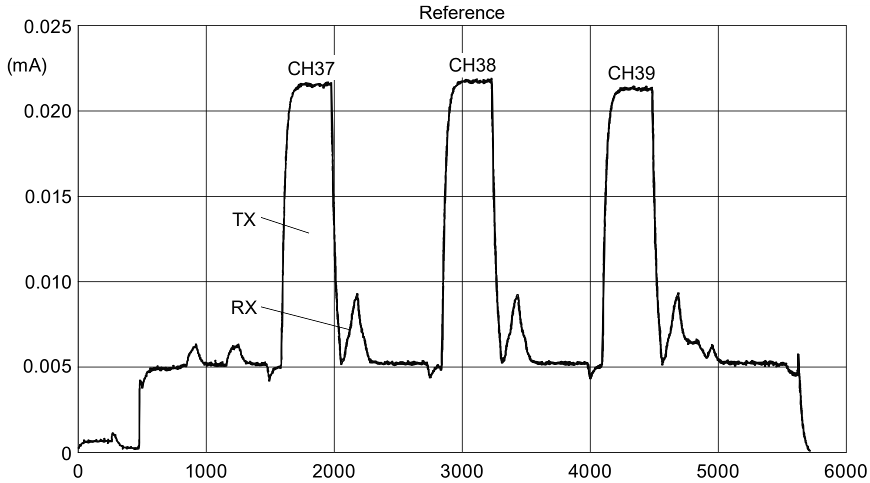


Figure 5. Current consumption vs. time in ADV phase for a Bluetooth LE peripheral device

The current variation with the time when system is in a typical advertising event is shown in Figure 5. All three advertising channels are used. For each channel, a TX operation followed with an RX operation is performed.

Another feature of Bluetooth LE is that the advertising events have a random temporal component, according to Bluetooth LE specifications. For more details, see Figure 6.

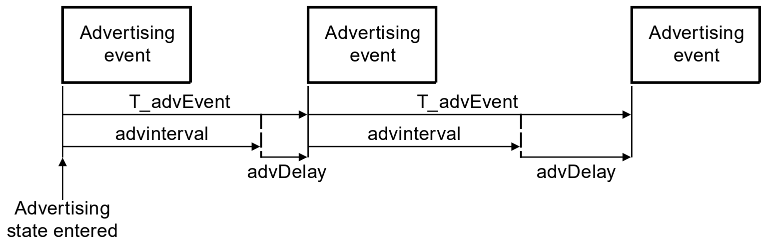


Figure 6. Advertising events occurring at unequal intervals

Equation:

$$T\_advEvent = advInterval + advDelay$$

Where:

- `advInterval`: Integer multiple of 0.625 ms, with a range from 20 ms to 10.24 s
- `advDelay`: Pseudo-random value generated by the link-layer with a range from 0 ms to 10 ms

Therefore, a minimum advertising event interval is 20 ms and a maximum interval is 10.25 s.

The Bluetooth LE is designed and implemented for ultra-low power battery-operated devices. The actual power consumption of a real Bluetooth LE device depends on the following:

- Bluetooth LE application profile
- Application duty cycle
- TX power
- Software management of low-power modes
- Board design and layout

3 Power consumption analysis

This section describes the following:

- The power consumption test setup when using the MCXW23_EVK_BB and MCXW236B_RDM boards
- Demo applications used
- Change advertisement, supply mode, and various fixed settings, which are used throughout the measurement
- Various power supply modes and RF transmitter modes of the MCX W23

3.1 Power supply modes and RF transmitter modes

The MCX W23 is designed for various application requirements that require different power supply and transmitter level options to optimize the power consumption better.

The MCX W23 has a flexible power supply management, which allows the MCX W23 to operate in two different Power supply modes as follows:

- High-voltage supply mode (HV_SM): The integrated DC-DC converter operates as a buck converter, which is powered from the VBAT_HV pin with output on VBAT_LV pin (1.2 V default). For example, as shown in Figure 7, the device is supplied from the VBAT_HV using a dual silver-oxide or lithium coincell. The VDD_IO pin is powered from the VBAT_HV and the VDD_RF is powered from the VBAT_LV. The power API can be used to set the output voltage from 1.1 V to 1.8 V, in steps of 100 mV.
- External regulated supply mode (XR_SM): The integrated DC-DC converter is disabled and an external power management-integrated circuit (PMIC) supplies the VBAT_LV and VBAT_HV pins. For example, an external dual supply (DS) PMIC supplies 1.2 V on VBAT_LV and 1.8 V on VBAT_HV, see Figure 8. A single supply (SS) PMIC where VBAT_LV = VBAT_HV = 1.8 V, see Figure 8.

For more information about these supply modes, see the *MCX W23 Data Sheet* document (MCXW23).

The jumpers are provided on the MCX W23 FRDM board to configure the VBAT_HV, VBAT_LV, VDD_RF, and VDD_IO appropriately to the desired configuration. The default configuration of the jumpers is such that the VBAT_HV = VDD_IO = 3.0 V and VDD_RF = VBAT_LV = 1.2 V. For more details on various power supply jumpers, see the *MCX W23 Hardware Design Guide* (document UG10233).

Note: *The VDD_IO and VDD_RF can be powered independently of VBAT_HV and VBAT_LV, the only requirement is that the VDD_IO must be available with the VBAT_HV.*

The MCX W23 also has a flexible RF transmitter level configuration, which allows the MCX W23 to operate in two different transmitter modes as follows:

- TX Mode 1 (TXM1): -31 dBm to +2 dBm, this mode requires VDD_RF to be greater than 1.1 V.
- TX Mode 2 (TXM2): -28 dBm to +6 dBm, this mode requires VDD_RF to be greater than 1.7 V.

For a given application use case, it is important to select the right power supply and RF transmitter mode for optimizing power consumption. Figure 9 and Figure 10 helps to identify the right configuration based on application requirements. These configurations are not the only possible configuration but can be used as a starting point to work with.

In this document, the Section 3.3 and Section 3.5 are performed in HV_SM mode, where VBAT_HV = 3.0 V, VDD_IO = VBAT_HV, VDD_RF = VBAT_LV = 1.2 V and TXM1 (0 dBm). The current is measured across VBAT_HV as depicted in Figure 11. The same steps can be used for current measurement in different power supply configurations and RF transmitter modes.

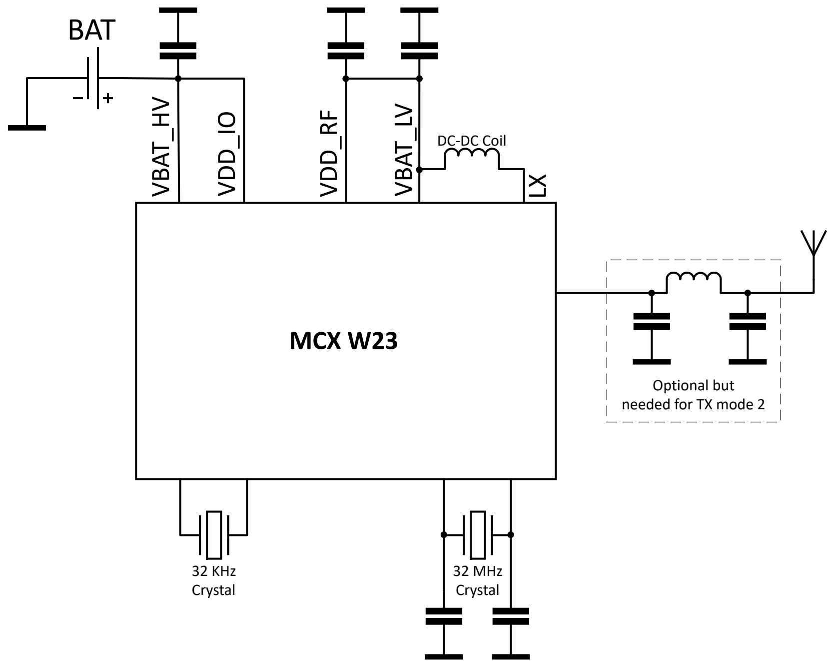


Figure 7. HV_SM supply mode - VBAT_HV = VDD_IO and VBAT_LV = VDD_RF

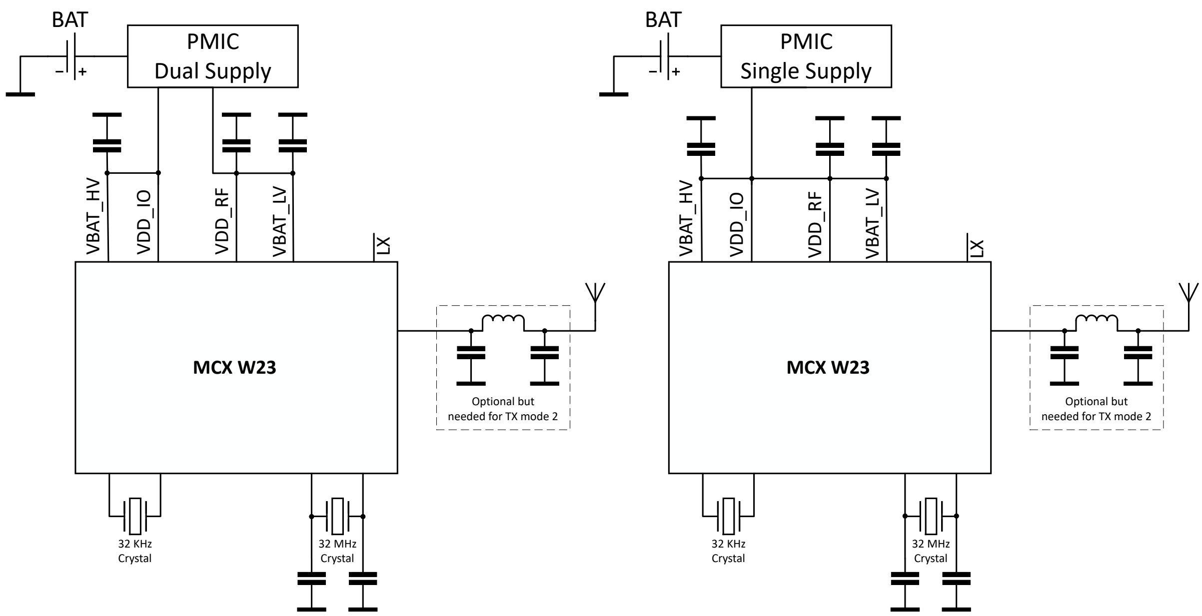


Figure 8. XR_SM supply mode

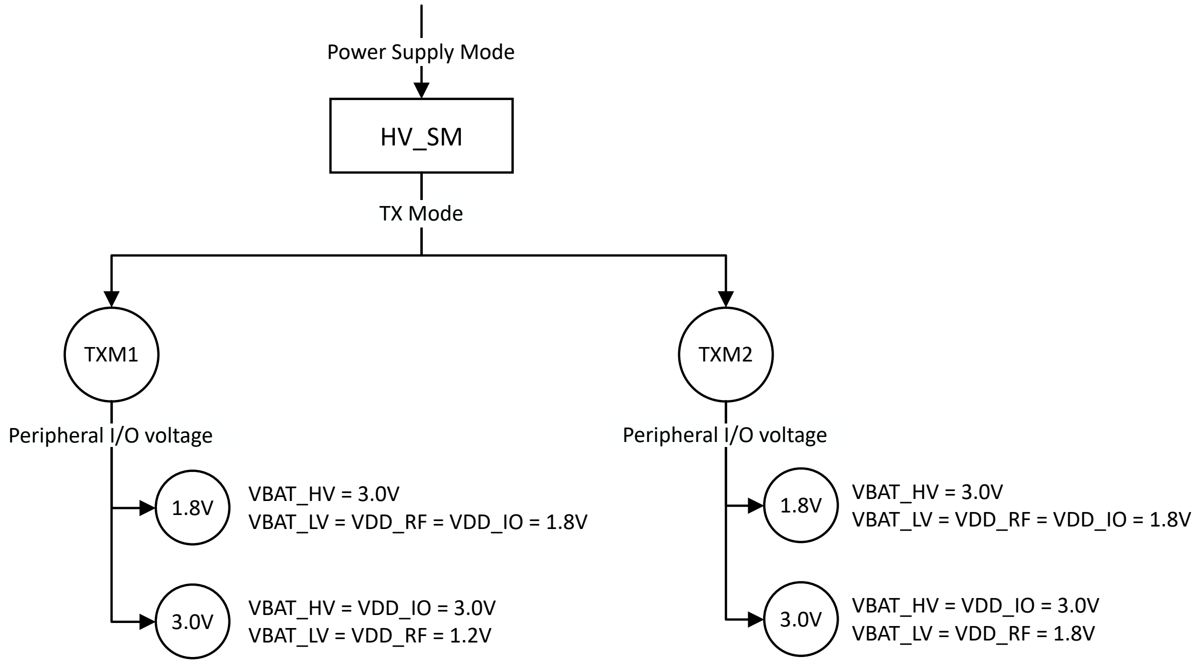


Figure 9. The MCX W23 power supply HV_SM mode and RF transmitter modes

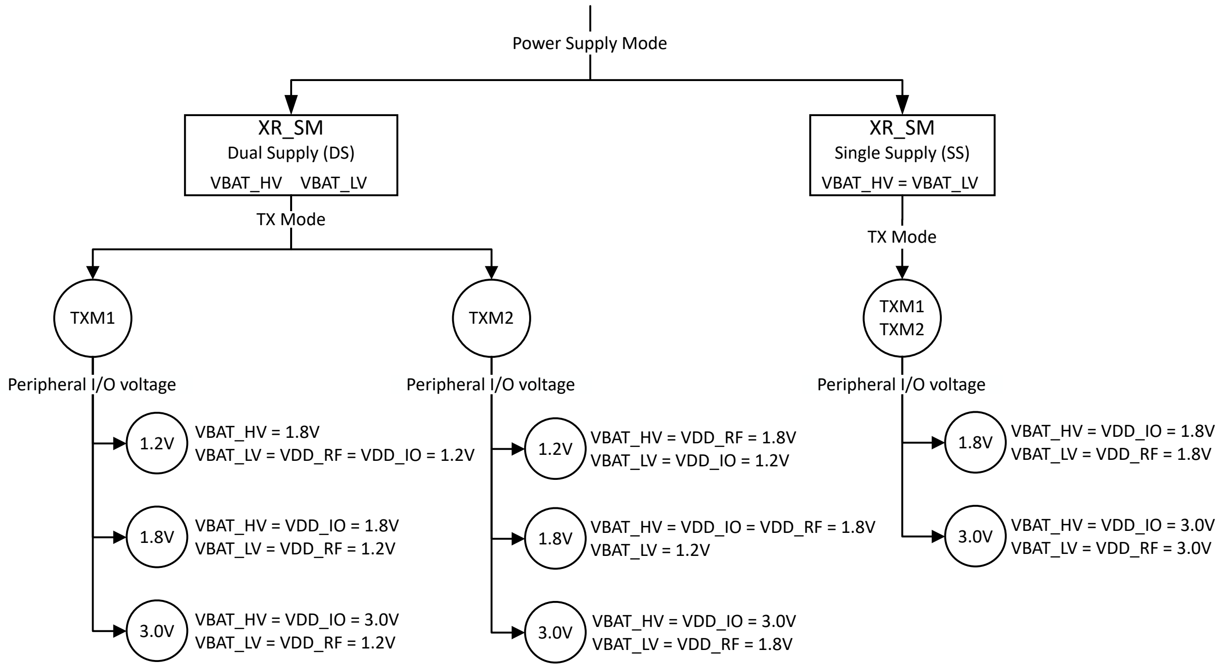


Figure 10. The MCX W23 power supply XR_SM mode and RF transmitter modes

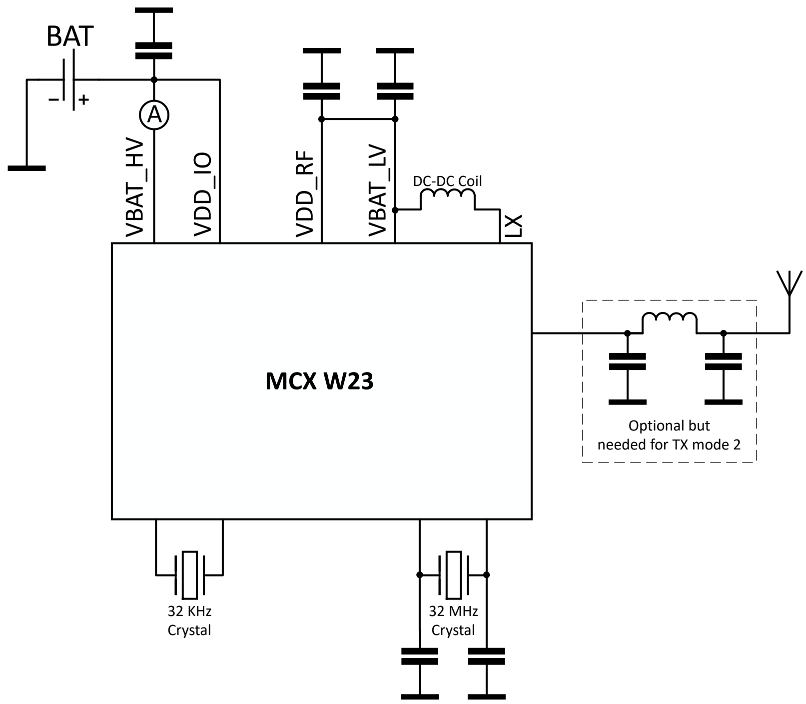


Figure 11. Measurement setup - HV_SM supply mode, VBAT_HV = 3.0 V, VDD_IO = VBAT_HV, VBAT_LV = VDD_RF = 1.2 V and TXM1 (0 dBm)

3.2 Test setup requirements

- Hardware
  - Two MCXW23_EVK_BB boards[1]
  - Two MCXW236B_RDM RDM boards[2]
  - Test equipment: Power/current analyzer, oscilloscope and ammeter, or onboard power measurement circuitry[3]
- Software
  - VSCODE IDE development environment[4]
  - Applications: `health_care_iot_peripheral_bm` and `health_care_iot_central`[5]

3.3 Preparing the software for power measurement

For all measurements, which are demonstrated in this document, the **health_care_iot_peripheral_bm** (peripheral) and **health_care_iot_central** (central) demo applications from SDK 25.06 are used. These applications are available in the MCX W23 SDK. An explanation on importing and flashing the application on the boards is described in the *FRDM-MCXW23B Getting Started Guide*.

1 For more information, see the *MCX W23 EVK Board User Manual*.
2 For more information, see the *MCX W23 Hardware Design Guide* (document UG10233).
3 The MCXW23_EVK_BB board has an onboard power measurement circuitry, based on an MCU-link debug probe.
4 See the *FRDM-MCXW23 Getting Started Guide*.
5 See the *FRDM-MCXW23 Getting Started Guide* for how to import the application in the VSCODE IDE.

These demo applications are Bluetooth LE reference applications, which are modified using macros to measure the current for the use cases described in this document. The following demo applications are used for measuring current during advertising:

- Advertising mode: For measuring the power consumption during advertising, only one MCX W23 EVK board and the **health_care_iot_central** demo application are used.

To prepare the **health_care_iot_peripheral_bm** for current measurements, ensure that the following definitions/macros are enabled:

- `ENABLE_LOW_POWER`: Initializes and enables the power manager.
- `BLE_POWER_PROFILING`: Disables the watchdog, brownout detection (BOD), memory profiling, the battery measurement task, and the temperature measurement task.

3.3.1 Advertising interval change

The average power consumption varies with the value of the interval in an advertising event. The shorter the interval, the higher the power consumption. To balance the power consumption and transaction time, the tuning intervals for specific applications are crucial. To adjust the advertising interval, modify the values of the macro definitions `gFastConnMinAdvInterval_c`, `gFastConnMaxAdvInterval_c`, `gReducedPowerMinAdvInterval_c`, and `gReducedPowerMaxAdvInterval_c` in the file `examples/wrieless_examples/reference_design/health_care_iot_peripheral/blemgr.c` of the **health_care_iot_peripheral_bm** demo application. The default values are shown in Figure 12.

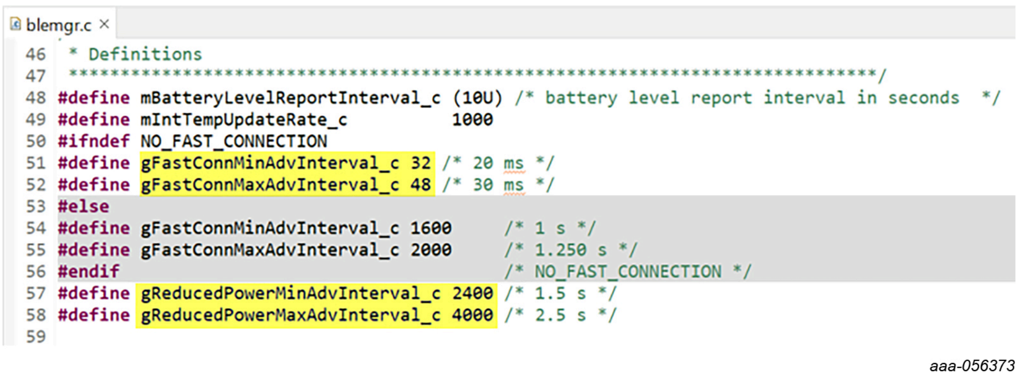


Figure 12. MCX W23 Advertising interval change

To get a known and fixed interval, set the minimum and the maximum interval in steps of 0.625 ms. For a 1 s interval, set the parameters as follows:

- `#define gFastConnMinAdvInterval_c 1600`
- `#define gFastConnMaxAdvInterval_c 1600`
- `#define gReducedPowerMinAdvInterval_c 1600`
- `#define gReducedPowerMaxAdvInterval_c 1600`

For a minimal power consumption scan, replace `gAdvConnectableUndirected_c` with `gAdvNonConnectable_c` in **examples/wrieless_examples/reference_design/health_care_iot_peripheral/app_config.c** to deny a response/request and make the advertisement non-connectable.

3.3.2 Supply mode change

In the health_care_iot_peripheral_bm application, the state of GPIO_6/`SUPPLY_MODE_SELECT_PIN` at the start of the application determines the Power supply mode, which is defined within **pin_mux.c**.

- To select HV_SM mode, leave the SUPPLY_MODE_SELECT_PIN pin floating or pull high at startup. This mode is the default mode of operation. To enable HV_SM mode with DC-DC bypass in low power state, define `SUPPLY_MODE_DCDCBYPASS`. During low power state, if `SUPPLY_MODE_DCDCBYPASS` is enabled, the VBAT_LV is pulled to VBAT_HV.
- To select XR-SM mode, pull the SUPPLY_MODE_SELECT_PIN pin low at startup. Ensure that the VBAT_HV, VBAT_LV, VDD_RF, and VDD_IO are powered appropriately with correct jumper settings on the MCXW236B_RDM board, see Figure 8. For more details, see the *Hardware Design Considerations for MCX W23* (document AN14658).

3.3.3 Fixed settings

The following settings are the same for all measurements in this document:

- The Bluetooth LE PHY calibration is scheduled in every 60 sec.
- Advertisement payload: 21 bytes.
- The content of all the memories is retained at low power.
- Transmit and receive power level: 0 dBm.

3.4 Measurement setup

This section describes two measurement setups for measuring current:

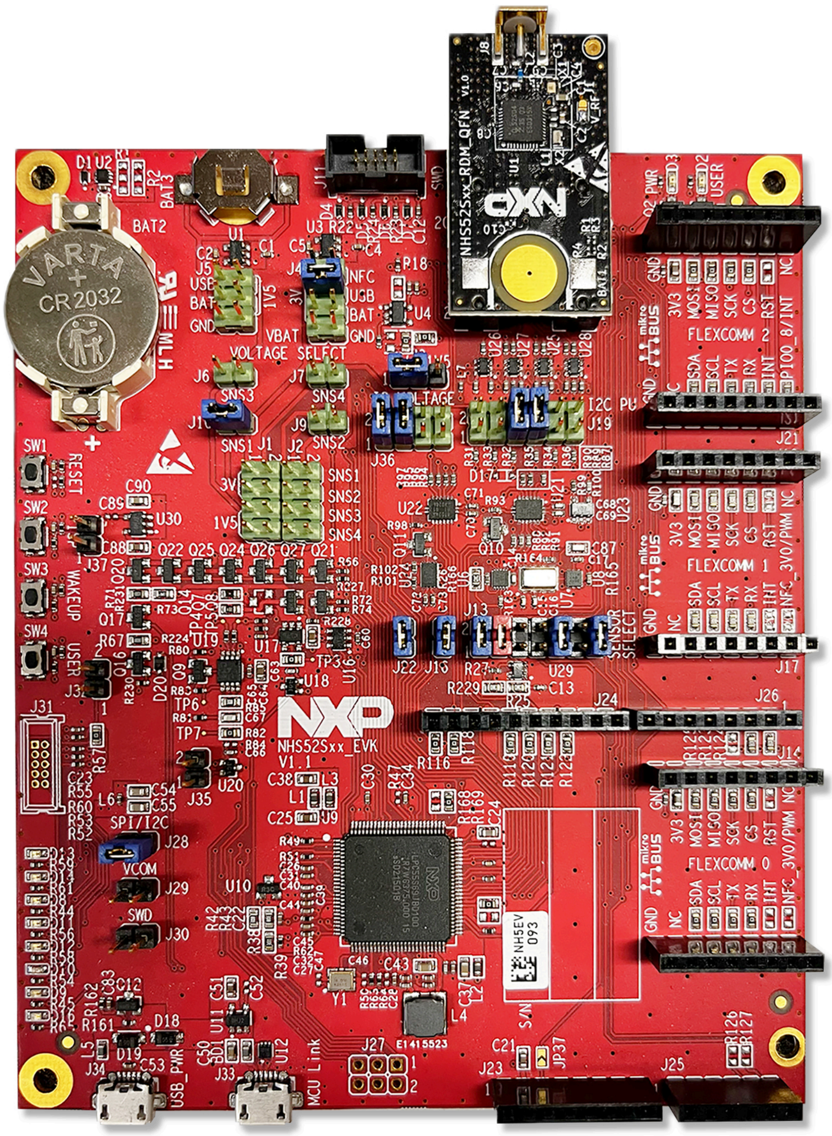
- Based on using external equipment
- Based on using onboard current measuring circuitry

In this document, the measurements are performed using external equipment.

3.4.1 Current measurement using external equipment

Figure 13 shows the jumper settings of the MCX W23 EVK board, which are required for measuring the current using external equipment. Remove all the jumpers on pin headers J1 and J2. Use pin header J9 as the current measuring point as shown in Figure 14. For more details about the various jumpers present on the board, see the MCX W23 Data Sheet.

The MCX W23 EVK board is configured for measuring the current that the MCX W23 draws from VBAT_HV = 3.0 V is the default setting. The VBAT_HV = 3.0 is derived from the 5.0 V USB (USB_PWR connector J34 or MCULink connector J33).



aaa-056376

Figure 13. MCX W23 EVK board jumper setting for measuring current using external equipment

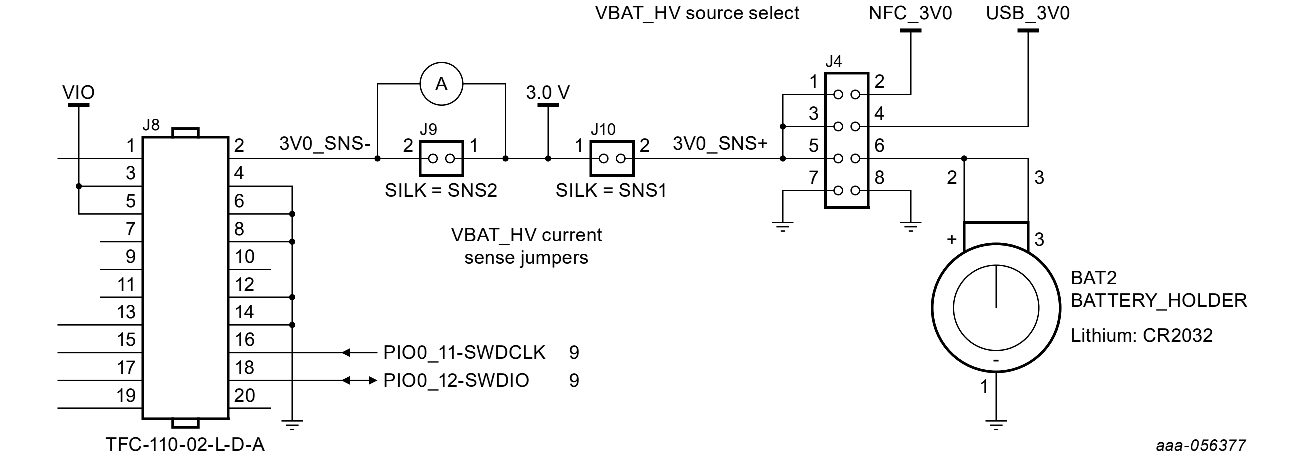


Figure 14. Current measurement across pin header J9

3.4.2 Current measurement using an onboard current measuring circuit

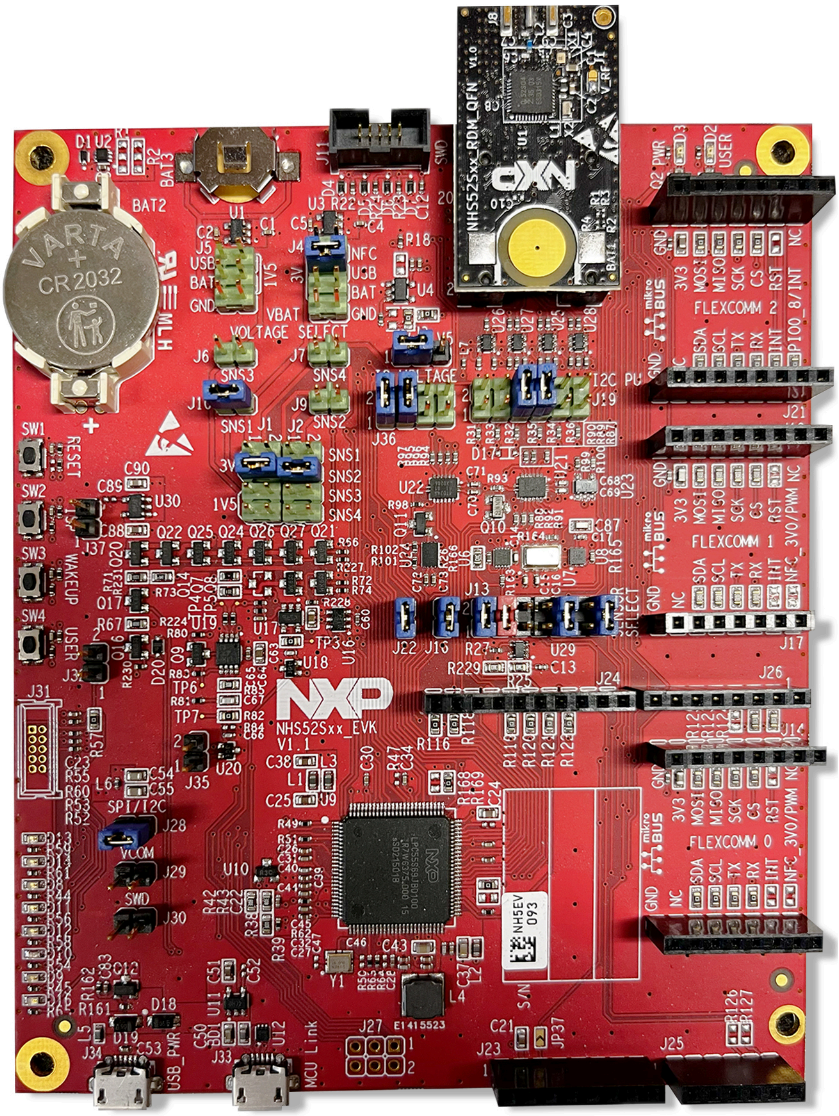
The EVK board has an MCU-link, which includes circuitry to measure the target supply voltage and current drawn. The energy measurement features in the MCUXpresso IDE can display this measurement data along with energy and power consumption.

Figure 15 shows the jumper settings of the MCX W23 EVK board, which are required for measuring the current using an onboard current measuring circuit.

The MCX W23 EVK board is configured for measuring the current that the MCX W23 draws from VBAT_HV = 3.0 V is the default setting. VBAT_HV = 3.0 V is derived from the 5.0 V USB. To provide the 5.0 V USB supply, only use the MCU-link connector J33 (USB port).

To use the onboard current measuring circuit, add jumpers on J1 (3-4) and J2 (3-4) as shown in Figure 16.

For more details on the energy measurement features of the MCU-link, see the *MCXW23_EVK HW User Manual* and the *MCU-Link Energy Measurement Capabilities* (document AN13660).



aaa-056378

Figure 15. The MCX W23 EVK board jumper settings for measuring the current using the onboard current measuring circuit

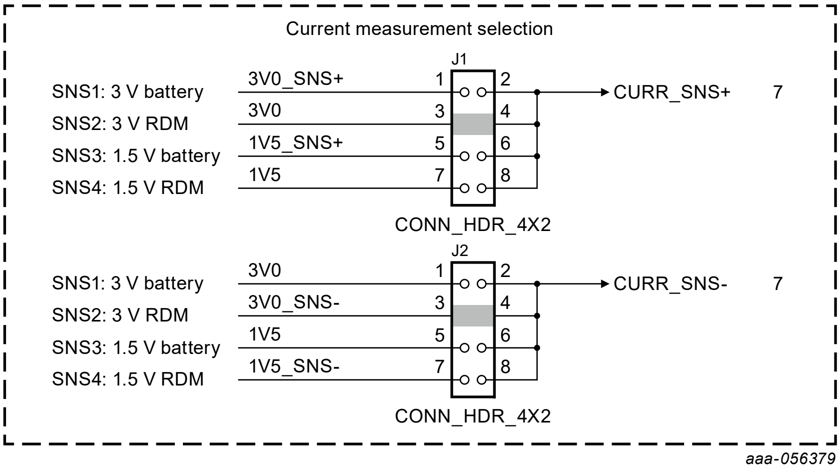


Figure 16. The J1 and J2 jumper settings for onboard current measurement circuitry

3.5 Measuring current

All measurements that are shown in this section are captured using an external measuring equipment.

In the measurement setup, a Keysight CX1102A current probe and a Keysight CX3324A current waveform analyzer are used as shown in Figure 17.

The average current consumption during advertising is made up of the following current consumptions:

- Static, which is a low-power state
- Dynamic, that is, during an advertisement event

For measurement accuracy, to measure the static current, a high-value series resistance is selected from the current probe. Whereas to measure the dynamic current, a low-value series resistance is selected.

To calculate the total average current during advertising mode, average currents from the static and the dynamic measurements are combined mathematically.

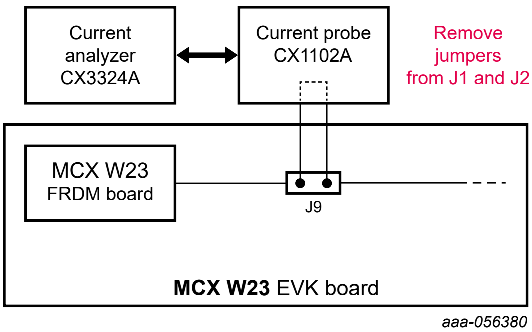


Figure 17. Test setup block diagram for the MCX W23 current measurement

3.5.1 Advertising mode

Test procedure:

- Demo application used: ref_app.
- To prepare the MCX W23 EVK board, see Section 3.4.

- To prepare the application and change the advertisement interval, see Section 3.3 and Section 3.3.1 respectively.
- Set up the measuring equipment and capture the data.

Test result:

- Table 2 shows the average current during various advertising intervals.

Table 2. Current consumption for various advertising intervals

Advertising, TX only, payload = 21 bytes, HV_SM, VBAT_HV = 3.0 V, VDD_RF = VDD_LV = 1.2 V, 0 dBm; Bluetooth LEPHY calibration every 60 sec

Advertising interval (ms)	I_{avg} (µA): DC-DC ON during low power	I_{avg} (µA): DC-DC bypass during low power
20	409.5	562.6
30	293.9	402.0
50	190.5	255.8
100	104.1	135.4
300	42.4	49.1
500	29.5	31.1
1000	19.7	17.5
1500	16.5	12.9
2000	14.8	10.6

3.5.2 Power profile of the Bluetooth LE events

A single Bluetooth LE event has various power states like preprocessing, RX, TX, RX/TX transition, and postprocessing. To get the correct assessment of the power consumption, an average power consumption is obtained from the start of one Bluetooth LE event to another. If there is no information to process between the Bluetooth LE events, the system is in low-power mode.

Figure 18 and Figure 19 show a single Bluetooth LE advertising event when captured on a current waveform analyzer. The zoomed in waveform shows the various states, which the MCX W23 goes through during a single Bluetooth LE advertising event.

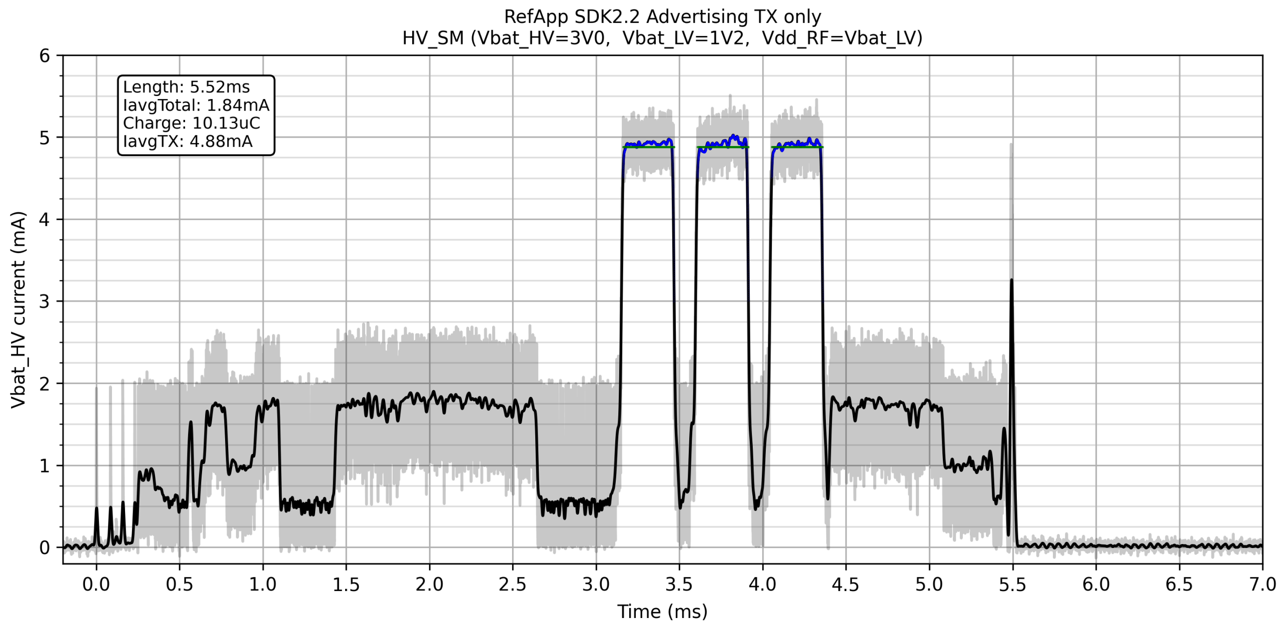


Figure 18. Advertising (TX only) event current profile

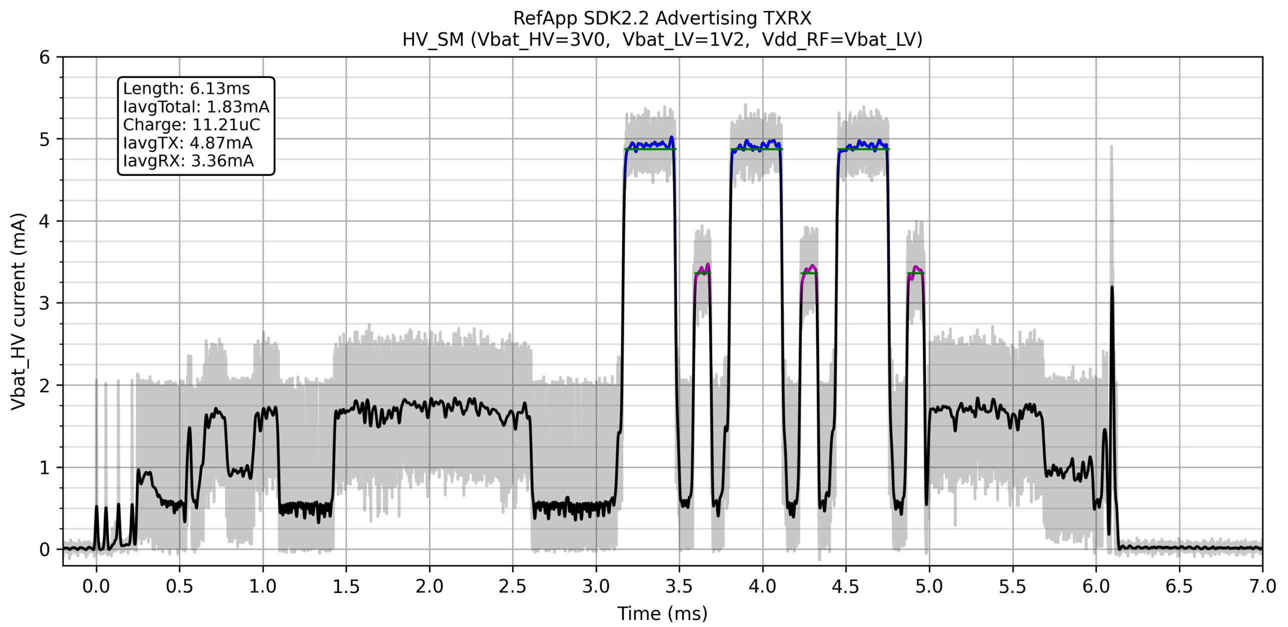


Figure 19. Advertising (TX-RX) event current profile

4 Acronyms

Table 3 lists the acronyms used in this document.

Table 3. Acronyms

Term	Description
BOD	Brownout detection
DS	Dual supply
GAP	Generic access profile
GFSK	Gaussian frequency-shift keying
HV_SM	High-voltage supply mode
ISM	Industrial scientific and medical
LE	Low energy
MCU	Microcontroller unit
PMIC	Power management-integrated circuit
RF	Radio frequency
SoC	System-on-chip
SS	Single supply
XR_SM	External regulated supply mode

5 References

Table 4 lists the references used to supplement this document.

Table 4. Related documentation

Document	Link/how to access
FRDM-MCXW23 Board User Manual	UM12359
FRDM-MCXW23 Getting Started Guide	FRDM-MCXW23 Getting Started Guide
MCX W23 Hardware Design Guide	UG10233
MCX W23 Data Sheet	MCXW23
Power Management for MCX W23	AN14660
MCU-Link Energy Measurement Capabilities	AN13660
MCXW23_EVK HW User Manual	Contact local FAE or NXP sales representative

6 Note about the source code in the document

Example code shown in this document has the following copyright and BSD-3-Clause license:

7 Revision history

Table 5 summarizes the revisions done to this document.

Table 5. Revision history

Document ID	Release date	Description
AN14659 v.2.0	04 August 2025	The following changes impact this revision: • Figures updated: – Figure 12 – Figure 13 – Figure 15 – Figure 18 – Figure 19 • Sections updated: – Section 1 – Section 3.1 – Section 3.2 – Section 5
AN14659 v.1.0	25 July 2025	Initial public release

Legal information

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at https://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

HTML publications — An HTML version, if available, of this document is provided as a courtesy. Definitive information is contained in the applicable document in PDF format. If there is a discrepancy between the HTML document and the PDF document, the PDF document has priority.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately.

Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

Suitability for use in industrial applications (functional safety) — This NXP product has been qualified for use in industrial applications. It has been developed in accordance with IEC 61508, and has been SIL-classified accordingly. If this product is used by customer in the development of, or for incorporation into, products or services (a) used in safety critical applications or (b) in which failure could lead to death, personal injury, or severe physical or environmental damage (such products and services hereinafter referred to as "Critical Applications"), then customer makes the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, safety, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. As such, customer assumes all risk related to use of any products in Critical Applications and NXP and its suppliers shall not be liable for any such use by customer. Accordingly, customer will indemnify and hold NXP harmless from any claims, liabilities, damages and associated costs and expenses (including attorneys' fees) that NXP may incur related to customer's incorporation of any product in a Critical Application.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

Bluetooth — the Bluetooth wordmark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by NXP Semiconductors is under license.

Tables

Figures

Contents