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.

Contents

List of Figures

List of Tables

Trademarks

SimpleLink, SmartRF are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

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
	loDivider	0x05
CMD_FS	Frequency	0x0364
	fractFreq	0x4CCC
CMD_PROP_TX	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.

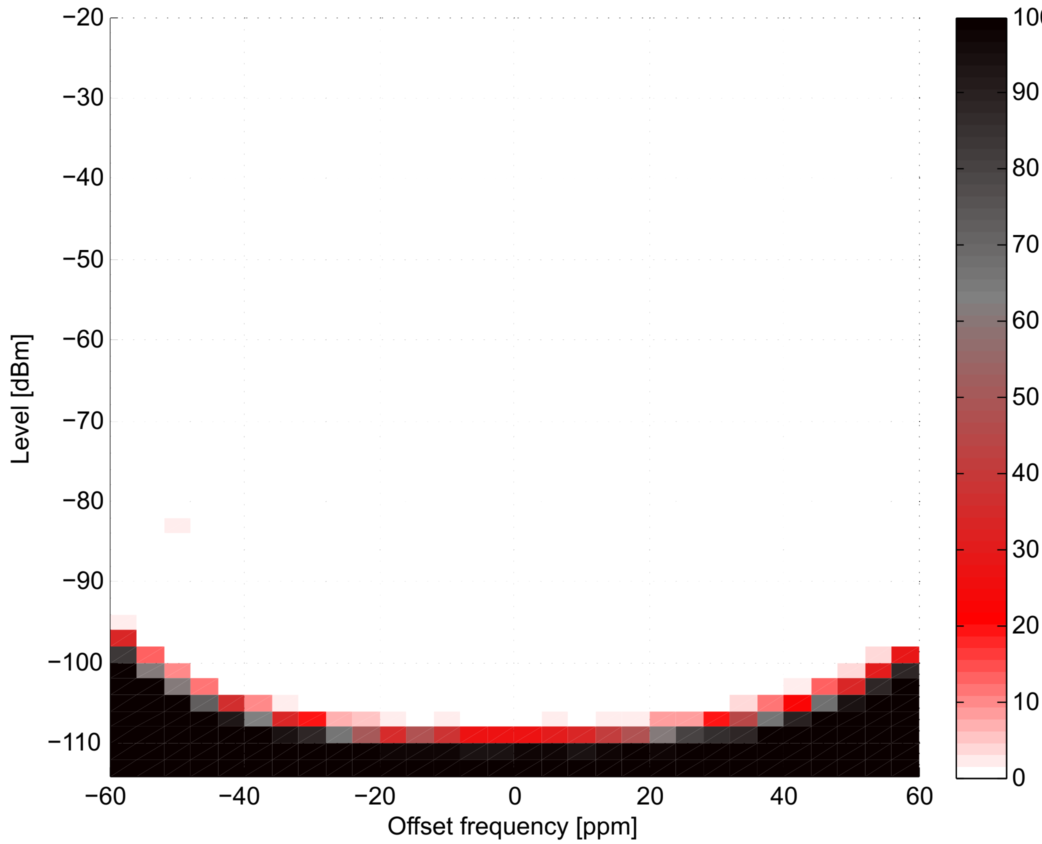

Figure 1. 32.768 kcps, ±50 kHz, 20-Byte Payload

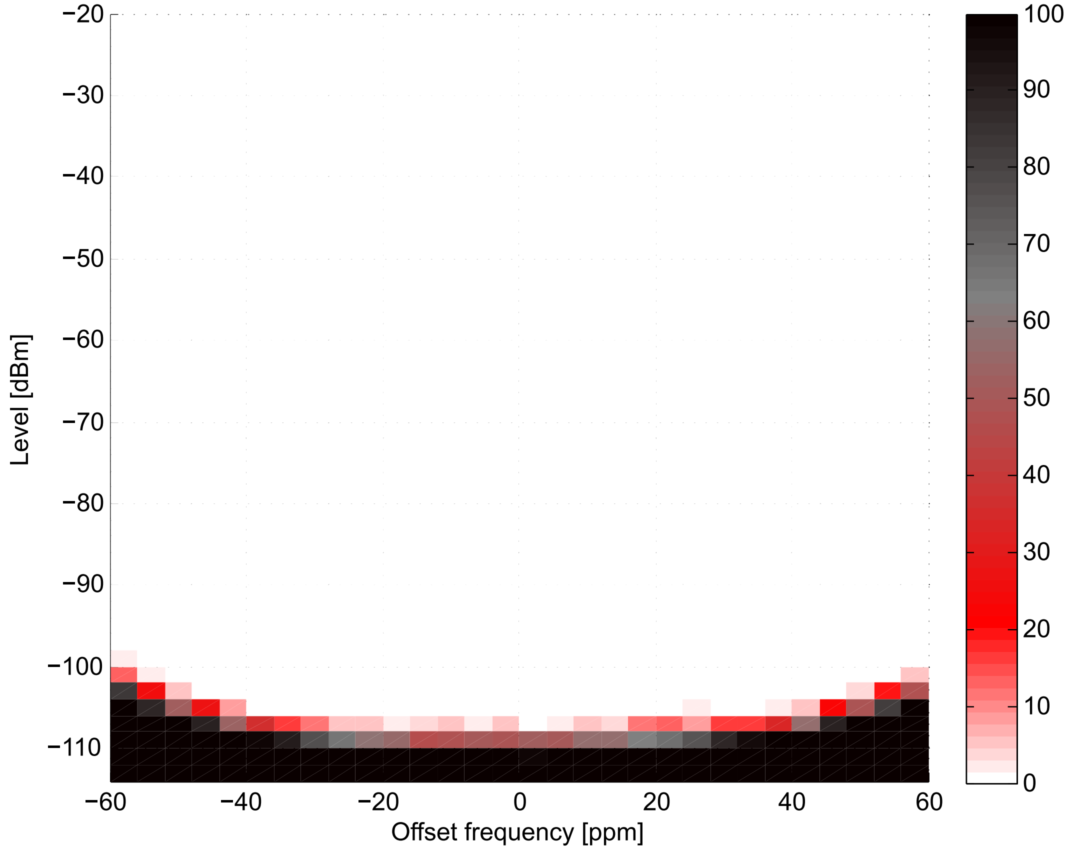

Figure 2. 32.113 kcps, ±40 kHz, 20-Byte Payload

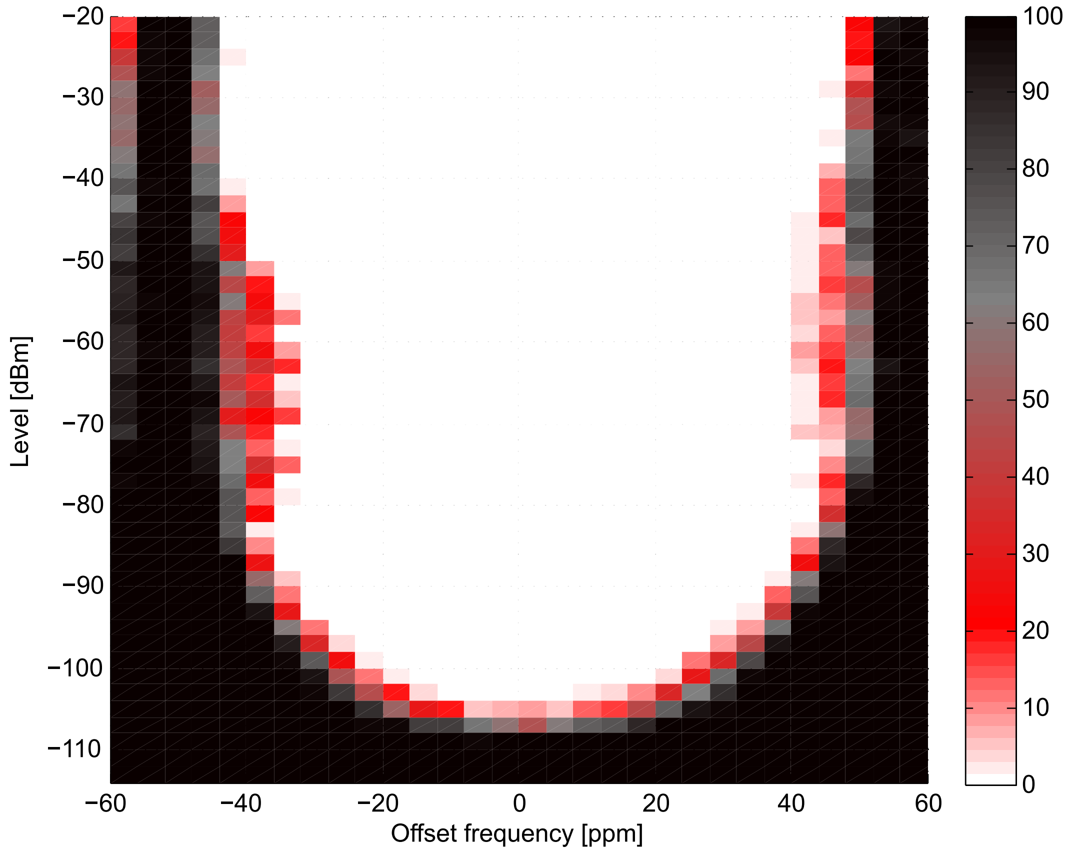

Figure 3. 33.423 kcps, ±80 kHz, 20-Byte Payload

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.

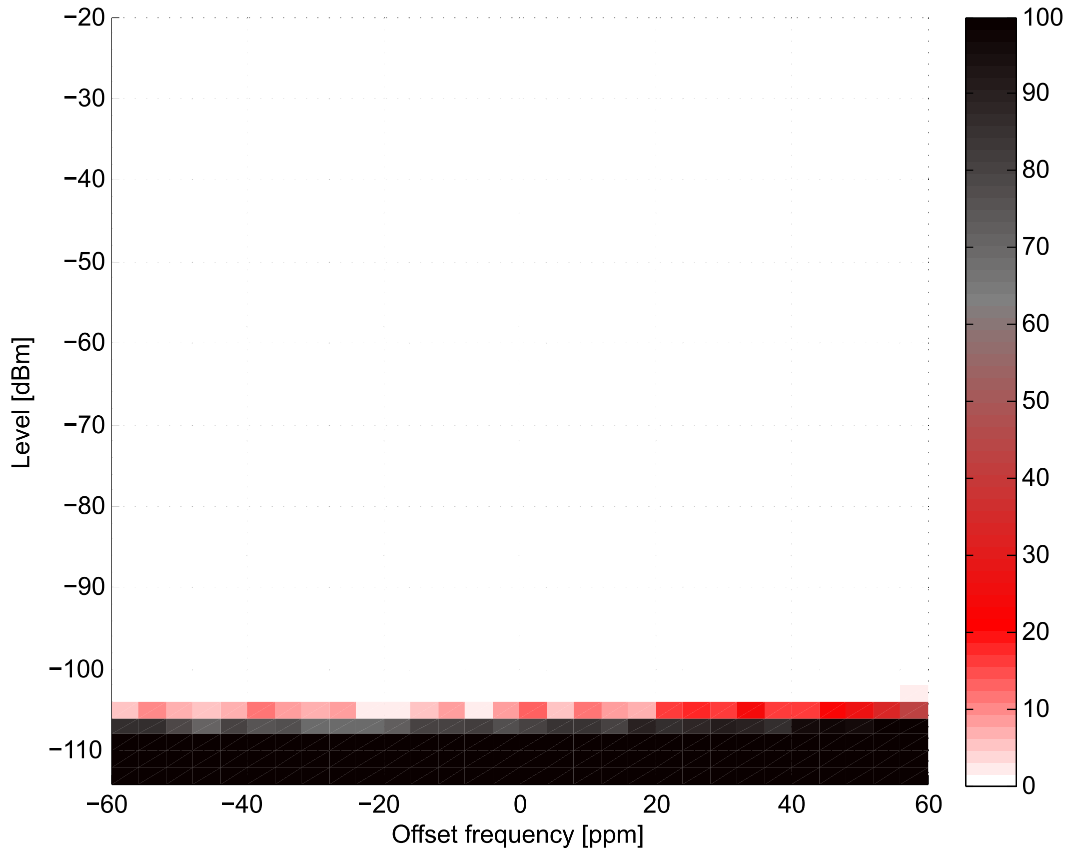

Figure 4. 32.768 kcps, ±50 kHz, 20-Byte Payload

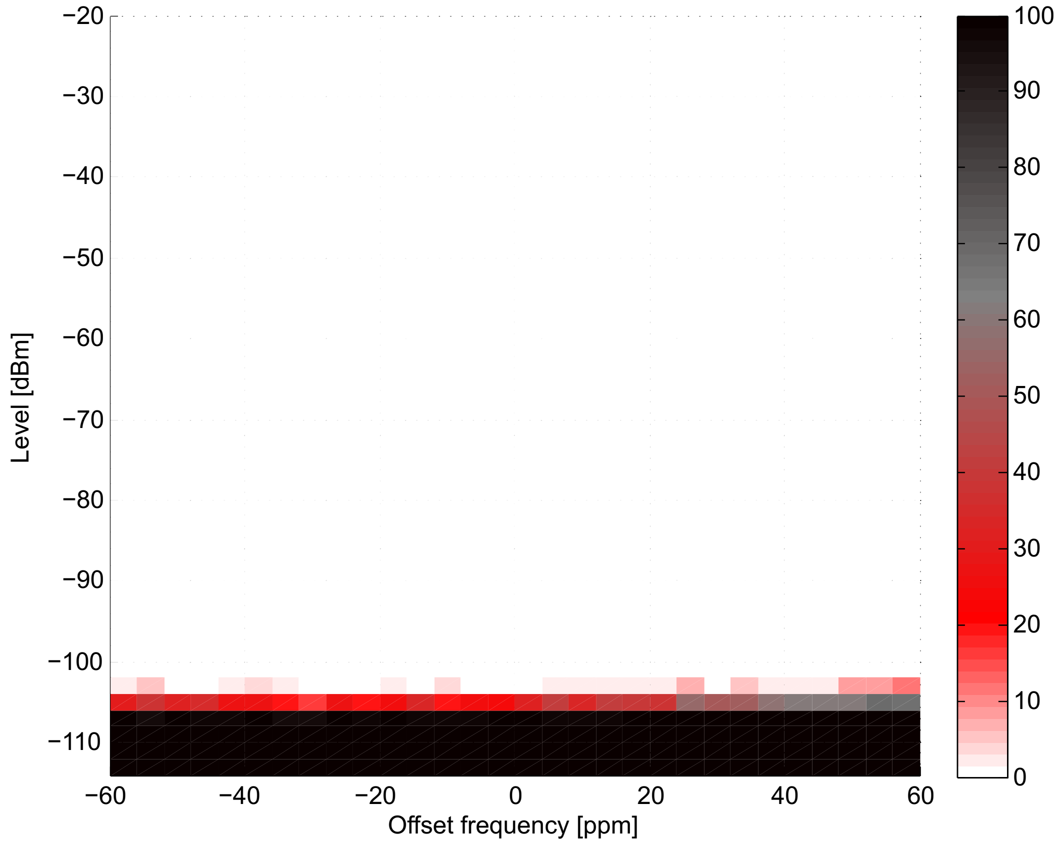

Figure 5. 32.113 kcps, ±40 kHz, 20-Byte Payload

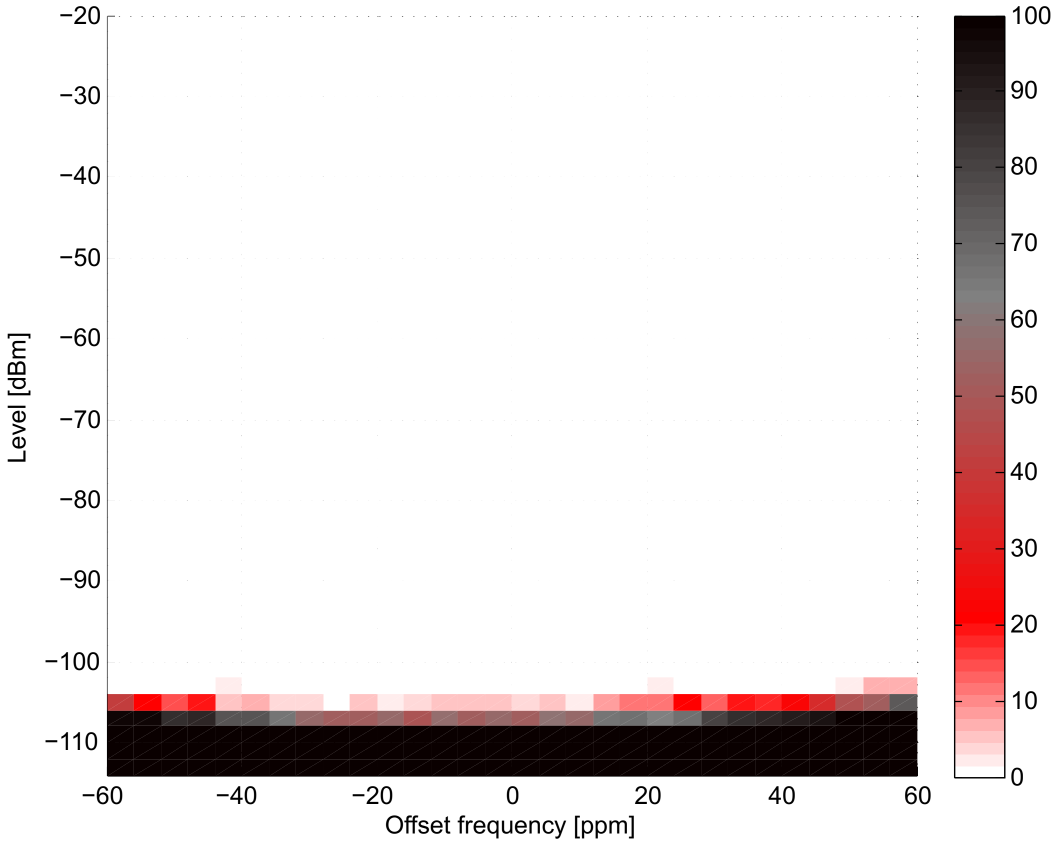

Figure 6. 33.423 kcps, ±80 kHz, 20-Byte Payload

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

IMPORTANT NOTICE AND DISCLAIMER