

CC13xx wM-Bus S-Mode

ABSTRACT

This application report describes a wM-Bus S-mode patch for the CC13xx SimpleLink™ Sub-1 GHz ultra-low power wireless microcontroller (MCU). Measurements show that CC13xx meets EN13757-4:2012 [2] specifications with margin.

Recommended register settings discussed in this application report can be downloaded from <http://www.ti.com/lit/zip/SWRA512>.

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1 wM-Bus S-Mode

The wireless meter bus (wM-Bus) is an open standard for systems using radio to read remote meters and is supported by all major metering companies in Europe.

wM-Bus stationary mode (S-mode) is intended for unidirectional (S1) or bidirectional (S2) communications between a meter and a stationary or mobile device (see [2]).

NOTE: T2-mode uses the same physical layer (PHY) parameters as S-mode when transmitting from the “other device” to the meter.

Table 1 lists the S-mode requirements.

Table 1. S-Mode Requirements

Parameter	Value
Chip rate	32.768 (typical), 32.1113 (minimum), 33.423 (maximum)
Deviation	50 (typical), 40 kHz (minimum), 80 kHz (maximum)
Data coding	Manchester
Sensitivity	-105 dBm (typical), -100 dBm (minimum)
RF carrier frequency	868.3 MHz
Frequency tolerance	±25 ppm in S2-mode ±60 ppm in S1-mode
Blocking @ 2 MHz offset for Class H _R receivers	≥ 35 dB – 10 log (BW _{kHz} / 16 kHz) where BW is the RX filter bandwidth 196 kHz BW: ≥ 24.1 dB 311 kHz BW: ≥ 22.1 dB
Blocking @ 10 MHz offset for Class H _R receivers	≥ 60 dB – 10 log (BW _{kHz} / 16 kHz) where BW is the RX filter bandwidth 196 kHz BW: ≥ 49.1 dB 311 kHz BW: ≥ 47.1 dB
Adjacent band selectivity for Class H _R receivers	≥ 40 dB

For S2-mode, the RX filter bandwidth is set wide enough to receive packets for all combinations of data rate, deviation, and frequency offset (±25 ppm). A 196-kHz RX filter bandwidth is used for S2-mode.

S1-mode is transmit only, but RX measurements (where CC1310 is configured to receive from an S1-mode transmitter) are included in this application report. Table 1 shows that S1-mode has a higher frequency tolerance than S2-mode. The RX filter bandwidth is increased to 311 kHz in S2-mode to allow for the ±60 ppm frequency offset.

Performance figures (when using the patch with CC1310) are included in Section 4 and Section 5 for S2-mode and S1-mode, respectively.

All measurements were performed on CC13xxEM-7793_4L reference design [1]. A 3-byte preamble was used in all the measurements.

Measurements show that the CC13xx device meets EN13757-4:2012 [2] specifications with margin.

2 wM-Bus S-Mode Patch

The wM-Bus PHY S-mode is not available in radio ROM code, and a wM-Bus patch is required to support this physical layer. The wM-Bus stack uses Proprietary API commands together with wM-Bus related overrides. The patch is part of the SimpleLink™ CC13x0 Software Development Kit [5] and recommended settings and overrides are covered in [Section 2.1](#).

2.1 Recommended Operating Limits

The patch is designed only for wM-Bus S-mode. The user must set the following to make the patch work properly:

- Set the data rate to 32.768 kcps.
- Set the sync word to 0x547696. The sync word is made up of the S-mode sync word 000111011010010110 preceded by 3 × (01) preamble bits.
- Set the number of sync word bits to 24.
- Enable the MSB first.
- Set the RF to 868.3 MHz.

[3] contains a smartrf_settings.c file that has the complete override list and all the required API settings to be used with the patch.

2.1.1 API Configuration

[Table 2](#) lists the required changes to the recommended 50 kbps, 2-GFSK radio operation commands from SmartRF™ Studio [4] to be compliant with recommended operation limits listed in [Section 2.1](#).

Table 2. API Settings Required for the Patch

Radio Operation Command	Field	Value
CMD_PROP_RADIO_DIV_SETUP	modulation.modType	0
	modulation.deviation	0xC8
	symbolRate.preScale	0xF
	symbolRate.rateWord	0x53E3
	rxBw	0x27 (S2-mode), 0x29 (S1-mode)
	preamConf.nPreamBytes	0x3
	preamConf.preamMode	0
	formatConf.nSwBits	0x18
	formatConf.bMsbFirst	0x1
	centerFreq	0x0364
	intFreq	0x8000
CMD_FS	loDivider	0x05
	Frequency	0x0364
CMD_PROP_TX	fractFreq	0x4CCC
	syncWord	0x547696
CMD_PROP_RX	syncWord	0x547696

2.1.2 Register Overrides

Table 3 lists the overrides needed in addition to the recommended 50 kbps, 2-GFSK overrides from SmartRF Studio [4] to be compliant with recommended operation limits in Section 2.1.

Table 3. Additional Register Overrides Required for the Patch

Override	Comment
HW_REG_OVERRIDE(0x6064,0x1306)	AGC win size 7 samples
HW32_ARRAY_OVERRIDE(0x405C,1)	Set divider bias to disabled
(uint32_t)0x1800 0200	Divider 5

Four of the 50 kbps, 2-GFSK overrides from SmartRF Studio must be changed (see [3] and Table 4).

Table 4. Register Overrides to be Changed from 50 kbps, 2-GFSK Radio Register Settings

Override	Comment
MCE_RFE_OVERRIDE(1, 0, 0, 1, 0, 0)	Run the MCE and RFE patches
(uint32_t)0x00F988A3	Set RSSI offset to adjust reported RSSI by +7 dB
HW_REG_OVERRIDE(0x6088,0x611F)	PA ramping and AGC reference level
HW_REG_OVERRIDE(0x608C,0x8112)	PA ramping and AGC settle wait = 21 samples

3 Building a Software Example

To test the RF performance of the patch, the user can refer to the rfPacketRX and rfPacketTX examples available when downloading the SimpleLink™ CC13x0 Software Development Kit [5]. See the Proprietary RF Quick Start Guide for more information. A local link to this guide can also be found in the documentation_overview_simplelink_cc13x0_sdk.html found here:

C:\ti\simplelink_cc13x0_sdk_x_xx_xx_xx\docs (assuming that installation has been to the default location)

The smartrf_settings.c file must be replaced with the one included with this document (see [3]).

NOTE: When using the rfPacketRX/TX examples, the correct packet format will not be transmitted (with respect to CRC and length information).

4 S2-Mode Measurement Summary

4.1 S2-Mode Sensitivity

Table 5 lists the measurement results for S2-mode sensitivity.

Table 5. S2-Mode Typical 1% BER Sensitivity vs Frequency Deviation (80% PER, 20-Byte Payload)

Typical Sensitivity [dBm]	Deviation [kHz]	Chip Rate [kcps]
-110.5	40	32.1113
-111.1	50 (nominal)	32.768 (nominal)
-108.8	80	33.423

4.2 S2-Mode Blocking

Table 6 lists the measurement results for S2-mode blocking.

Table 6. S2-Mode Blocking

Frequency Offset [MHz]	Blocking [dB]
±20	76 / 76
±10	72 / 68
±2	55 / 52
±1	52 / 43
±0.4	47 / 41
±0.2	43 / 42

4.3 S2-Mode PER vs Input Power Level vs Frequency Offset

The frequency offset can be up to ± 25 ppm in S2-mode. [Figure 1](#), [Figure 2](#), and [Figure 3](#) show the packet error rate (PER) versus input power level and frequency offset. An 80% PER corresponds to a 1% bit error rate (BER). During the measurements, 100 packets were transmitted at each power level.

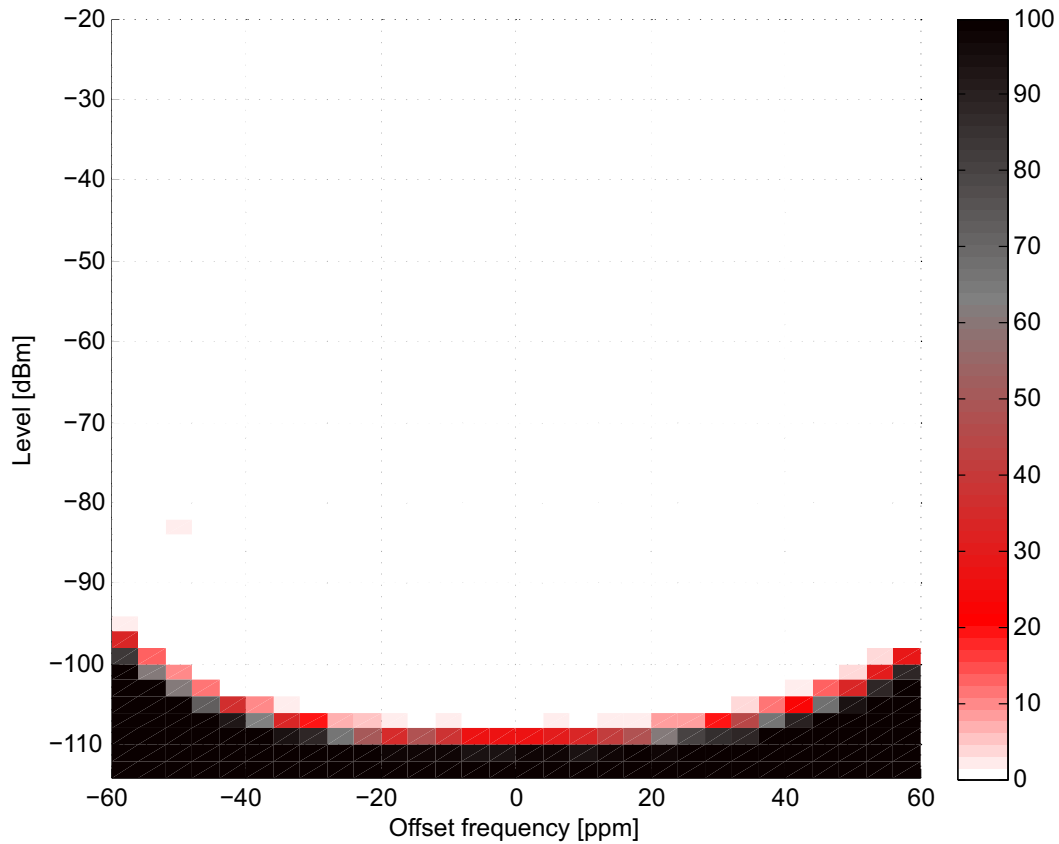


Figure 1. 32.768 kcps, ± 50 kHz, 20-Byte Payload

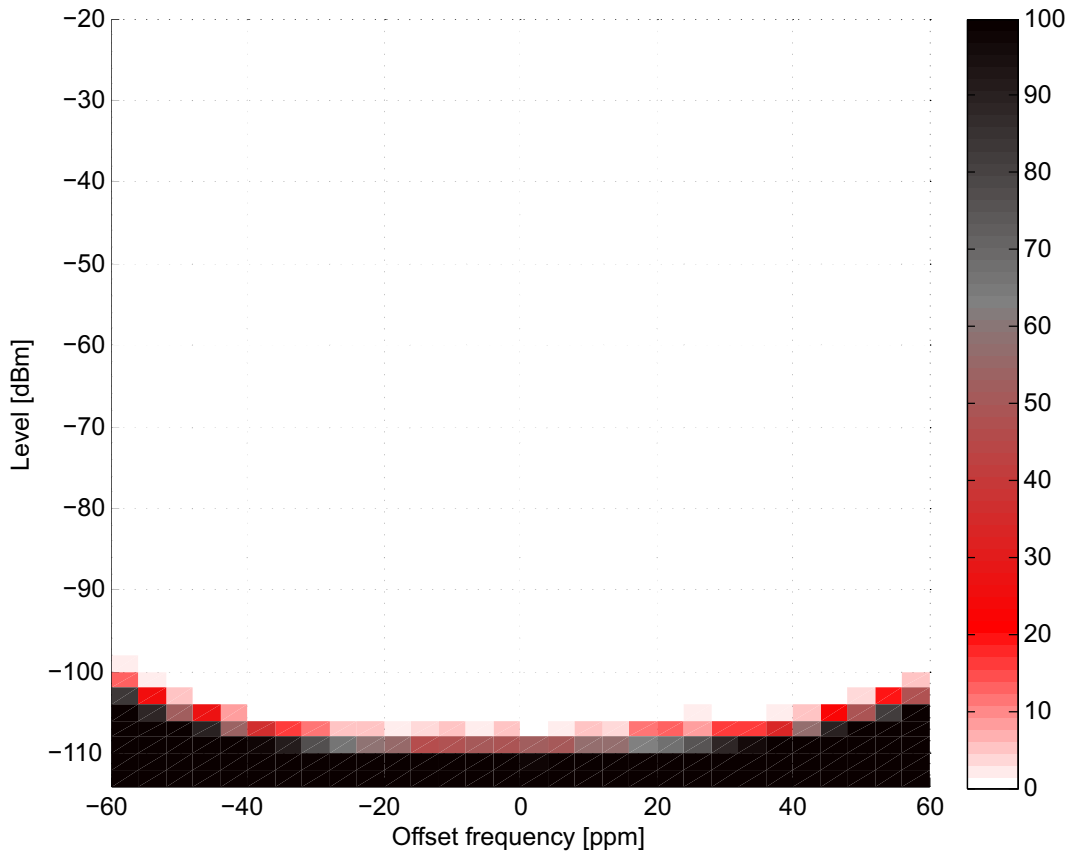


Figure 2. 32.113 kcps, ±40 kHz, 20-Byte Payload

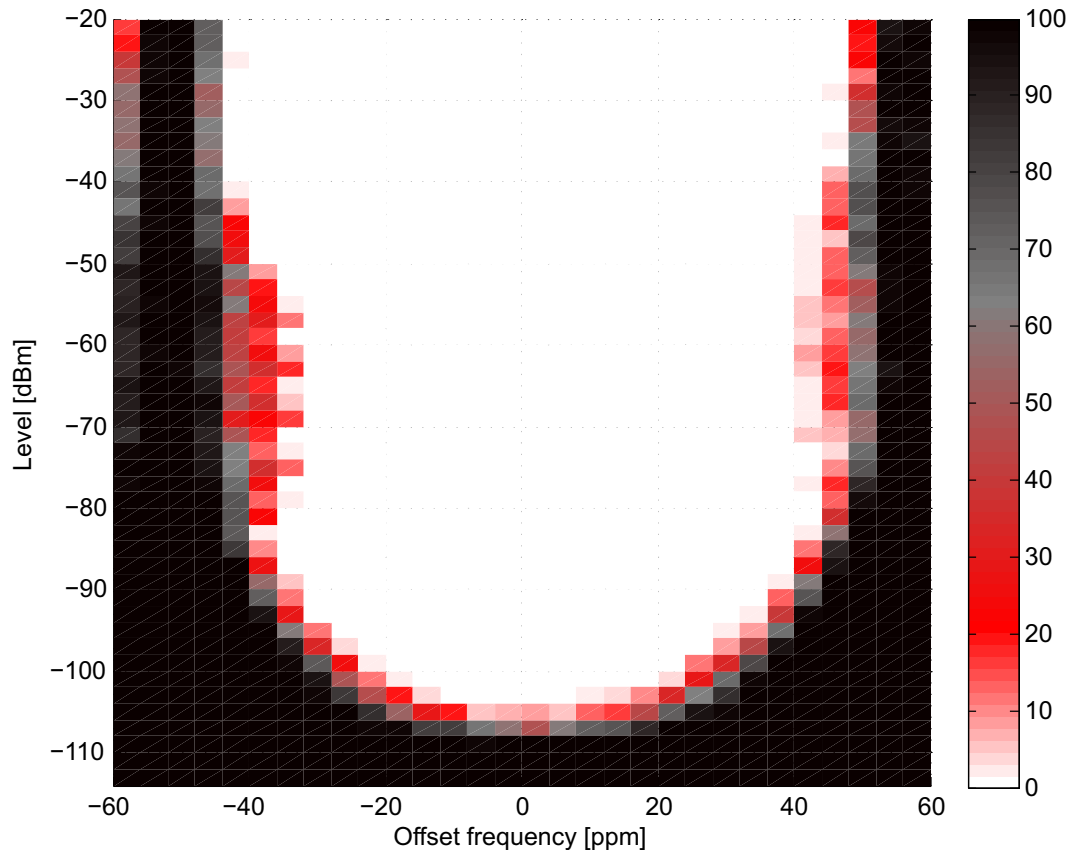


Figure 3. 33.423 kcps, ±80 kHz, 20-Byte Payload

5 S1-Mode Measurement Summary

5.1 S1-Mode Sensitivity

Table 7 lists the measurement results for S1-mode.

Table 7. S1-Mode Typical 1% BER Sensitivity vs Frequency Deviation (80% PER, 20-Byte Payload)

Typical Sensitivity [dBm]	Deviation [kHz]	Chip Rate [kcps]
-107.0	40	32.1113
-108.2	50 (nominal)	32.768 (nominal)
-108.7	80	33.423

5.2 S1-Mode Blocking

Table 8 lists the measurement results for S1-mode blocking.

Table 8. S1-Mode Blocking

Frequency Offset [MHz]	Blocking [dB]
±20	74 / 73
±10	67 / 66
±2	51 / 40
±1	52 / 47
±0.4	49 / 46

5.3 S1-Mode PER vs Input Power Level vs Frequency Offset

The frequency offset can be up to ± 60 ppm in S1-mode. Figure 4, Figure 5, and Figure 6 show the packet error rate (PER) versus input power level and frequency offset. An 80% PER corresponds to a 1% bit error rate (BER). During the measurements, 100 packets were transmitted at each power level.

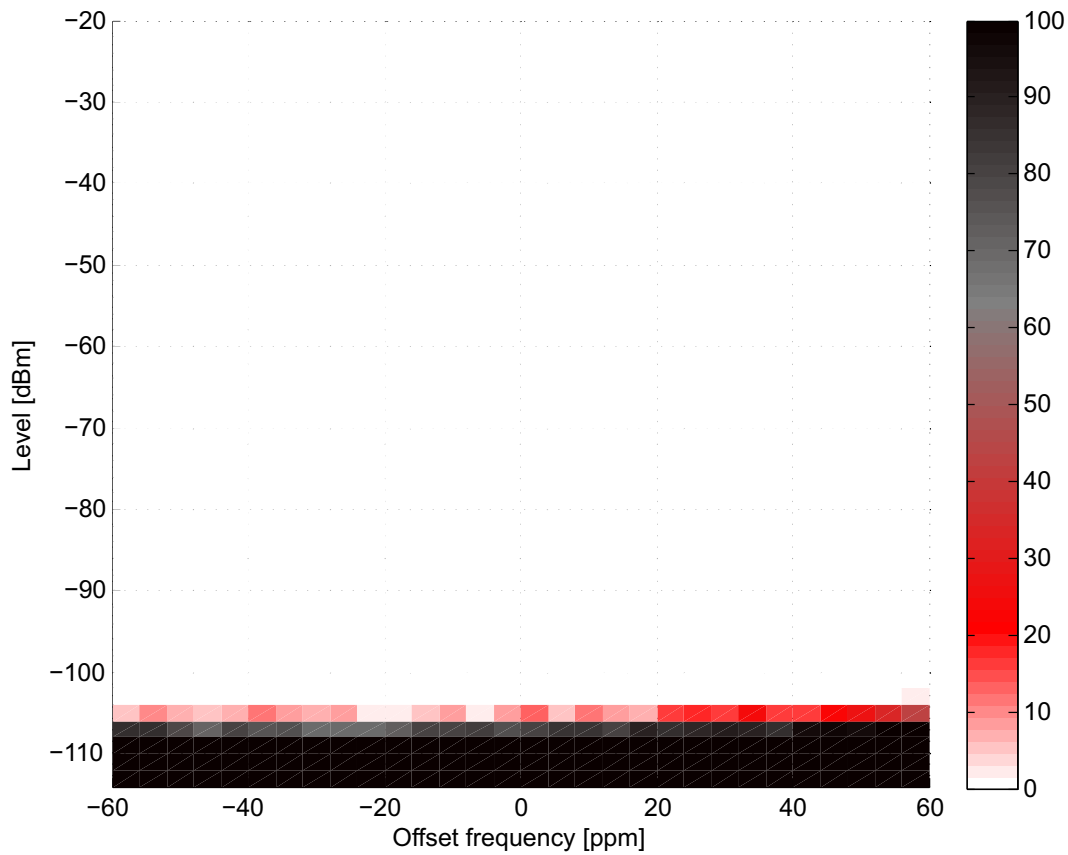


Figure 4. 32.768 kcps, ± 50 kHz, 20-Byte Payload

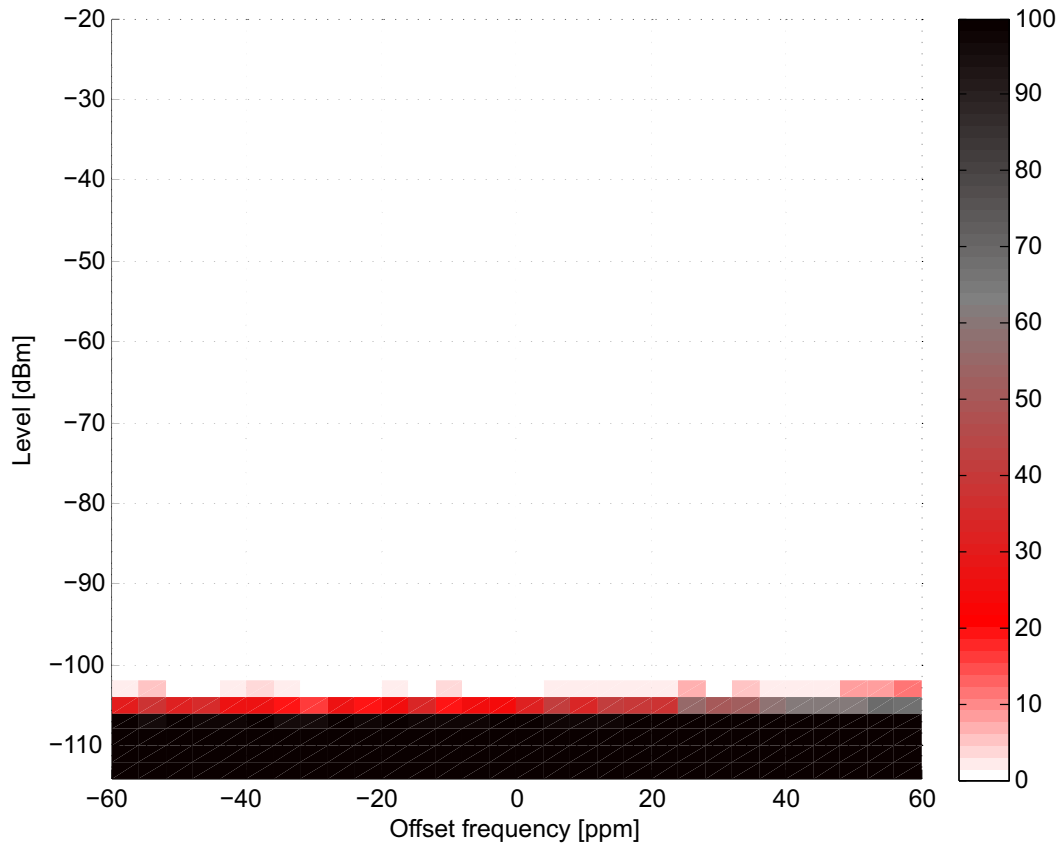


Figure 5. 32.113 kcps, ±40 kHz, 20-Byte Payload

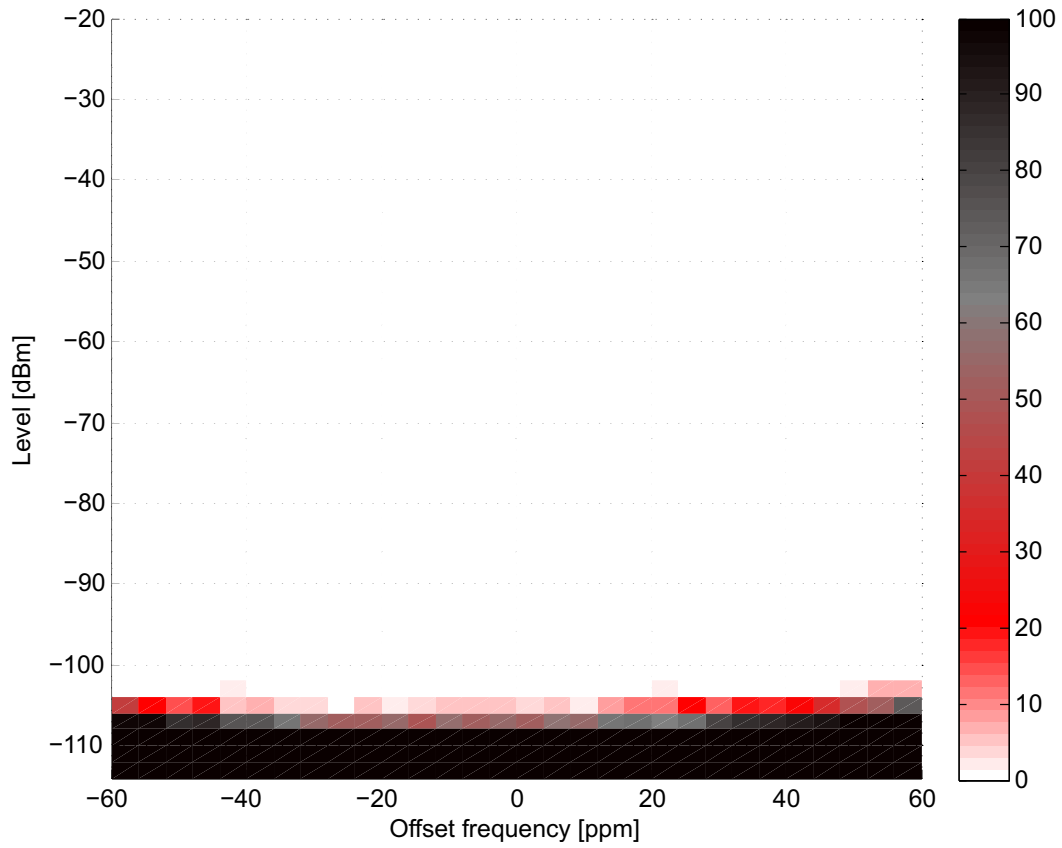


Figure 6. 33.423 kcps, ±80 kHz, 20-Byte Payload

6 References

1. Texas Instruments, [CC13xxEM-7793_4L](#), Reference Design
2. European Standard, EN 13757-4:2012: Communication System for Meters and Remote Reading of Meters
3. Texas Instruments, [SWRA512.zip](#) (.zip file with recommended settings and overrides)
4. Texas Instruments, [SmartRF Studio 7](#)
5. Texas Instruments, [SimpleLink CC13x0 Software Development Kit](#)

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (March 2017) to A Revision	Page
• Updated the associated zip file for this document.	1

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