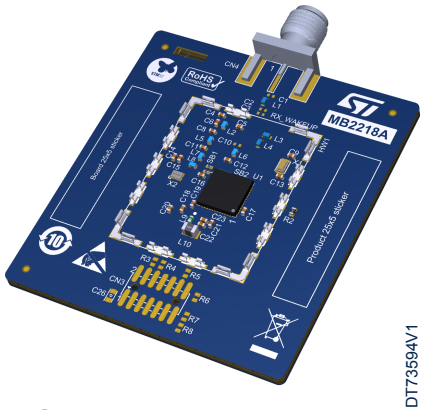
STDES-WL3xxxxx

Data brief

Reference designs for STM32WL3xxx microcontrollers



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Designs with different references show different layouts. Picture is not contractual. PCB color may differ.

Product link
STDES-WL3xxxxx
STDES-WL3C2ILL, STDES-WL3C2IMH, STDES-WL3C2IML, STDES-WL3C2SLH, STDES-WL3C2SLL, STDES-WL3C2SMH, STDES-WL3C2SML, STDES-WL3C4EEW, STDES-WL3C4SHH, STDES-WL3C4SLH, STDES-WL3C4SLL, STDES-WL3C4SMH, STDES-WL3C4SML, STDES-WL3K2IMR, STDES-WL3K2SMR

Features

Includes ST state-of-the-art patented technology

Reference designs

- Fully open hardware platforms
- Suitable for rapid prototyping of end nodes based on Sigfox™, Wireless M-Bus, mioty, and many other proprietary protocols

STM32WL3xxx microcontroller

- Ultra-low power sub-GHz wireless system-on-chip
- Programmable MCU
- Core: Arm® Cortex®-M0+ 32-bit, running up to 64 MHz
- Program memory: 64-Kbyte, 128-Kbyte, or 256-Kbyte flash memory
- RF transceiver (frequency bands: 159-185 MHz, 276-319 MHz, 413-479 MHz, 826-958 MHz) supporting 2(G)FSK, 2(G)MSK, 4(G)FSK, OOK, ASK, D-BPSK, DSSS modulations
- Low-power autonomous wake-up receiver (LPAWUR)

Oscillators

- 48 MHz or 50 MHz HSE (on-board TCXO or XO)
- 32.768 kHz LSE crystal

Connectors

- 2×25 header
- SMA

Supply voltage

- 1.7 V to 3.6 V

Description

The main objective of the STM32WL3xxx microcontroller reference designs is to recommend a layout and associated BOM for dedicated applications (these boards are not for sale).

These reference designs can be manufactured from files available for download from the *www.st.com* website. The access to all GPIOs allows the prototyping of a complete application.

Sensitive layout parts can be extracted and pasted in any user board design with the same PCB characteristics and feature set.

The STM32WL3xxx microcontroller reference designs are provided with the STM32WL3xxx comprehensive software HAL library. The STM32CubeWL3 MCU Package contains many software examples developed with the STM32WL3xxx Nucleo-64 boards (NUCLEO-WL33CC1 and NUCLEO-WL33CC2). These examples can be easily adapted for the STM32WL3xxx microcontroller reference designs.

Using the reference designs to design the user application helps to get the right RF performance and to pass certification.

1 General information

The STM32WL3xxx microcontrollers in the STDES-WL3xxxxx reference designs are based on the Arm® Cortex®-M0+ processor.

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2 STM32WL3xxx microcontroller reference designs and codification

Table 1. **STM32WL3xxx microcontroller reference designs**

Part number	Board reference	Board variant	MCU order code	MCU package	Number of layers	SMD, IPD, or external PA	PCB characteristics	HSE crystal frequency	Optimized BOM target
STDES-WL3C2ILL	MB2176	VB-MB2176-01	STM32WL33CCV6	VFQFPN48	2	IPD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/10 dBm
STDES-WL3C2IMH	MB2176	VB-MB2176-03	STM32WL33CCV6	VFQFPN48	2	IPD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	868 MHz/14-16 dBm
STDES-WL3C2IML	MB2176	VB-MB2176-02	STM32WL33CCV6A	VFQFPN48	2	IPD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/14-16 dBm
STDES-WL3C2SLH	MB2168	VB-MB2168-03	STM32WL33CCV6	VFQFPN48	2	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	868 MHz/10 dBm
		VB-MB2168-04							915 MHz/10 dBm
STDES-WL3C2SLL	MB2168	VB-MB2168-01	STM32WL33CCV6	VFQFPN48	2	SMD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/10 dBm
STDES-WL3C2SMH	MB2168	VB-MB2168-05	STM32WL33CCV6	VFQFPN48	2	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	868 MHz/14-16 dBm
STDES-WL3C2SML	MB2168	VB-MB2168-02	STM32WL33CCV6	VFQFPN48	2	SMD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/14-16 dBm
STDES-WL3C4EEW	MB2158	VB-MB2158-01	STM32WL33CCV6A	VFQFPN48	4	SMD, external PA	1.6 mm FR4 with plated through holes and buried vias	48 MHz	169 MHz/27 dBm
STDES-WL3C4SHH	MB2218	VB-MB2218-05	STM32WL33CCV6	VFQFPN48	4	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	915 MHz/20 dBm
STDES-WL3C4SLH	MB2218	VB-MB2218-03	STM32WL33CCV6	VFQFPN48	4	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	868 MHz/10 dBm
STDES-WL3C4SLL	MB2218	VB-MB2218-01	STM32WL33CCV6	VFQFPN48	4	SMD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/10 dBm
STDES-WL3C4SMH	MB2218	VB-MB2218-04	STM32WL33CCV6	VFQFPN48	4	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	868 MHz/14-16 dBm

Part number	Board reference	Board variant	MCU order code	MCU package	Number of layers	SMD, IPD, or external PA	PCB characteristics	HSE crystal frequency	Optimized BOM target
STDES-WL3C4SML	MB2218	VB-MB2218-02	STM32WL33CCV6	VFQFPN48	4	SMD	1.6 mm FR4 with plated through holes and buried vias	50 MHz	433 MHz/14-16 dBm
STDES-WL3K2IMR	MB2408	VB-MB2408-01	STM32WL3RK8V6	VFQFPN32	2	IPD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	315 MHz/16 dBm
STDES-WL3K2SMR	MB2406	VB-MB2406-01	STM32WL3RK8V6	VFQFPN32	2	SMD	1.6 mm FR4 with plated through holes and buried vias	48 MHz	315 MHz/16 dBm

Table 2. **STM32WL3xxx microcontroller reference designs codification**

Example:	STDES-	WL3	C	2	S	L	H

Device family

STDES- = STMicroelectronics reference design

Wireless products

WL3 = Long-range STM32WL3xxx microcontrollers

Wireless microcontroller package

C = VFQFPN48, 48 pins

K = VFQFPN32, 32 pins

Reference design number of layers

2 = 2 layers

4 = 4 layers

Antenna matching and Tx/Rx path connection to the antenna

I = IPD

S = SMD

E = SMD with external PA controlled by the MCU

D = SMD with discrete external PA controlled by the MCU

Power mode

L = low power (up to +10 dBm)

M = medium power (up to +14/16 dBm)

H = high power (up to +20 dBm)

E = extended range (up to +27 dBm)

Frequency band

W = 159-185 MHz

L = 413-479 MHz

H = 826-958 MHz

R = 276-319 MHz

3 Development environment

3.1 System requirements

- Multi-OS support: Windows® 10 or 11, Linux® 64-bit, or macOS®
- USB Type-A or USB Type-C® to USB Type-C® cable

Note: *macOS® is a trademark of Apple Inc., registered in the U.S. and other countries and regions.*

Linux® is a registered trademark of Linus Torvalds.

Windows is a trademark of the Microsoft group of companies.

3.2 Development toolchains

- IAR Systems® - IAR Embedded Workbench®(1)
- Keil® - MDK-ARM(1)
- STMicroelectronics - STM32CubeIDE

1. *On Windows® only.*

3.3 Demonstration software

The demonstration software, included in the STM32Cube MCU Package corresponding to the on-board microcontroller, is preloaded in the STM32 flash memory for easy demonstration of the device peripherals in standalone mode. The latest versions of the demonstration source code and associated documentation can be downloaded from *www.st.com*.

3.4 EDA resources

All board design resources, including schematics, EDA databases, manufacturing files, and the bill of materials, are available from the corresponding product page at *www.st.com*.

The bill of materials for the VFQFPNxx package is also applicable to the VFQFPN32 package.

4 Conventions

Table 3 provides the conventions used for the ON and OFF settings in the present document.

Table 3. Conventions for solder bridges

Convention	Definition
Solder bridge SBx ON	SBx connections closed by 0 Ω resistor
Solder bridge SBx OFF	SBx connections left open

5 Measurement environment

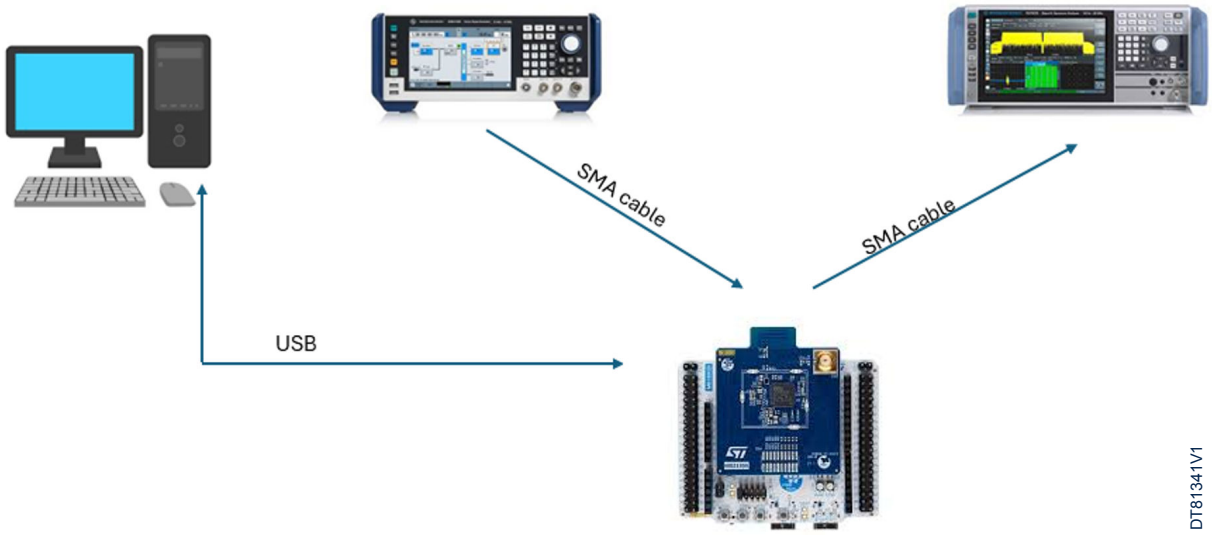
5.1 Measurement setup

The Tx and Rx measurement setup includes the following equipment:

- RF signal generator: Agilent E4438C
- Spectrum analyzer: Rohde & Schwarz FSW13
- PC running Windows® with Python™ script

Test bench loss is measured and included in the results.

Figure 1. Measurement setup



5.2 Firmware programming

To download firmware, connect a Serial Wire Debug Port from an external probe. For example, use the STLINK-V3SET through the MB1801 mezzanine board to perform the connection.

5.3 Transparent mode and UART pins

To test RF performance using the transparent mode firmware, connect a UART. The DUT UART Rx and Tx pins are indicated on the CN1 connector of both the MCU RF board and the mezzanine board (MB1801):

- Pin 45 VCP1_RX (GPIO23)
- Pin 47 VCP1_TX (GPIO24)

For more information about using the transparent mode firmware for performance measurements, refer to the RF test panel section of the user manual *STM32CubeMonitor-RF software tool for wireless performance measurements* (UM2288).

Table 4. UART Rx and Tx

UART	Board reference (MB1801)
Virtual COM port 1	Rx: GPIO23 Tx: GPIO24

6 Hardware layout and configuration

This section presents examples of Tx output power and Rx sensitivity measurements for each reference design. These measurements are not contractual.

A continuous-wave (CW) signal is used to evaluate Tx performance. Refer to the radio settings described in Table 38. Radio setting summary. Use these settings to obtain the specified output power for each example.

The following radio settings are used to evaluate Rx performance:

- Modulation: 2-GFSK05
- Data rate: 38 400 samp/s
- Channel filter: 100 kHz
- Frequency deviation: 20 kHz
- Sensitivity in dynamic bypass on-the-fly mode (BOF), low-power mode (LPM), and high-performance mode (HPM). Refer to the STM32WL3xxx microcontroller datasheet (DS14221) for the related radio configuration.

STMicroelectronics develops integrated passive device (IPD) companion chips for optimized matching, filtering, and balun. The IPD provides a compact, all-in-one solution for the following use cases:

- 10-16 dBm at 315 MHz
- 10 dBm at 433 MHz
- 16 dBm at 433 MHz
- 16 dBm at 868 MHz
- 20 dBm at 915 MHz

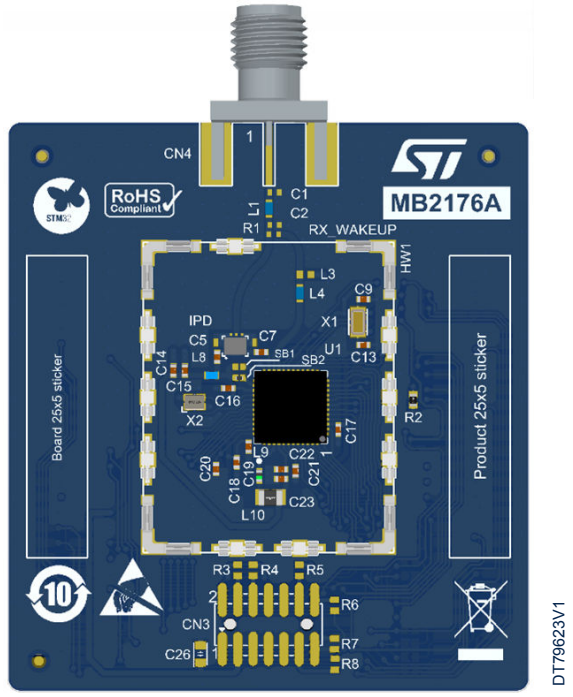
For optimum implementation, use the IPD instead of discrete matching circuitry.

6.1 MB2176 reference board

6.1.1 MB2176 description

The MB2176 reference board implements the STM32WL33CC microcontroller in a VFQFPN48 package with IPD filtering. The RF PA pin is configurable by using the solder bridge.

Figure 2. MB2176



Picture is not contractual.

6.1.2 STDES-WL3C2ILL 433 MHz/10 dBm

Solder bridges

The STDES-WL3C2ILL reference design is configurable to meet specific application requirements.

Table 5. STDES-WL3C2ILL solder bridge configurations

MB2176 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 6. STDES-WL3C2ILL radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2ILL	433 MHz/10 dBm	1.4 V	TX	0x51	ON

6.1.2.1 STDES-WL3C2ILL 433 MHz/10 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 3. **STDES-WL3C2ILL Tx output power**

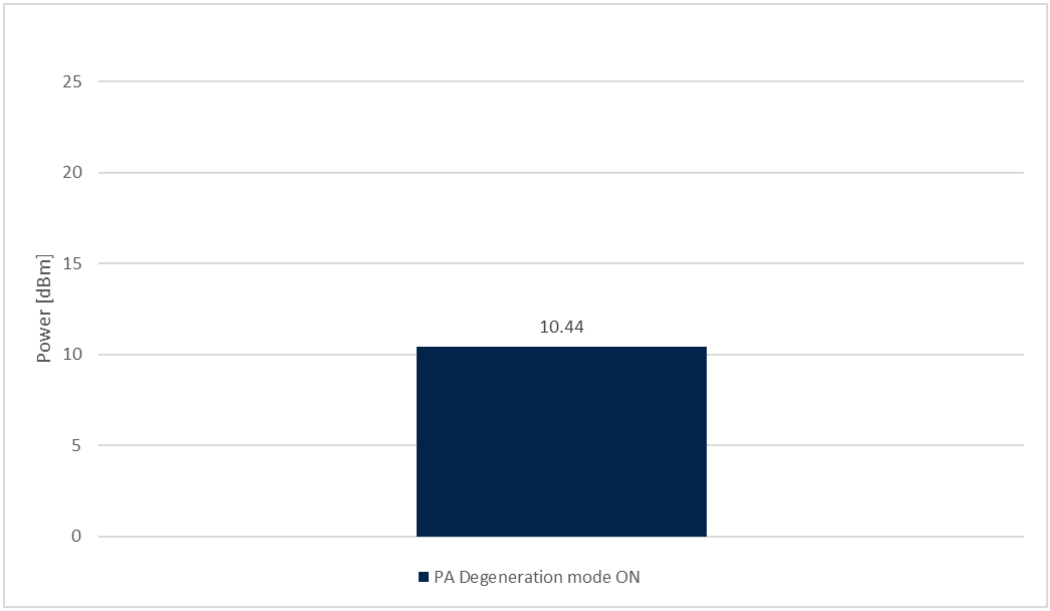


Figure 4. **STDES-WL3C2ILL Tx current consumption**

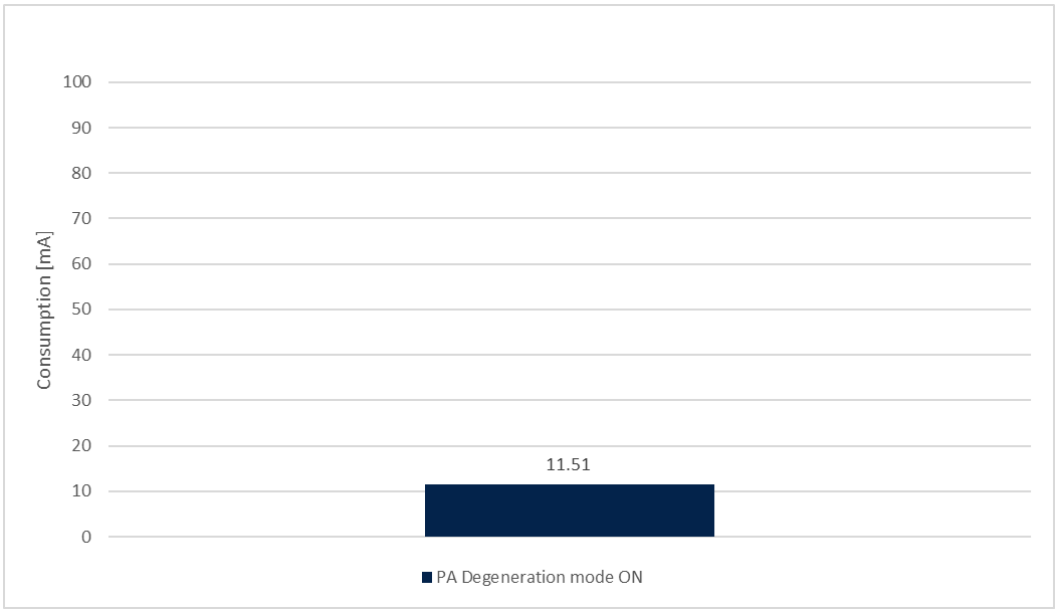
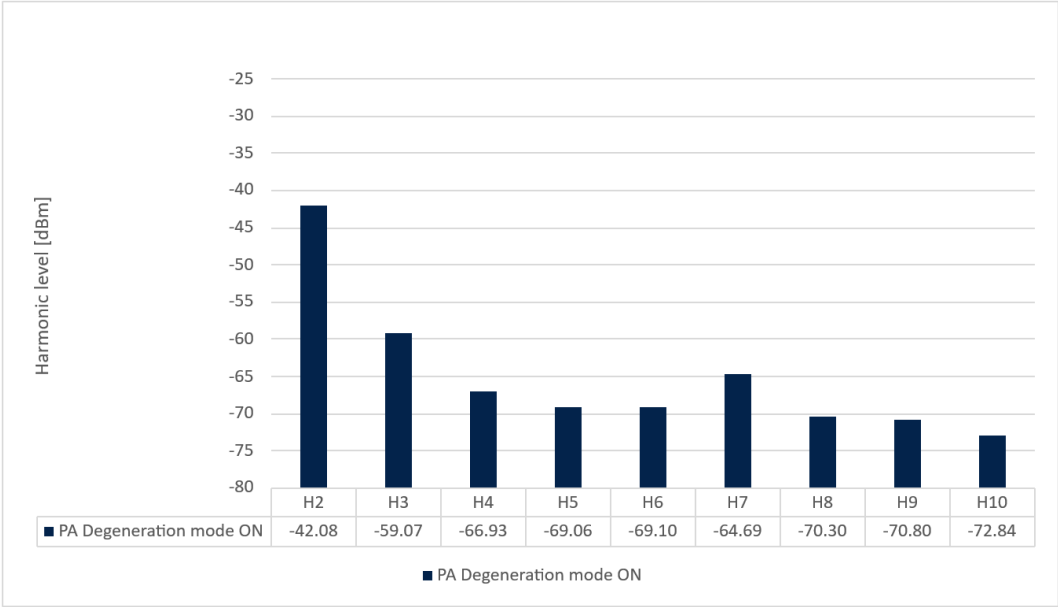


Figure 5. **STDES-WL3C2ILL Tx harmonic levels**



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6.1.2.2 *STDES-WL3C2ILL 433 MHz/10 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 6. **STDES-WL3C2ILL Rx sensitivity**

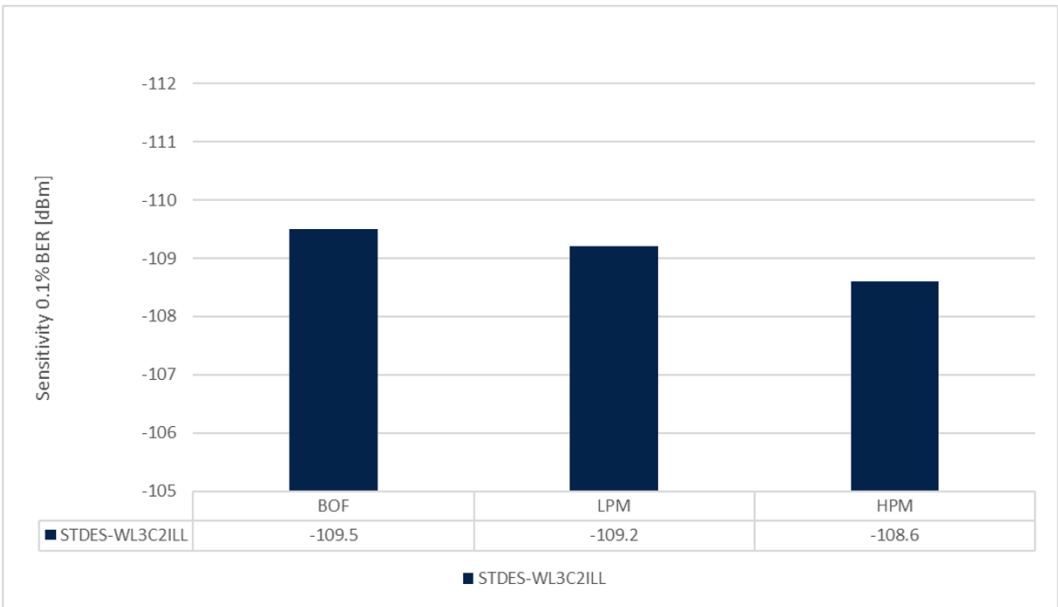

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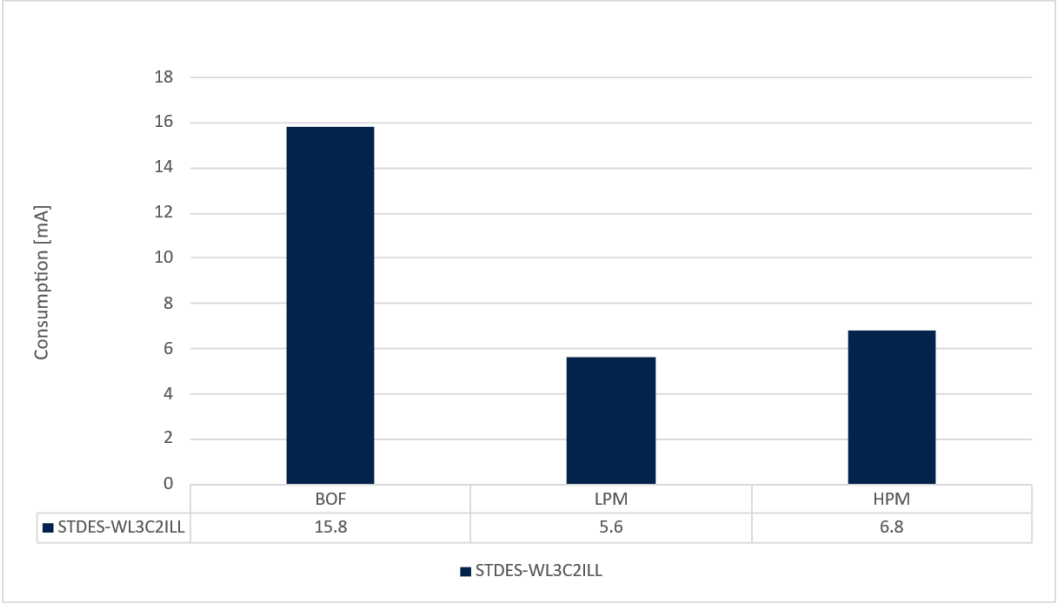
Figure 7. **STDES-WL3C2ILL Rx current consumption**



6.1.3 STDES-WL3C2IMH 868 MHz/16 dBm

Solder bridges

The STDES-WL3C2IMH reference design is configurable to meet specific application requirements.

Table 7. **STDES-WL3C2IMH solder bridge configurations**

MB2176 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 8. **STDES-WL3C2IMH radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2IMH	868 MHz/16 dBm	1.6 V	TX_HP	0x51	ON

6.1.3.1 STDES-WL3C2IMH 868 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 8. **STDES-WL3C2IMH Tx output power**

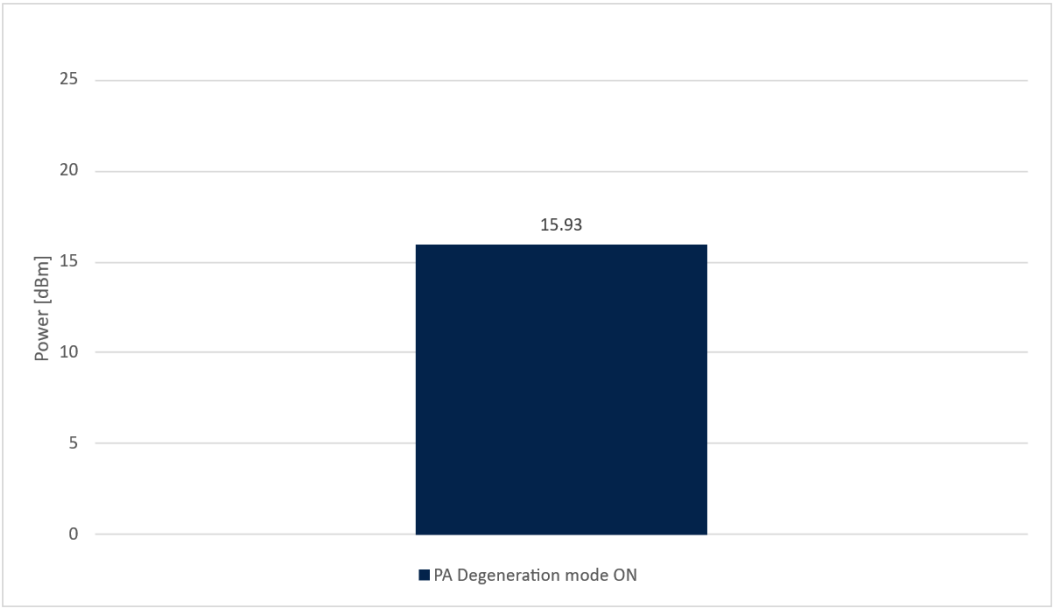


Figure 9. **STDES-WL3C2IMH Tx current consumption**

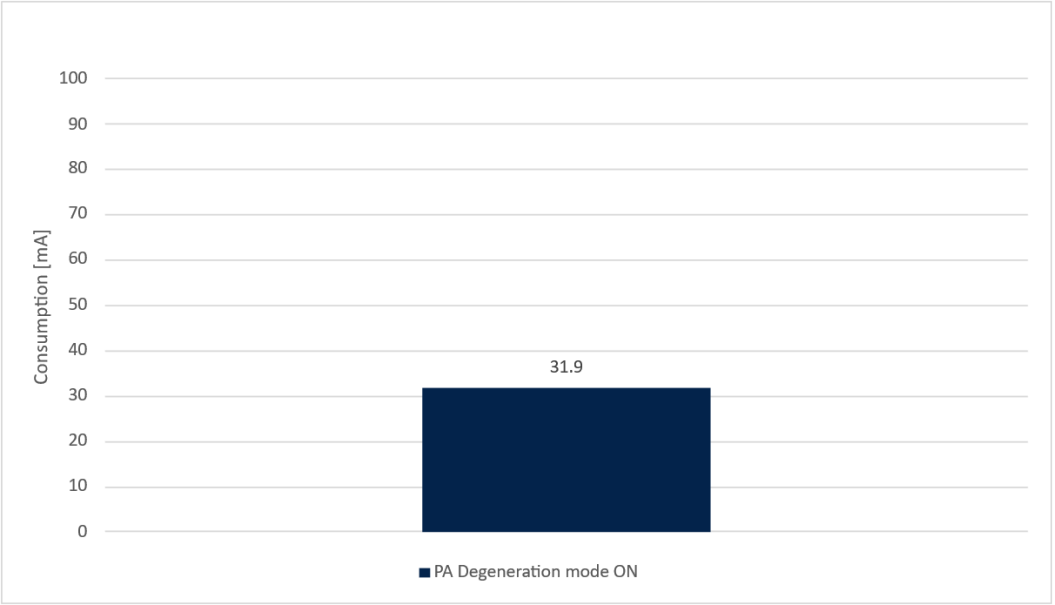
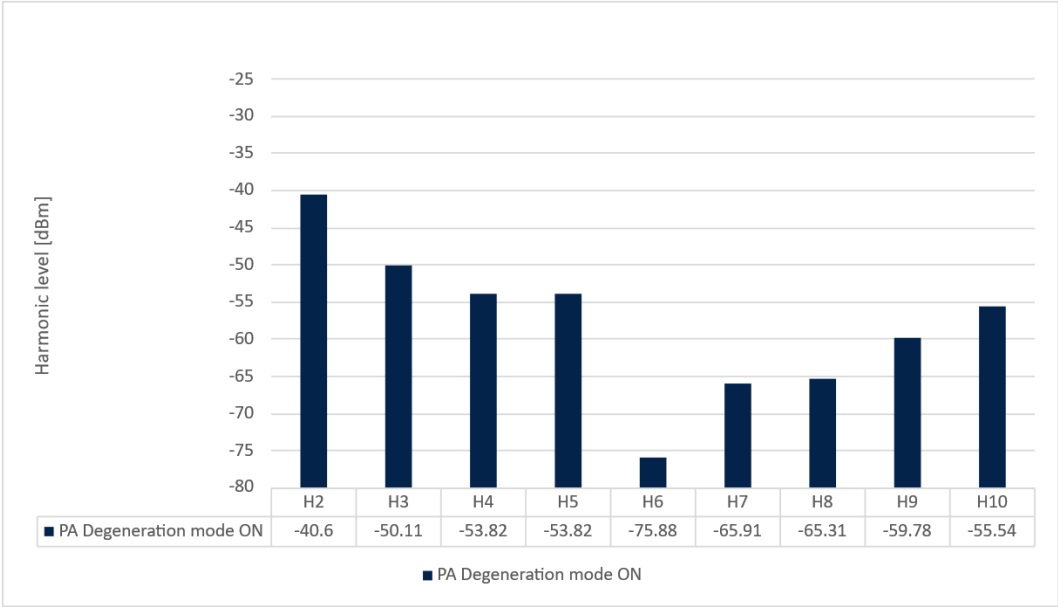


Figure 10. **STDES-WL3C2IMH Tx harmonic levels**



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6.1.3.2 *STDES-WL3C2IMH 868 MHz/16 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 11. **STDES-WL3C2IMH Rx sensitivity**

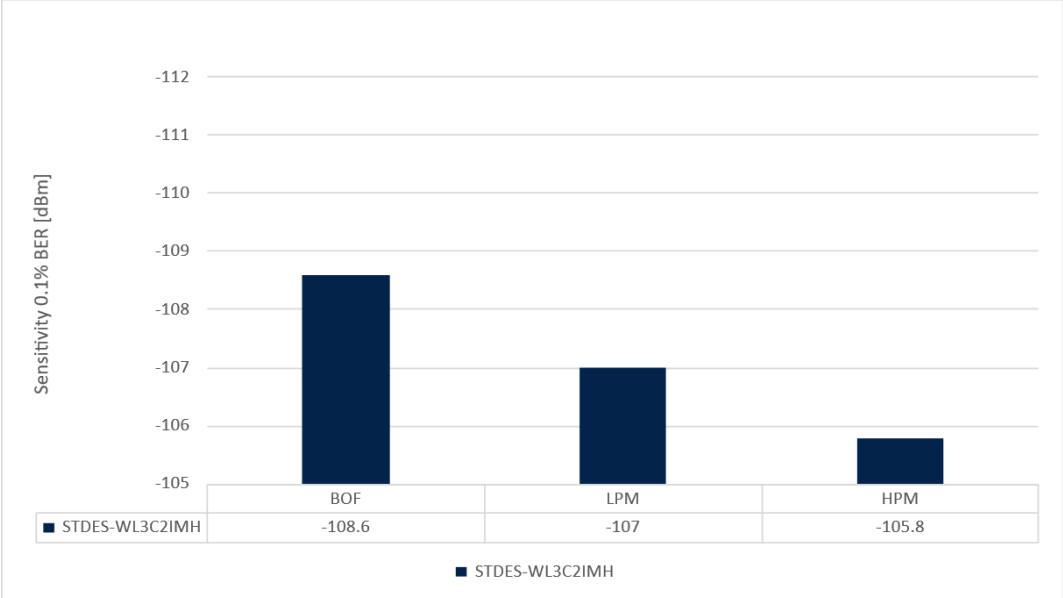

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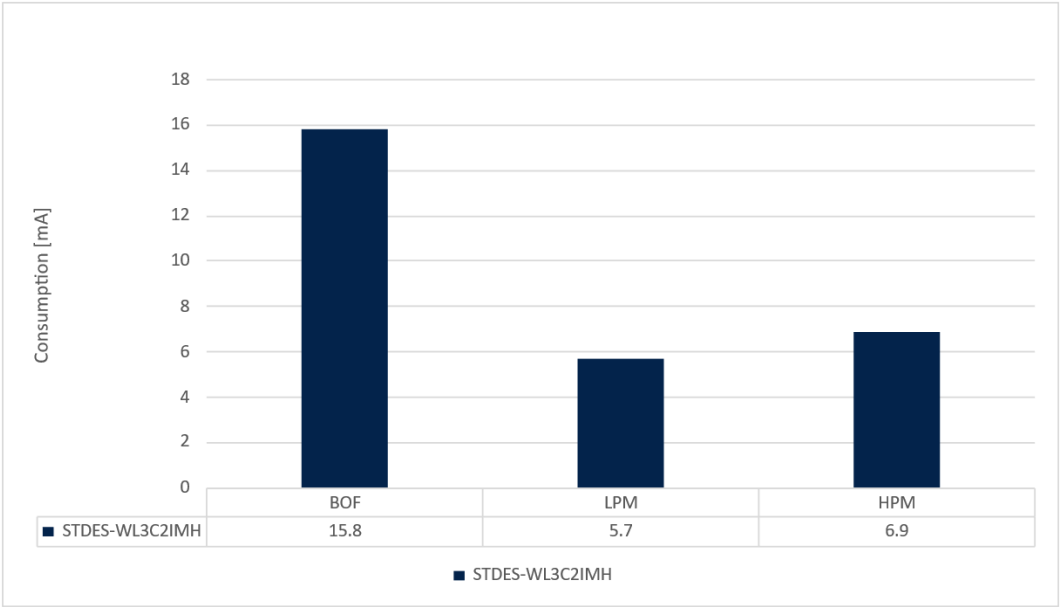
Figure 12. **STDES-WL3C2IMH Rx current consumption**



6.1.4 STDES-WL3C2IML 433 MHz/16 dBm

Solder bridges

The STDES-WL3C2IML reference design is configurable to meet specific application requirements.

Table 9. **STDES-WL3C2IML solder bridge configurations**

MB2176 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 10. **STDES-WL3C2IML radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2IML	433 MHz/16 dBm	1.8 V	TX_HP	0x51	ON

6.1.4.1 STDES-WL3C2IML 433 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 13. **STDES-WL3C2IML Tx output power**

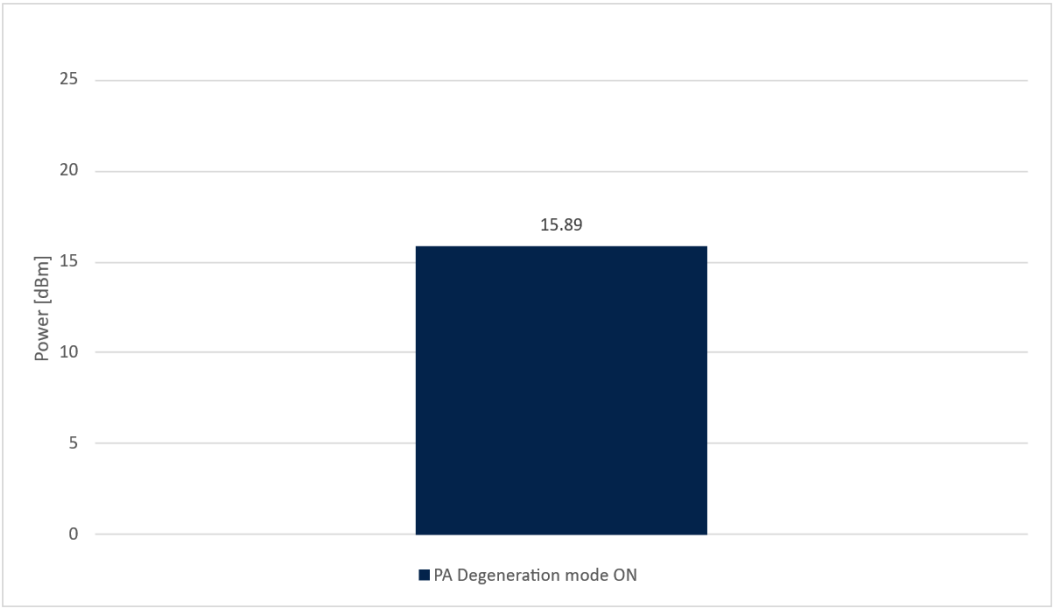


Figure 14. **STDES-WL3C2IML Tx current consumption**

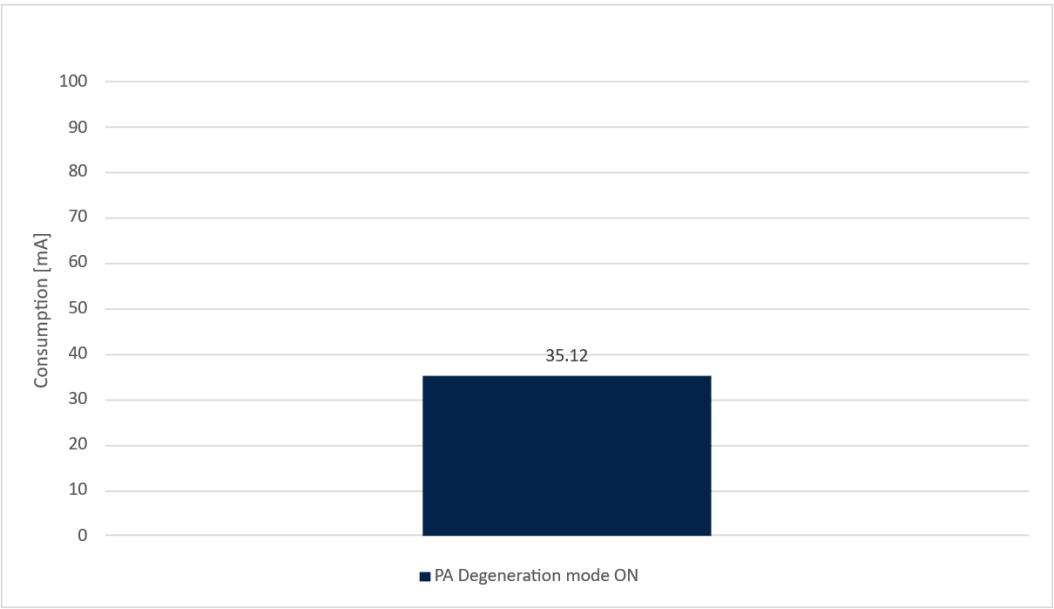
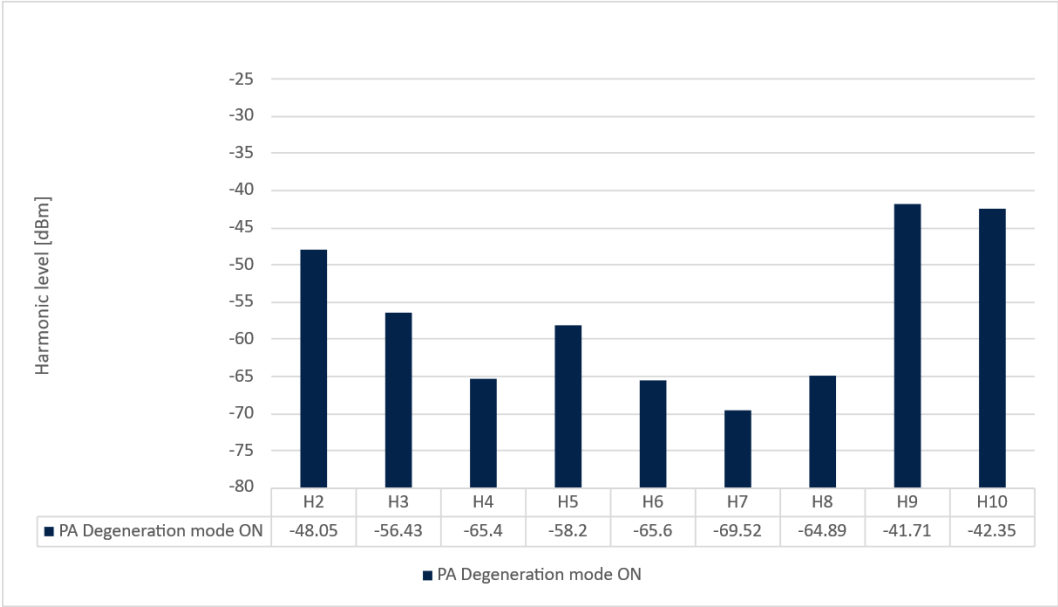


Figure 15. **STDES-WL3C2IML Tx harmonic levels**



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6.1.4.2 *STDES-WL3C2IML 433 MHz/16 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 16. **STDES-WL3C2IML Rx sensitivity**

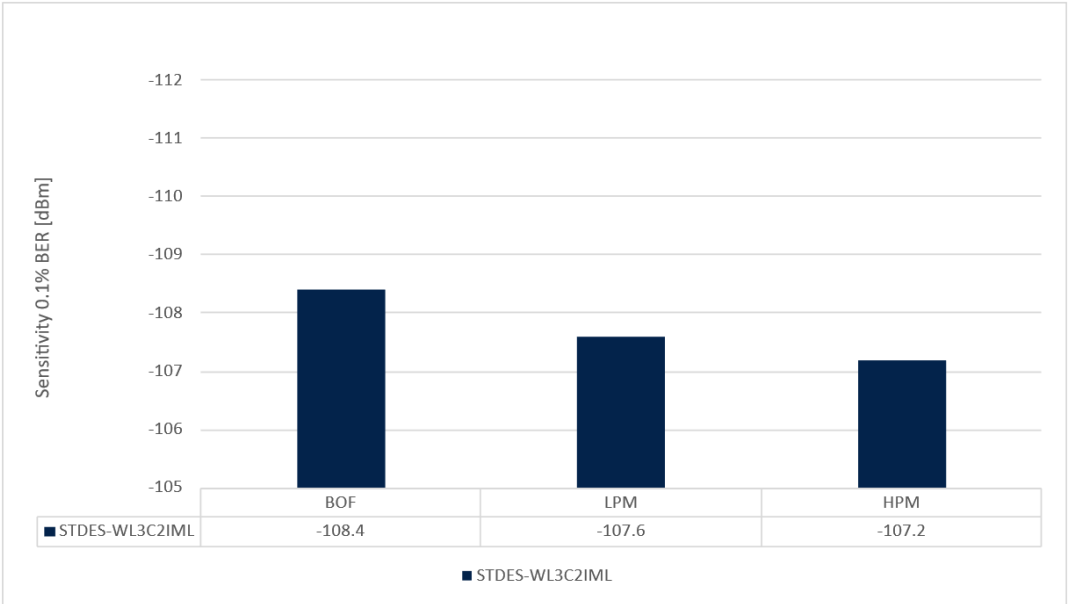

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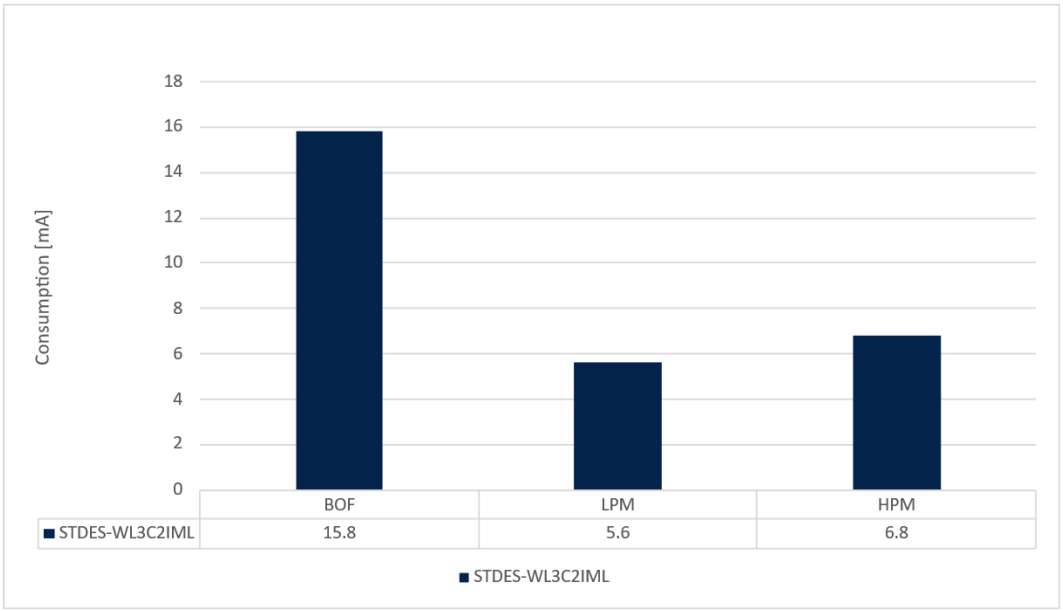
Figure 17. **STDES-WL3C2IML Rx current consumption**

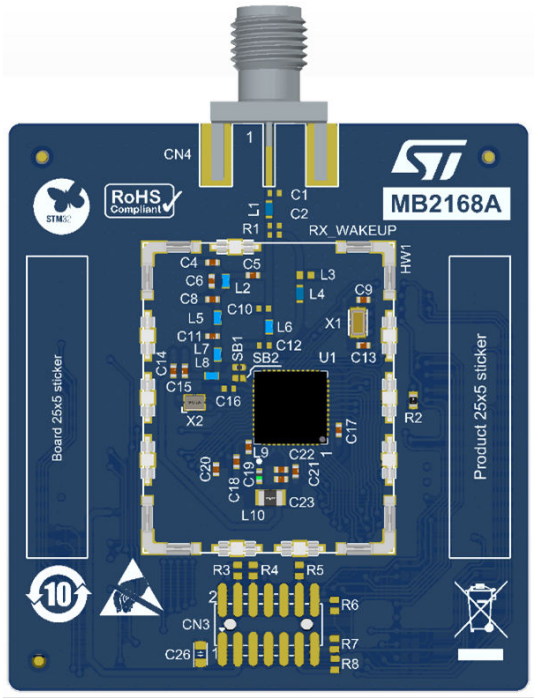


6.2 MB2168 reference board

6.2.1 MB2168 description

The MB2168 reference board implements the STM32WL33CC microcontroller in a VFQFPN48 package with SMD filtering. The RF PA pin is configurable by using the solder bridge.

Figure 18. **MB2168**



Picture is not contractual.

6.2.2 STDES-WL3C2SLH 868 MHz/10 dBm

Solder bridges

The STDES-WL3C2SLH reference design is configurable to meet specific application requirements.

Table 11. STDES-WL3C2SLH solder bridge configurations (868 MHz/10 dBm)

MB2168 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 12. STDES-WL3C2SLH radio setting (868 MHz/10 dBm)

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2SLH	868 MHz/10 dBm	1.4 V	TX	0x51	ON
		1.5 V	TX	0x51	OFF

6.2.2.1 STDES-WL3C2SLH 868 MHz/10 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 19. STDES-WL3C2SLH Tx output power (868 MHz)

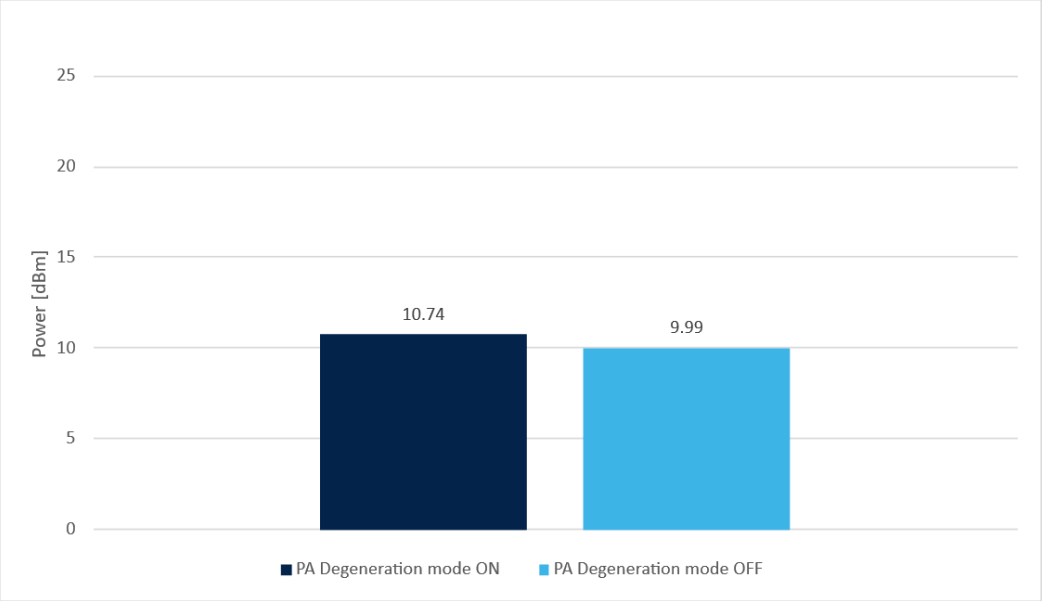


Figure 20. **STDES-WL3C2SLH Tx current consumption (868 MHz)**

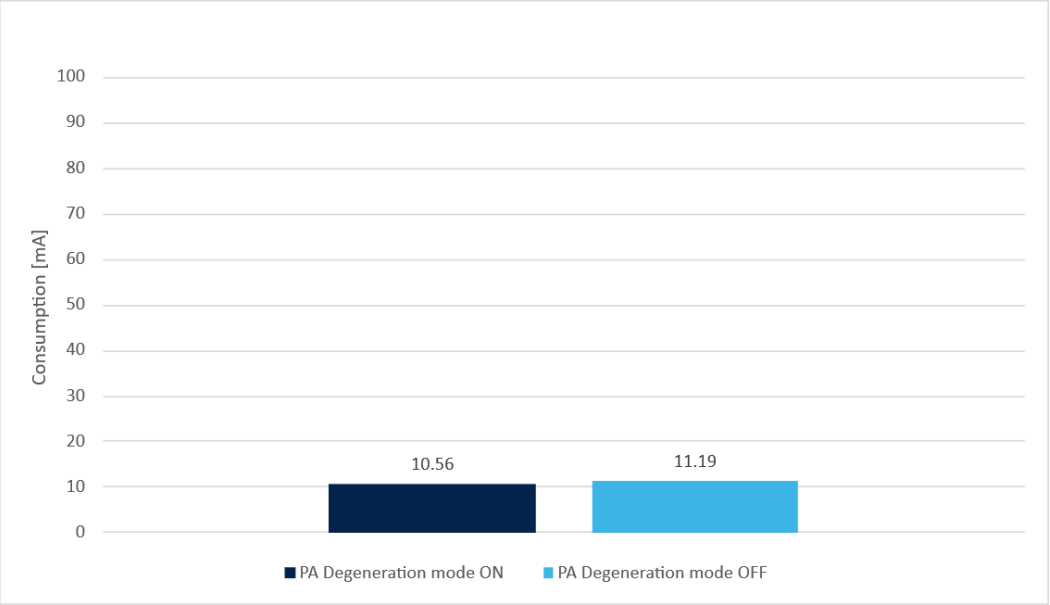


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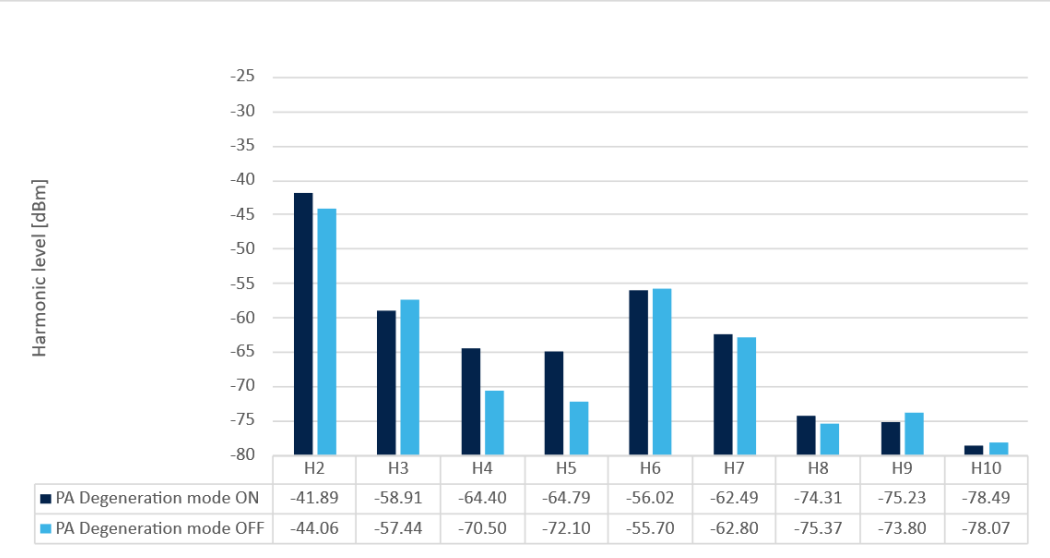
Figure 21. **STDES-WL3C2SLH Tx harmonic levels (868 MHz)**



	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-41.89	-58.91	-64.40	-64.79	-56.02	-62.49	-74.31	-75.23	-78.49
PA Degeneration mode OFF	-44.06	-57.44	-70.50	-72.10	-55.70	-62.80	-75.37	-73.80	-78.07

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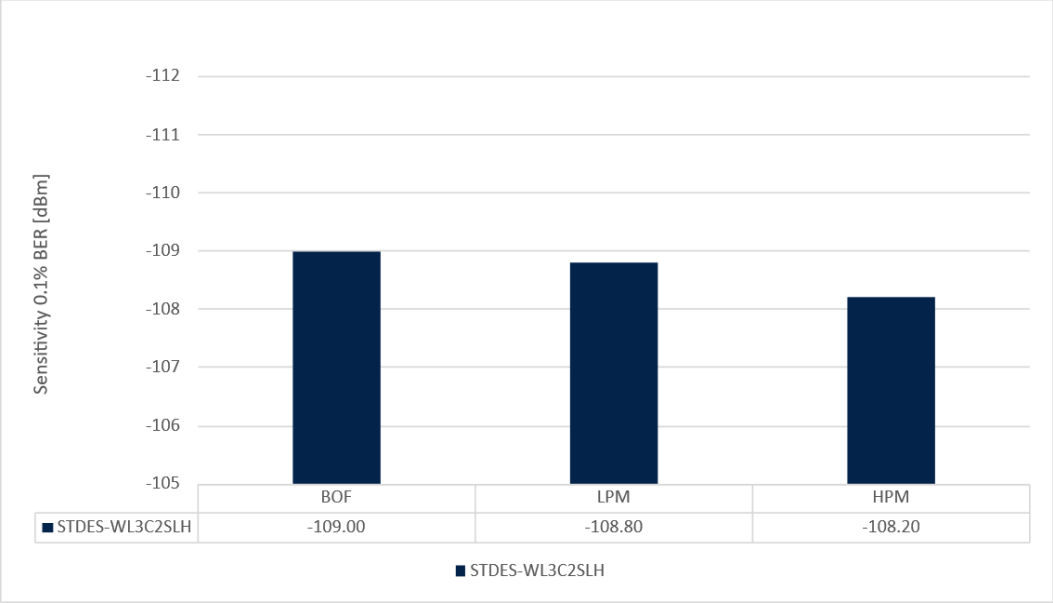
6.2.2.2 *STDES-WL3C2SLH 868 MHz/10 dBm Rx*

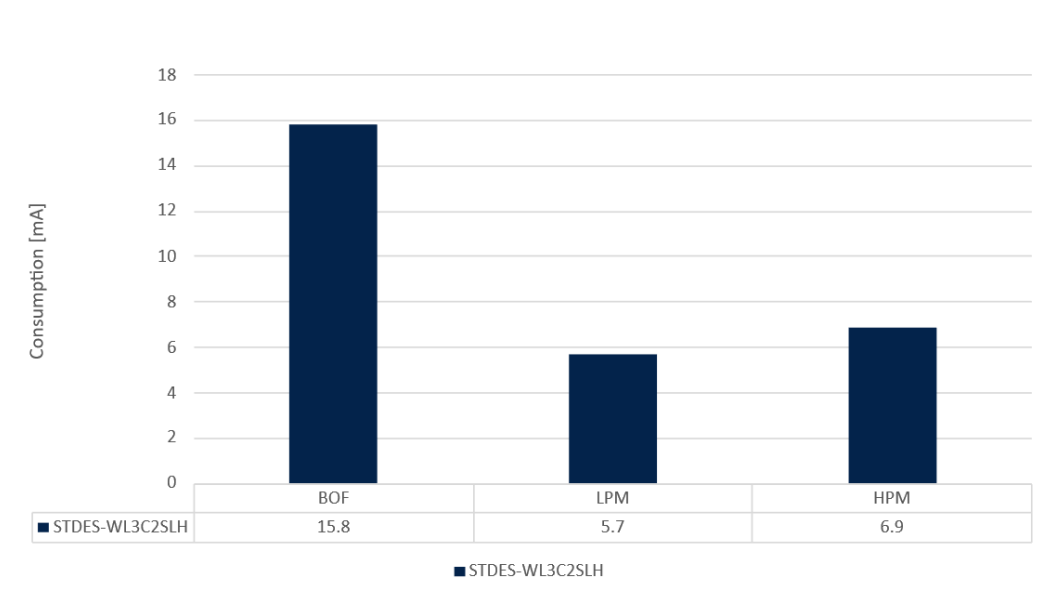
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 22. **STDES-WL3C2SLH Rx sensitivity (868 MHz)**



DT79676V1

Figure 23. **STDES-WL3C2SLH Rx current consumption (868 MHz)**



DT79677V1

6.2.3 STDES-WL3C2SLH 915 MHz/10 dBm

Solder bridges

The STDES-WL3C2SLH reference design is configurable to meet specific application requirements.

Table 13. **STDES-WL3C2SLH solder bridge configurations (915 MHz/10 dBm)**

MB2168 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 14. STDES-WL3C2SLH radio setting (915 MHz/10 dBm)

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2SLH	915 MHz/10 dBm	1.4 V	TX	0x4F	ON
		1.4 V	TX	0x51	OFF

6.2.3.1 *STDES-WL3C2SLH 915 MHz/10 dBm Tx*

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 24. STDES-WL3C2SLH Tx output power (915 MHz)

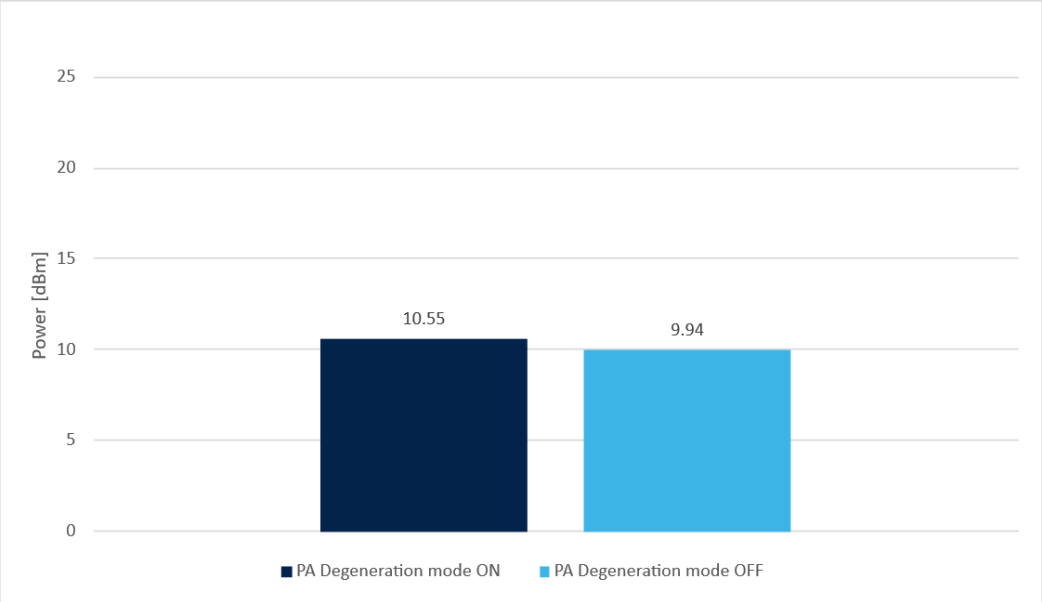


Figure 25. STDES-WL3C2SLH Tx current consumption (915 MHz)

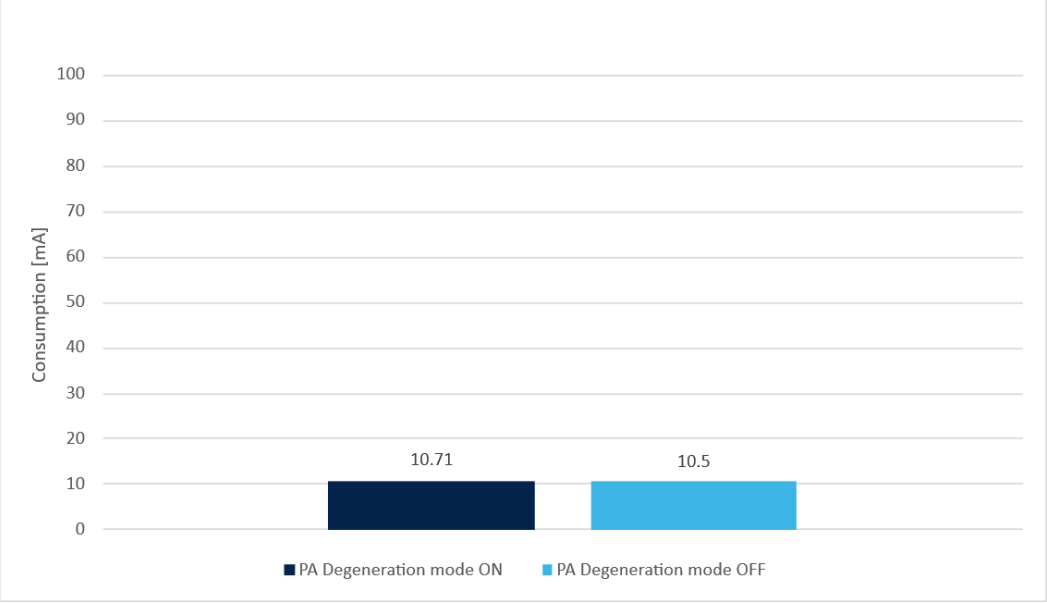
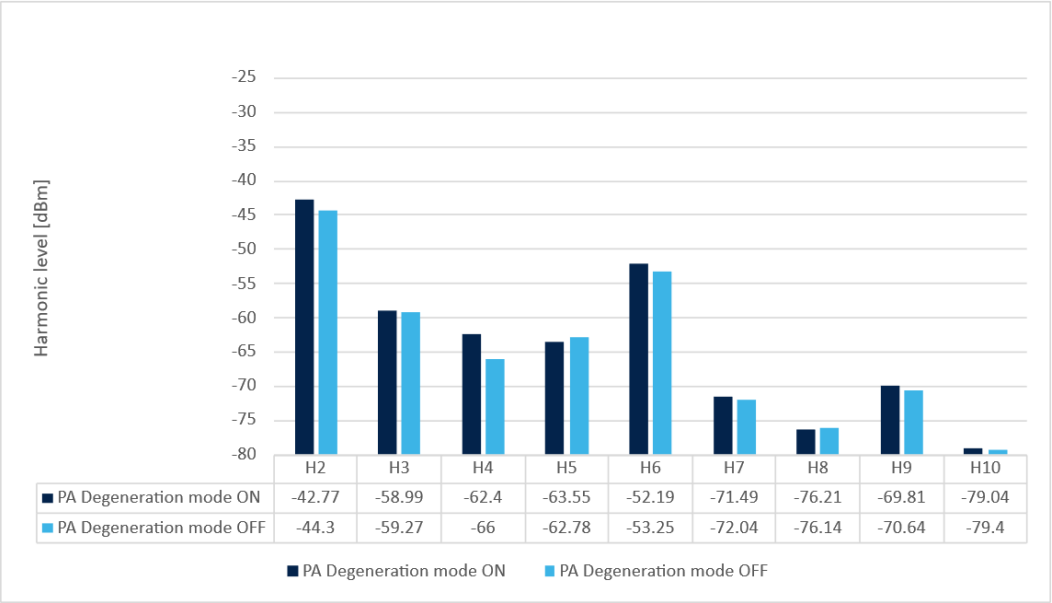


Figure 26. **STDES-WL3C2SLH Tx harmonic levels (915 MHz)**



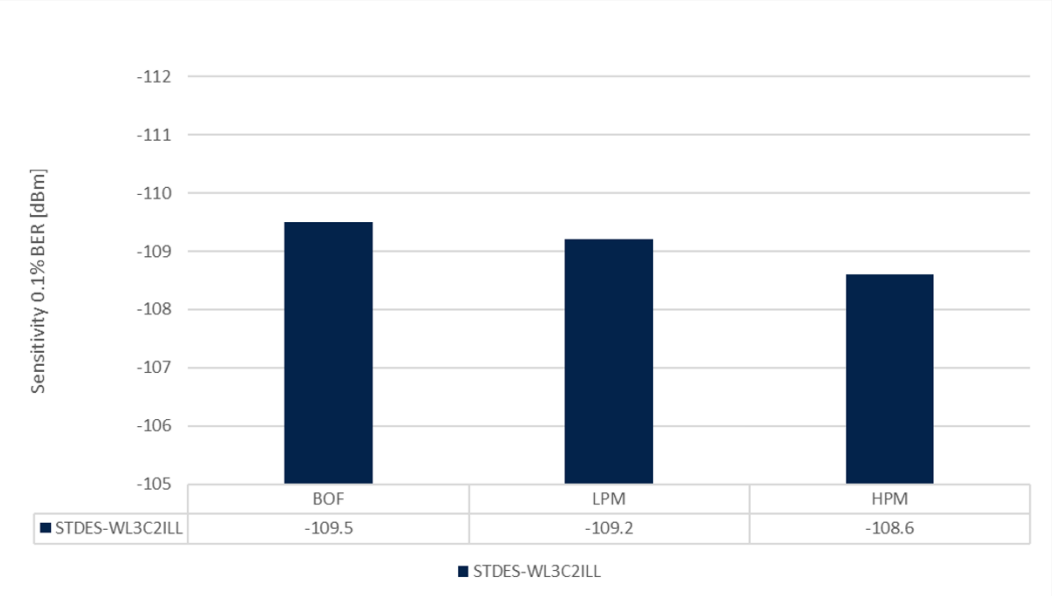
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-42.77	-58.99	-62.4	-63.55	-52.19	-71.49	-76.21	-69.81	-79.04
PA Degeneration mode OFF	-44.3	-59.27	-66	-62.78	-53.25	-72.04	-76.14	-70.64	-79.4

DT79680V1

6.2.3.2 *STDES-WL3C2SLH 915 MHz/10 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

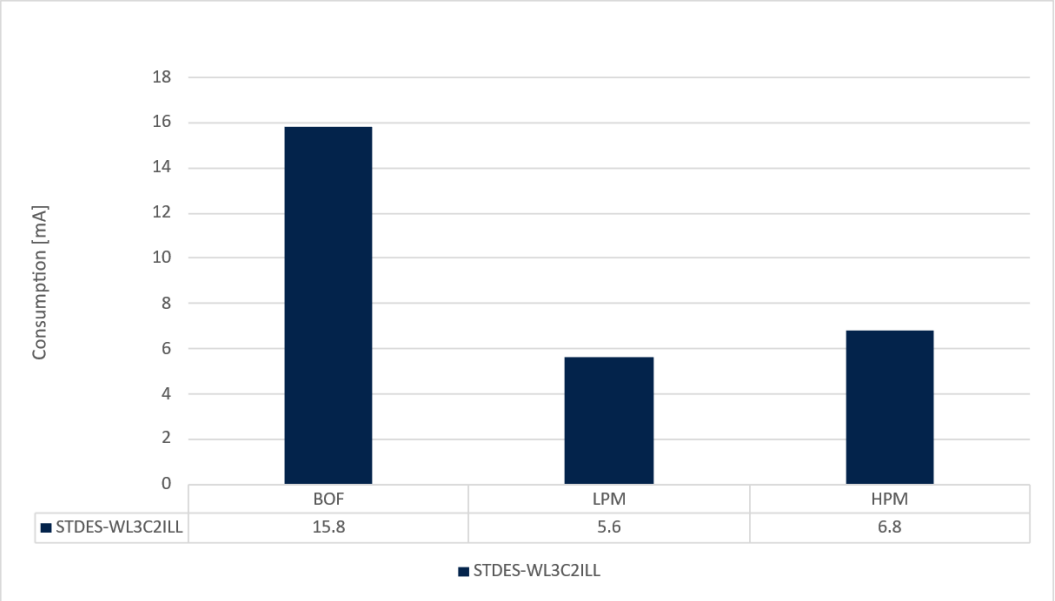
Figure 27. **STDES-WL3C2SLH Rx sensitivity (915 MHz)**



	BOF	LPM	HPM
STDES-WL3C2ILL	-109.5	-109.2	-108.6

DT79661V1

Figure 28. **STDES-WL3C2SLH Rx current consumption (915 MHz)**



6.2.4 STDES-WL3C2SLL 433 MHz/10 dBm

Solder bridges

The STDES-WL3C2SLL reference design is configurable to meet specific application requirements.

Table 15. **STDES-WL3C2SLL solder bridge configurations**

MB2168 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 16. **STDES-WL3C2SLL radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2SLL	433 MHz/10 dBm	1.4 V	TX	0x4C	ON
		1.4 V	TX	0x51	OFF

6.2.4.1 STDES-WL3C2SLL 433 MHz/10 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 29. **STDES-WL3C2SLL Tx output power**

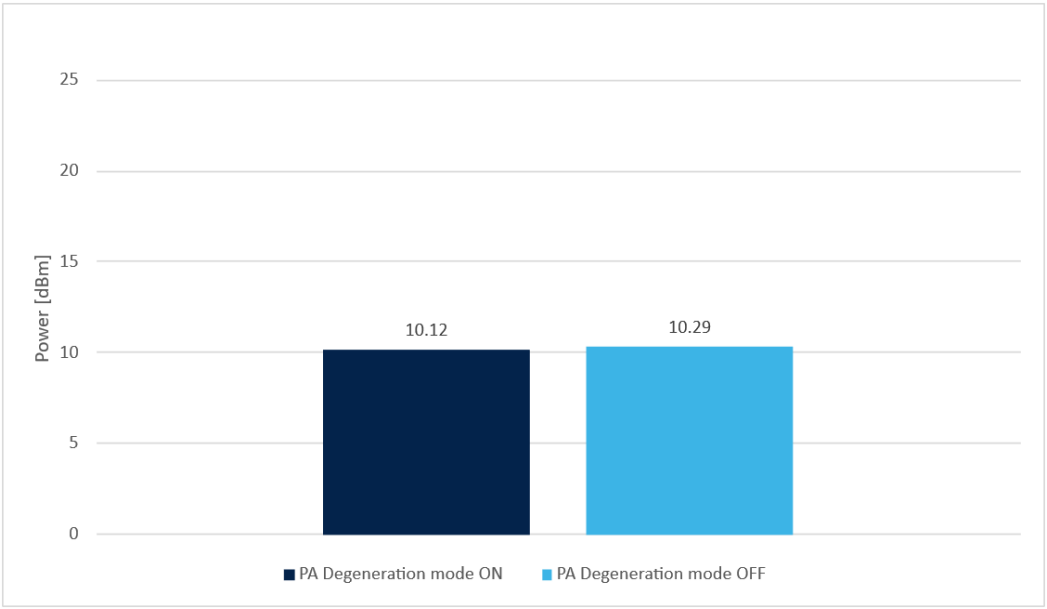


Figure 30. **STDES-WL3C2SLL Tx current consumption**

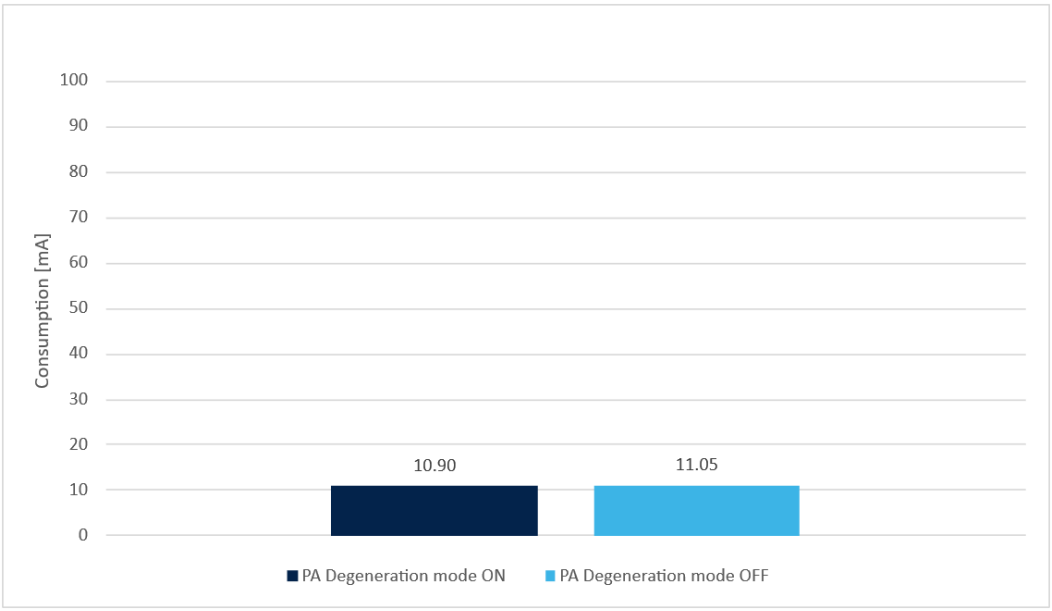
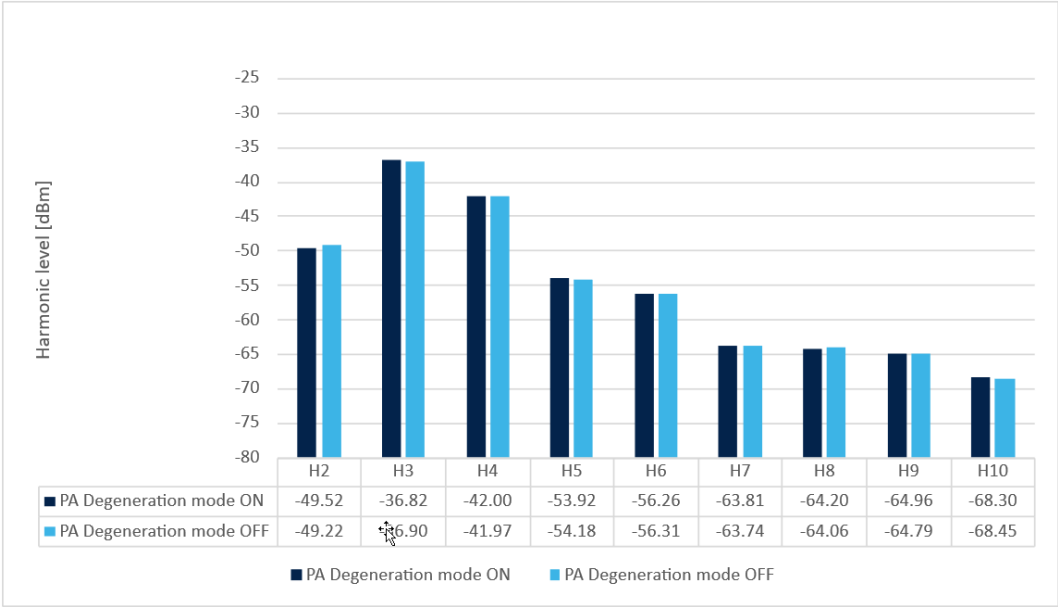


Figure 31. **STDES-WL3C2SLL Tx harmonic levels**



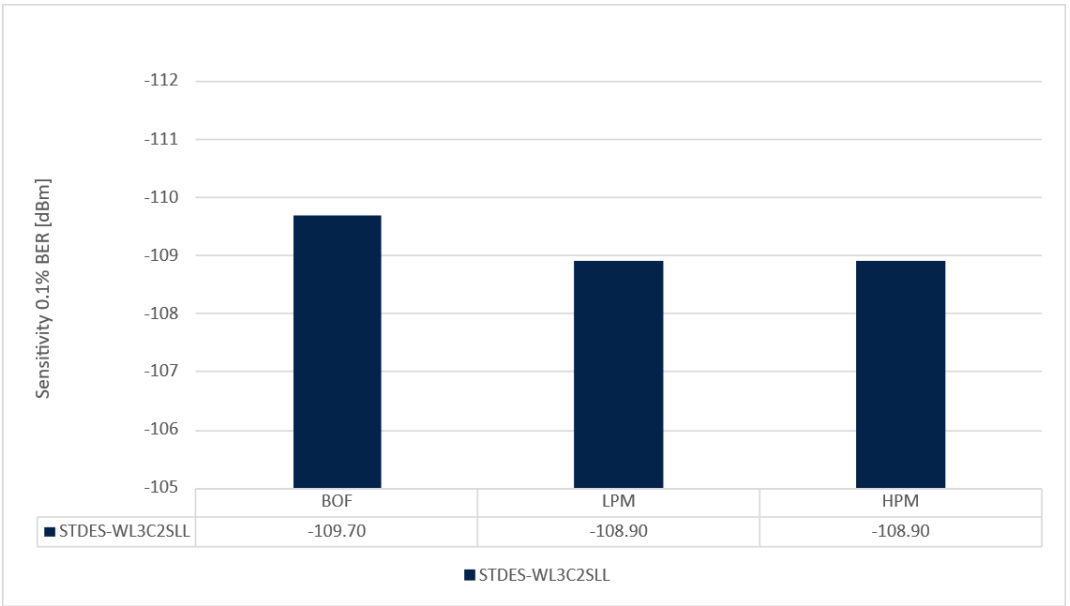
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-49.52	-36.82	-42.00	-53.92	-56.26	-63.81	-64.20	-64.96	-68.30
PA Degeneration mode OFF	-49.22	-36.90	-41.97	-54.18	-56.31	-63.74	-64.06	-64.79	-68.45

DT79685V1

6.2.4.2 *STDES-WL3C2SLL 433 MHz/10 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

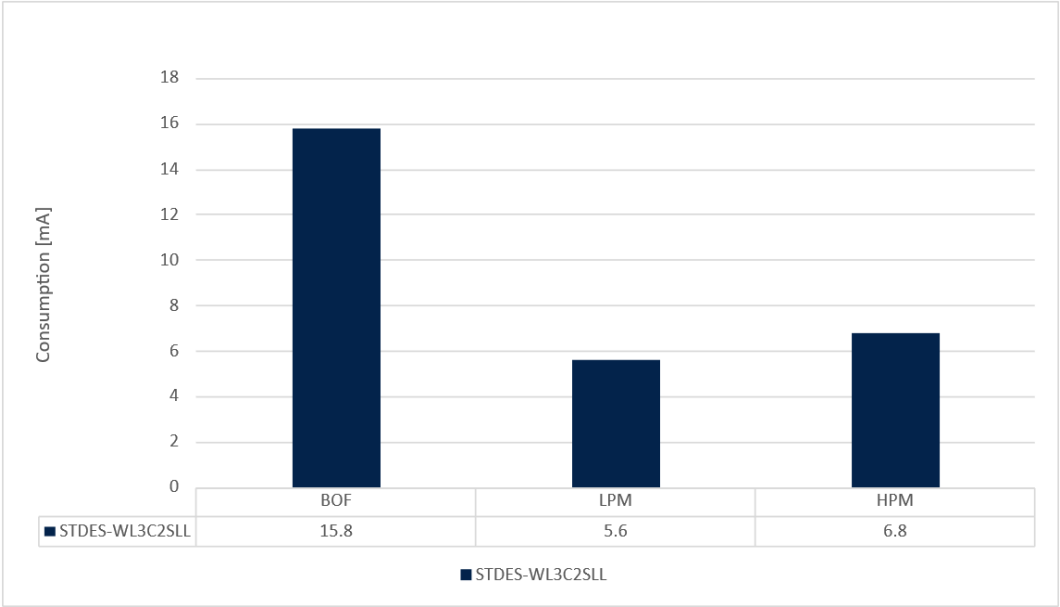
Figure 32. **STDES-WL3C2SLL Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3C2SLL	-109.70	-108.90	-108.90

DT79686V1

Figure 33. **STDES-WL3C2SLL Rx current consumption**



6.2.5 STDES-WL3C2SMH 868 MHz/16 dBm

Solder bridges

The STDES-WL3C2SMH reference design is configurable to meet specific application requirements.

Table 17. **STDES-WL3C2SMH solder bridge configurations**

MB2168 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 18. **STDES-WL3C2SMH radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2SMH	868 MHz/16 dBm	2.0 V	TX_HP	0x51	ON
		2.4 V	TX_HP	0x51	OFF

6.2.5.1 STDES-WL3C2SMH 868 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 34. **STDES-WL3C2SMH Tx output power**

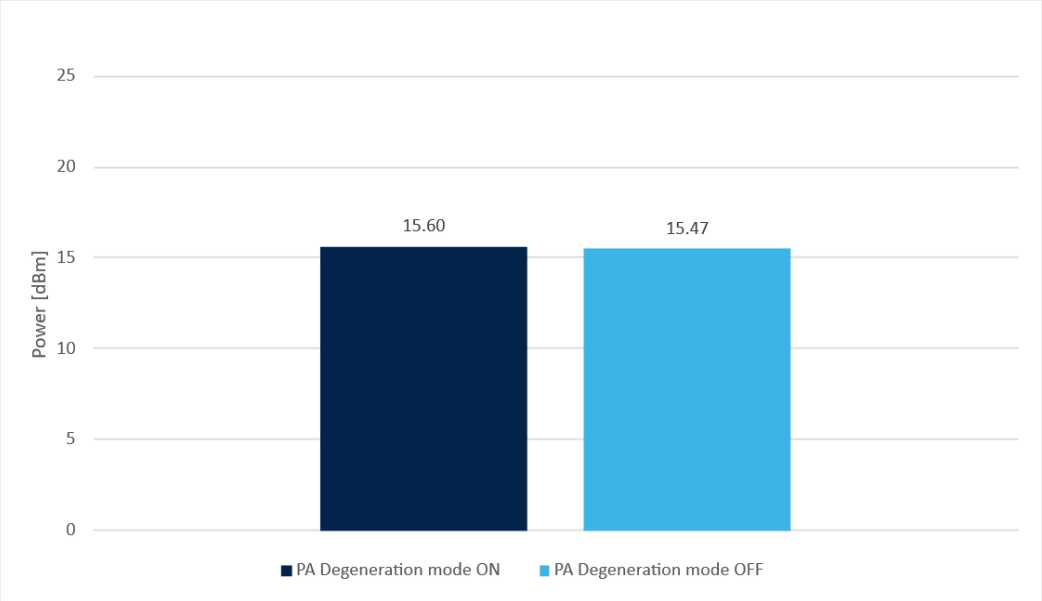


Figure 35. **STDES-WL3C2SMH Tx current consumption**

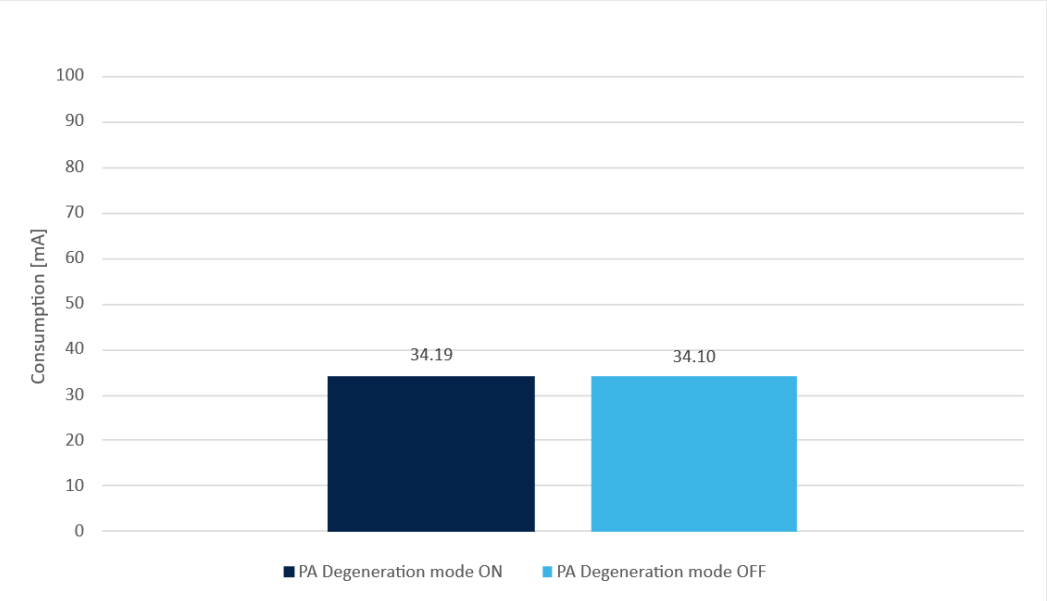
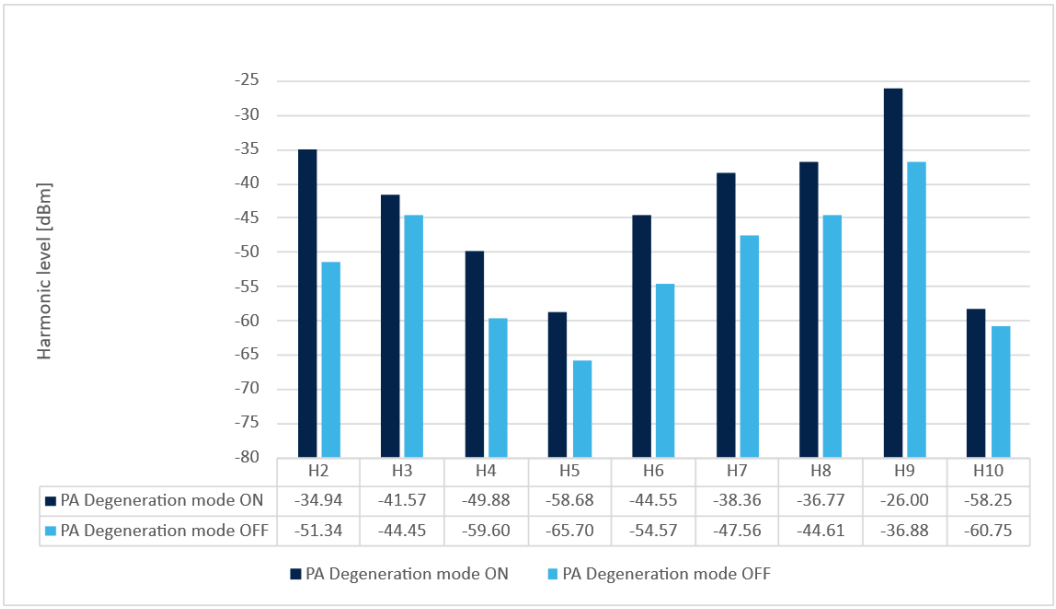


Figure 36. **STDES-WL3C2SMH Tx harmonic levels**



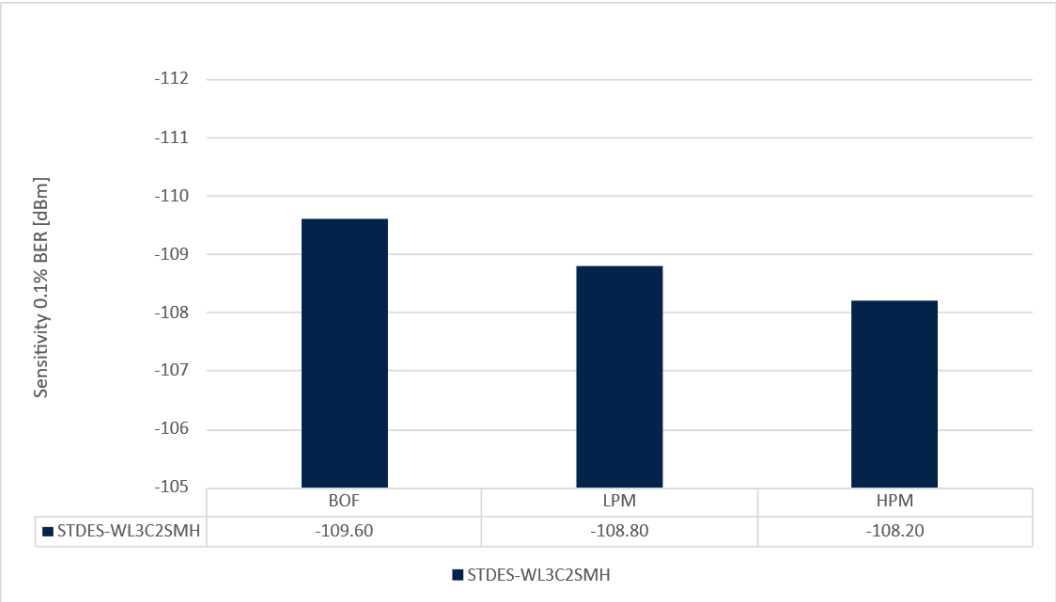
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-34.94	-41.57	-49.88	-58.68	-44.55	-38.36	-36.77	-26.00	-58.25
PA Degeneration mode OFF	-51.34	-44.45	-59.60	-65.70	-54.57	-47.56	-44.61	-36.88	-60.75

DT79690V1

6.2.5.2 *STDES-WL3C2SMH 868 MHz/16 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

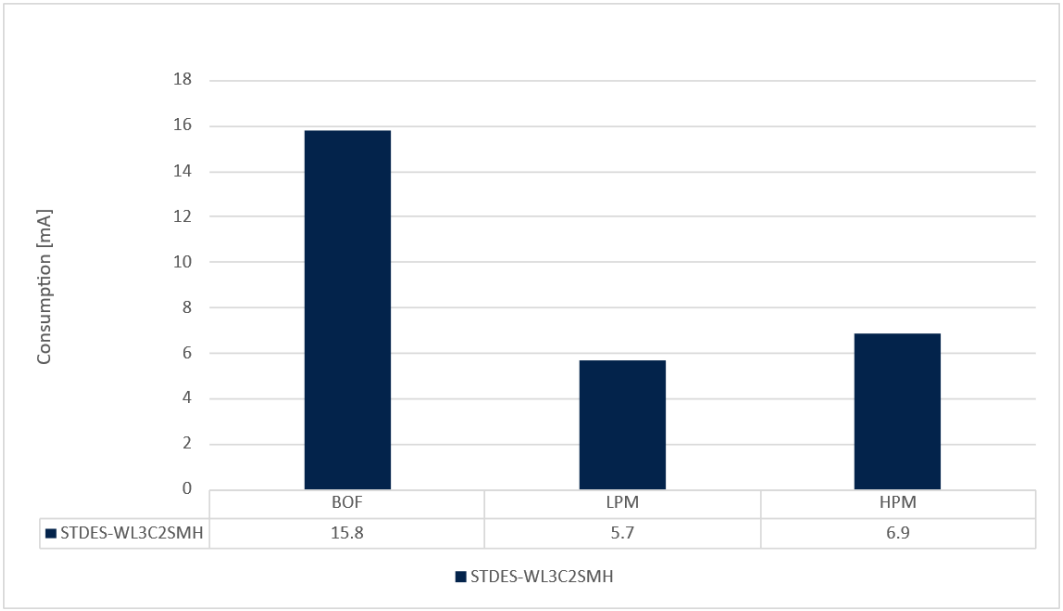
Figure 37. **STDES-WL3C2SMH Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3C2SMH	-109.60	-108.80	-108.20

DT79691V1

Figure 38. **STDES-WL3C2SMH Rx current consumption**



6.2.6 STDES-WL3C2SML 433 MHz/16 dBm

Solder bridges

The STDES-WL3C2SML reference design is configurable to meet specific application requirements.

Table 19. **STDES-WL3C2SML solder bridge configurations**

MB2168 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 20. **STDES-WL3C2SML radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2SML	433 MHz/16 dBm	2.1 V	TX_HP	0x51	ON
		2.4 V	TX_HP	0x51	OFF

6.2.6.1 STDES-WL3C2SML 433 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 39. **STDES-WL3C2SML Tx output power**

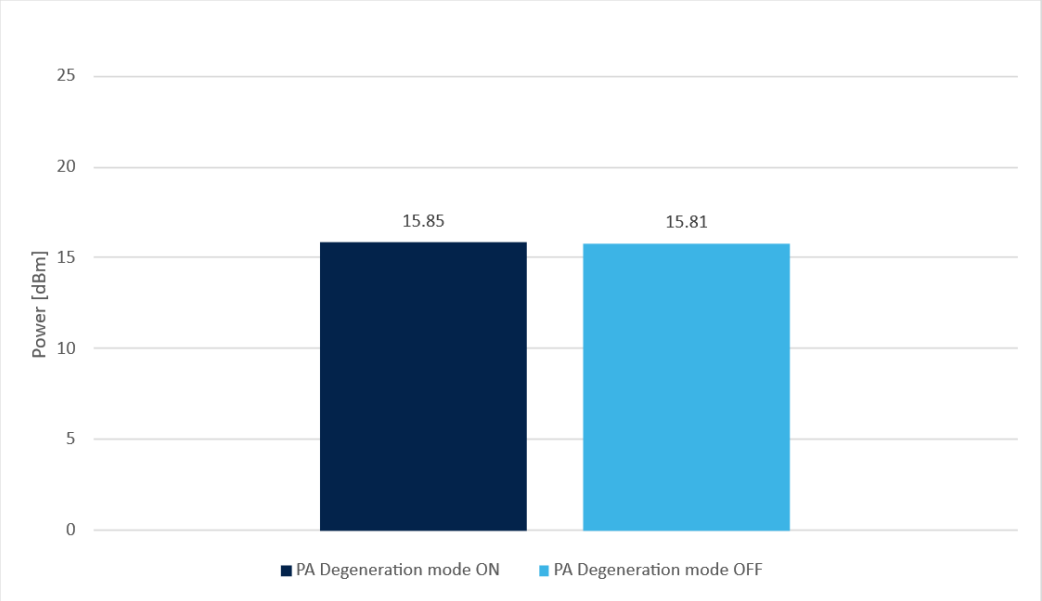


Figure 40. **STDES-WL3C2SML Tx current consumption**

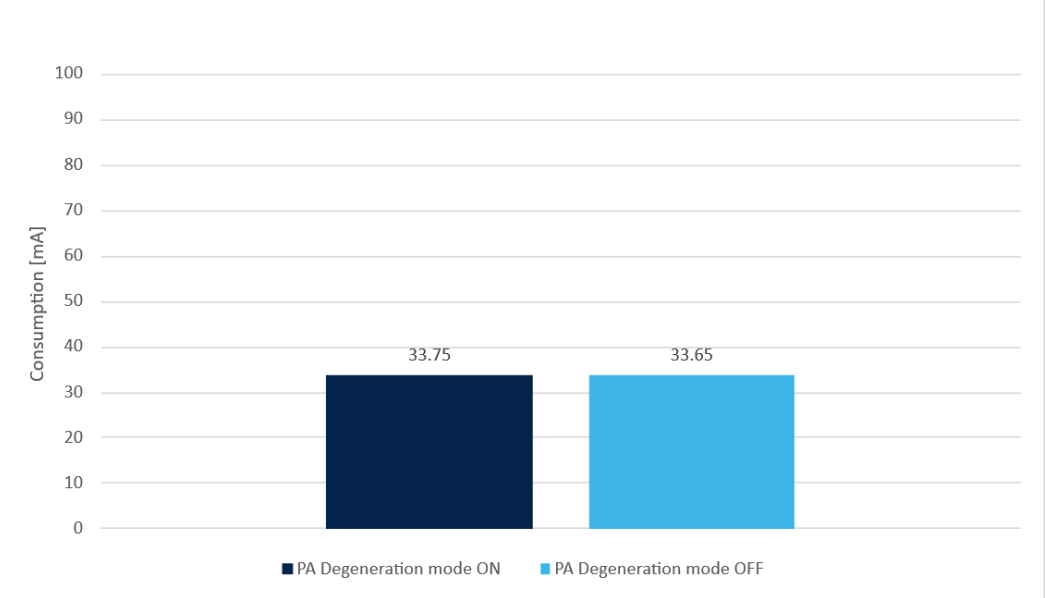
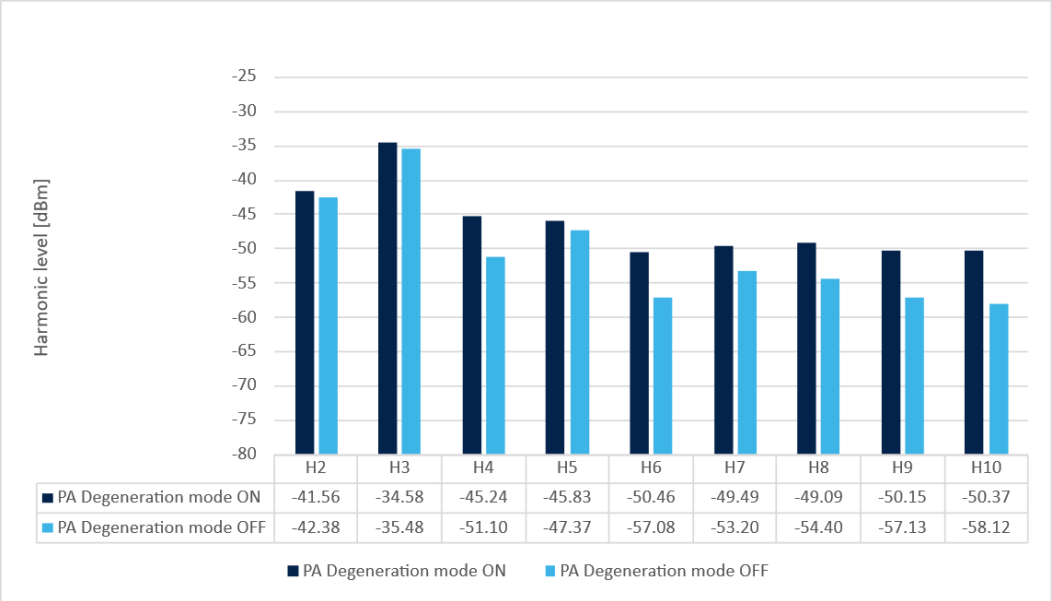


Figure 41. **STDES-WL3C2SML Tx harmonic levels**



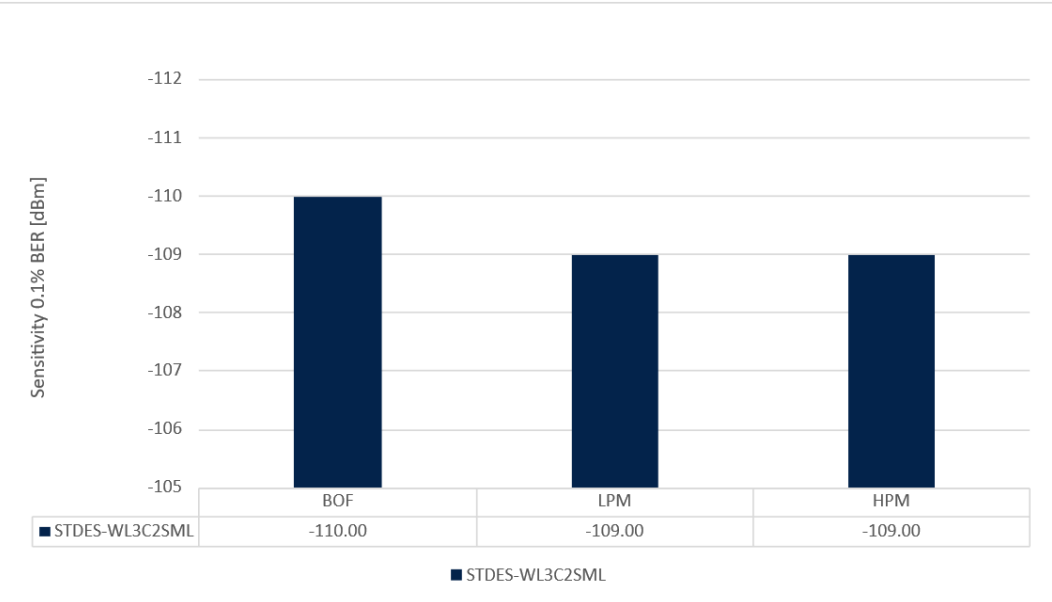
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-41.56	-34.58	-45.24	-45.83	-50.46	-49.49	-49.09	-50.15	-50.37
PA Degeneration mode OFF	-42.38	-35.48	-51.10	-47.37	-57.08	-53.20	-54.40	-57.13	-58.12

DT79695V1

6.2.6.2 *STDES-WL3C2SML 433 MHz/16 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

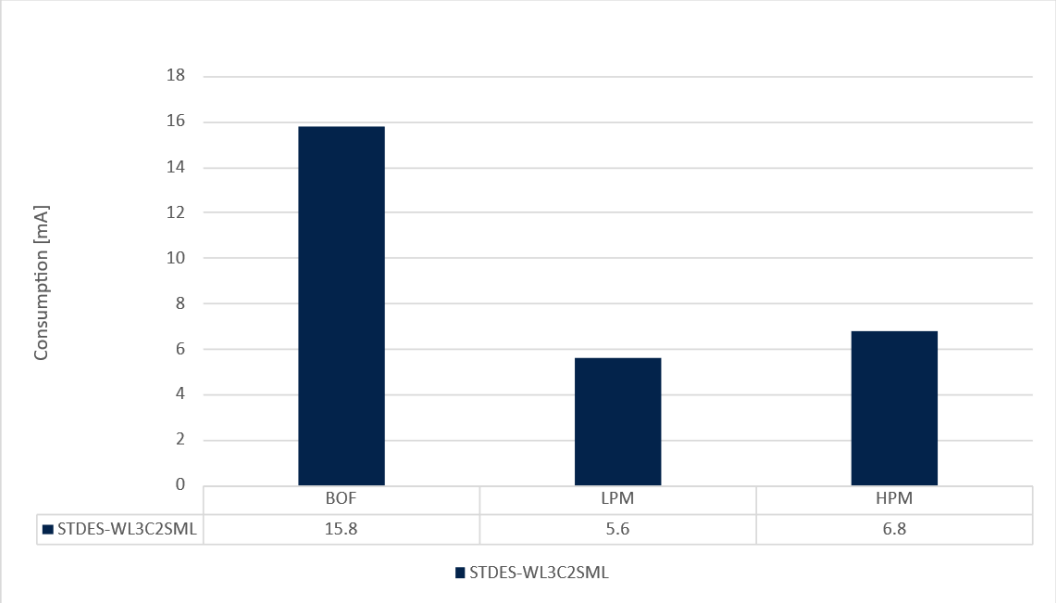
Figure 42. **STDES-WL3C2SML Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3C2SML	-110.00	-109.00	-109.00

DT79696V1

Figure 43. **STDES-WL3C2SML Rx current consumption**

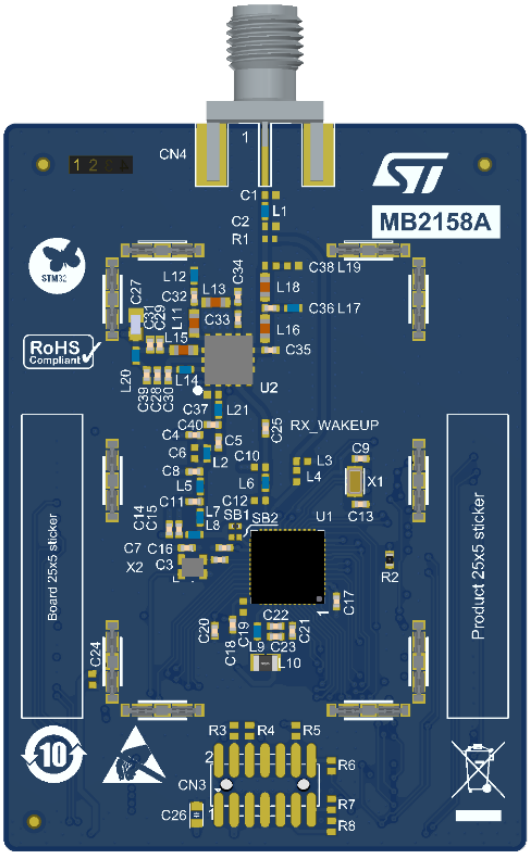


6.3 MB2158 reference board

6.3.1 MB2158 description

The MB2158 reference board implements the STM32WL33CC microcontroller in a VFQFPN48 package with SMD, external PA filtering. The RF PA pin is configurable by using the solder bridge.

Figure 44. MB2158



Picture is not contractual.

6.3.2 STDES-WL3C4EEW 169 MHz/27 dBm

Solder bridges

The STDES-WL3C4EEW reference design is configurable to meet specific application requirements.

Table 21. STDES-WL3C4EEW solder bridge configurations

MB2158 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 22. STDES-WL3C4EEW radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4EEW	169 MHz/27 dBm	1.4 V	TX_HP	0x35	ON

6.3.2.1 *STDES-WL3C4EEW 169 MHz/27 dBm Tx*

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 45. STDES-WL3C4EEW Tx output power

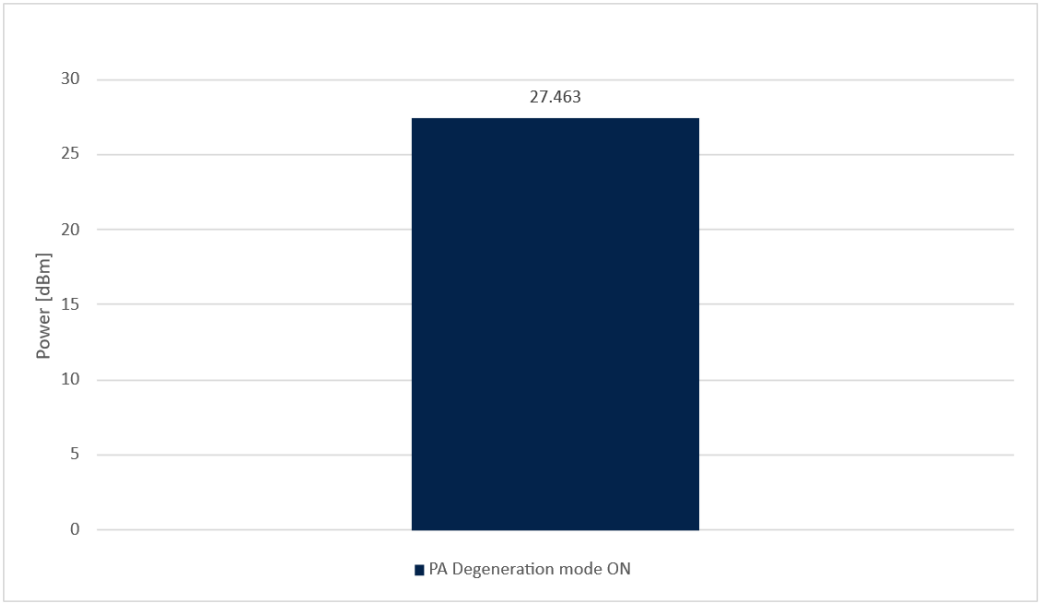


Figure 46. STDES-WL3C4EEW Tx current consumption

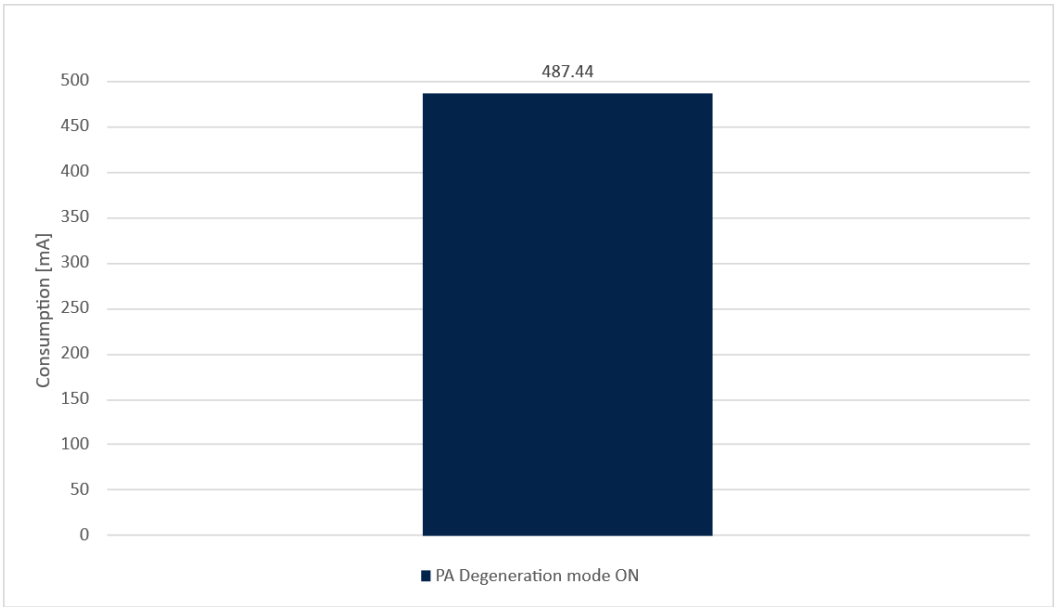
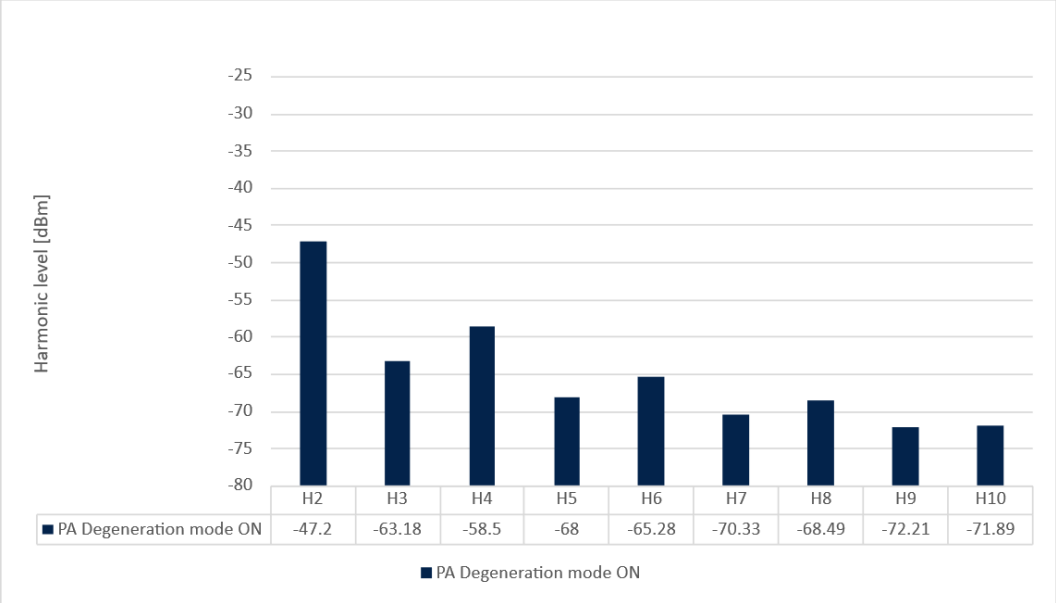


Figure 47. **STDES-WL3C4EEW Tx harmonic levels**

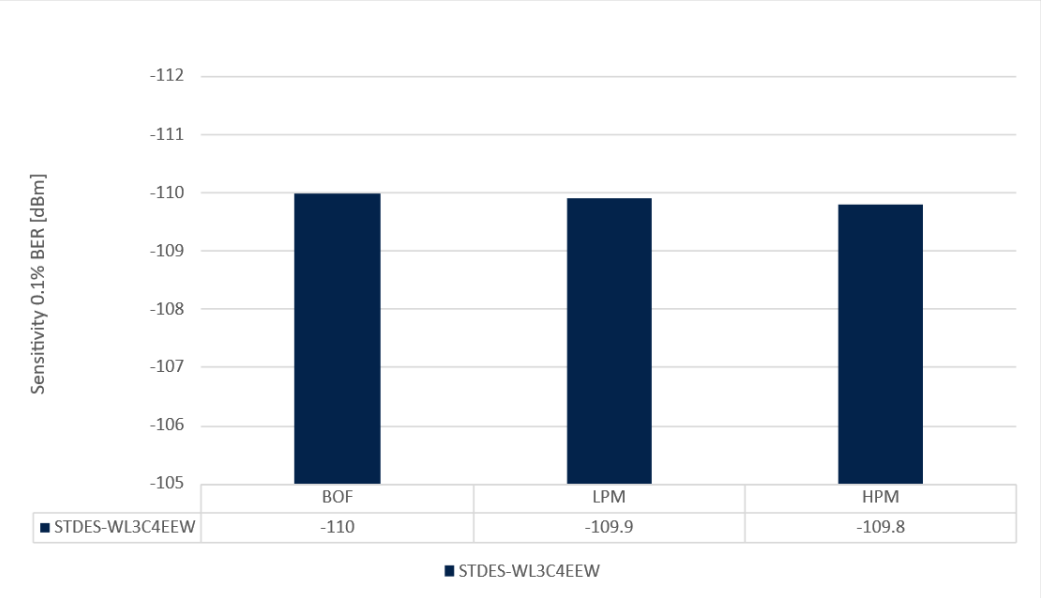


DT81300V1

6.3.2.2 *STDES-WL3C4EEW 169 MHz/27 dBm Rx*

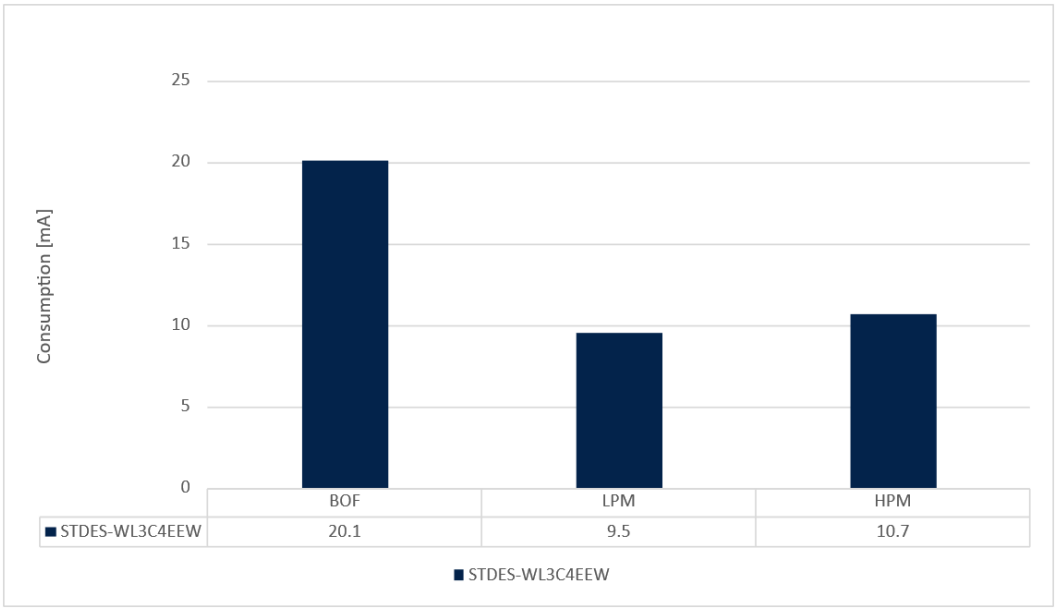
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 48. **STDES-WL3C4EEW Rx sensitivity**



DT81301V1

Figure 49. **STDES-WL3C4EEW Rx current consumption**

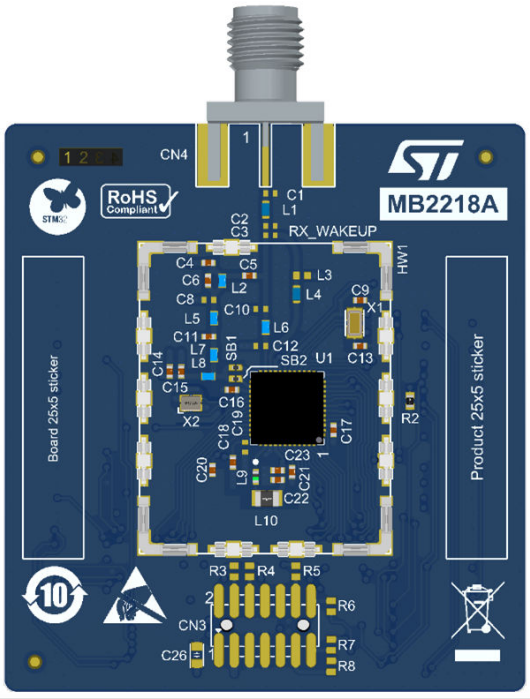


6.4 MB2218 reference board

6.4.1 MB2218 description

The MB2218 reference board implements the STM32WL33CC microcontroller in a VFQFPN48 package with SMD filtering. The RF PA pin is configurable by using the solder bridge.

Figure 50. **MB2218**



Picture is not contractual.

6.4.2 STDES-WL3C4SHH 915 MHz/20 dBm

Solder bridges

The STDES-WL3C4SHH reference design is configurable to meet specific application requirements.

Table 23. STDES-WL3C4SHH solder bridge configurations

MB2218 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 24. STDES-WL3C4SHH radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4SHH	915 MHz/20 dBm	2.1 V	TX + TX_HP	0x51	ON

6.4.2.1 STDES-WL3C4SHH 915 MHz/20 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 51. STDES-WL3C4SHH Tx output power

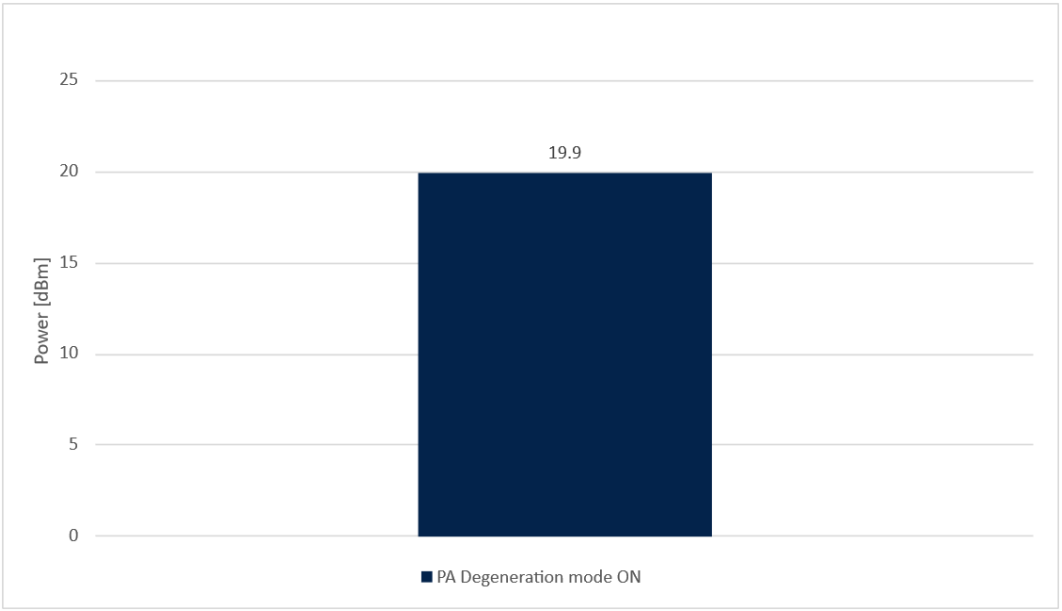


Figure 52. **STDES-WL3C4SHH Tx current consumption**

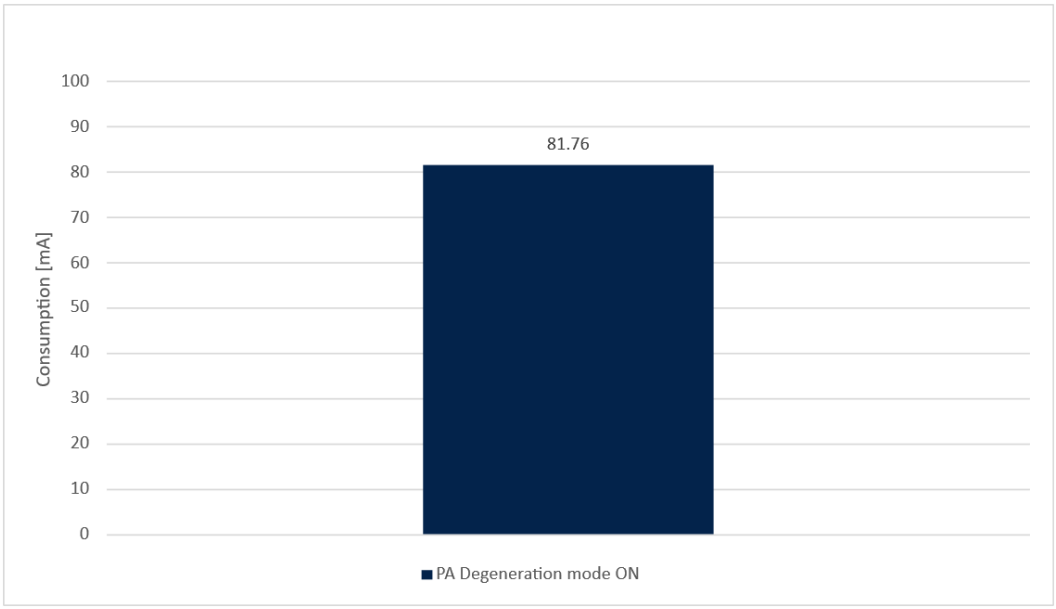
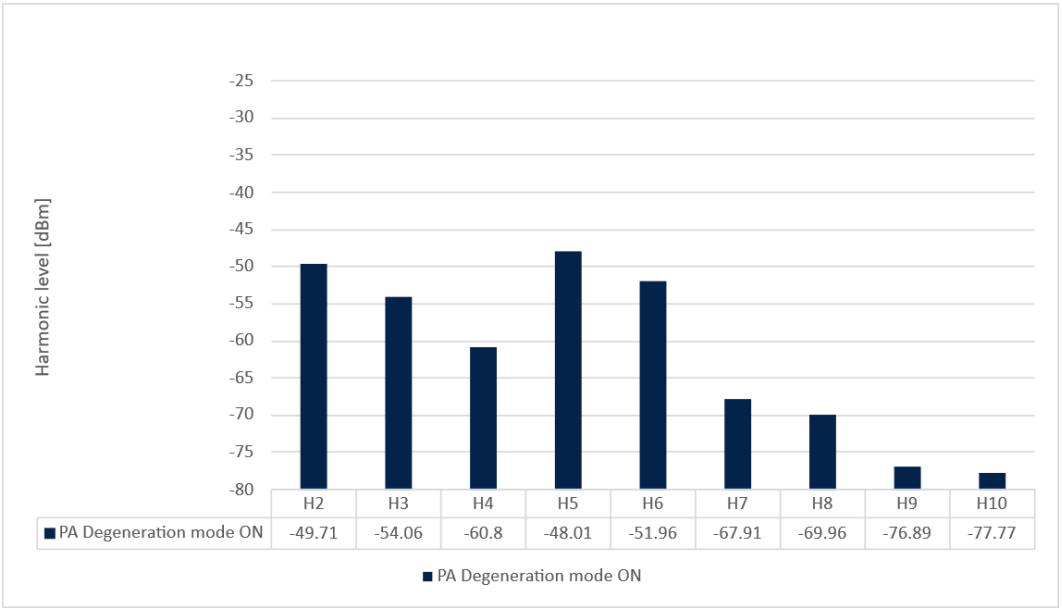


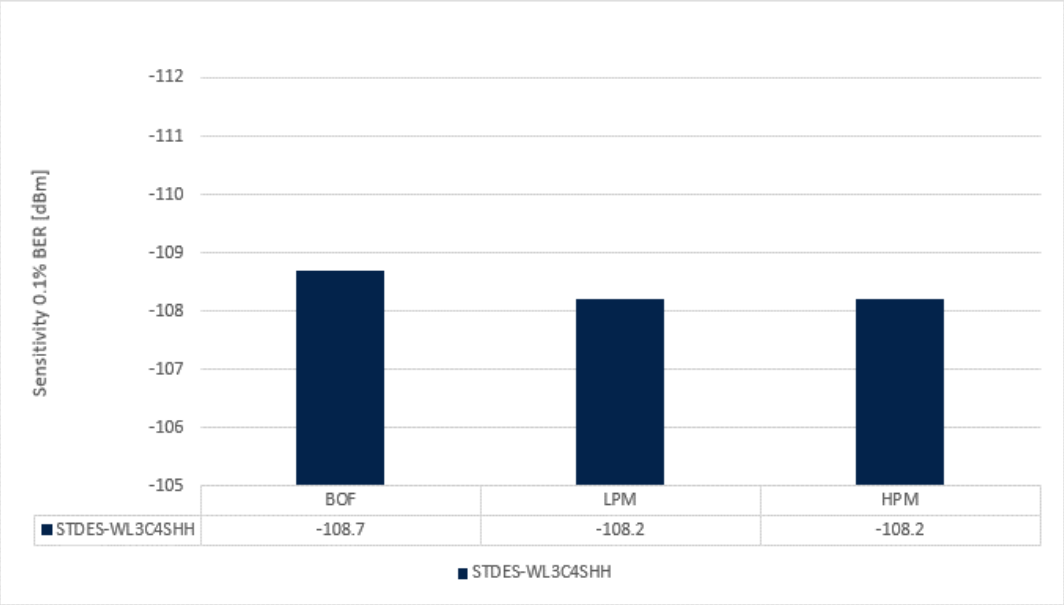
Figure 53. **STDES-WL3C4SHH Tx harmonic levels**



6.4.2.2 *STDES-WL3C4SHH 915 MHz/20 dBm Rx*

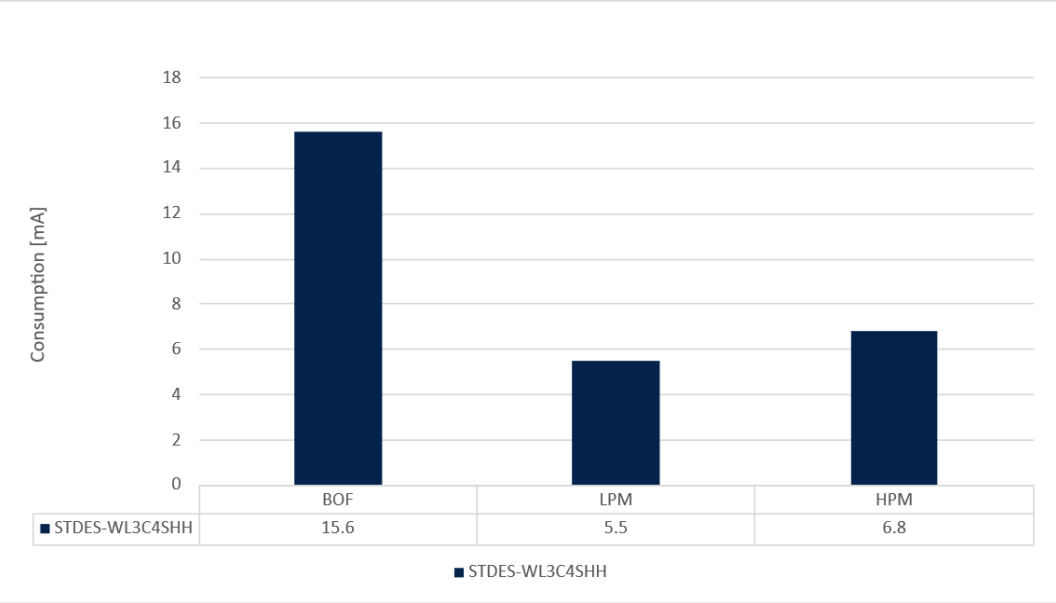
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 54. **STDES-WL3C4SHH Rx sensitivity**



DT81306V1

Figure 55. **STDES-WL3C4SHH Rx current consumption**



DT81307V1

6.4.3 STDES-WL3C4SLH 868 MHz/10 dBm

Solder bridges

The STDES-WL3C4SLH reference design is configurable to meet specific application requirements.

Table 25. **STDES-WL3C4SLH solder bridge configurations**

MB2218 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 26. STDES-WL3C4SLH radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4SLH	868 MHz/10 dBm	1.4 V	TX	0x51	ON
		1.5 V	TX	0x51	OFF

6.4.3.1 *STDES-WL3C4SLH 868 MHz/10 dBm Tx*

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 56. STDES-WL3C4SLH Tx output power

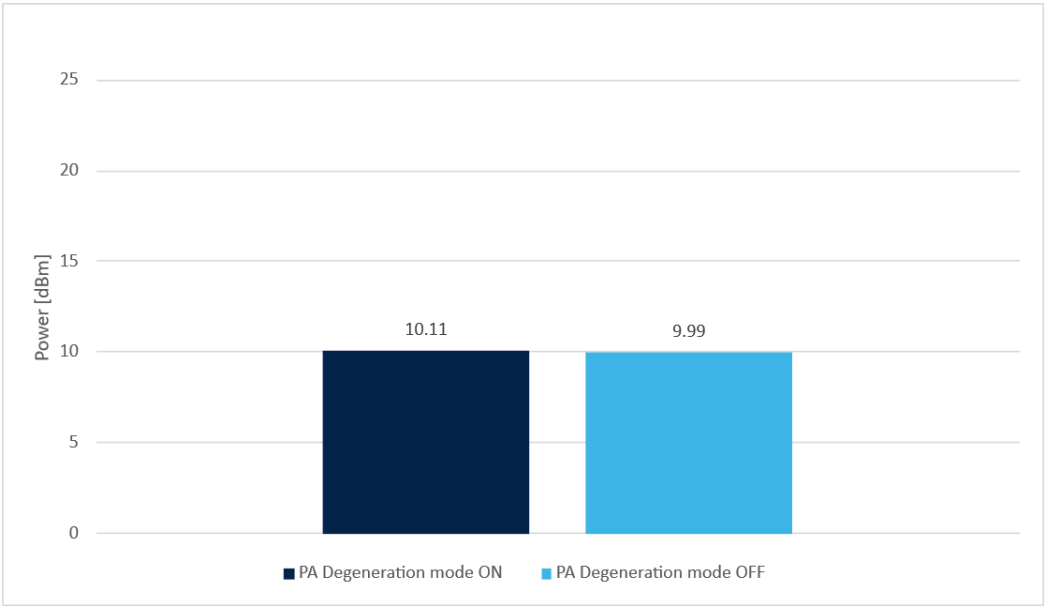


Figure 57. STDES-WL3C4SLH Tx current consumption

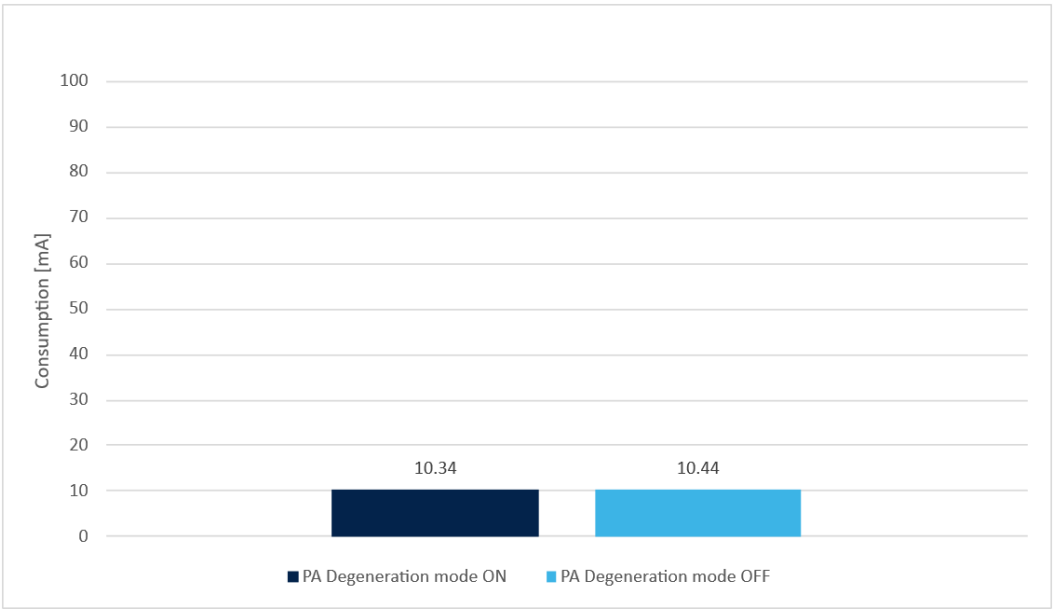
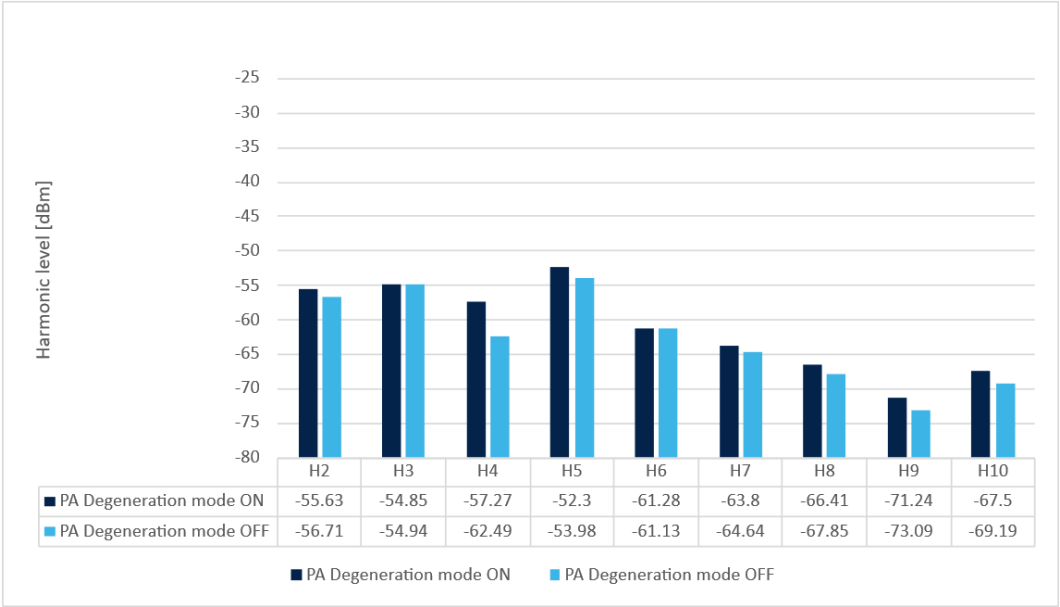


Figure 58. **STDES-WL3C4SLH Tx harmonic levels**



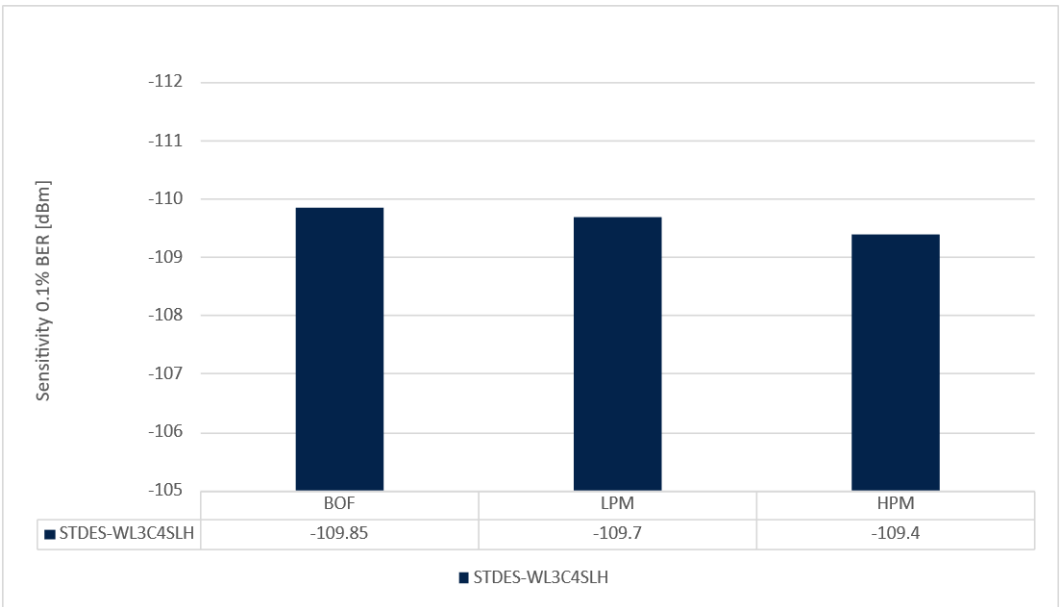
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-55.63	-54.85	-57.27	-52.3	-61.28	-63.8	-66.41	-71.24	-67.5
PA Degeneration mode OFF	-56.71	-54.94	-62.49	-53.98	-61.13	-64.64	-67.85	-73.09	-69.19

DT81310V1

6.4.3.2 *STDES-WL3C4SLH 868 MHz/10 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

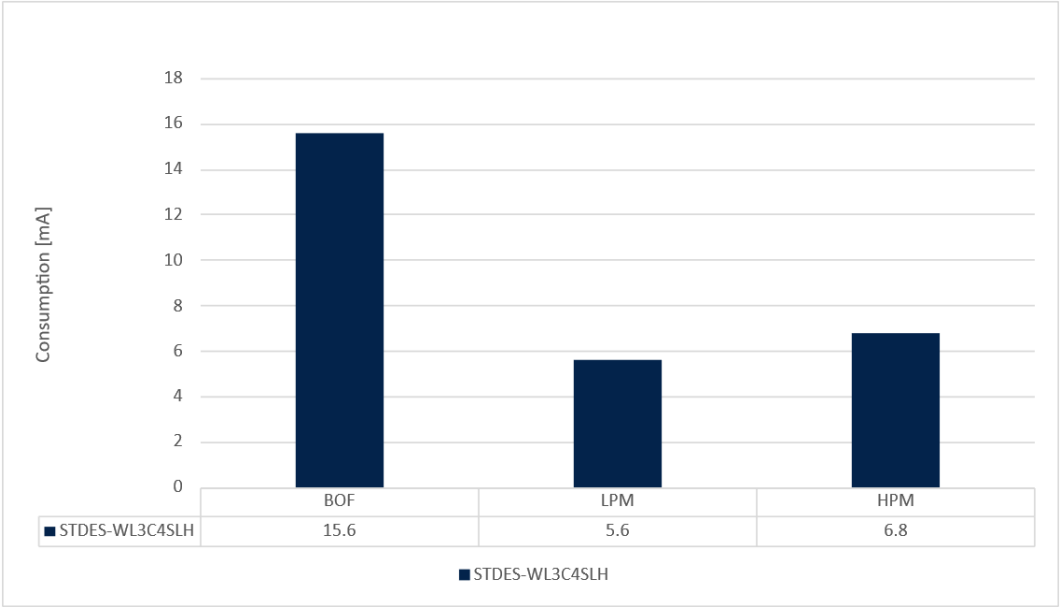
Figure 59. **STDES-WL3C4SLH Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3C4SLH	-109.85	-109.7	-109.4

DT81311V1

Figure 60. **STDES-WL3C4SLH Rx current consumption**



6.4.4 STDES-WL3C4SLL 433 MHz/10 dBm

Solder bridges

The STDES-WL3C4SLL reference design is configurable to meet specific application requirements.

Table 27. **STDES-WL3C4SLL solder bridge configurations**

MB2218 reference board	Solder bridge state	Description
SB1/SB2	OFF	RF PA TX_HP pin
	ON	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 28. **STDES-WL3C4SLL radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4SLL	433 MHz/10 dBm	1.3 V	TX	0x4E	ON
		1.3 V	TX	0x4E	OFF

6.4.4.1 STDES-WL3C4SLL 433 MHz/10 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 61. **STDES-WL3C4SLL Tx output power**

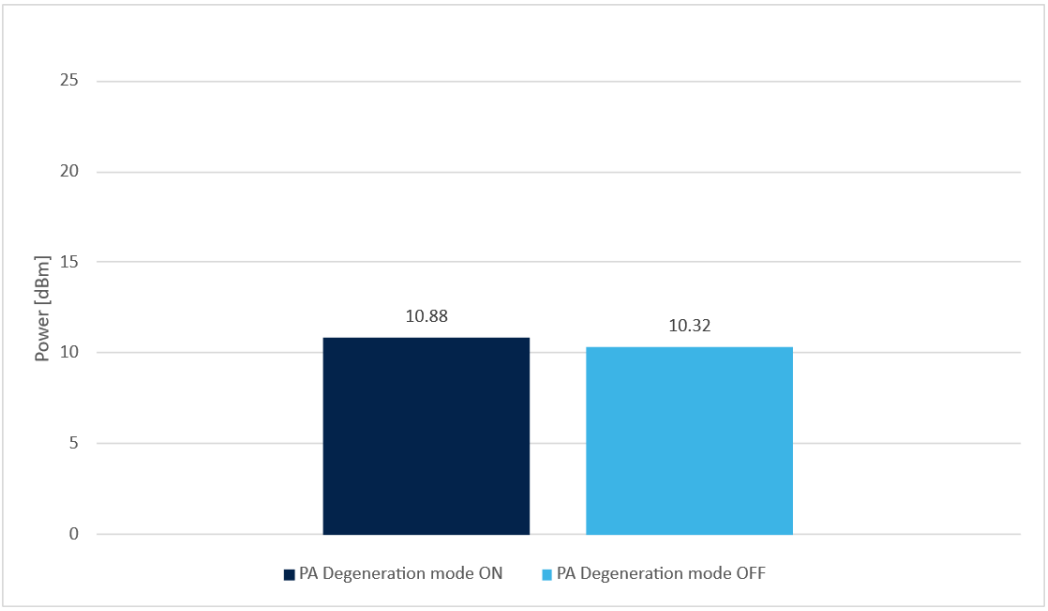


Figure 62. **STDES-WL3C4SLL Tx current consumption**

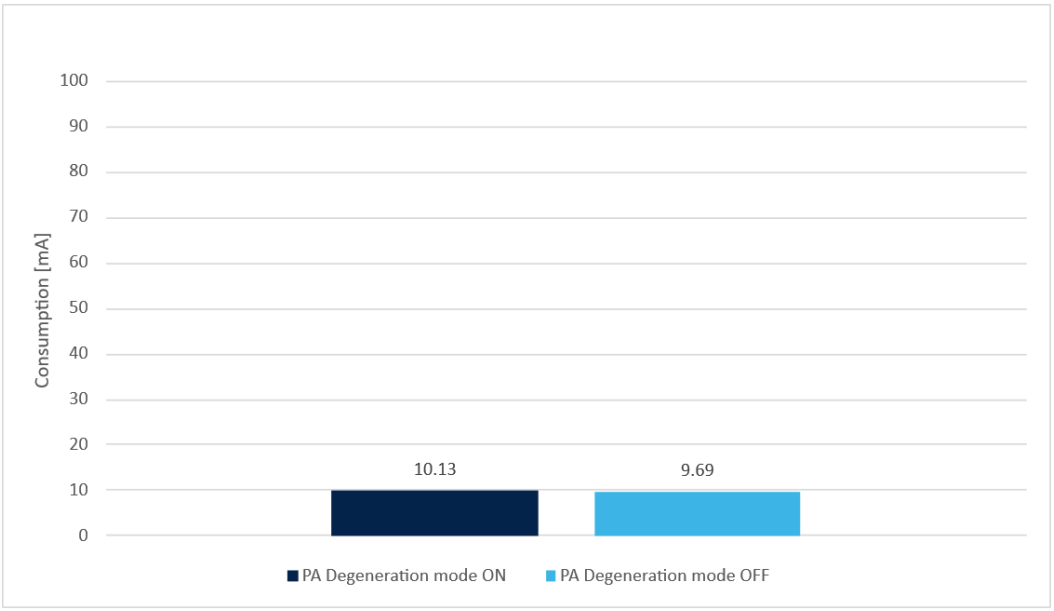
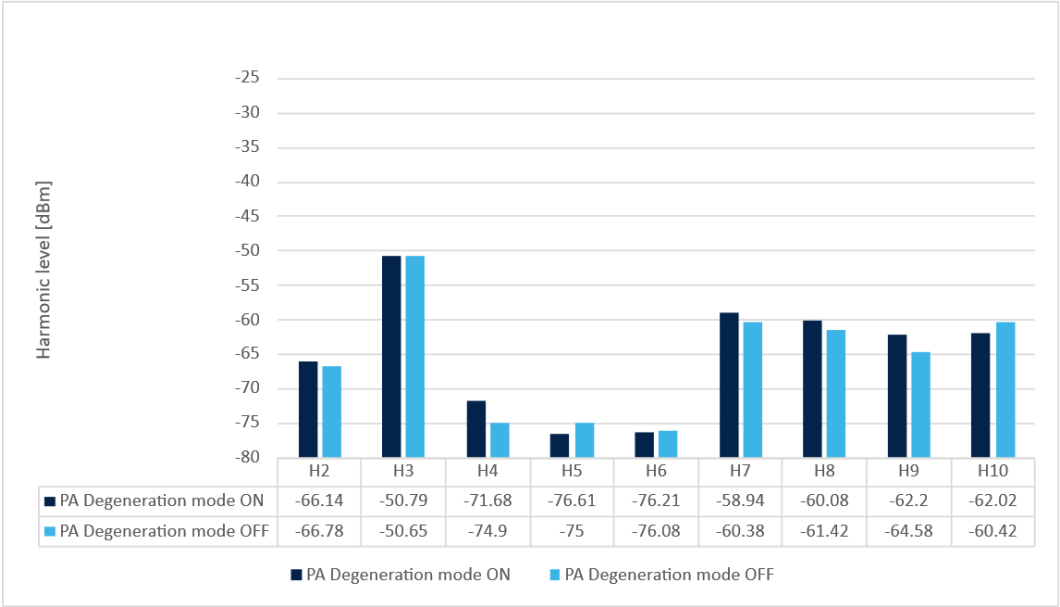


Figure 63. **STDES-WL3C4SLL Tx harmonic levels**

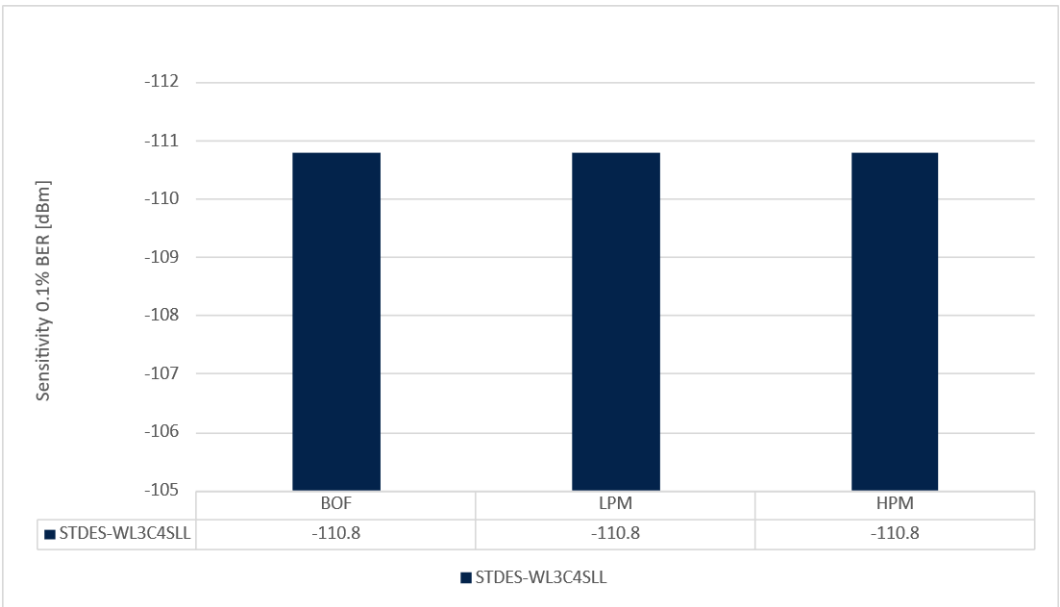


DT81315V1

6.4.4.2 *STDES-WL3C4SLL 433 MHz/10 dBm Rx*

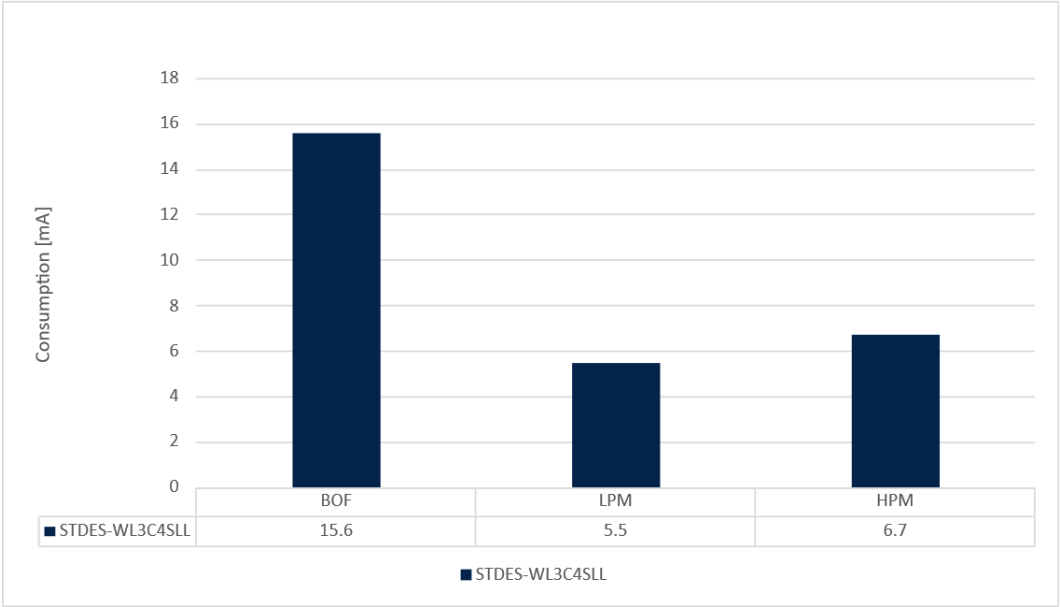
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 64. **STDES-WL3C4SLL Rx sensitivity**



DT81316V1

Figure 65. **STDES-WL3C4SLL Rx current consumption**



6.4.5 STDES-WL3C4SMH 868 MHz/16 dBm

Solder bridges

The STDES-WL3C4SMH reference design is configurable to meet specific application requirements.

Table 29. **STDES-WL3C4SMH solder bridge configurations**

MB2218 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 30. **STDES-WL3C4SMH radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4SMH	868 MHz/16 dBm	1.8 V	TX_HP	0x51	ON
		2.3 V	TX_HP	0x51	OFF

6.4.5.1 STDES-WL3C4SMH 868 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 66. **STDES-WL3C4SMH Tx output power**

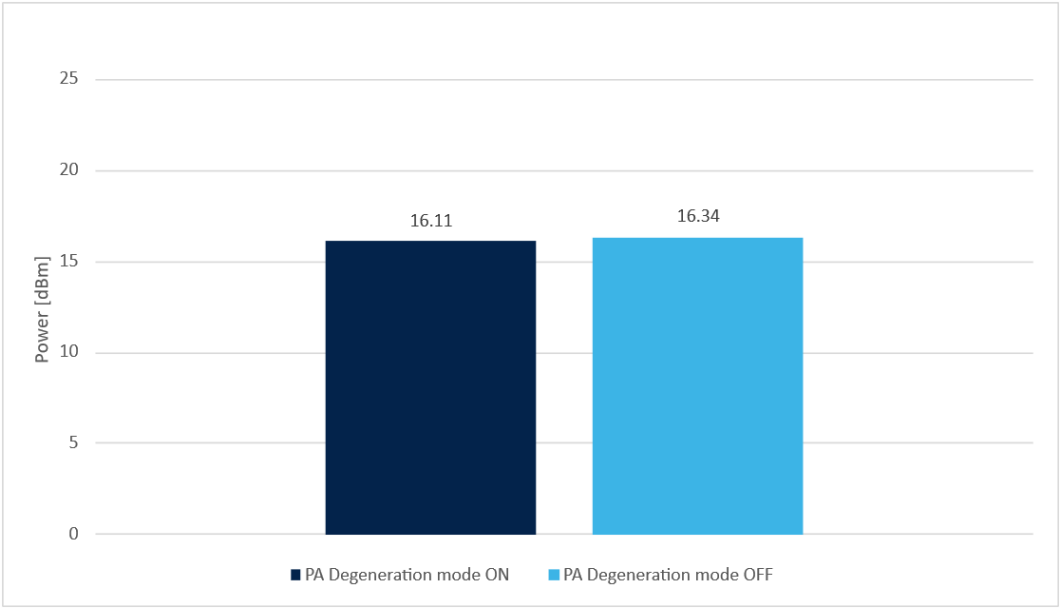


Figure 67. **STDES-WL3C4SMH Tx current consumption**

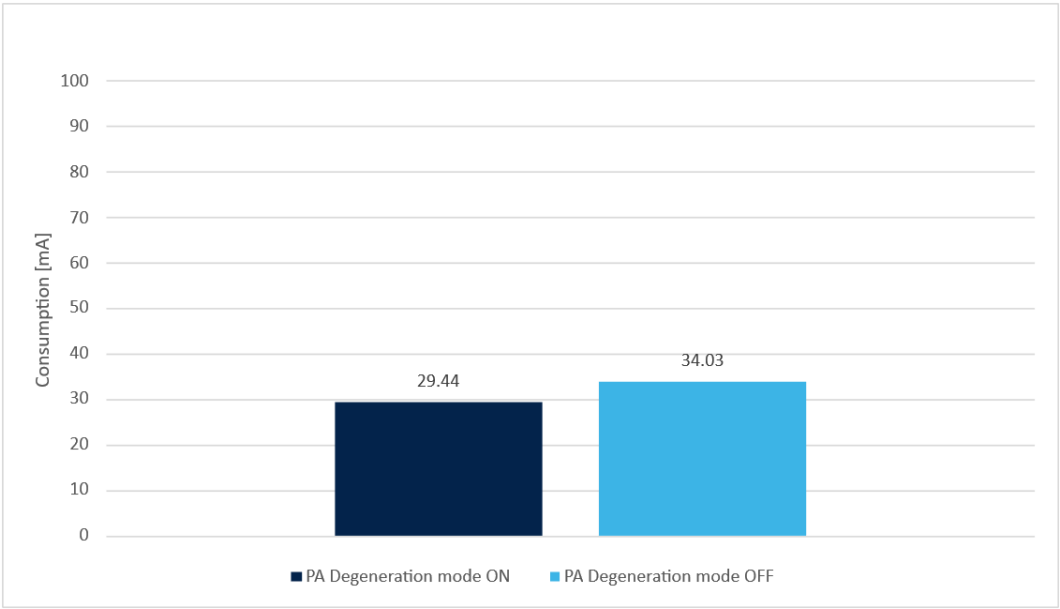
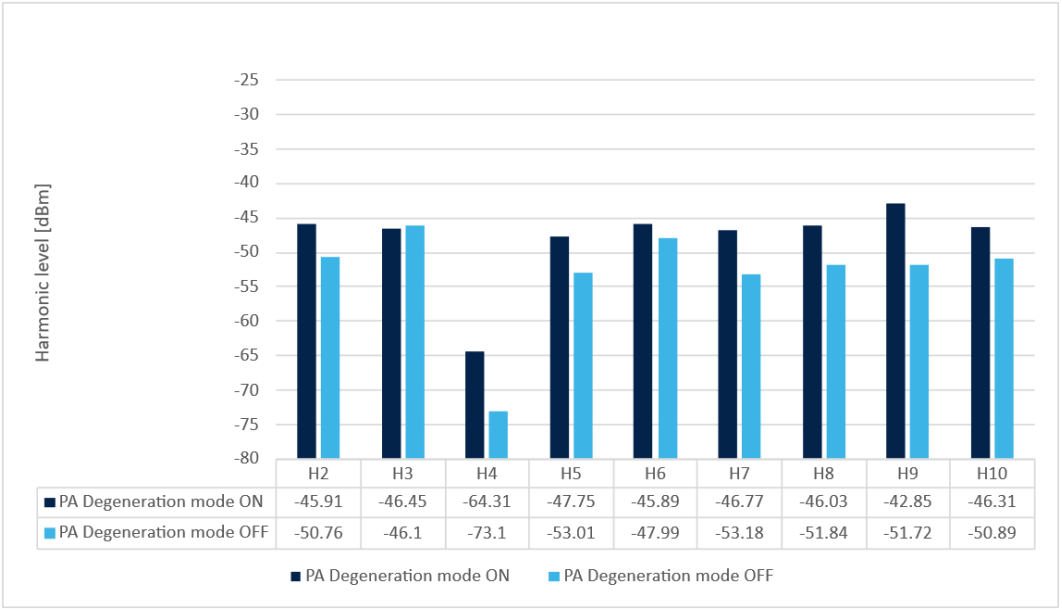


Figure 68. **STDES-WL3C4SMH Tx harmonic levels**

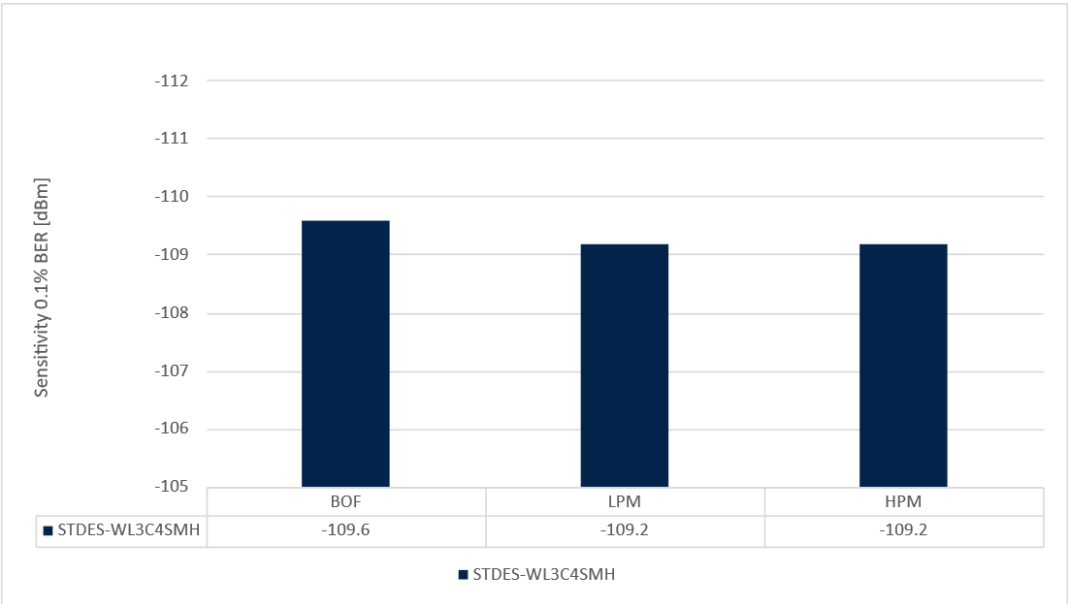


DT81320V1

6.4.5.2 *STDES-WL3C4SMH 868 MHz/16 dBm Rx*

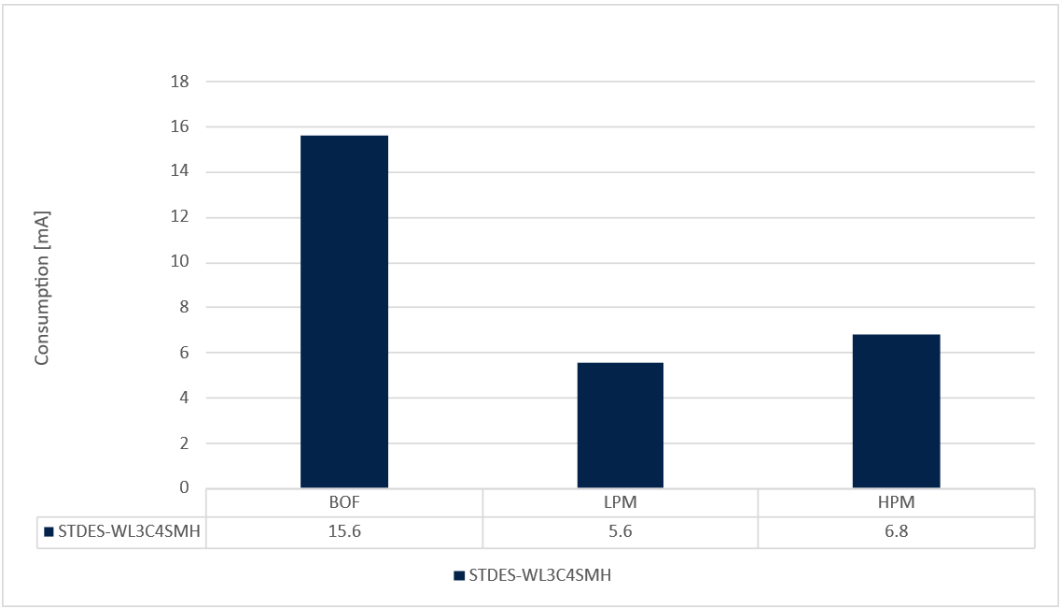
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 69. **STDES-WL3C4SMH Rx sensitivity**



DT81321V1

Figure 70. **STDES-WL3C4SMH Rx current consumption**



6.4.6 STDES-WL3C4SML 433 MHz/16 dBm

Solder bridges

The STDES-WL3C4SML reference design is configurable to meet specific application requirements.

Table 31. **STDES-WL3C4SML solder bridge configurations**

MB2218 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 32. **STDES-WL3C4SML radio setting**

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C4SML	433 MHz/16 dBm	1.8 V	TX_HP	0x51	ON
		2.2 V	TX_HP	0x51	OFF

6.4.6.1 STDES-WL3C4SML 433 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 71. **STDES-WL3C4SML Tx output power**

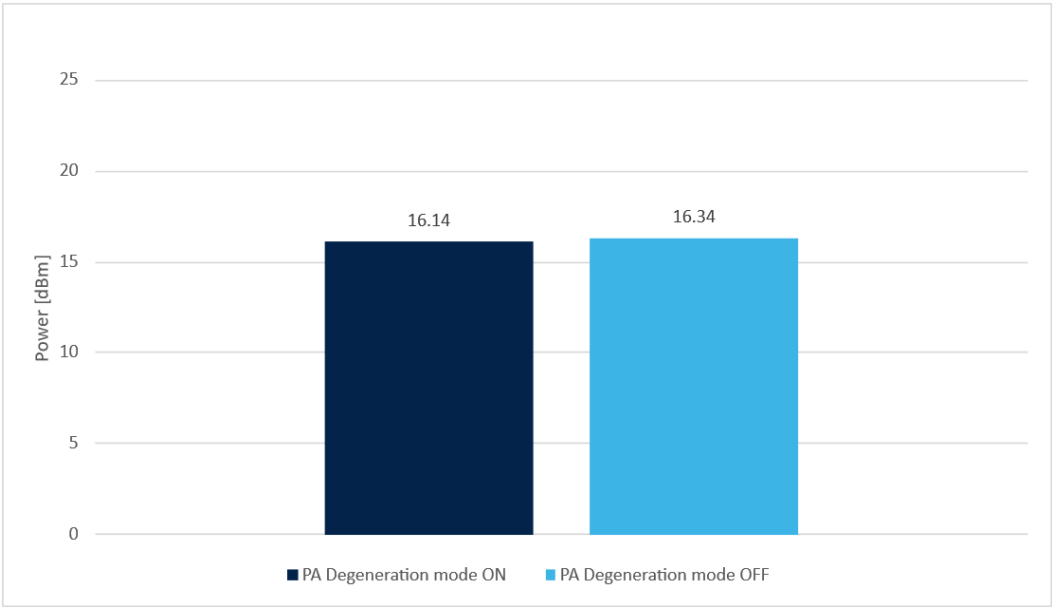


Figure 72. **STDES-WL3C4SML Tx current consumption**

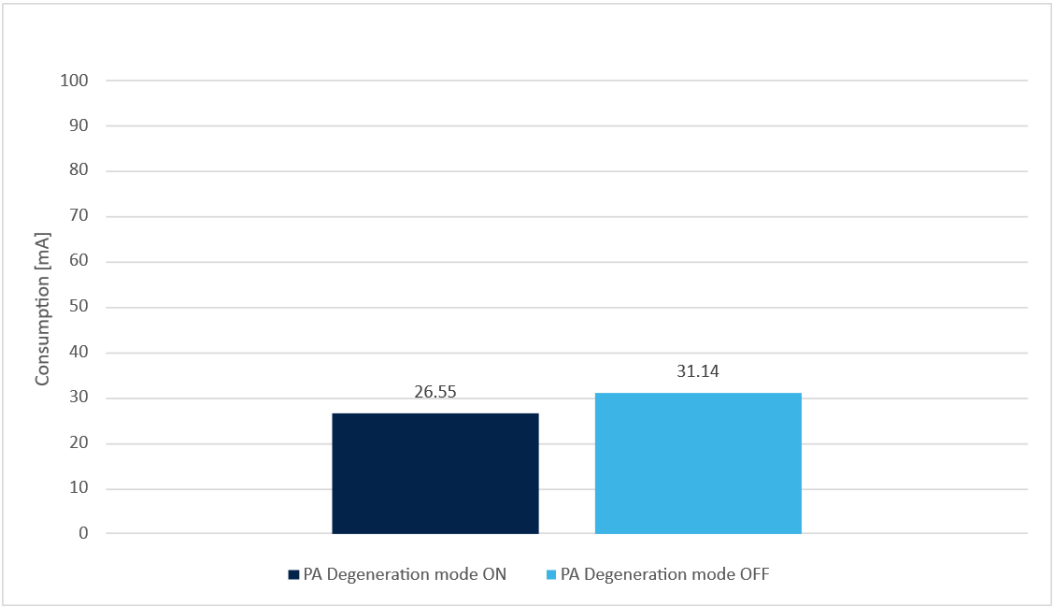
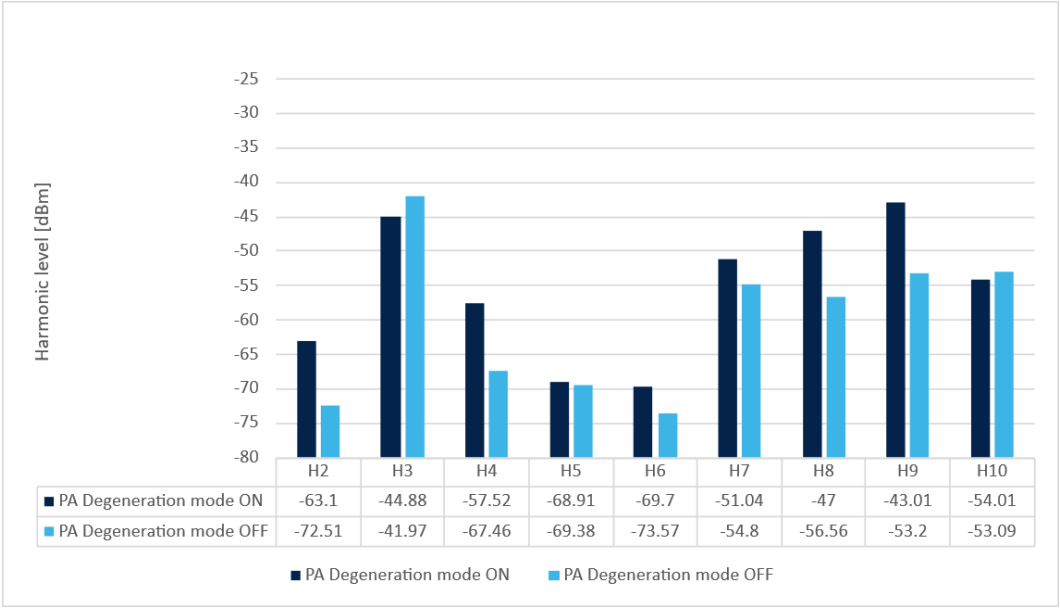


Figure 73. **STDES-WL3C4SML Tx harmonic levels**



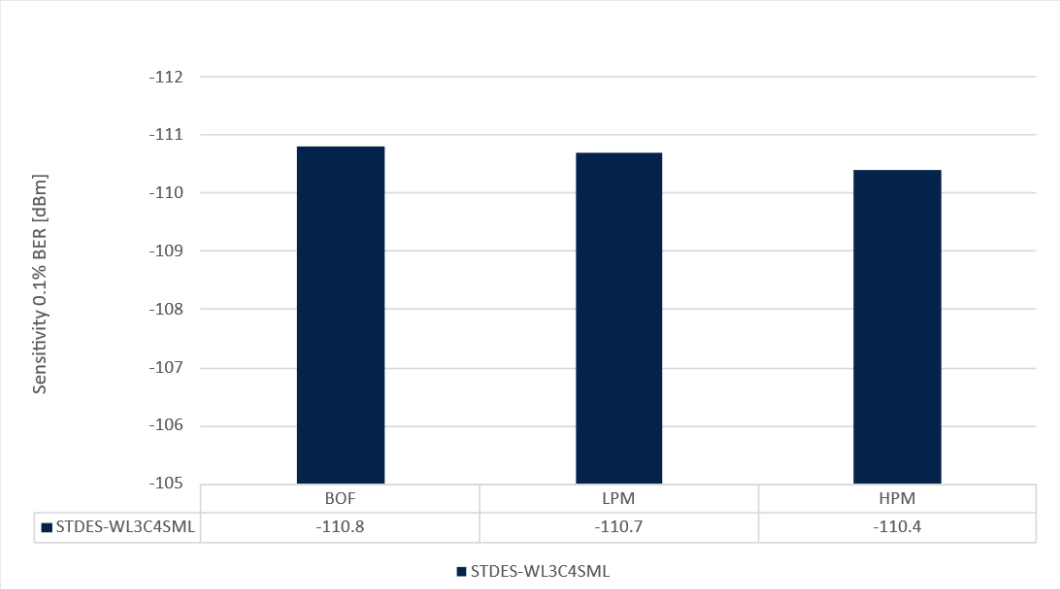
	H2	H3	H4	H5	H6	H7	H8	H9	H10
PA Degeneration mode ON	-63.1	-44.88	-57.52	-68.91	-69.7	-51.04	-47	-43.01	-54.01
PA Degeneration mode OFF	-72.51	-41.97	-67.46	-69.38	-73.57	-54.8	-56.56	-53.2	-53.09

DT81325V1

6.4.6.2 *STDES-WL3C4SML 433 MHz/16 dBm Rx*

The figures below show the MCU sensitivity and current consumption in Rx mode.

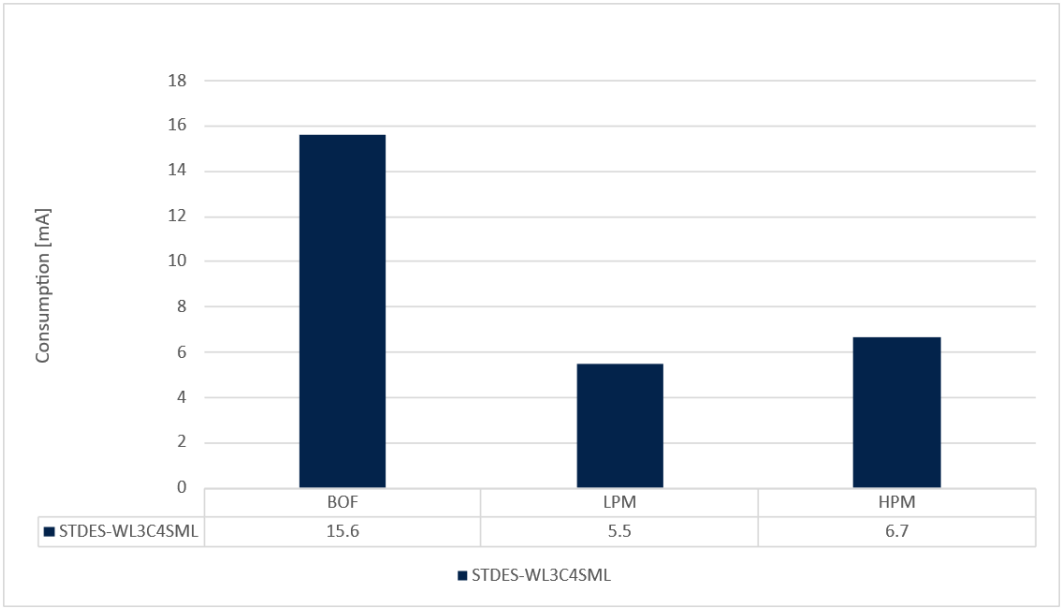
Figure 74. **STDES-WL3C4SML Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3C4SML	-110.8	-110.7	-110.4

DT81326V1

Figure 75. **STDES-WL3C4SML Rx current consumption**



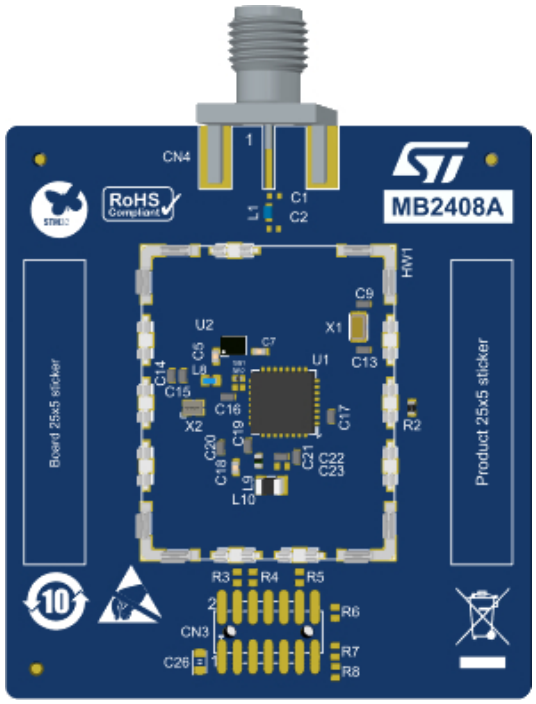
DT81327V1

6.5 MB2408 reference board

6.5.1 MB2408 description

The MB2408 reference board implements the STM32WL3RK8 microcontroller in a VFQFPN32 package with IPD filtering. The RF PA pin is configurable by using the solder bridge.

Figure 76. **MB2408**



DT81342V1

Picture is not contractual.

6.5.2 STDES-WL3K2IMR 315 MHz/16 dBm

Solder bridges

The STDES-WL3K2IMR reference design is configurable to meet specific application requirements.

Table 33. STDES-WL3K2IMR solder bridge configurations

MB2408 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 34. STDES-WL3K2IMR radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3K2IMR	315 MHz/16 dBm	2.1 V	TX_HP	0x51	ON
		2.3 V	TX_HP	0x51	OFF

6.5.2.1 STDES-WL3K2IMR 315 MHz/16 dBm Tx

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 77. STDES-WL3K2IMR Tx output power

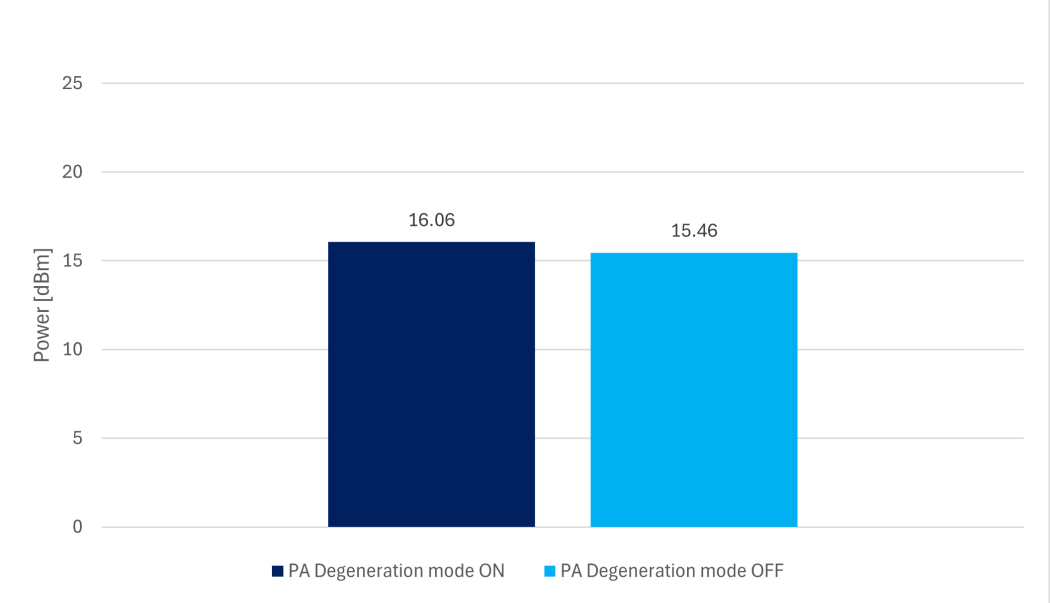


Figure 78. **STDES-WL3K2IMR Tx current consumption**

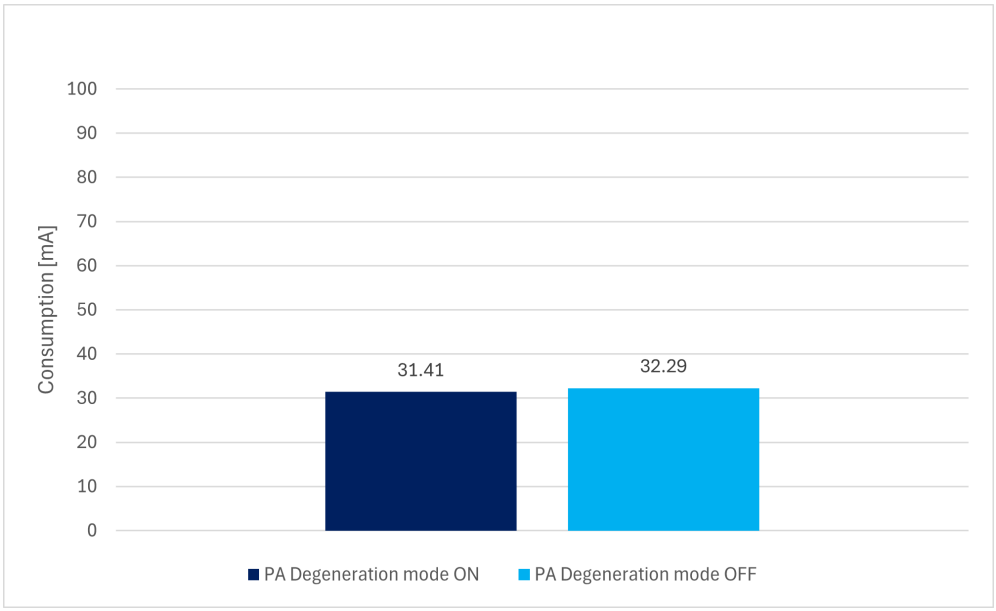
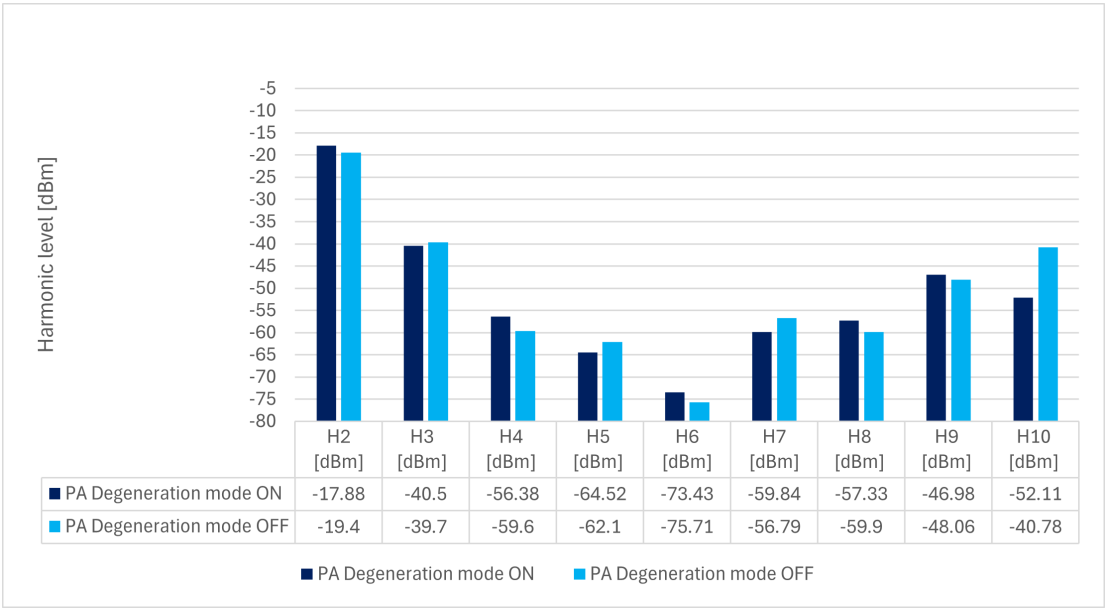


Figure 79. **STDES-WL3K2IMR Tx harmonic levels**

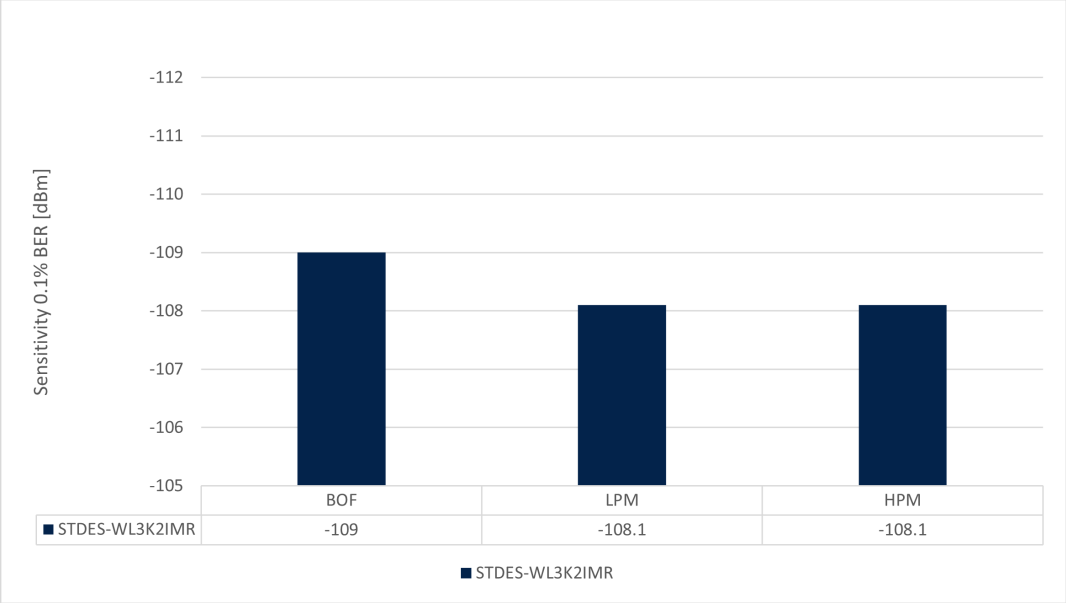


	H2 [dBm]	H3 [dBm]	H4 [dBm]	H5 [dBm]	H6 [dBm]	H7 [dBm]	H8 [dBm]	H9 [dBm]	H10 [dBm]
PA Degeneration mode ON	-17.88	-40.5	-56.38	-64.52	-73.43	-59.84	-57.33	-46.98	-52.11
PA Degeneration mode OFF	-19.4	-39.7	-59.6	-62.1	-75.71	-56.79	-59.9	-48.06	-40.78

6.5.2.2 *STDES-WL3K2IMR 315 MHz/16 dBm Rx*

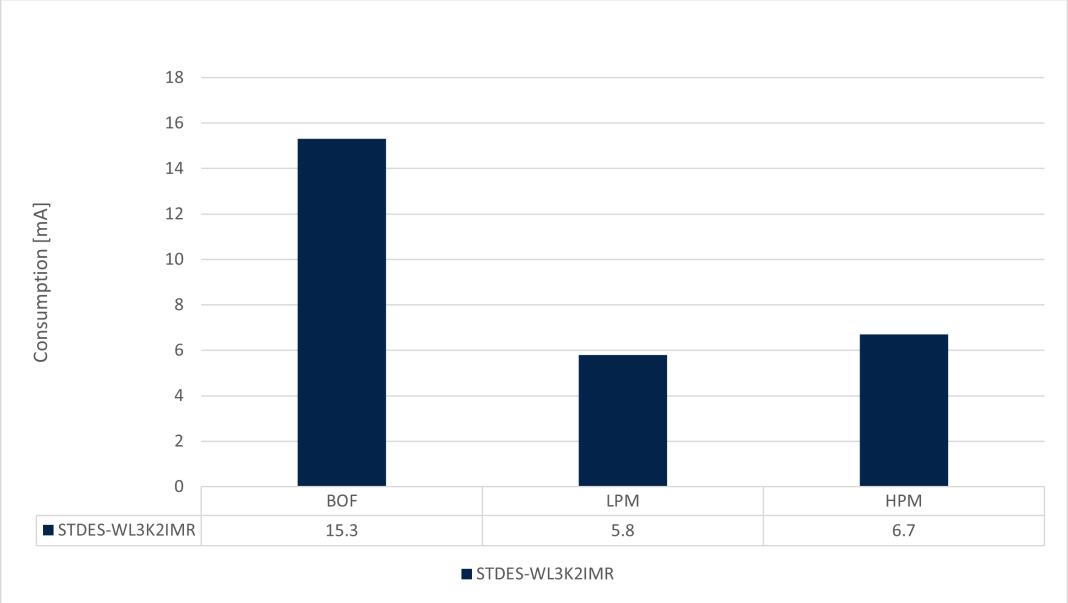
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 80. **STDES-WL3K2IMR Rx sensitivity**



DT81347V1

Figure 81. **STDES-WL3K2IMR Rx current consumption**



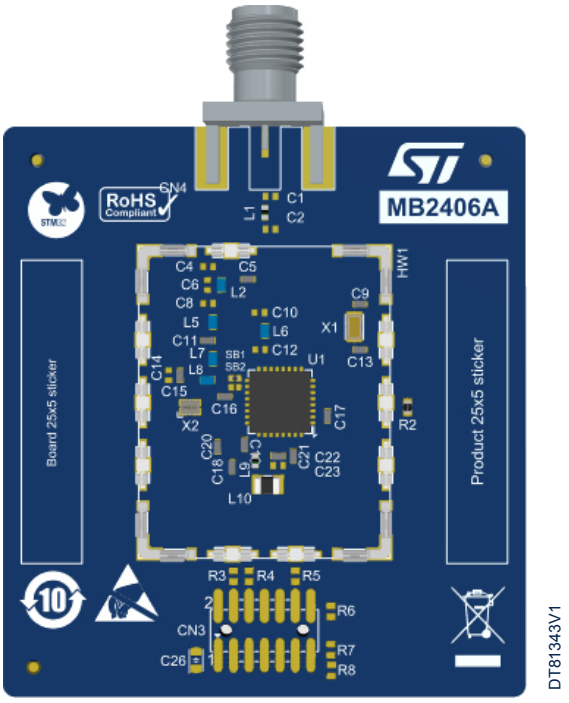
DT81348V1

6.6 MB2406 reference board

6.6.1 MB2406 description

The MB2406 reference board implements the STM32WL3RK8 microcontroller in a VFQFPN32 package with SMD filtering. The RF PA pin is configurable by using the solder bridge.

Figure 82. MB2406



Picture is not contractual.

6.6.2 STDES-WL3K2SMR 315 MHz/16 dBm

Solder bridges

The STDES-WL3K2SMR reference design is configurable to meet specific application requirements.

Table 35. STDES-WL3K2SMR solder bridge configurations

MB2406 reference board	Solder bridge state	Description
SB1/SB2	ON	RF PA TX_HP pin
	OFF	RF PA TX pin

Radio setting

Use the settings indicated in the table below to achieve optimal performance.

Table 36. STDES-WL3K2SMR radio setting

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3K2SMR	315 MHz/16 dBm	2.0 V	TX_HP	0x51	ON
		2.1 V	TX_HP	0x51	OFF

6.6.2.1 *STDES-WL3K2SMR 315 MHz/16 dBm Tx*

The figures below show the MCU output power, current consumption, and harmonic levels in Tx mode.

Figure 83. STDES-WL3K2SMR Tx output power

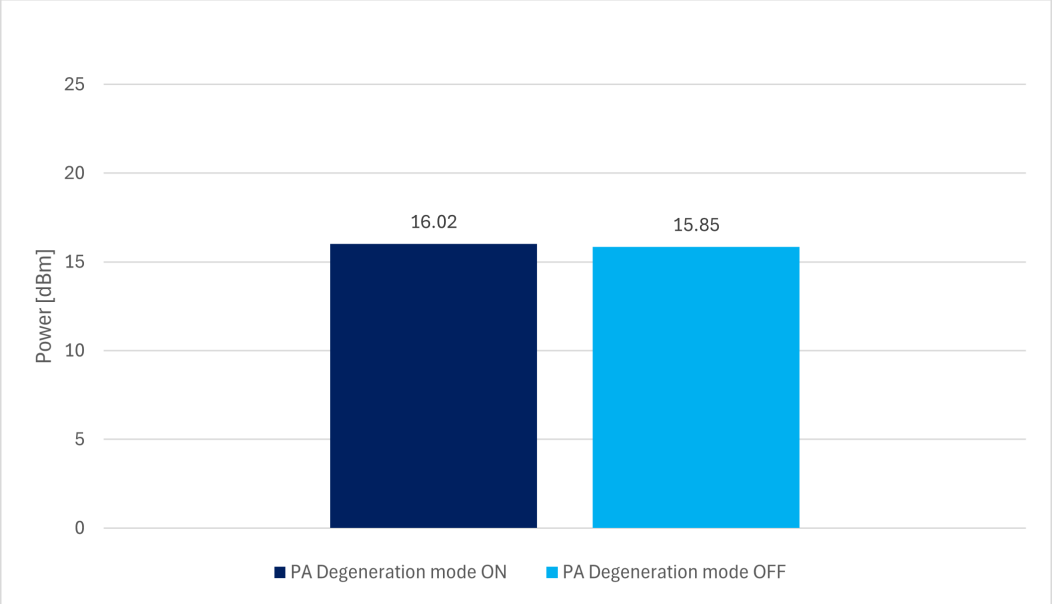


Figure 84. STDES-WL3K2SMR Tx current consumption

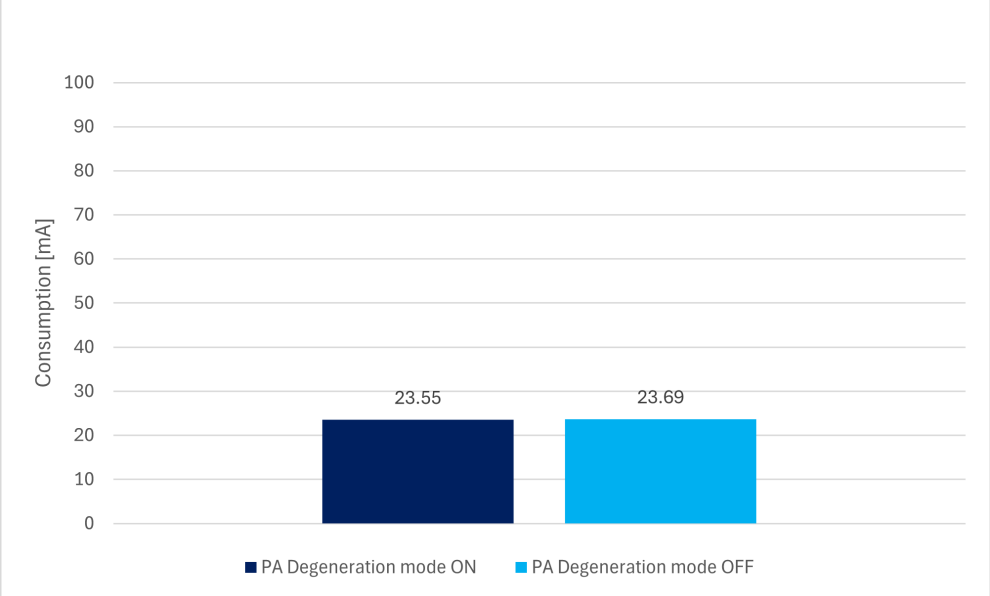
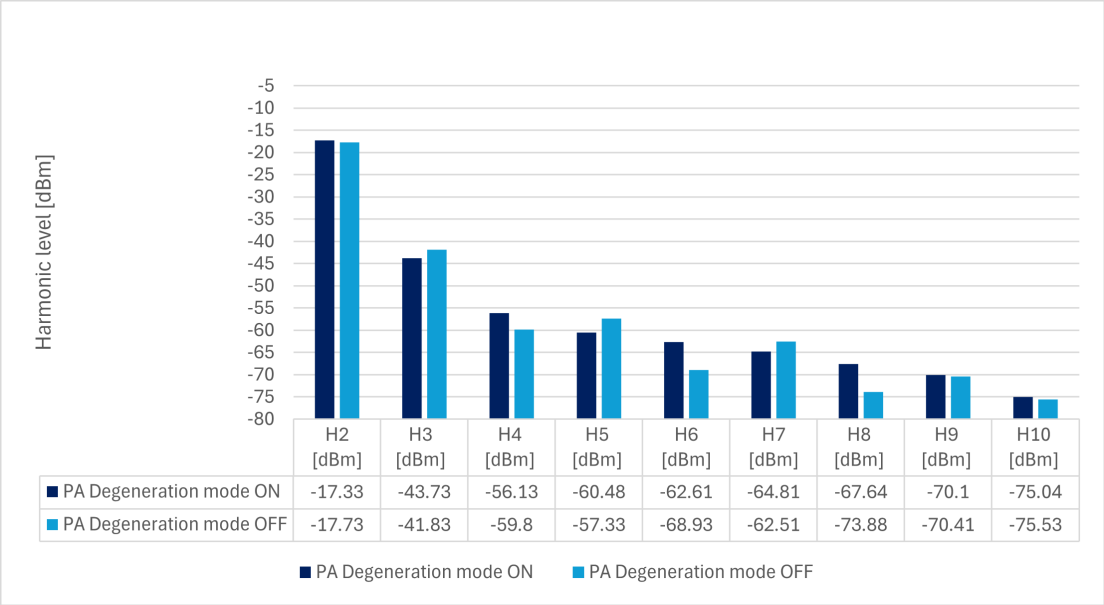


Figure 85. **STDES-WL3K2SMR Tx harmonic levels**

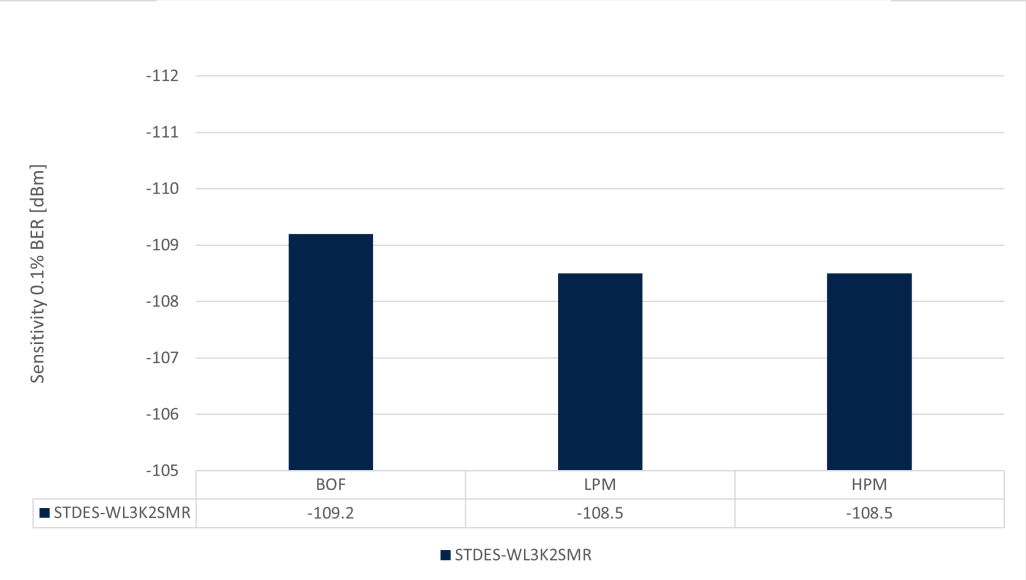


	H2 [dBm]	H3 [dBm]	H4 [dBm]	H5 [dBm]	H6 [dBm]	H7 [dBm]	H8 [dBm]	H9 [dBm]	H10 [dBm]
PA Degeneration mode ON	-17.33	-43.73	-56.13	-60.48	-62.61	-64.81	-67.64	-70.1	-75.04
PA Degeneration mode OFF	-17.73	-41.83	-59.8	-57.33	-68.93	-62.51	-73.88	-70.41	-75.53

6.6.2.2 *STDES-WL3K2SMR 315 MHz/16 dBm Rx*

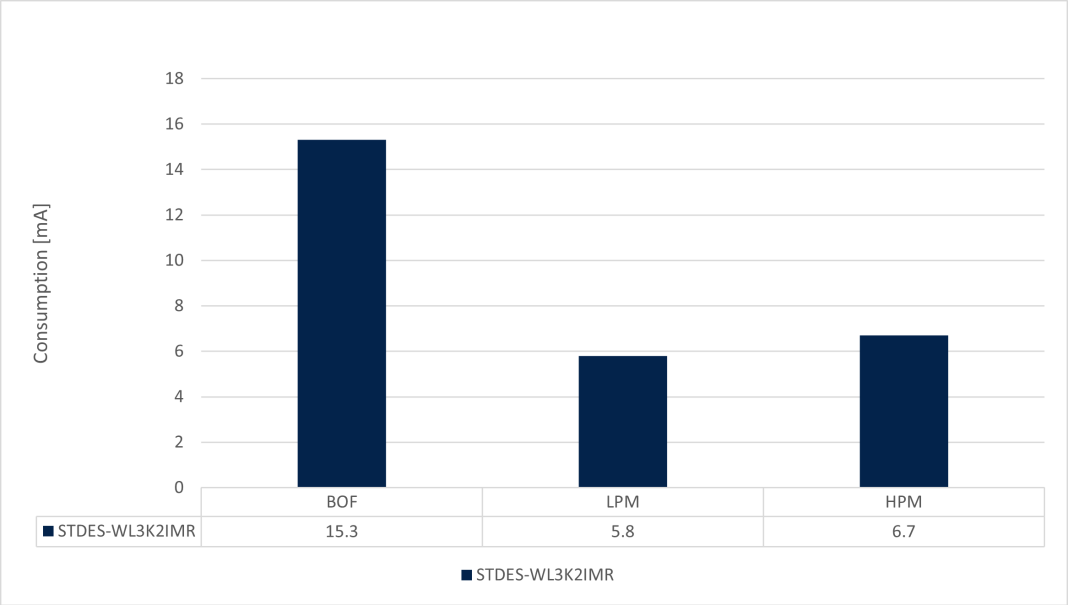
The figures below show the MCU sensitivity and current consumption in Rx mode.

Figure 86. **STDES-WL3K2SMR Rx sensitivity**



	BOF	LPM	HPM
STDES-WL3K2SMR	-109.2	-108.5	-108.5

Figure 87. **STDES-WL3K2SMR Rx current consumption**



7 Configuration summary

7.1 Output power selection

The reference designs can be tailored to meet the specific output power requirements.

Table 37. Solder bridge configurations

Output power	SB1	SB2
Not applicable	OFF	OFF
10 dBm	OFF	ON
14/16 dBm	ON	OFF
20 dBm	ON	ON

7.2 Radio setting summary

Depending on the reference design, use the settings indicated in the table below to achieve the best performance for each radio configuration.

Table 38. Radio setting summary

Reference design	Optimized BOM target	SMPS level	PA drive mode	PA_LEVEL7	Degeneration mode
STDES-WL3C2ILL	433 MHz/10 dBm	1.4 V	TX	0x51	ON
STDES-WL3C2IMH	868 MHz/14 dBm	1.4 V	TX_HP	0x51	ON
	868 MHz/16 dBm	1.6 V	TX_HP	0x51	ON
STDES-WL3C2IML	433 MHz/14 dBm	1.4 V	TX_HP	0x51	ON
	433 MHz/16 dBm	1.8 V	TX_HP	0x51	ON
STDES-WL3C2SLH	868 MHz/10 dBm	1.4 V	TX	0x51	ON
		1.5 V	TX	0x51	OFF
	915 MHz/10 dBm	1.4 V	TX	0x4F	ON
		1.4 V	TX	0x51	OFF
STDES-WL3C2SLL	433 MHz/10 dBm	1.4 V	TX	0x4C	ON
		1.4 V	TX	0x51	OFF
STDES-WL3C2SMH	868 MHz/14 dBm	1.7 V	TX_HP	0x51	ON
		1.9 V	TX_HP	0x51	OFF
	868 MHz/16 dBm	2.0 V	TX_HP	0x51	ON
		2.4 V	TX_HP	0x51	OFF
STDES-WL3C2SML	433 MHz/14 dBm	1.6 V	TX_HP	0x51	ON
		1.8 V	TX_HP	0x51	OFF
	433 MHz/16 dBm	2.1 V	TX_HP	0x51	ON
		2.4 V	TX_HP	0x51	OFF
STDES-WL3C4EEW	169 MHz/27 dBm	1.4 V	TX_HP	0x35	ON
STDES-WL3C4SHH	915 MHz/20 dBm	2.1 V	TX + TX_HP	0x51	ON
STDES-WL3C4SLH	868 MHz/10 dBm	1.4 V	TX	0x51	ON
		1.5 V	TX	0x51	OFF
STDES-WL3C4SLL	433 MHz/10 dBm	1.3 V	TX	0x4E	ON
		1.3 V	TX	0x4E	OFF
STDES-WL3C4SMH	868 MHz/14 dBm	1.4 V	TX_HP	0x51	ON
		1.6 V	TX_HP	0x51	OFF
	868 MHz/16 dBm	1.8 V	TX_HP	0x51	ON
		2.3 V	TX_HP	0x51	OFF
STDES-WL3C4SML	433 MHz/14 dBm	1.4 V	TX_HP	0x51	ON
		1.5 V	TX_HP	0x51	OFF
	433 MHz/16 dBm	1.8 V	TX_HP	0x51	ON
		2.2 V	TX_HP	0x51	OFF
STDES-WL3K2IMR	315 MHz/16 dBm	2.1 V	TX_HP	0x51	ON
		2.3 V	TX_HP	0x51	OFF
STDES-WL3K2SMR	315 MHz/16 dBm	2.0 V	TX_HP	0x51	ON
		2.1 V	TX_HP	0x51	OFF

Revision history

Table 39. **Document revision history**

Date	Revision	Changes
14-Nov-2024	1	Initial release.
22-Jan-2025	2	Added reference designs STDES-WL3C4SLH and STDES-WL3C4SMH: • Updated *Product status link* • Updated *Table 1. STM32WL3x microcontroller reference designs* • Updated *Table 4. Radio setting* Updated the maximum value of PA_LEVEL7 from 0x53 to 0x51 in *Table 4. Radio setting*. Added a remark about the applicability of VFQFPN48's bills of materials to VFQFPN32-based reference designs in *Section 4.1: Schematics and BOM (bill of materials)*.
18-Feb-2025	3	Updated the maximum value of PA_LEVEL7 from 0x53 to 0x51 in *Table 4. Radio setting* for STDES-WL3C2SLL.
14-Apr-2025	4	Added reference designs STDES-WL3C2ILL, STDES-WL3C2IMH, STDESWL3C2IML, STDES-WL3C2SMH, STDES-WL3C2SML, STDES-WL3C4SLL, and STDES-WL3C4SML: • Updated *Product status* • Updated *Table 1. STM32WL3x microcontroller reference designs* • Updated *Table 4. Radio setting* Updated *Section 4.1: EDA resources*.
18-Aug-2026	5	Added reference designs STDES-WL3C2ILL and STDES-WL3C2IMH with the 276-319 MHz frequency band, updated the document structure, and added example measurement results. Updated: • Document title • Features • Table 1. STM32WL3xxx microcontroller reference designs, including the optimized BOM target entry for STDES-WL3C2SML • Table 38. Radio setting summary, including: – Maximum value of PA_LEVEL7 from 0x4C to 0x51 for STDES-WL3C2ILL – SMPS levels for STDES-WL3C2IML, STDES-WL3C2SMH, and STDES-WL3C2SML – Degeneration mode for STDES-WL3C4EEW • Section 3.4: EDA resources Added: • Section 3: Development environment • Section 5: Measurement environment • Measurement results, organized by board, in Section 6: Hardware layout and configuration Removed: • *Main features*

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