AN1076: EFR32FG1x Wireless M-Bus Performance Measurement Results

This application note explains the Wireless M-Bus modes and the corresponding measurement results.

KEY POINTS

- Provides an overview of the EFR32FG1x measurement results
- Discusses radio link requirements for Wireless M-Bus (WMBUS) modes
- Shows WMBUS measurement results
- Provides information on the ETSI maximum usable sensitivity limit, blocking limits, and desired level for blocking measurements
- Discusses Wireless M-Bus PHY measurement configuration
- EFR32FG1x SoCs meet the Wireless M-Bus specification requirements

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1. Summary

EFR32FG1x SoCs meet the Wireless M-Bus specification requirements.

Table 1.1. EFR32FG1x Measurement Results

Mode	Parameter	EFR32FG1 Results	EFR32FG12, EFR32FG13 and EFR32FG14 Results	Comments
T1, T2	80% PER Sensitivity (Meter-to-Other) (Other-to-Meter)	-104.6 dBm -107.6 dBm	-103.7 dBm -107.2 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	Adj. Ch. Selectivity > 40 dB (Meter-to-Other) (Other-to-Meter)	± 350 kHz ± 280 kHz	± 400 kHz ± 250 kHz	Meets WMBUS Specifications
	2 MHz Blocking (Meter-to-Other) (Other-to-Meter)	53 dB 59 dB	56 dB 63 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking (Meter-to-Other) (Other-to-Meter)	68 dB 72 dB	74 dB 78 dB	Meets ETSI CAT II Specifications
C1, C2	80% PER Sensitivity (Meter-to-Other) (Other-to-Meter)	-107.4 dBm -108.8 dBm	-106.5 dBm -108.1 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	2 MHz Blocking (Meter-to-Other) (Other-to-Meter)	59 dB 57 dB	61 dB 62 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking (Meter-to-Other) (Other-to-Meter)	71 dB 70 dB	76 dB 78 dB	Meets ETSI CAT II Specifications
N2g	80% PER Sensitivity	-115.4 dBm	-116.3 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	2 MHz Blocking	56 dB	63 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	71 dB	81 dB	Meets ETSI CAT II Specifications

Mode	Parameter	EFR32FG1 Results	EFR32FG12, EFR32FG13 and EFR32FG14 Results	Comments
N1a	80% PER Sensitivity	-119.9 dBm	-119.6 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	42 dB	42 dB	Meets WMBUS Specifications
	±2 MHz Blocking	67 dB	66 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	77 dB	85 dB	Meets ETSI CAT II Specifications
N1c	80% PER Sensitivity	-120.9 dBm	-120.4 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	41 dB	44 dB	Meets WMBUS Specifications
	±2 MHz Blocking	67 dB	65 dB	Meets WMBUS Specifications
	±10 MHz Blocking	78 dB	86 dB	Meets ETSI CAT II Specifications
S	80% PER Sensitivity	-108.0 dBm	-107.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 260 kHz	± 250 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	64 dB	63 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	71 dB	71 dB	Meets ETSI CAT II Specifications
R	80% PER Sensitivity	-116.5 dBm	-116.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	±60 kHz Selectivity	57 dB	53 dB	Meets WMBUS Specifications
	±2 MHz Blocking	70 dB	74 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	80 dB	94 dB	Meets ETSI CAT II Specifications

Mode	Parameter	EFR32FG1 Results	EFR32FG12, EFR32FG13 and EFR32FG14 Results	Comments
F	80% PER Sensitivity	-120.5 dBm	-119.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 45 kHz	± 30 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	68 dB	71 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	83 dB	94 dB	Meets ETSI CAT II Specifications

2. Wireless M-Bus Modes

The name of a mode is specified by a letter and a number. The letter specifies a mode and the number specifies whether the modes supports unidirectional (=1) or bidirectional (=2) [1].

Modes:

- Mode S (Stationary Mode)
- Mode T (Frequent Transmit Mode)
- Mode R (Frequent Receive Mode)
- Mode C (Compact Mode)
- Mode N (Narrowband VHF)
- Mode F (Frequent Receive and Transmit Mode)

Table 2.1. Wireless M-Bus Modes [1]

Modes and Sub-Modes	WAY	Chip-rate kcps	Data Coding
S1	1	32.768	Manchester
S1-m	1	32.768	Manchester
S2	2	32.768	Manchester
T1	1	100	3-to-6
T2	2	100 (Meter) 32.768 (Other)	3-to-6 / Manchester
R2	2	4.8	Manchester
C1	1	100	NRZ
C2	2	100 (Meter) 50 (Other)	NRZ
N1a-f	1	2.4 or 4.8	NRZ
N2a-f	2	2.4 or 4.8	NRZ
N2g	2	9.6 (19.2 kbps)	NRZ
F2-m	2	2.4	NRZ
F2	2	2.4	NRZ

2.1 Radio Link Requirements for Mode T

Table 2.2. Mode T2 only, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0.8)	H_R	P_O	-100	-105		dBm	
Blocking Performance	L_R		-	3	-	Category	
Blocking Performance	M_R		-	2	-	Category	
Blocking Performance	H_R		-	2	-	Category	
Acceptable Header Chip Rate Range: (Other)	T1,T2	f_{chip}	88	100	112	kbps	±12%
Acceptable Chip Rate Variation During Header and Frame: (Other)	T1,T2	D_{chip}	-	0	±2	%	
Acceptable Chip Rate Tolerance	T2	D_{chip}	-		±2	%	
Chip Rate (Meter)	T2	f_{chip}	-	32,768	-	kcps	
Acceptable Chip Rate Tolerance (Meter)	T2	D_{fchip2}	-	0	±2	%	

Notes:

1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40 dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

2.2 Radio Link Requirements for Mode C

Table 2.3. Mode C, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0.8) (Other Device)	H_R	P_O	-100	-105		dBm	
Sensitivity (BER < 10^{-2}) or (PER < 0.8) (Meter)	H_R	P_O	-95			dBm	
Blocking Performance	L_R		-	3	-	Category	
Blocking Performance	M_R		-	2	-	Category	
Blocking Performance	H_R		-	2	-	Category	

Notes:
1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

2.3 Radio Link Requirements for Mode N

Table 2.4. Mode N, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0.8) (Other Device / Meter) GFSK	H_R	P_O	-115	-123		dBm	2.4 kbps
Sensitivity (BER < 10^{-2}) or (PER < 0.8) (Other Device / Meter) GFSK	H_R	P_O	-112	-120		dBm	4.8 kbps
Sensitivity (BER < 10^{-2}) or (PER < 0.8) (Other Device / Meter) 4GFSK	H_R	P_O	-104	-107		dBm	19.2 kbps
	L_R		-	3	-	Category	
Blocking Performance	M_R		-	2	-	Category	
Blocking Performance	H_R		-	2	-	Category	

Notes:
1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40 dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

2.4 Radio Link Requirements for Mode S

Table 2.5. Mode S, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0,8) [1]	H_R	P_O	−100	−105		dBm	
Blocking Performance[2]	L_R		3			Category	
Blocking Performance[2,3]	M_R		2			Category	
Blocking Performance[2,3,4]	H_R		2			Category	
Acceptable chip rate tolerance		D_{fchip}			±2	%	
Chip rate (Meter)		f_{fchip}		32,768		kcps	

Notes:
1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40 dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

2.5 Radio Link Requirements for Mode R

Table 2.6. Mode R, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0,8) [1]	H_R	P_O	−105	−110		dBm	
Blocking Performance[2]	L_R		3			Category	
Blocking Performance[2,3]	M_R		2			Category	
Blocking Performance[2,3,4]	H_R		2			Category	
Acceptable chip rate range		D_{fchip}	4,7	4,8	4,9	kcps	~ ±2
Acceptable chip rate variation during header and frame		Df_{chip}		0	±0,2	%	

Notes:
1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40 dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

2.6 Radio Link Requirements for Mode F

Table 2.7. Mode F, Receiver [1]

Characteristic	Class	Symbol	Min	Typ	Max	Unit	Note
Sensitivity (BER < 10^{-2}) or (PER < 0,8) [1]	H_R	P_O	−105	−117		dBm	2,4 kbps
Blocking Performance[2]	L_R		3			Category	
Blocking Performance[2,3]	M_R		2			Category	
Blocking Performance[2,3,4]	H_R		2			Category	

Notes:
1. At a frame size of 20 bytes.
2. Receiver category according to ETSI EN 300 220-1, V2.4.1:2012, 4.1.1.
3. Additional requirement for Class M_R and H_R receivers: The equipment shall meet the immunity requirements as specified in ETSI EN 301 498-1, V1.9.2:2011, 9.2.
4. Additional requirements for Class H_R receivers: Adjacent band selectivity shall be > 40 dB when measured according to ETSI EN 300 220-1, V2.4.1:2012, 8.3.

3. Wireless M-Bus Measurement Results

3.1 EFR32FG1

3.1.1 T Mode

3.1.1.1 From-Meter Receiver Sensitivity
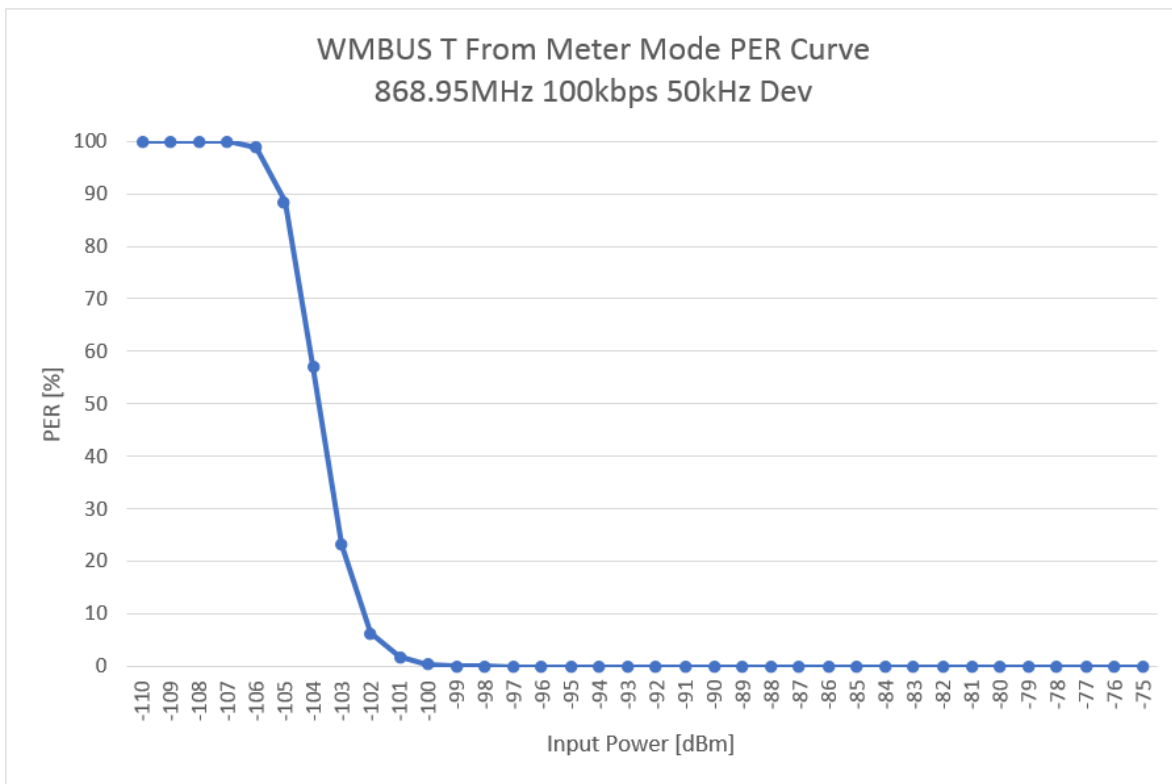
Figure 3.1. EFR32FG1 T From-Meter Mode Receiver Sensitivity PER Curve

Table 3.1. EFR32FG1 T From-Meter Mode Measured Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.95 MHz	100 kbps	50 kHz	80	-104.6
			20	-102.8
			1	-100.5

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

Table 3.2. EFR32FG1 T-Mode Measured Receiver Sensitivity – Corner Conditions

Frequency	Data Rate	Frequency Deviation	Sensitivity at 80% PER
868.876 MHz	88 kbps	40 kHz	-102.5 dBm
		80 kHz	-101.3 dBm
	112 kbps	40 kHz	-103.3 dBm
		80 kHz	-101.7 dBm
869.024 MHz	88 kbps	40 kHz	-102.8 dBm
		80 kHz	-101.4 dBm
	112 kbps	40 kHz	-103.6 dBm
		80 kHz	-101.7 dBm

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm

3.1.1.2 From-Meter Receiver Frequency Error Tolerance

The following figures show the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm, frequency tolerance limits are ±85 ppm (±74 kHz).
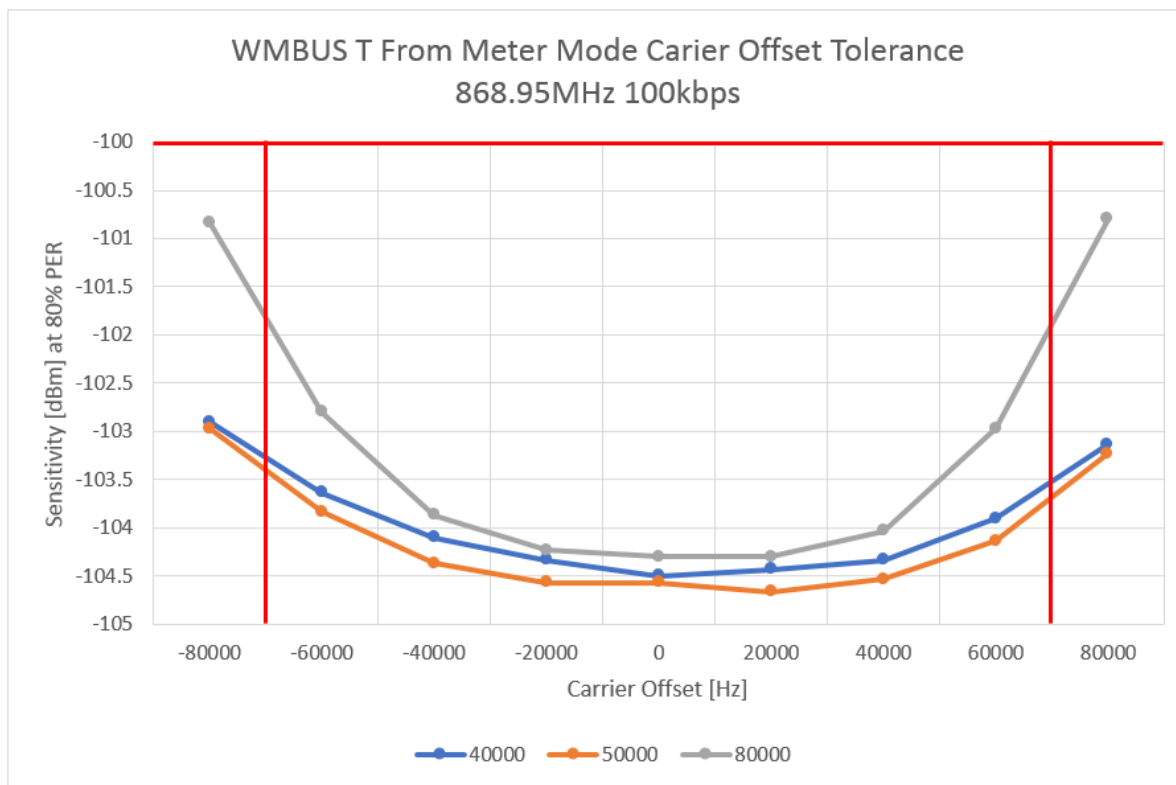
Figure 3.2. EFR32FG1 T From-Meter Mode 100 kbps Receiver Frequency Error Tolerance
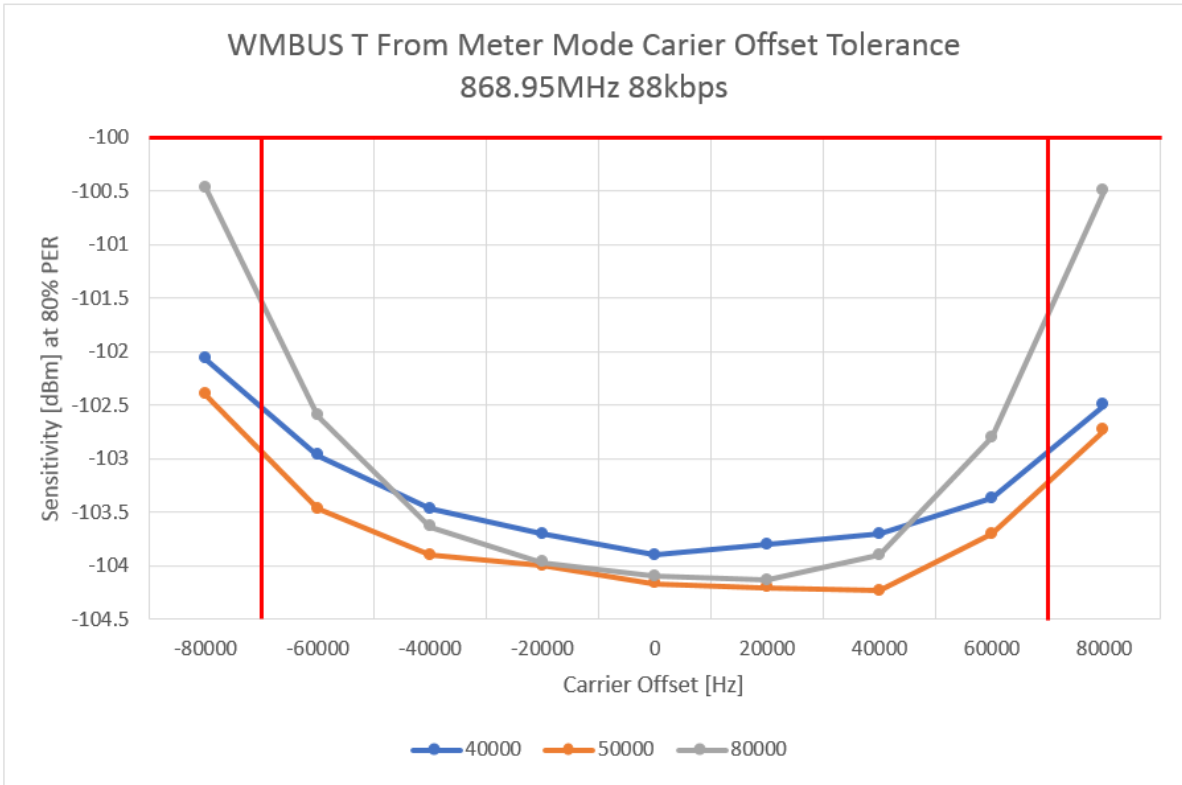
Figure 3.3. EFR32FG1 T From-Meter Mode 88 kbps Receiver Frequency Error Tolerance
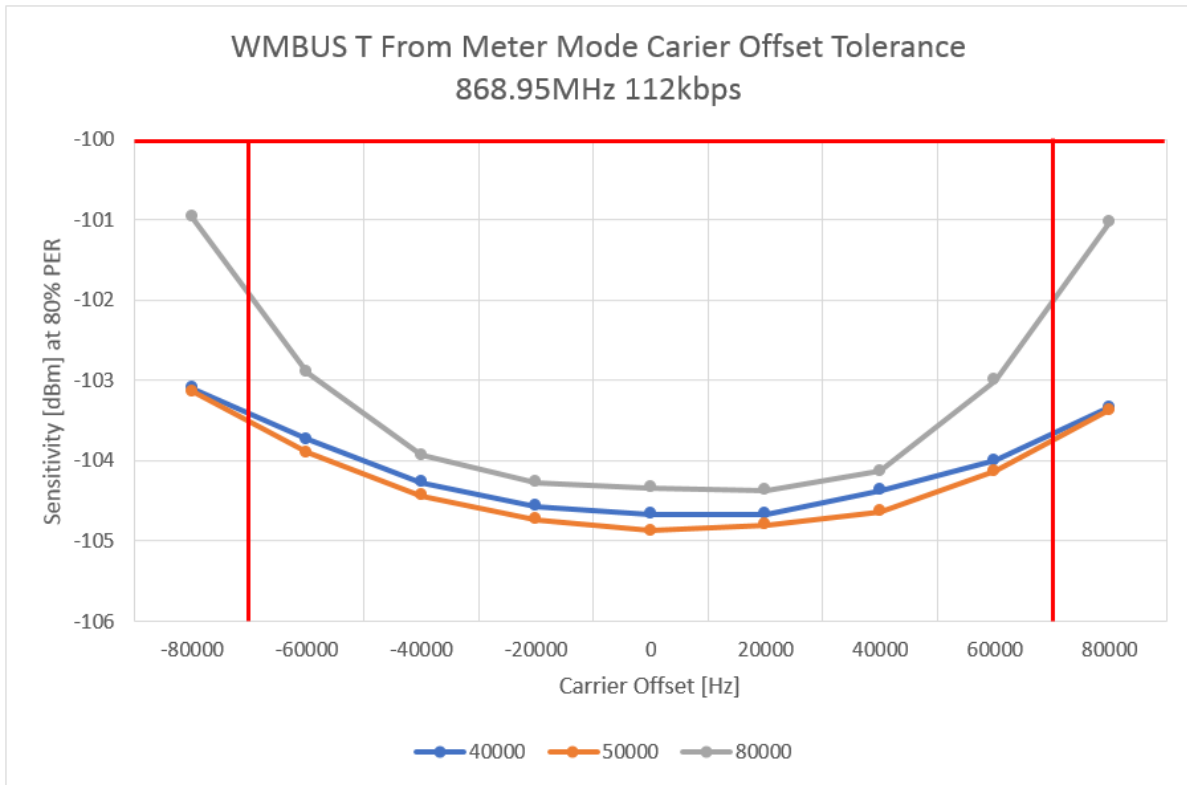
Figure 3.4. EFR32FG1 T From-Meter Mode 112 kbps Receiver Frequency Error Tolerance

3.1.1.3 From-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset.

FprEN 13757-4:2013 T Mode Acceptable header chip rate range is ±12 % (± 12 kcps).

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
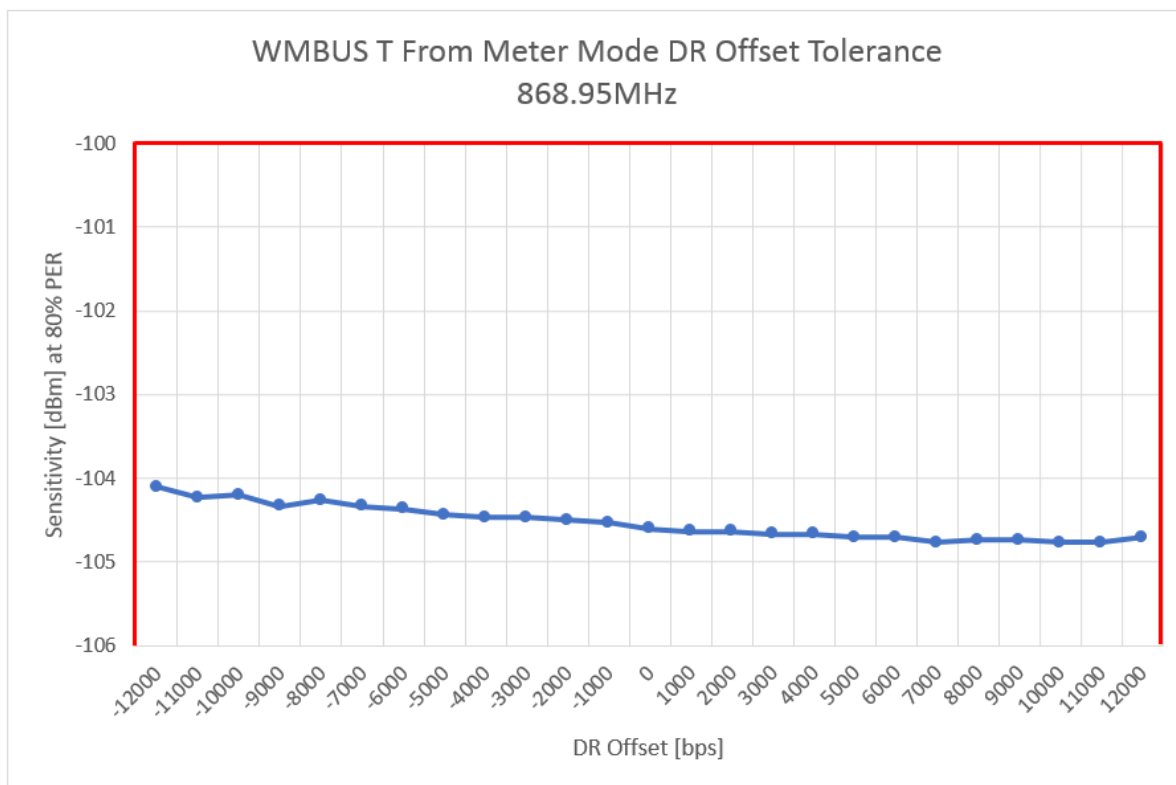
Figure 3.5. EFR32FG1 T From-Meter Mode Receiver Data Rate Error Tolerance

3.1.1.4 From-Meter Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 T Mode FSK Deviation limits is -10 kHz & 30 kHz.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
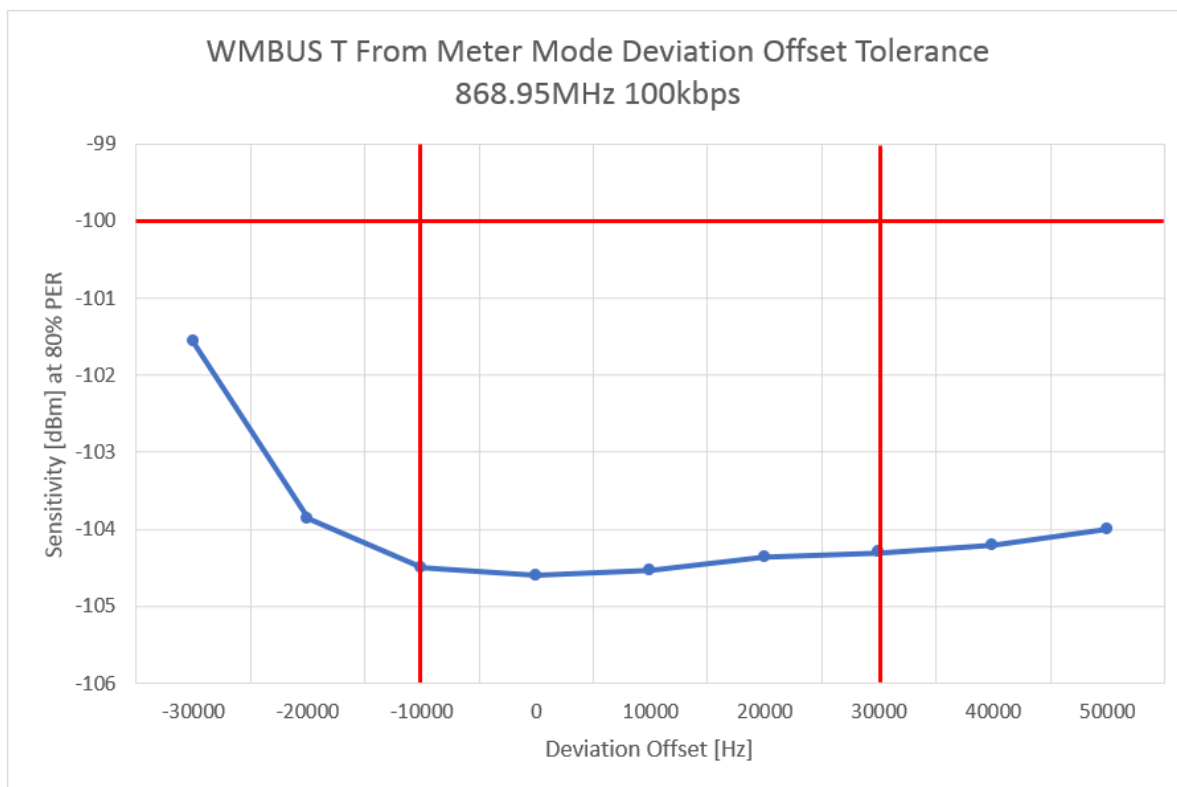
Figure 3.6. EFR32FG1 T From-Meter Mode Receiver Deviation Error Tolerance

3.1.1.5 From-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±350 kHz.

Table 3.3. EFR32FG1 T From-Meter Mode ETSI CAT II Blocking Performance [5.3]

Frequency Offset	Measurement	Limit
±2 MHz	53 dB	>22 dB
±10 MHz	68 dB	>47 dB
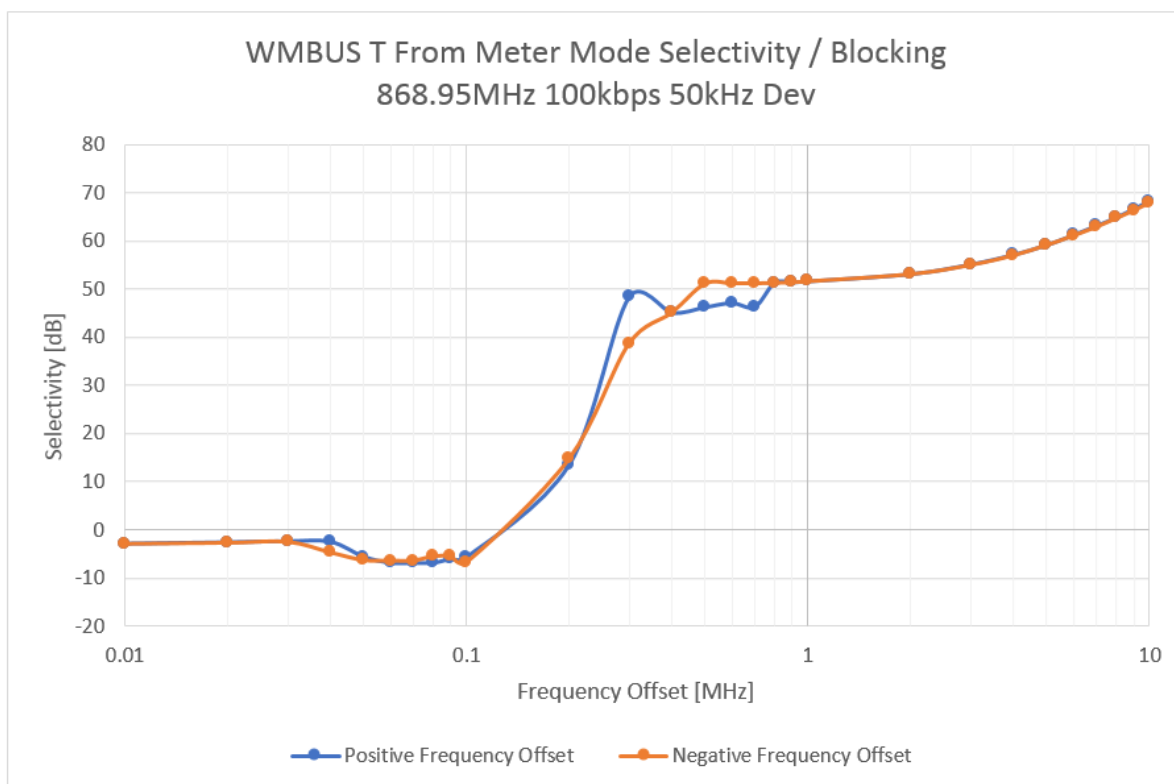
Figure 3.7. EFR32FG1 T From-Meter Mode Receiver Selectivity

3.1.1.6 To-Meter Receiver Sensitivity
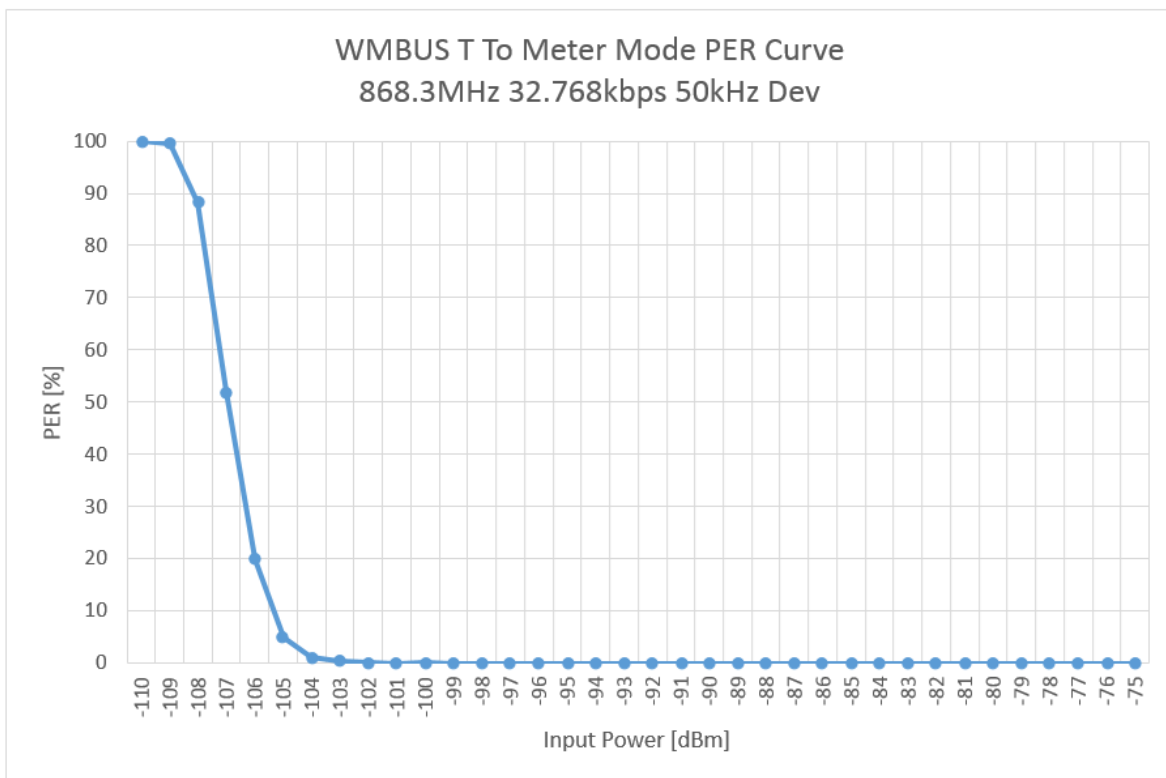
Figure 3.8. EFR32FG1 T To-Meter Mode Receiver Sensitivity PER Curve

Table 3.4. EFR32FG1 T To-Meter Mode Measured Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.3 MHz	32.768 kbps	50 kHz	80	-107.6
			20	-106.0
			1	-103.8

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.1.1.7 To-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm. Frequency tolerance limits are ±85 ppm (±74 kHz).
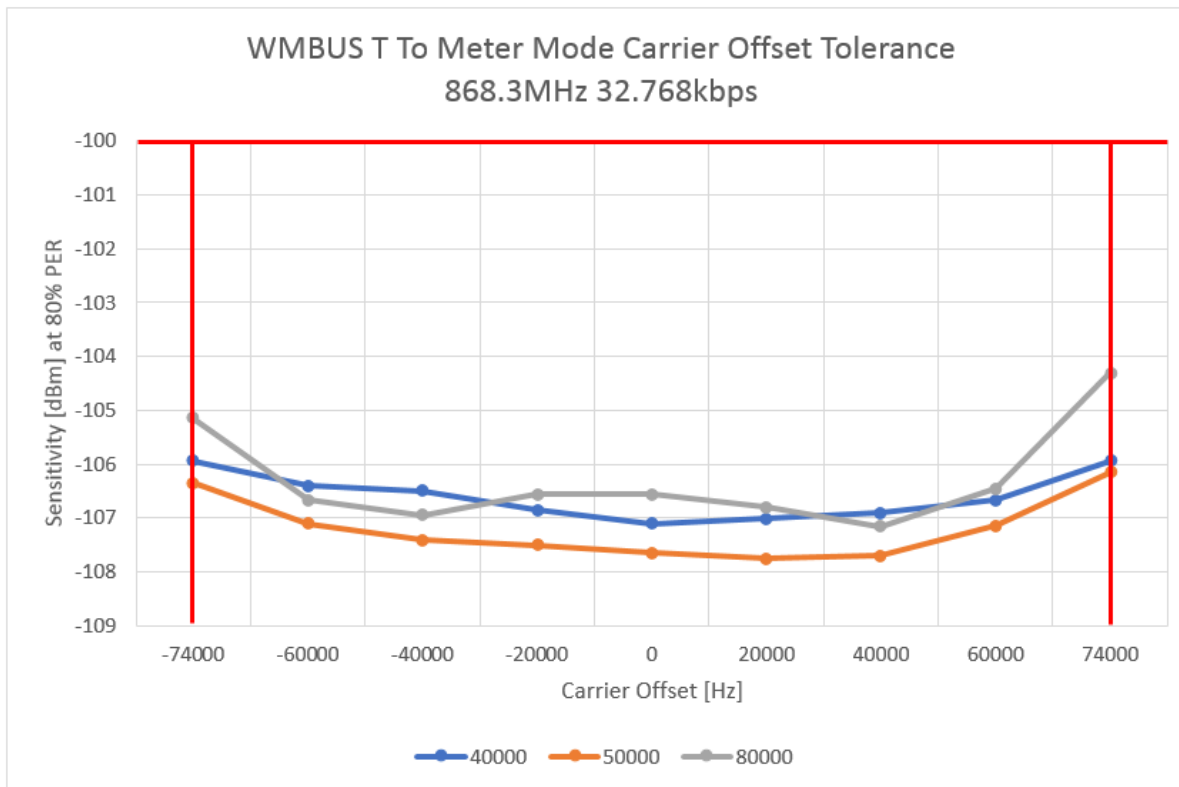
Figure 3.9. EFR32FG1 T To-Meter Mode Receiver Frequency Error Tolerance

3.1.1.8 To-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±2%. Therefore, the limit used is ± 655 bps.

FprEN 13757-4:2013 Receiver Acceptable Chip Rate Tolerance (Meter) is ±2 %.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
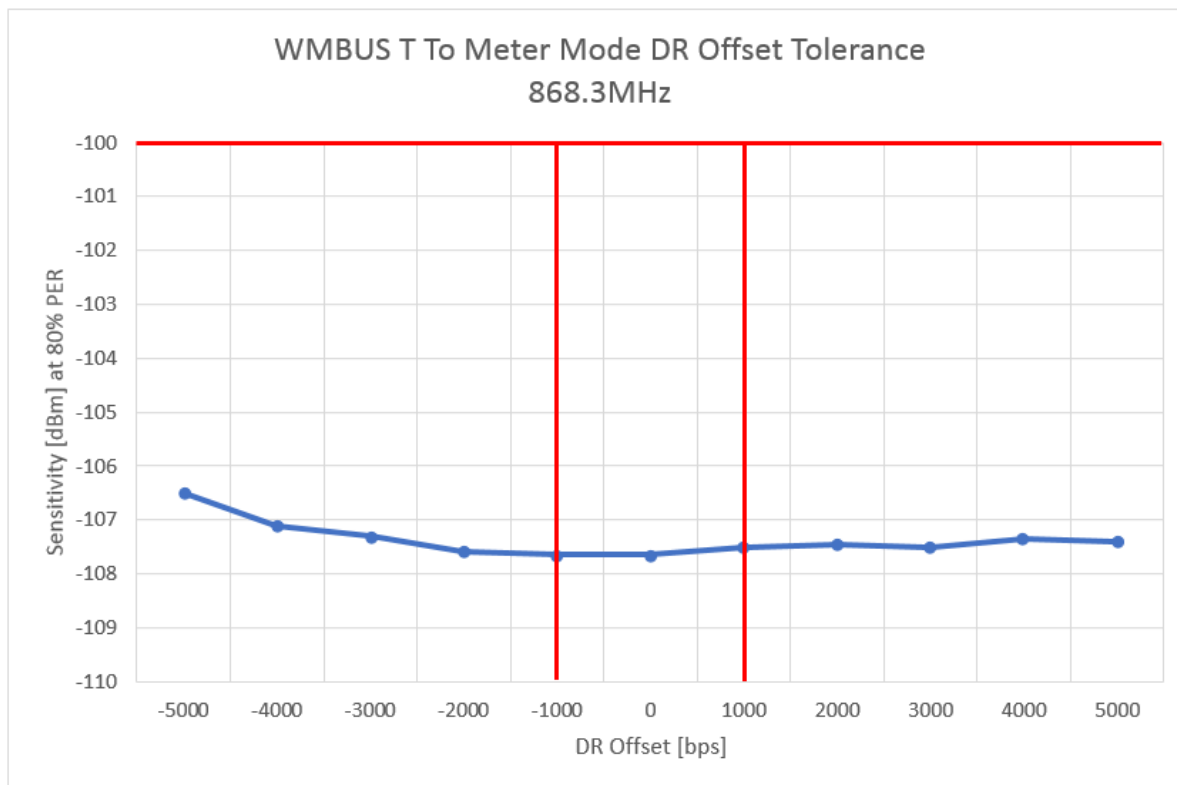
Figure 3.10. EFR32FG1 T To-Meter Mode Receiver Data Rate Error Tolerance

3.1.1.9 To-Meter Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 T Mode FSK Deviation limits are -10kHz & 30kHz.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
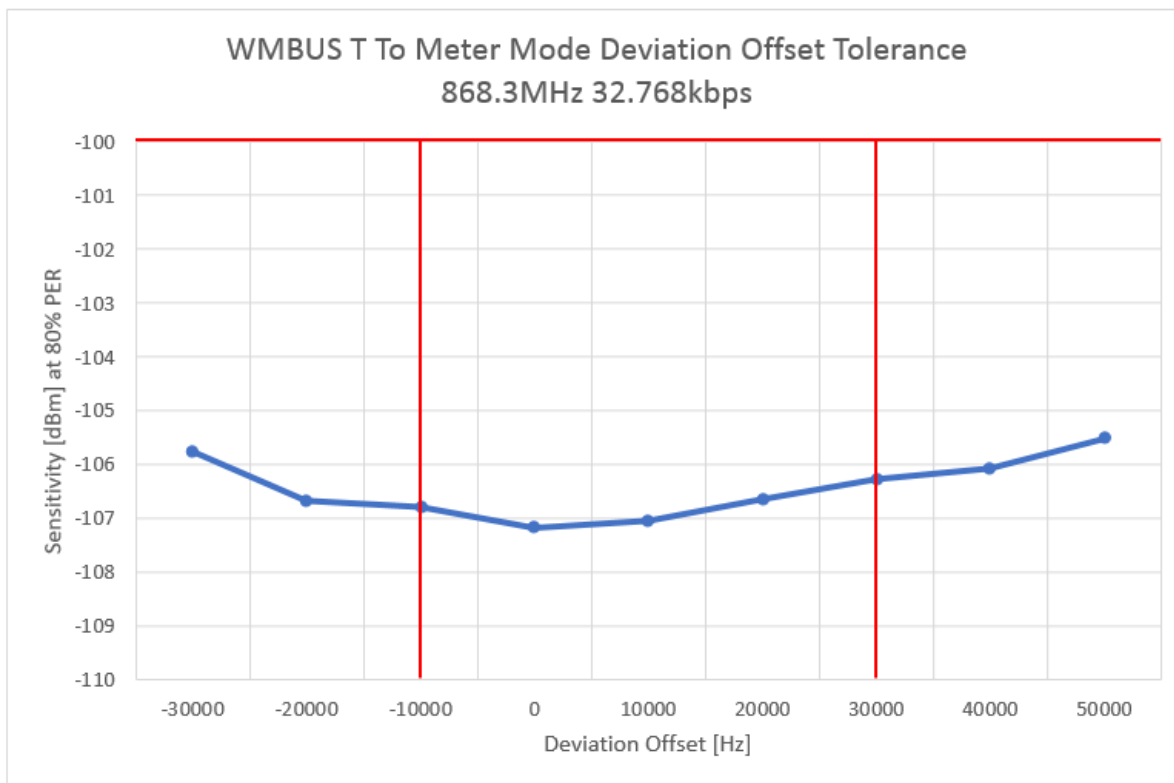
Figure 3.11. EFR32FG1 T To-Meter Mode Receiver Deviation Error Tolerance

3.1.1.10 To-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±280 kHz.

Table 3.5. EFR32FG1 T To-Meter Mode ETSI CAT II Blocking Performance [5.4]

Frequency Offset	Measurement	Limit
±2 MHz	59 dB	>22 dB
±10 MHz	72 dB	>47 dB
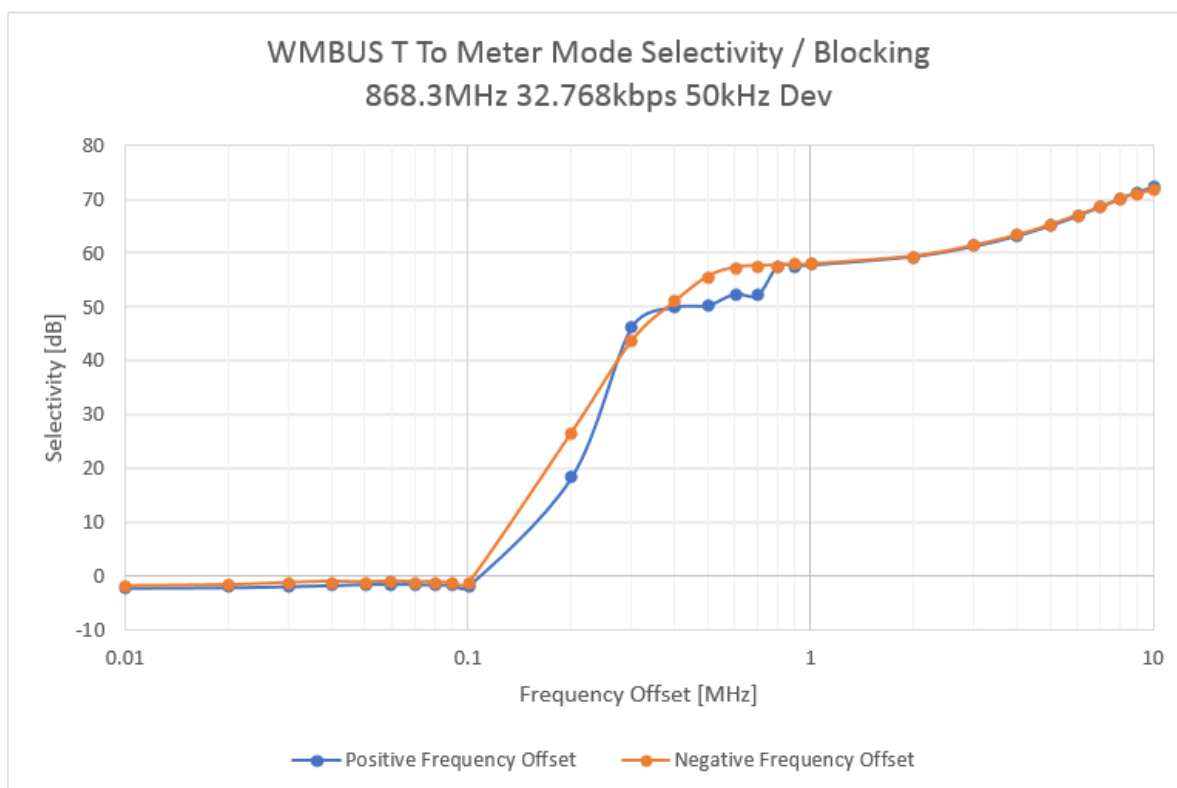
Figure 3.12. EFR32FG1 T To-Meter Mode Receiver Selectivity

3.1.1.11 Summary

Table 3.6. EFR32FG1 T Mode Summary

Mode	Parameter	Measurement Results	Comments
T1, T2	80% PER Sensitivity	(Meter-to-Other) -104.6 dBm (Other-to-Meter) -107.6 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	(Meter-to-Other) ± 350 kHz (Other-to-Meter) ± 280 kHz	Meets WMBUS Specifications
	2 MHz Blocking	(Meter-to-Other) 53 dB (Other-to-Meter) 59 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	(Meter-to-Other) 68 dB (Other-to-Meter) 72 dB	Meets ETSI CAT II Specifications

3.1.2 C Mode

3.1.2.1 From-Meter Receiver Sensitivity
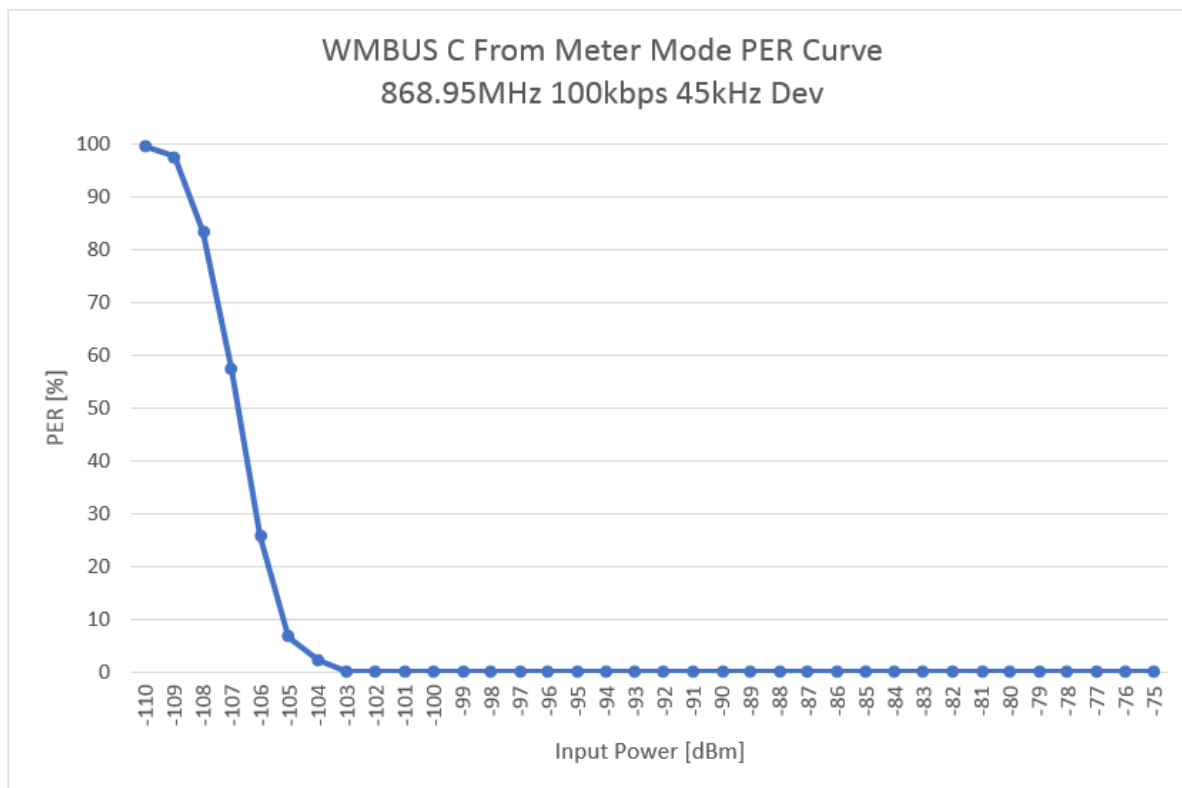
Figure 3.13. EFR32FG1 C From-Meter Mode PER Curve

Table 3.7. EFR32FG1 C From-Meter Mode 100kbps Measured Receiver Sensitivity

PER < %	Sensitivity dBm
80	-107.4
20	-105.2
1	-103.2

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

Table 3.8. EFR32FG1 C From-Meter Mode Corner Conditions Measured Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	Sensitivity at 80% PER
868.9065 MHz	100 kbps	33.75 kHz	-106.2
		56.25 kHz	-104.2
868.9935 MHz		33.75 kHz	-106.2
		56.25 kHz	-103.5

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.1.2.2 From-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (C1) will have ±25 ppm accuracy and worst case receive modes (C2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

The frequency tolerance limits are ±50 ppm (±43.5 kHz).
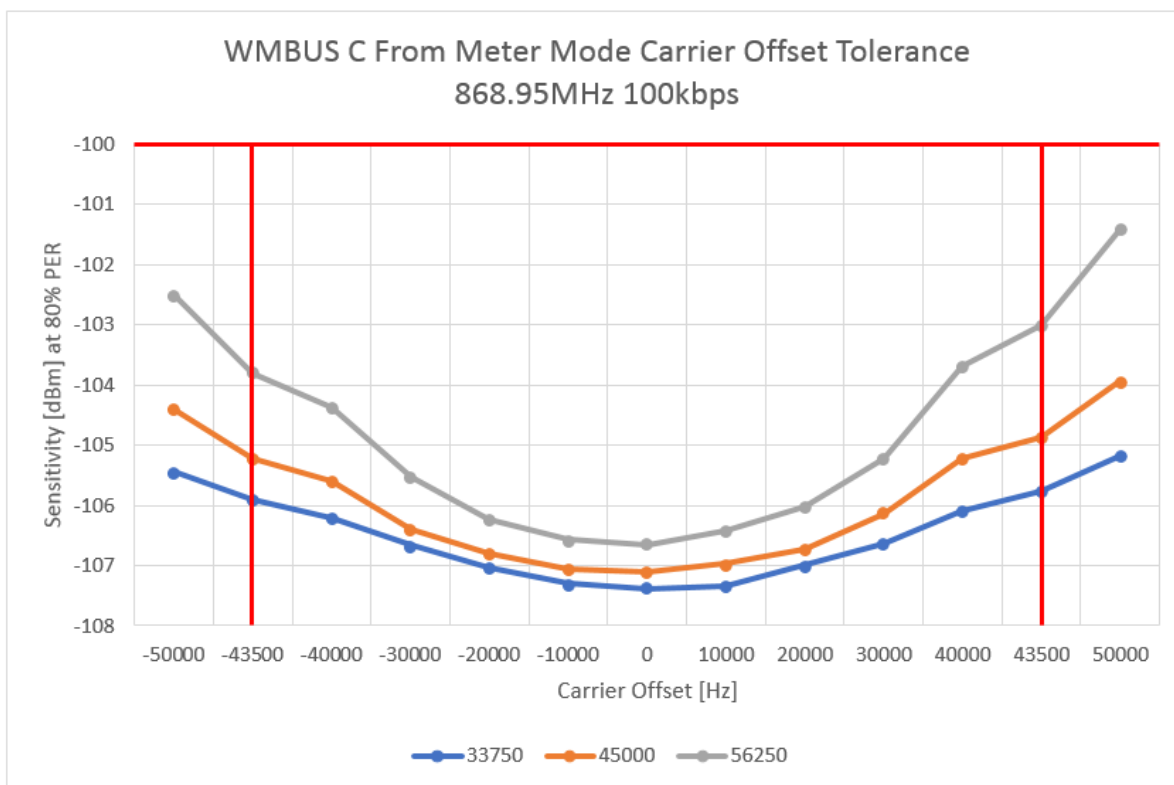
Figure 3.14. EFR32FG1 C From-Meter Mode Receiver Frequency Error Tolerance

3.1.2.3 From-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset in ppm.

FprEN 13757-4:2013 C From-Meter Mode Chip Rate Tolerance is ±100 ppm.

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
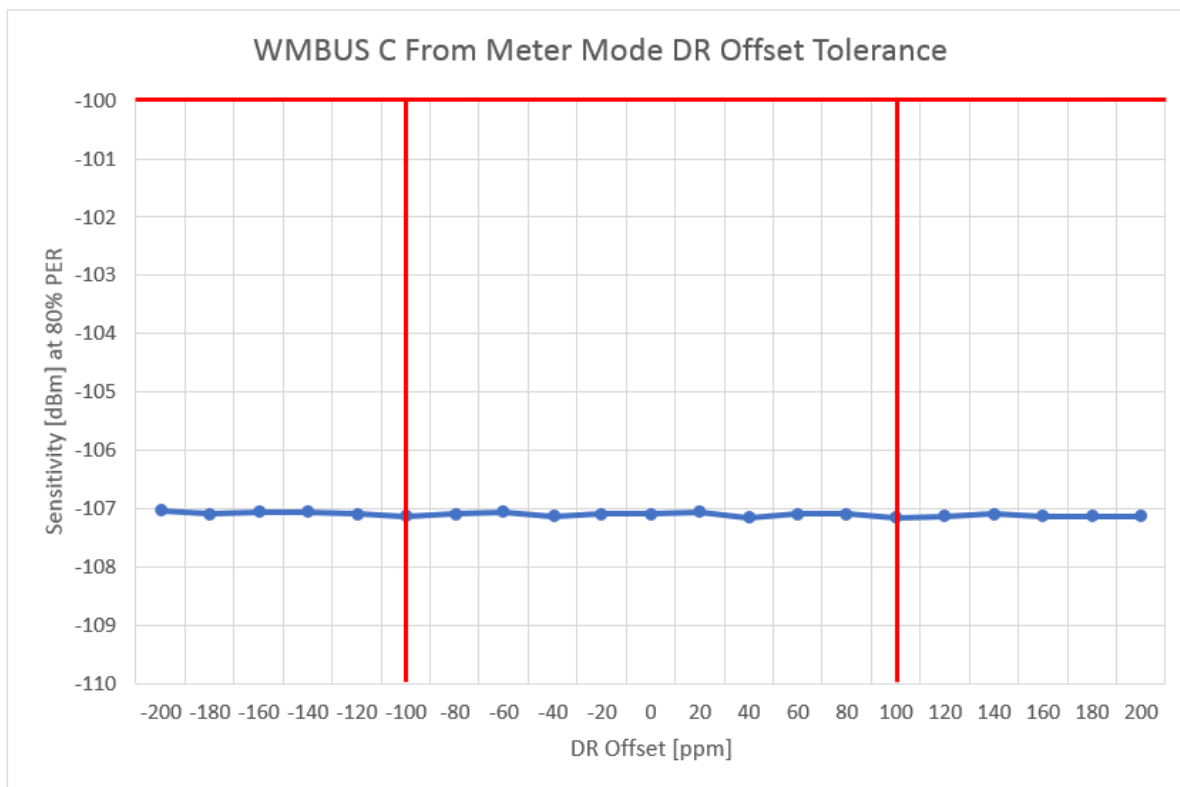
Figure 3.15. EFR32FG1 C From-Meter Mode Receiver Data Rate Error Tolerance

3.1.2.4 From-Meter Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 C From-Meter Mode FSK Deviation limits are ±11.25 kHz.

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
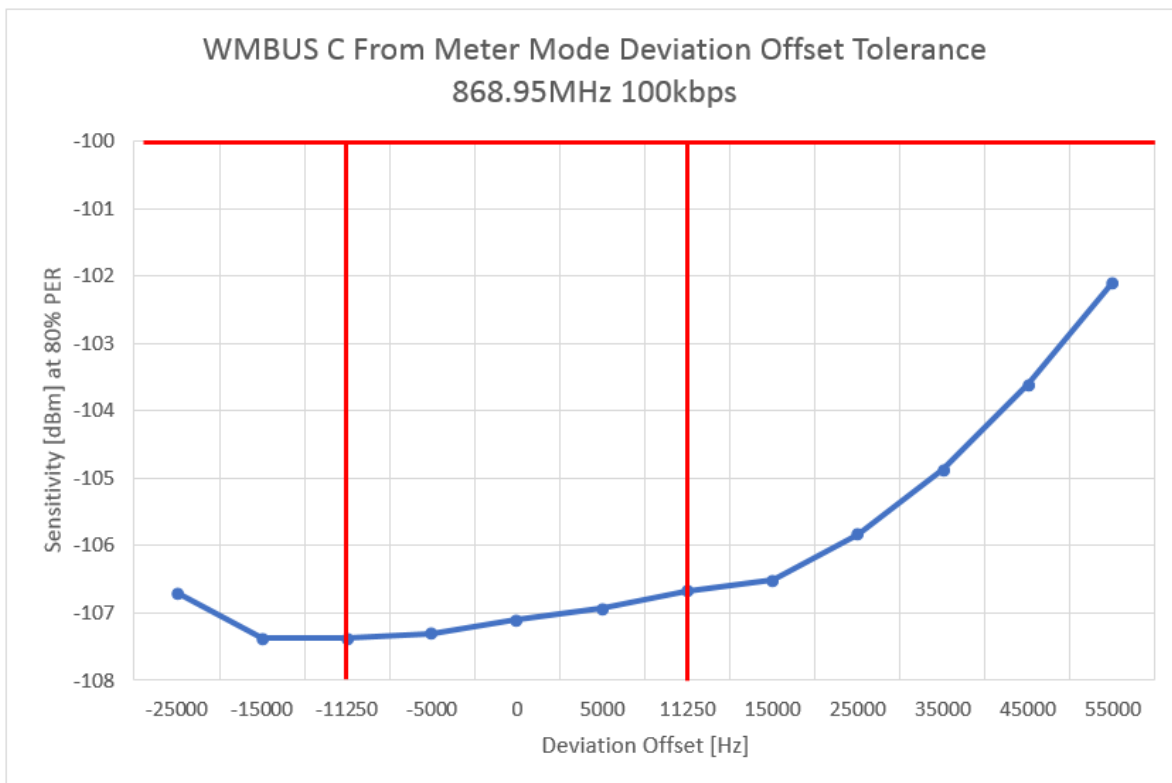
Figure 3.16. EFR32FG1 C-Mode From-Meter Mode Deviation Offset Tolerance

3.1.2.5 From-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±180 kHz.

Table 3.9. EFR32FG1 C From-Meter Mode ETSI CAT II Blocking Performance [5.5]

Frequency Offset	Measurement	Limit
±2 MHz	59 dB	>24 dB
±10 MHz	71 dB	>49 dB
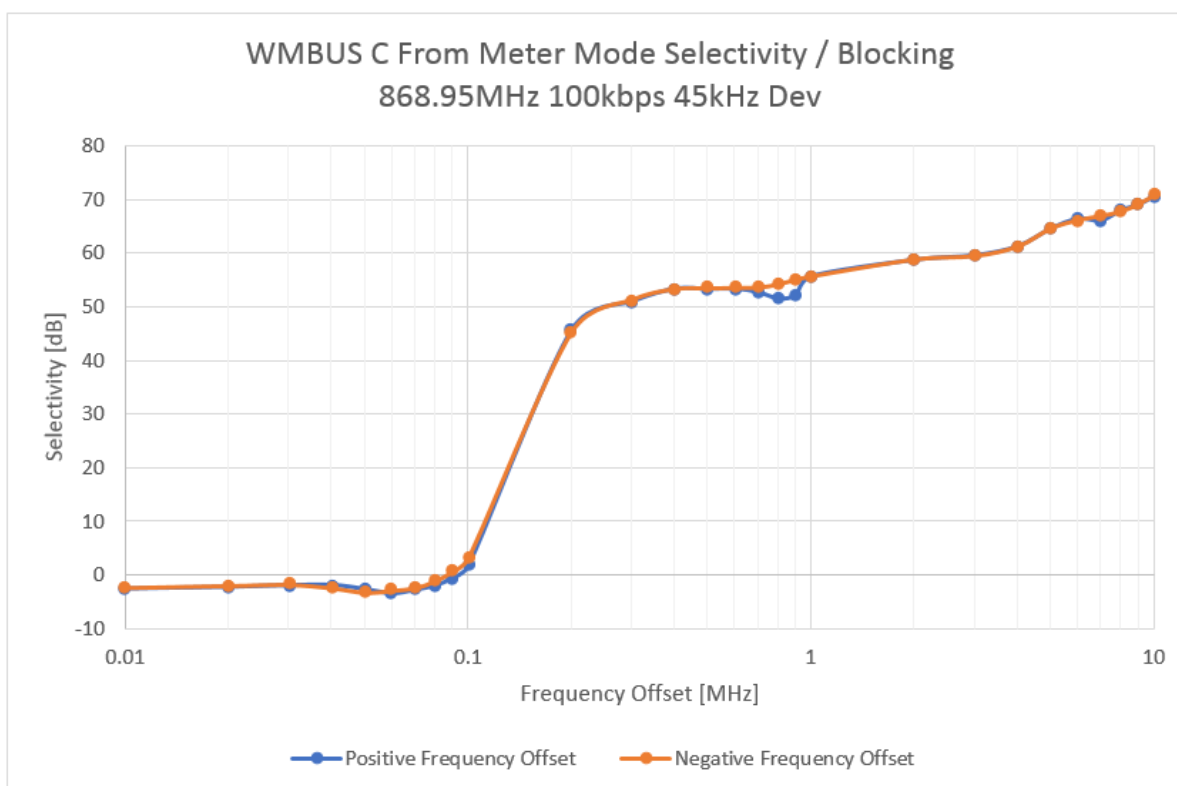
Figure 3.17. EFR32FG1 C From-Meter Mode Receiver Selectivity

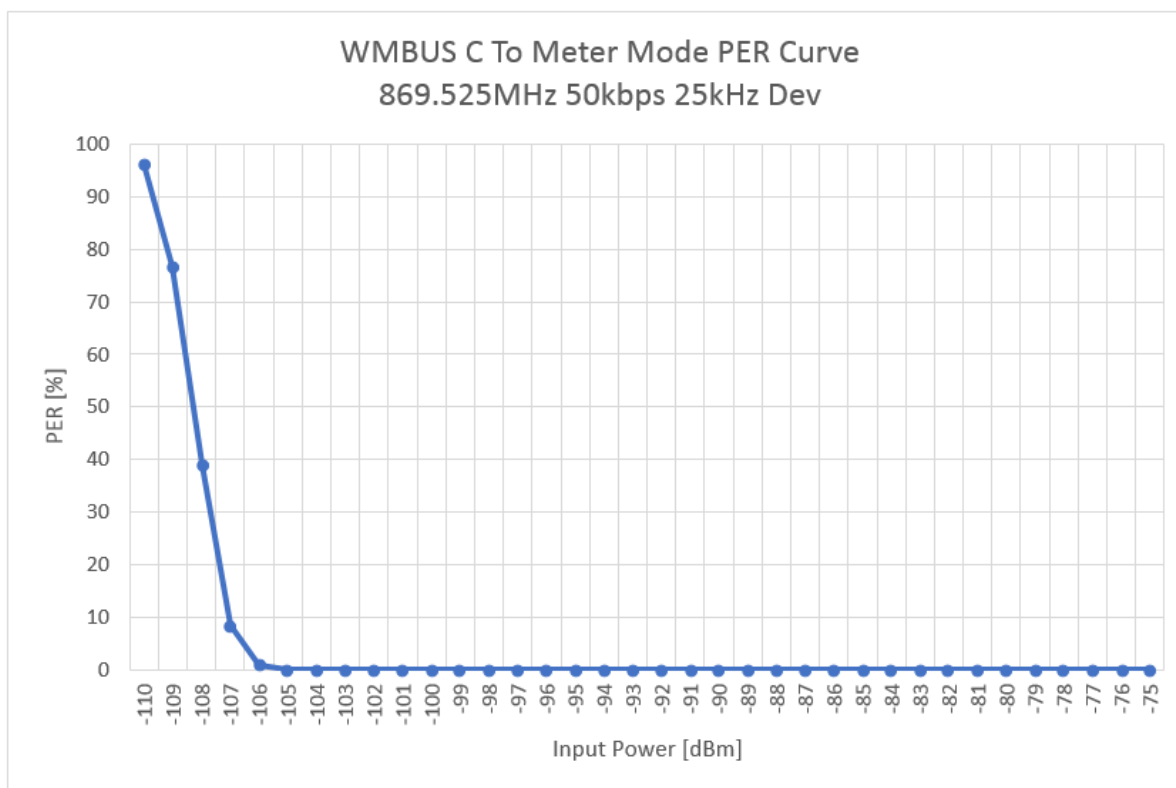**3.1.2.6 To-Meter Receiver Sensitivity**

Figure 3.18. EFR32FG1 C To-Meter Mode PER Curve

Table 3.10. EFR32FG1 C To-Meter Mode Measured Receiver Sensitivity

PER < %	Sensitivity dBm
80	-108.8
20	-106.5
1	-104.5

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

Table 3.11. EFR32FG1 C To-Meter Mode Receiver Sensitivity – Corner Conditions

Frequency	Data Rate	Frequency Deviation	Sensitivity at 80% PER
869.4815 MHz	50 kbps	18.75 kHz	-105.9
		31.25 kHz	-105.7
869.5685 MHz		18.75 kHz	-105.5
		31.25 kHz	-105.5

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

3.1.2.7 To-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (C1) will have ±25 ppm accuracy and worst case receive modes (C2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

The frequency tolerance limits are ±50 ppm (±43.5 kHz).
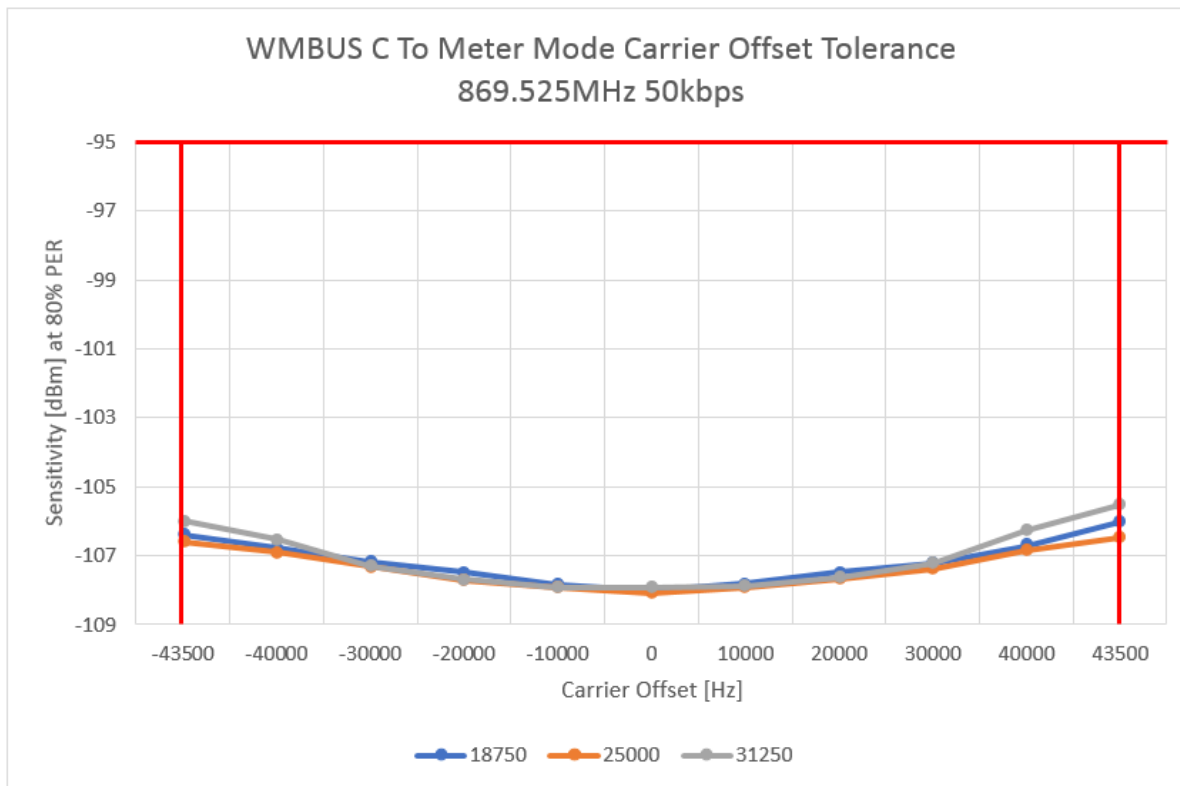
Figure 3.19. EFR32FG1 C To-Meter Mode Receiver Frequency Error Tolerance

3.1.2.8 To-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset in ppm.

FprEN 13757-4:2013 C To-Meter Mode Chip Rate Tolerance are ±100 ppm.

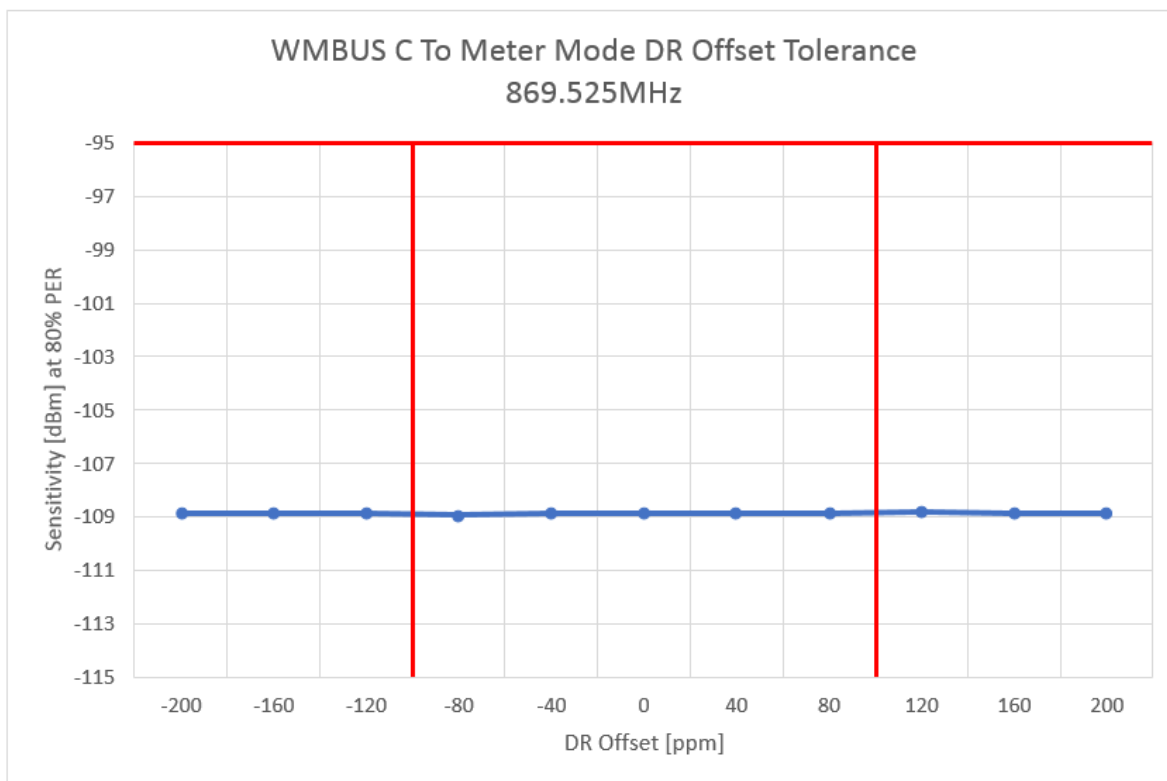FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

Figure 3.20. EFR32FG1 C-Mode To-Meter Mode Data Rate Offset Tolerance

3.1.2.9 To-Meter Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 C To-Meter Mode FSK Deviation limits are ±6.25 kHz.

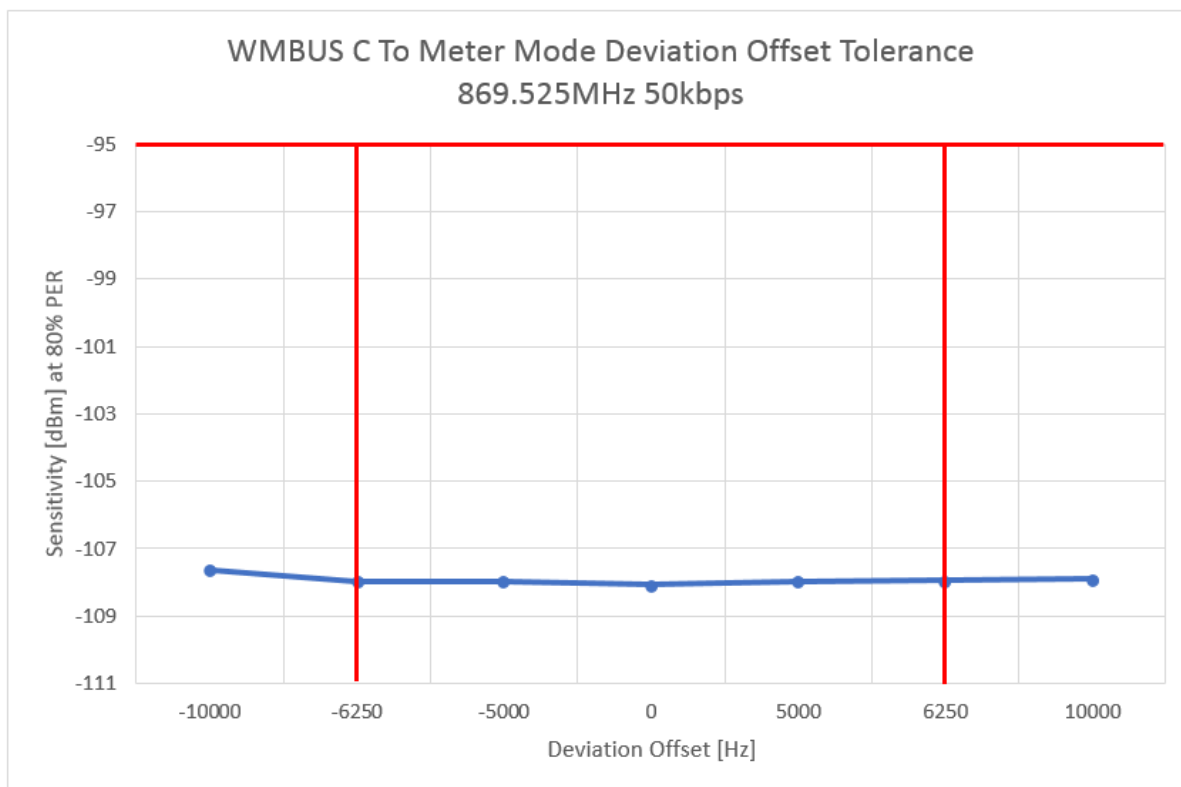FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

Figure 3.21. EFR32FG1 C-Mode To-Meter Mode Deviation Offset Tolerance

3.1.2.10 To-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±150 kHz.

Table 3.12. EFR32FG1 C To-Meter Mode ETSI CAT II Blocking Performance [5.6]

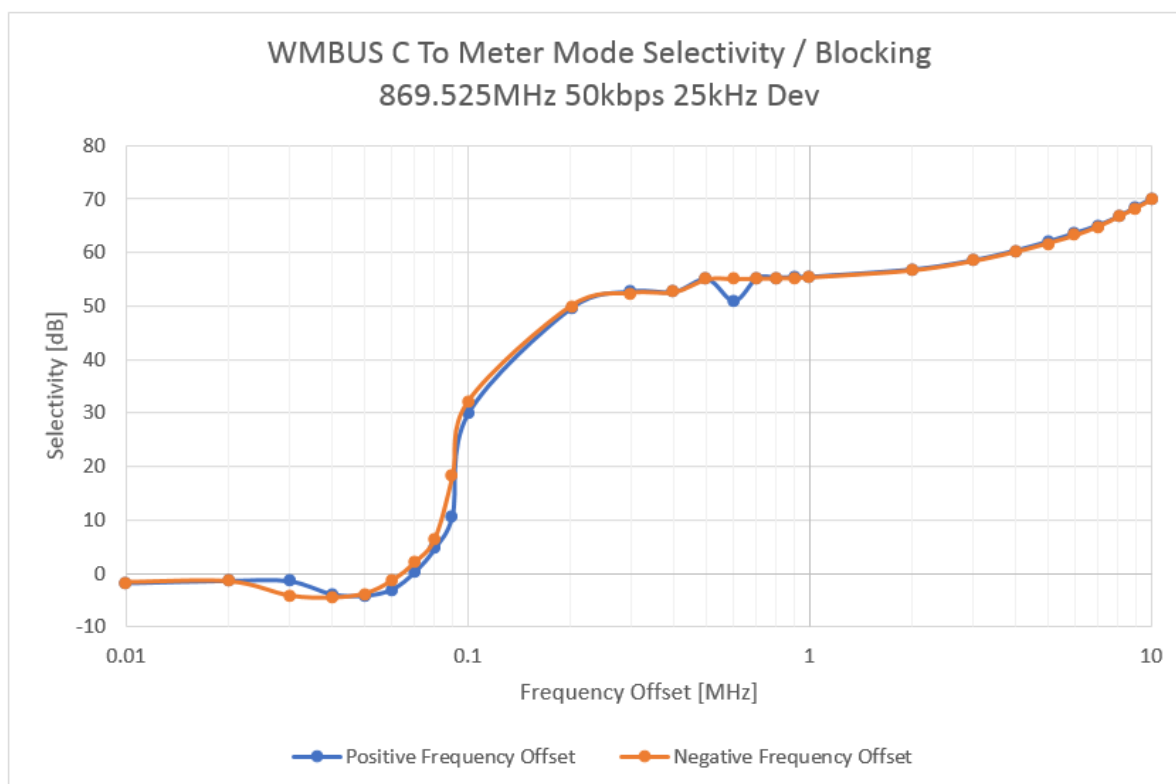| Frequency Offset	Measurement	Limit
±2 MHz	57 dB	>25 dB
±10 MHz	70 dB	>50 dB

Figure 3.22. EFR32FG1 C From-Meter Mode Receiver Selectivity

3.1.2.11 Summary

Table 3.13. EFR32FG1 C Mode Summary

Mode	Parameter	Measurement Results	Comments
C1, C2	80% PER Sensitivity	(Meter-to-Other) -107.4 dBm (Other-to-Meter) -108.8 dBm	Meets MBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets MBUS Specifications
	2 MHz Blocking	(Meter-to-Other) 59 dB (Other-to-Meter) 57 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	(Meter-to-Other) 71 dB (Other-to-Meter) 70 dB	Meets ETSI CAT II Specifications

3.1.3 N Mode

3.1.3.1 N2g Receiver Sensitivity
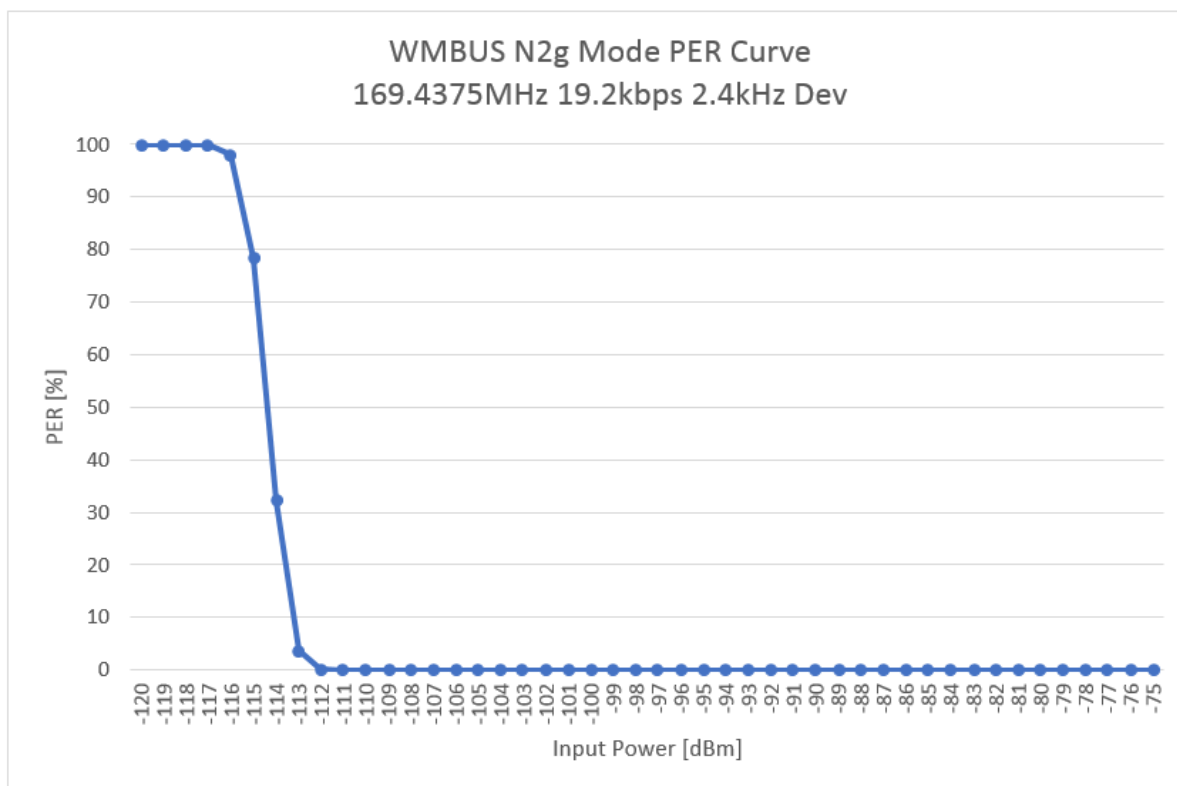
Figure 3.23. EFR32FG1 N2g Mode Receiver Sensitivity PER Curve

Table 3.14. EFR32FG1 N2g Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.4375 MHz	19.2 kbps	±2.4 kHz, ±7.2 kHz	80	-115.4
			20	-114.1
			1	-113.0

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

3.1.3.2 N2g Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Table 18 Mode N, Frequencies of the MBUS specification indicates frequency tolerance of ±2.5 kHz. Therefore, the overall frequency error accounting for transmitter and receiver will be ±5 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

FprEN 13757-4:2013 N2g Mode Frequency Tolerance limits are ±5 kHz.
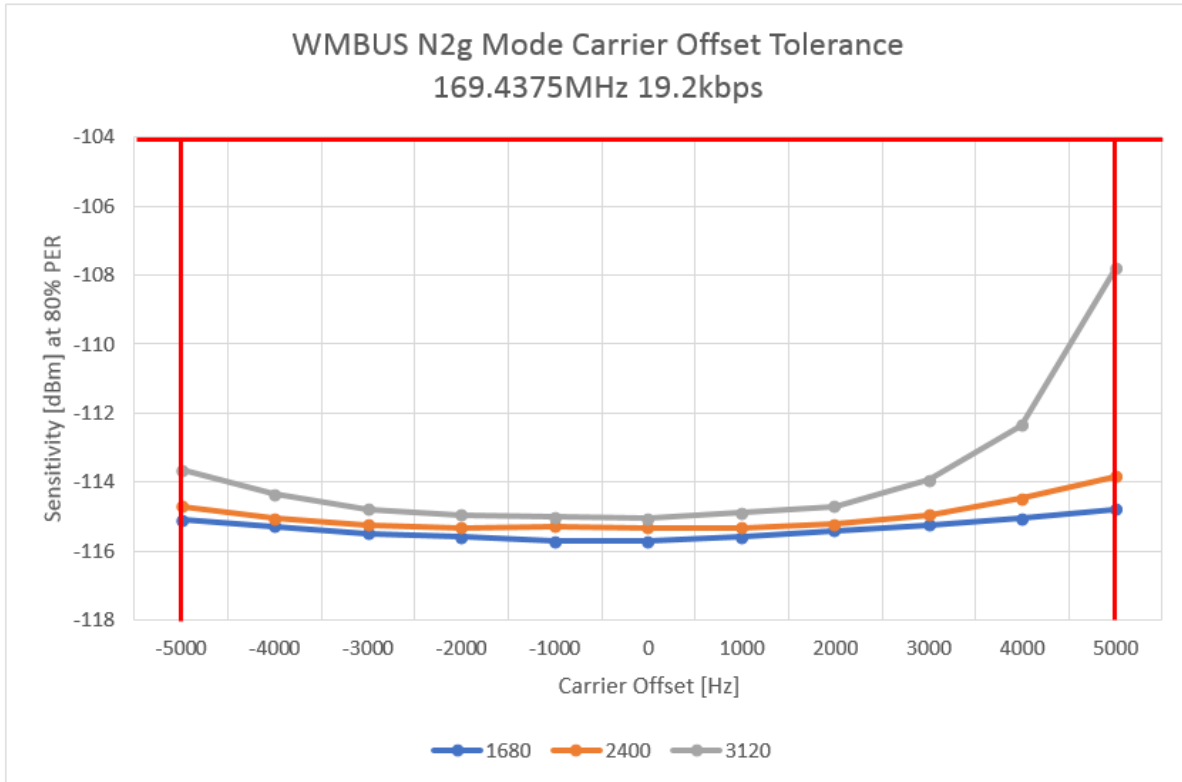
Figure 3.24. EFR32FG1 N2g Mode Receiver Frequency Error Tolerance

3.1.3.3 N2g Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

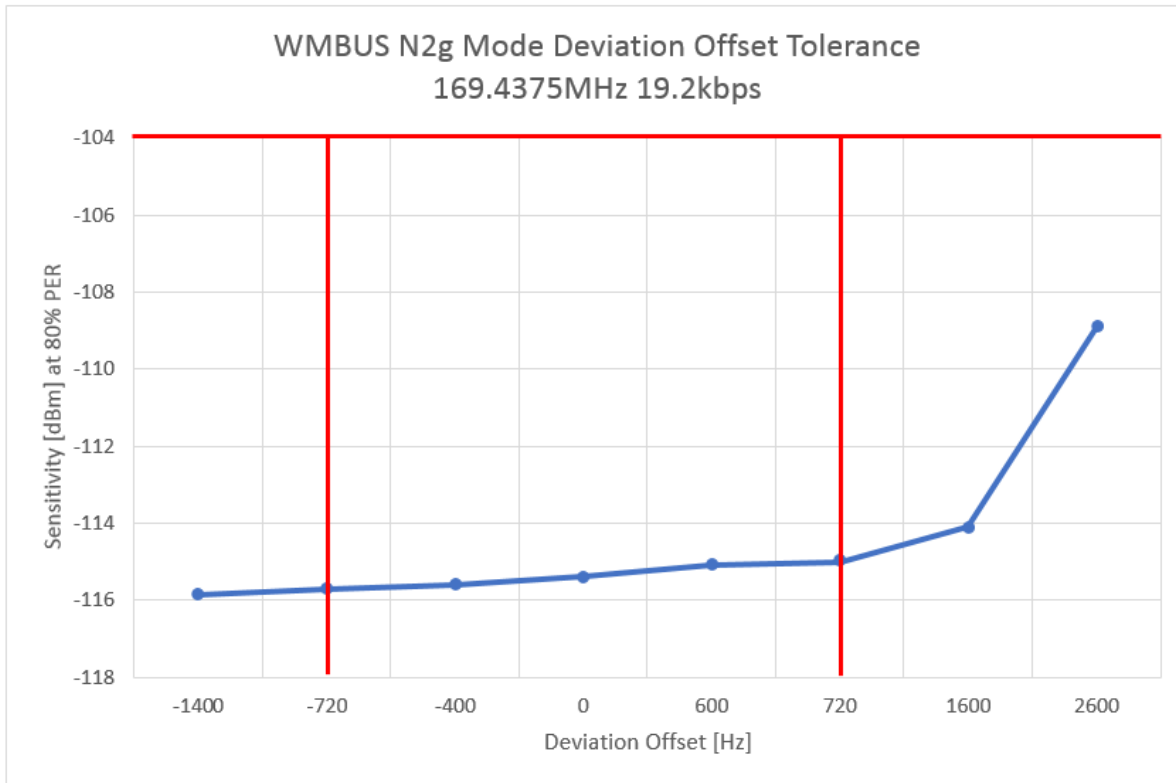FprEN 13757-4:2013 N2g Mode Deviation Tolerance limits are ±720 kHz.

Figure 3.25. EFR32FG1 N2g Receiver Deviation Offset Tolerance

3.1.3.4 N2g Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.15. EFR32FG1 N2g Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±50 kHz	54 dB	>40 dB

Table 3.16. EFR32FG1 N2g Mode ETSI CAT II Blocking Performance [5.7]

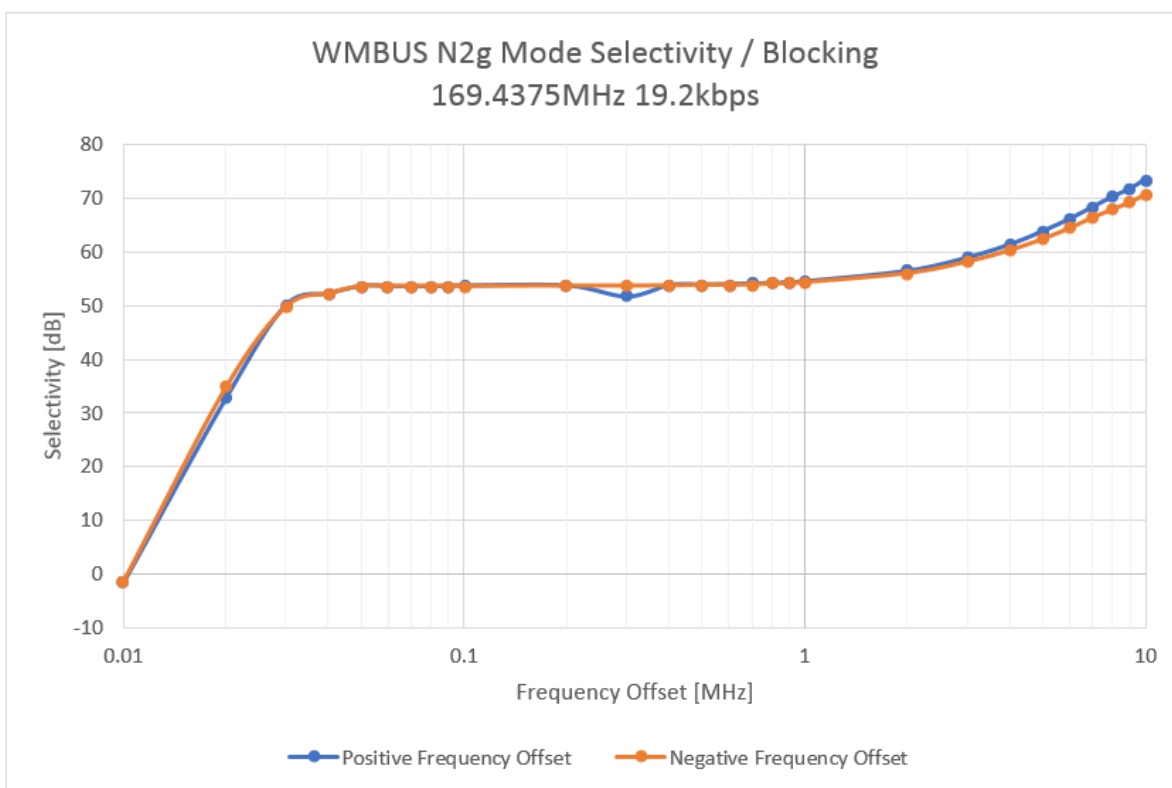| Frequency Offset	Measurement	Limit
±2 MHz	56 dB	>33 dB
±10 MHz	71 dB	>58 dB

Figure 3.26. EFR32FG1 N2g Receiver Selectivity

3.1.3.5 N Mode Summary

Table 3.17. EFR32FG1 N Mode Summary

Mode	Parameter	Measurement Results	Comments
N2g	80% PER Sensitivity	-115.4 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	2 MHz Blocking	56 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	71 dB	Meets ETSI CAT II Specifications

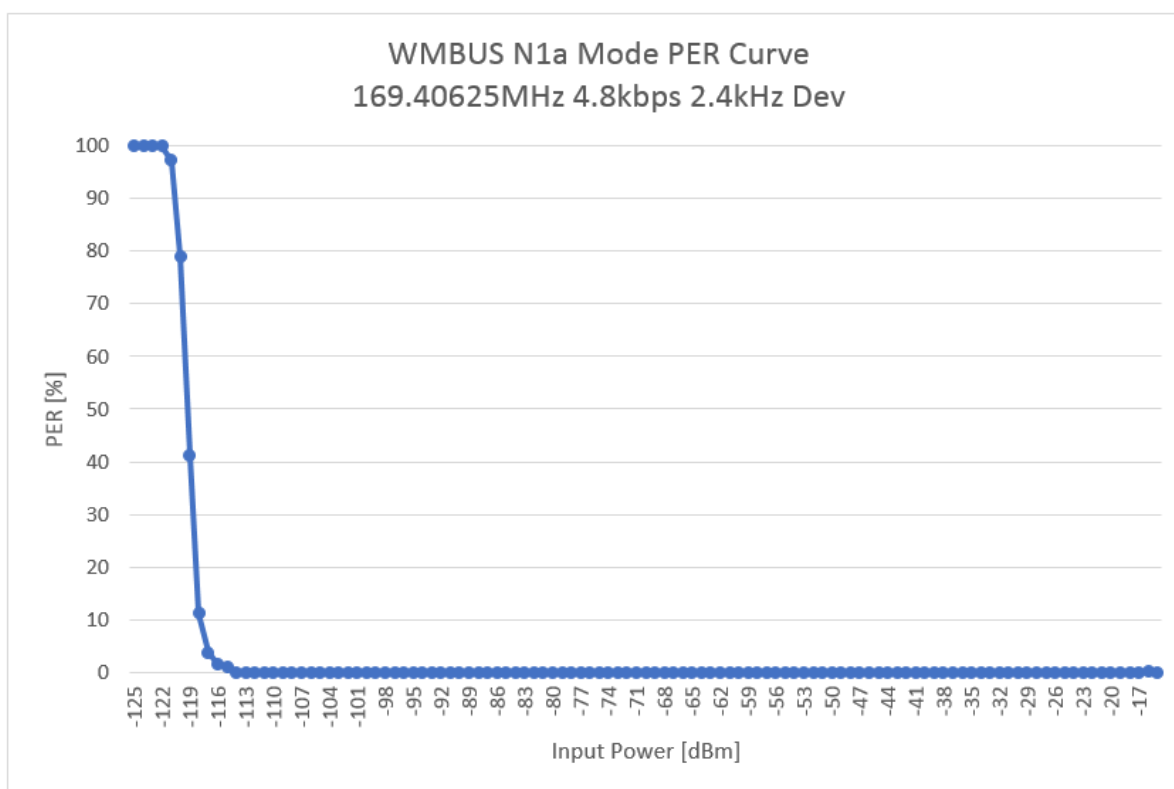**3.1.3.6 N1a Receiver Sensitivity**

Figure 3.27. EFR32FG1 N1a Mode Receiver Sensitivity PER Curve

Table 3.18. EFR32FG1 N1a Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.40625 MHz	4.8 kbps	±2.4 kHz	80	-119.6
			20	-117.9
			1	-116.4

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

3.1.3.7 N1a Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. **Table 18 Mode N, Frequencies of the Wireless M-Bus specification** indicates frequency tolerance of ±1.5 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

FprEN 13757-4:2013 N1a Mode Frequency Tolerance limits are ±1.5 kHz.

Note: The ±1.5 kHz frequency offset tolerance is considered for the whole link.
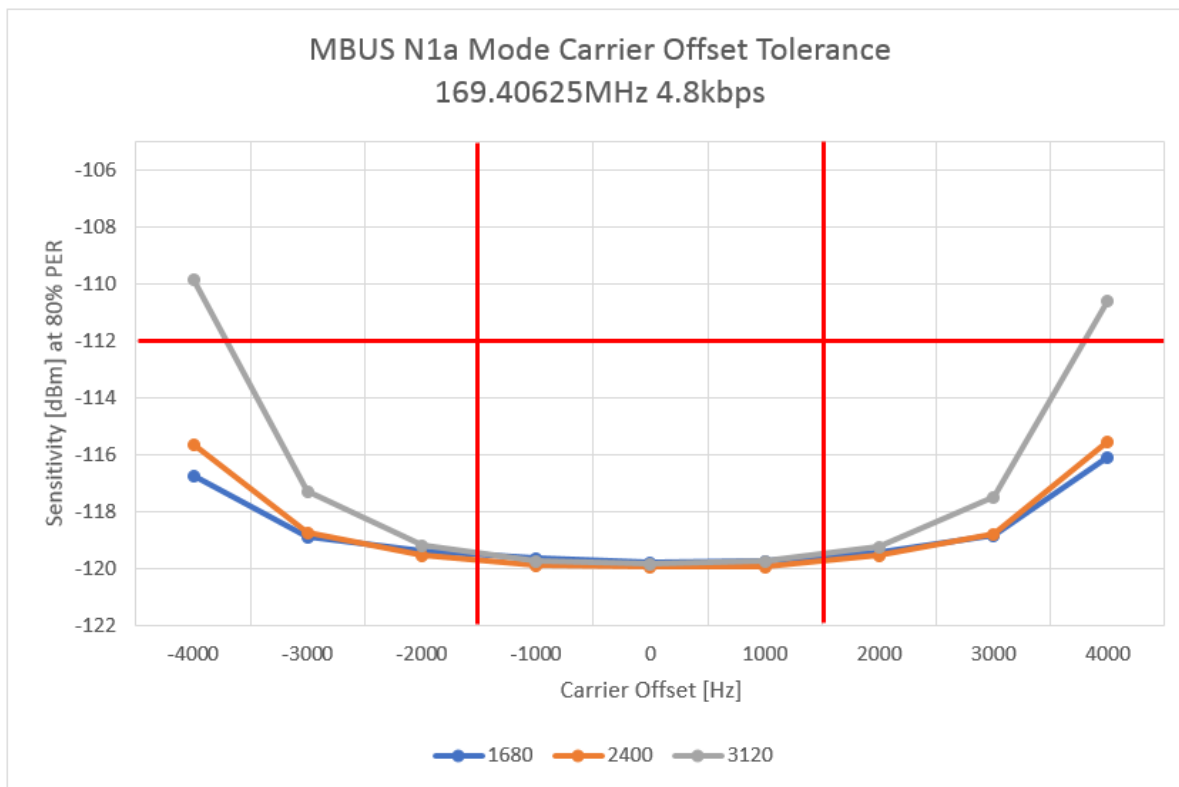

Figure 3.28. EFR32FG1 N1a Mode Receiver Frequency Error Tolerance

3.1.3.8 N1a Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

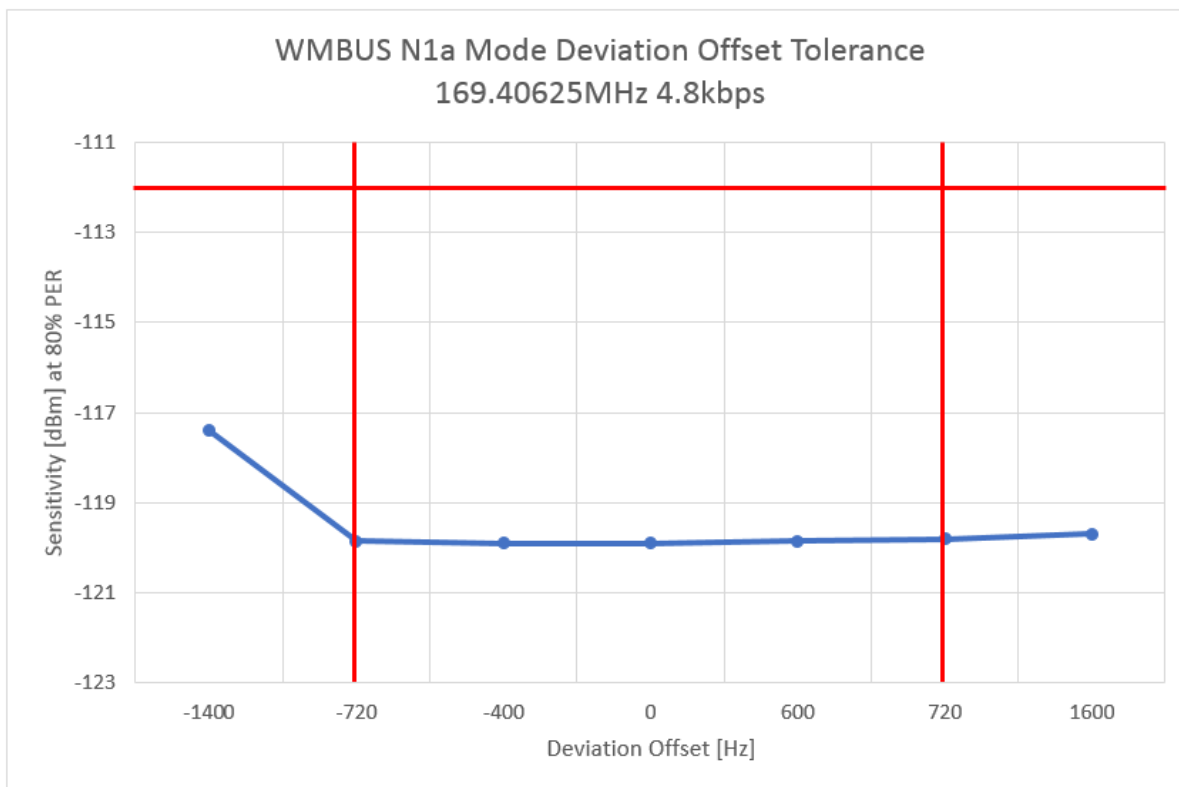FprEN 13757-4:2013 N1a Mode Deviation Tolerance limits are ±720 kHz.

Figure 3.29. EFR32FG1 N1a Receiver Deviation Offset Tolerance

3.1.3.9 N1a Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.19. EFR32FG1 N1a Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±12.5 kHz	42 dB	>40 dB

Table 3.20. EFR32FG1 N1a Mode ETSI CAT II Blocking Performance [5.7]

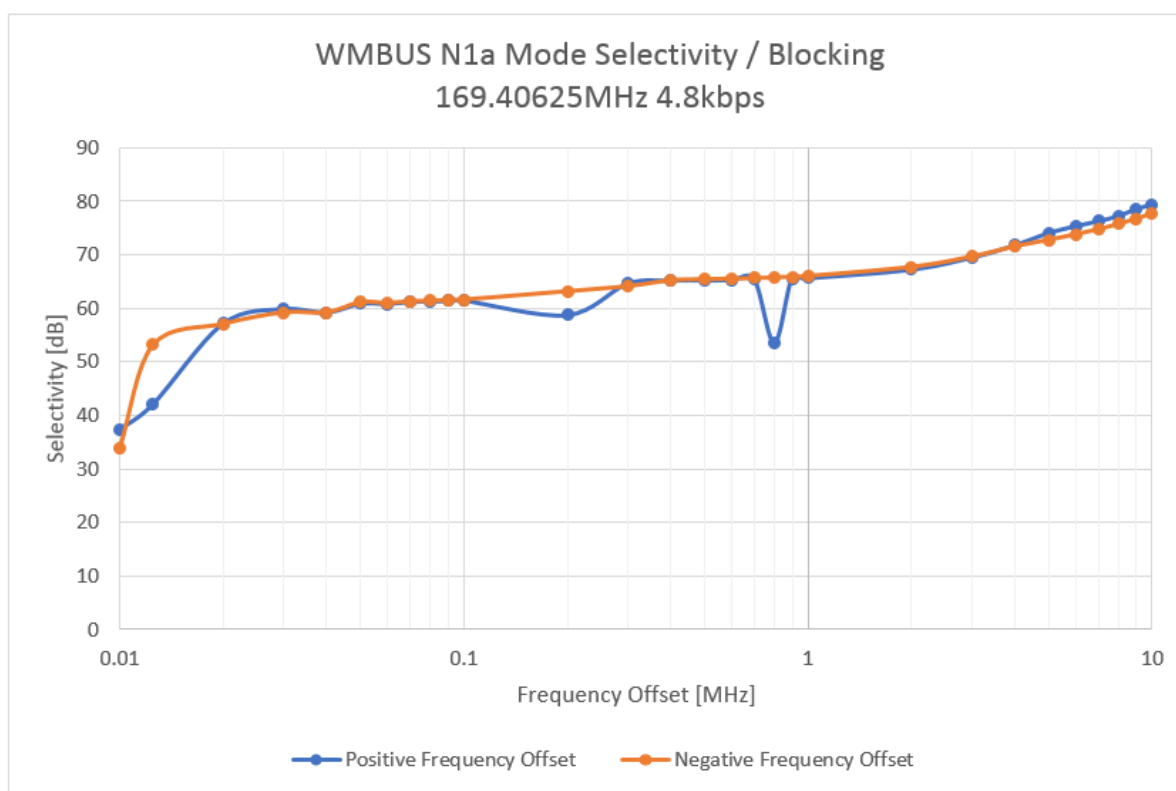| Frequency Offset	Measurement	Limit
±2 MHz	67 dB	> 36 dB
±10 MHz	77 dB	> 61 dB

Figure 3.30. EFR32FG1 N1a Receiver Selectivity

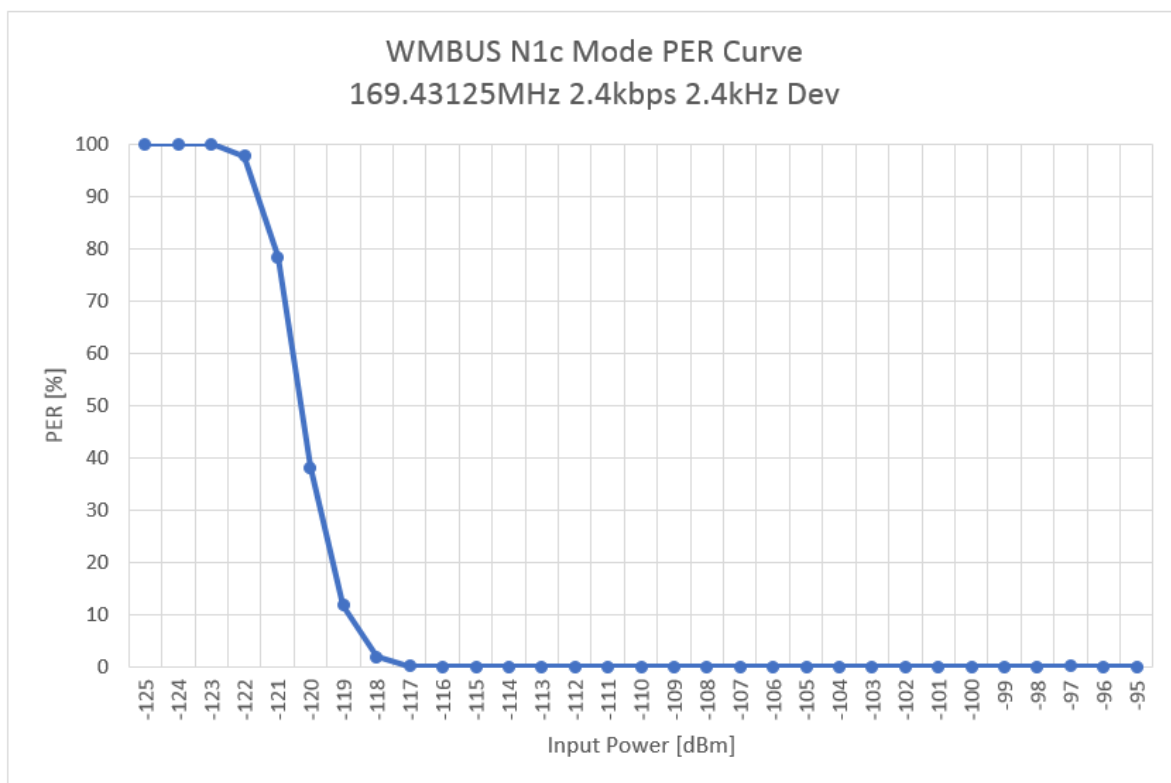**3.1.3.10 N1c Receiver Sensitivity**

Figure 3.31. EFR32FG1 N1c Mode Receiver Sensitivity PER Curve

Table 3.21. EFR32FG1 N1c Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.43125 MHz	2.4 kbps	±2.4 kHz	80	-120.9
			20	-119.4
			1	-117.7

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

3.1.3.11 N1c Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Table 18 Mode N, Frequencies of the Wireless M-Bus specification indicates frequency tolerance of ±2 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

FprEN 13757-4:2013 N1c Mode Frequency Tolerance limits are ±2 kHz.

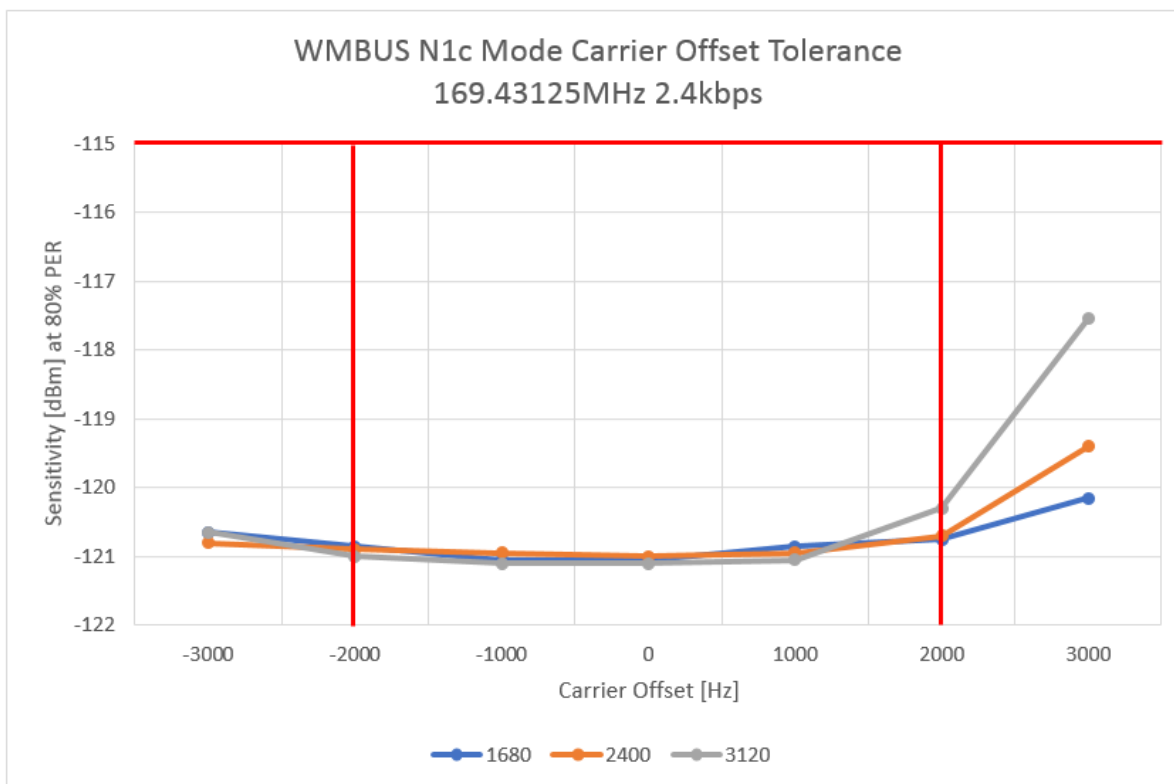**Note:** The ±2 kHz frequency offset tolerance is considered for the whole link.

Figure 3.32. EFR32FG1 N1c Mode Receiver Frequency Error Tolerance

3.1.3.12 N1c Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

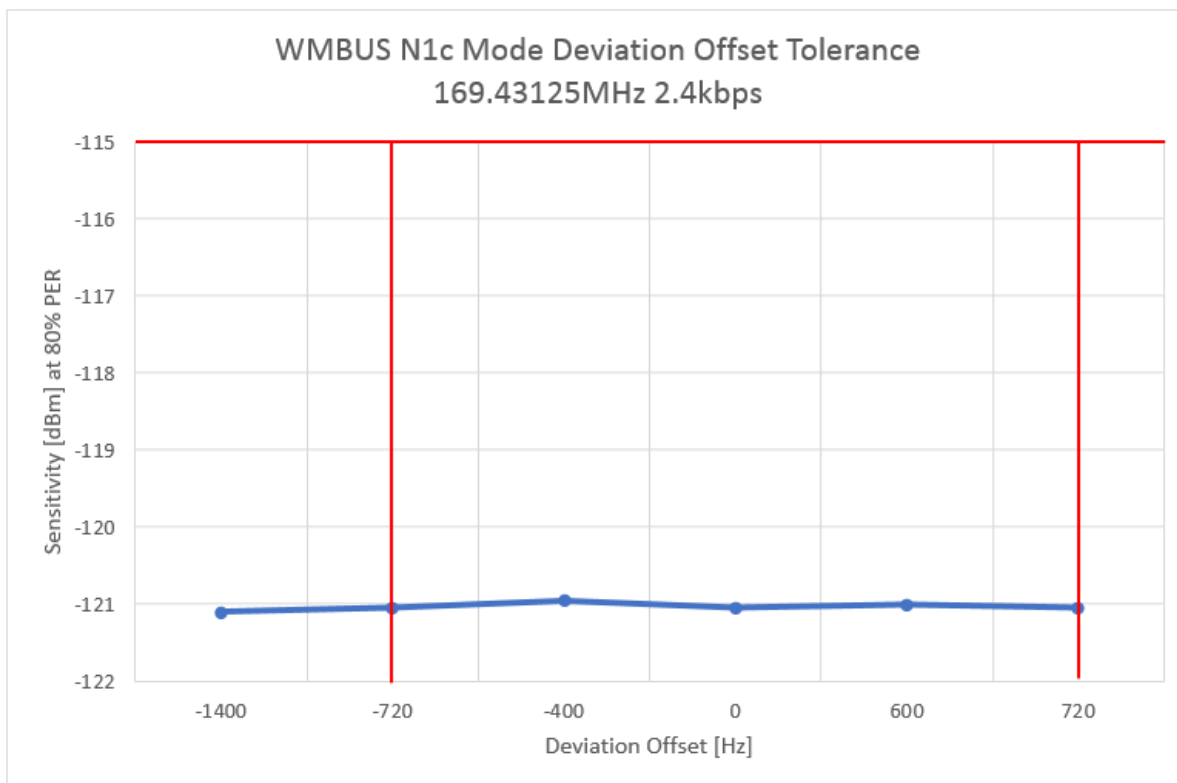FprEN 13757-4:2013 N1c Mode Deviation Tolerance limits are ±720 kHz.

Figure 3.33. EFR32FG1 N1c Receiver Deviation Offset Tolerance

3.1.3.13 N1c Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.22. EFR32FG1 N1c Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±12.5 kHz	41 dB	>40 dB

Table 3.23. EFR32FG1 N1c Mode ETSI CAT II Blocking Performance [5.7]

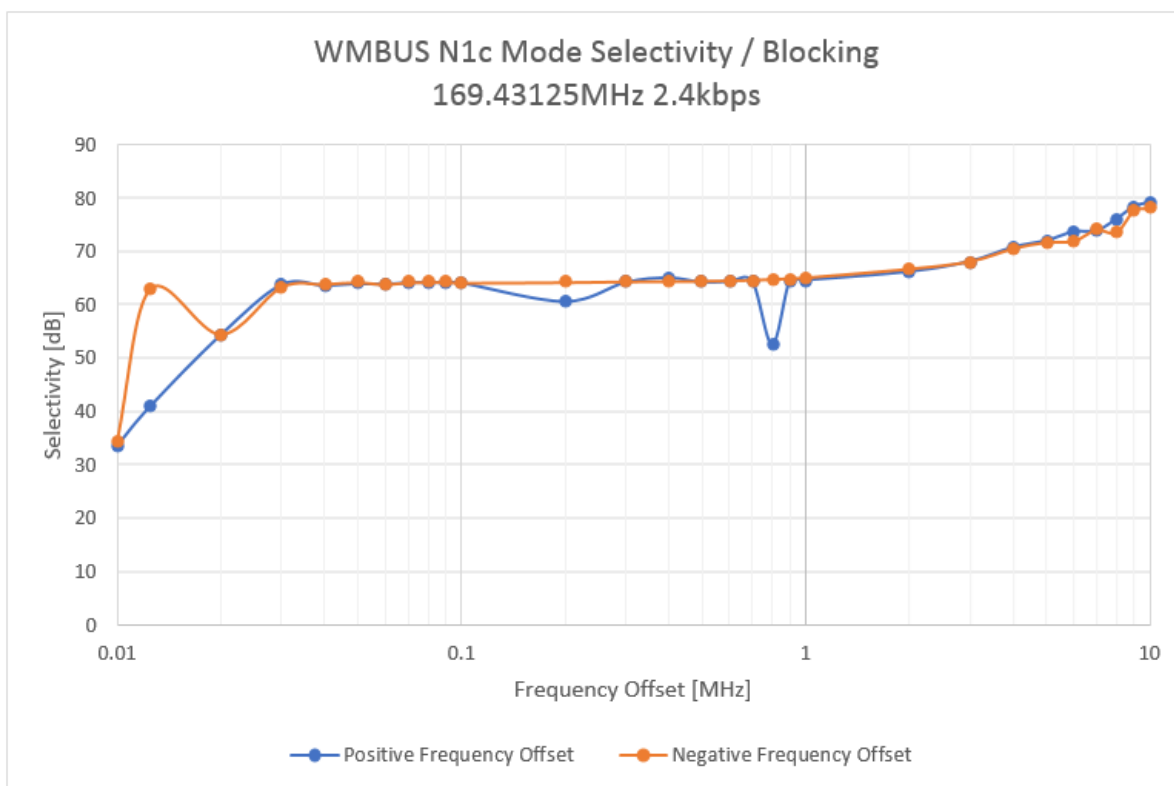| Frequency Offset	Measurement	Limit
±2 MHz	67 dB	> 36 dB
±10 MHz	78 dB	> 61 dB

Figure 3.34. EFR32FG1 N1c Receiver Selectivity

3.1.3.14 Summary

Table 3.24. EFR32FG1 N2g Mode Summary

Mode	Parameter	Measurement Results	Comments
N2g	80% PER Sensitivity	-115.4 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±50kHz Selectivity	54 dB	Meets WMBUS Specifications
	±2 MHz Blocking	56 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	71 dB	Meets ETSI CAT II Specifications

Table 3.25. EFR32FG1 N1a Mode Summary

Mode	Parameter	Measurement Results	Comments
N1a	80% PER Sensitivity	-119.9 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	42 dB	Meets WMBUS Specifications
	±2 MHz Blocking	67 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	77 dB	Meets ETSI CAT II Specifications

Table 3.26. EFR32FG1 N1c Mode Summary

Mode	Parameter	Measurement Results	Comments
N1c	80% PER Sensitivity	-120.9 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	41 dB	Meets WMBUS Specifications
	±2 MHz Blocking	67 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	78 dB	Meets ETSI CAT II Specifications

3.1.4 S Mode
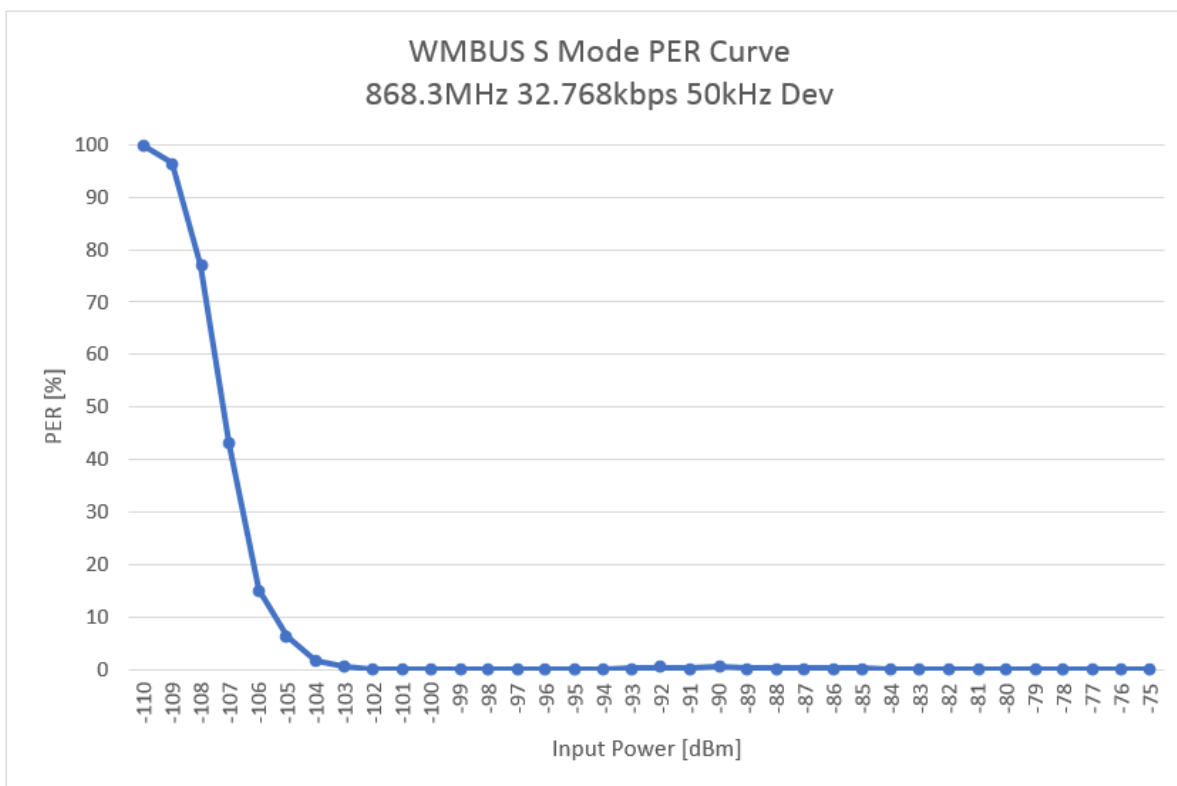
3.1.4.1 Receiver Sensitivity

Figure 3.35. EFR32FG1 S Mode Receiver Sensitivity PER Curve

Table 3.27. EFR32FG1 S Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.3 MHz	32.768 kbps	±50 kHz	80	-108.0
			20	-106.2
			1	-103.6

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.1.4.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm. The frequency error tolerance limits are ±85 ppm (±74 kHz).
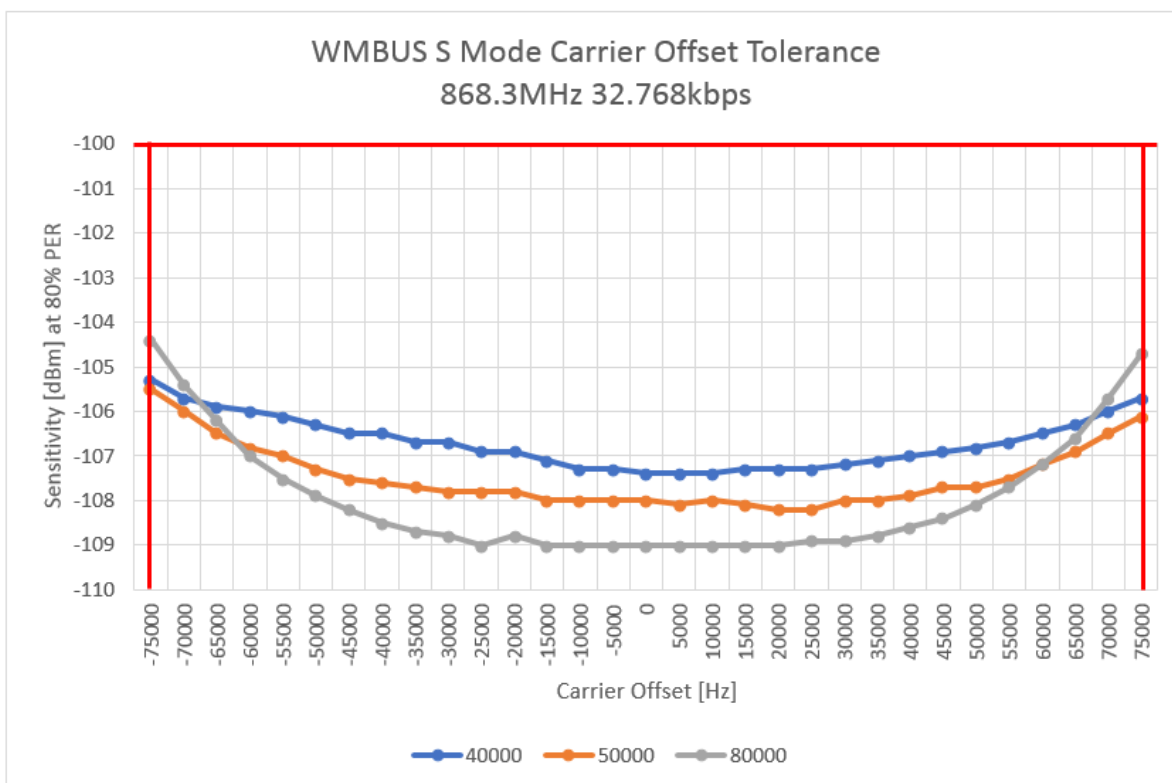

Figure 3.36. EFR32FG1 S Mode Receiver Frequency Error Tolerance

3.1.4.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±2%.

FprEN 13757-4:2013 Receiver Acceptable Chip Rate Tolerance (Meter) is ±2 %.

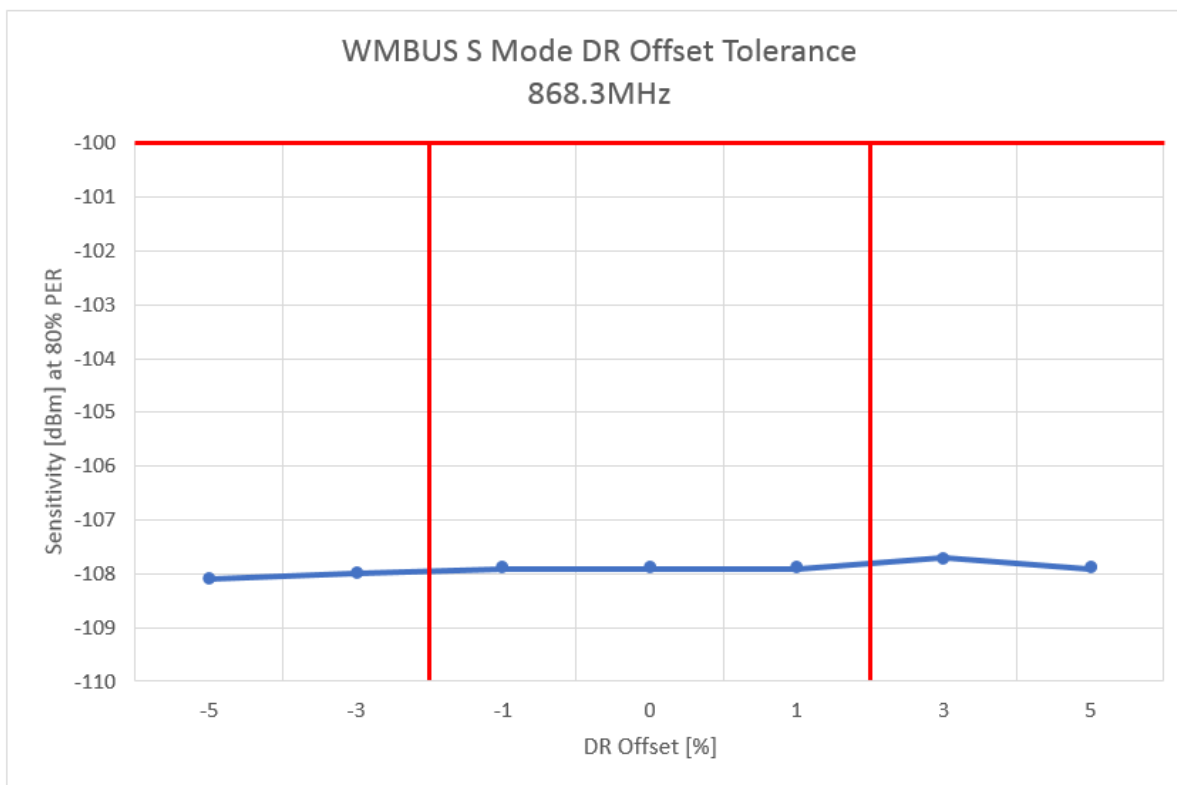FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

Figure 3.37. EFR32FG1 S Mode Receiver Data Rate Error Tolerance

3.1.4.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 S Mode FSK Deviation limits are -10 kHz & 30 kHz.

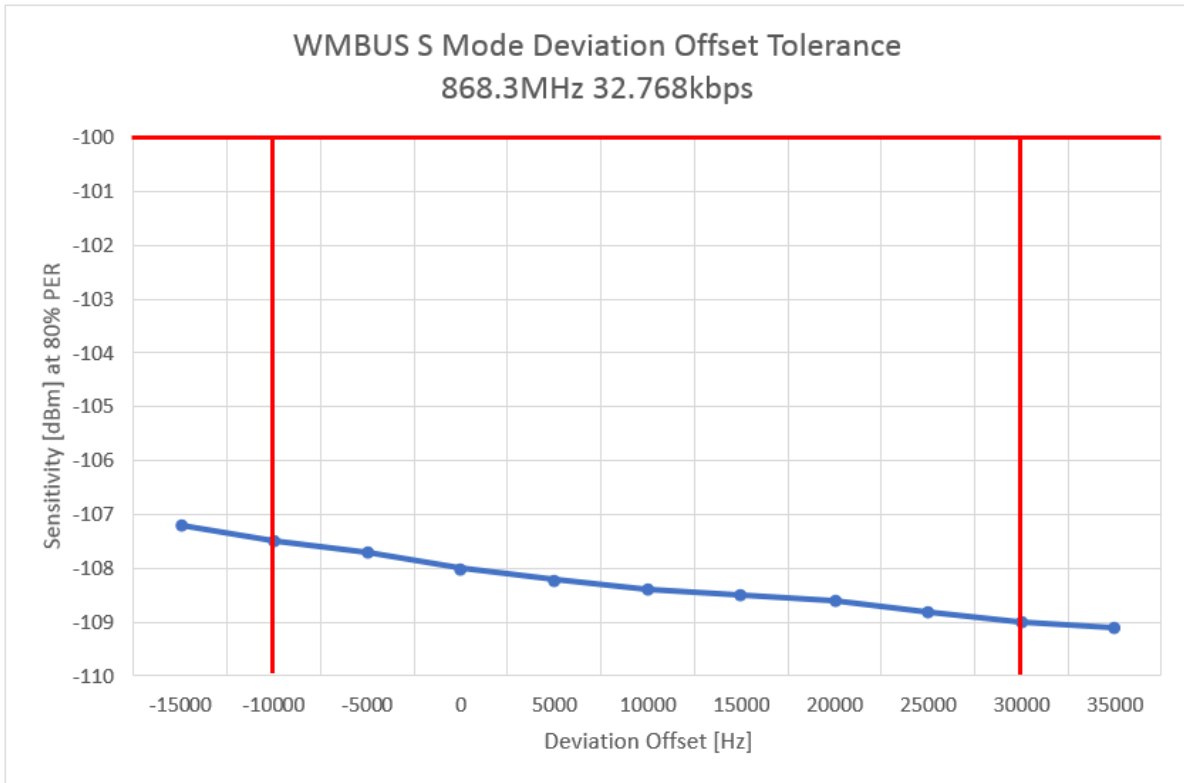FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

Figure 3.38. EFR32FG1 S Mode Receiver Deviation Error Tolerance

3.1.4.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±260 kHz.

Table 3.28. EFR32FG1 S Mode ETSI CAT II Blocking Performance [5.4]

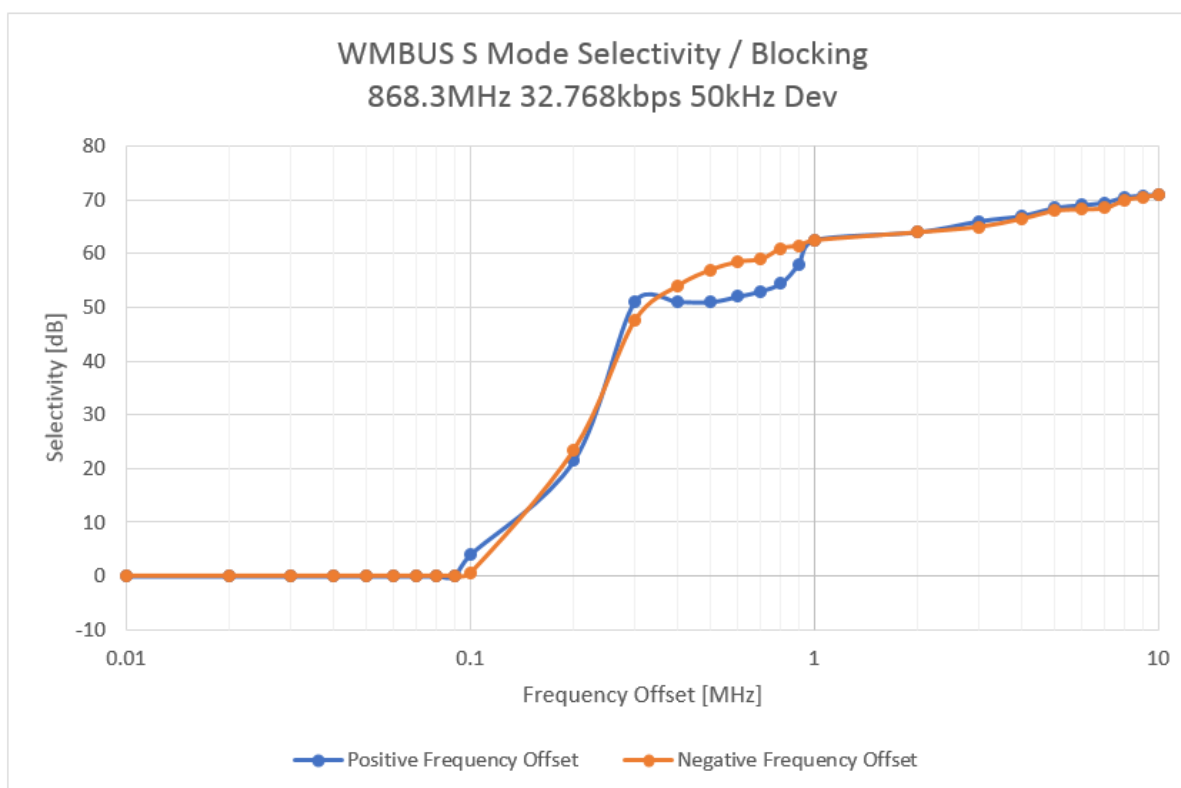| Frequency Offset	Measurement	Limit
±2 MHz	64 dB	> 22 dB
±10 MHz	71 dB	> 47 dB

Figure 3.39. EFR32FG1 S Mode Receiver Selectivity

3.1.4.6 Summary

Table 3.29. EFR32FG1 S Mode Summary

Mode	Parameter	Measurement Results	Comments
S	80% PER Sensitivity	-108.0 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 260 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	64 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	71 dB	Meets ETSI CAT II Specifications

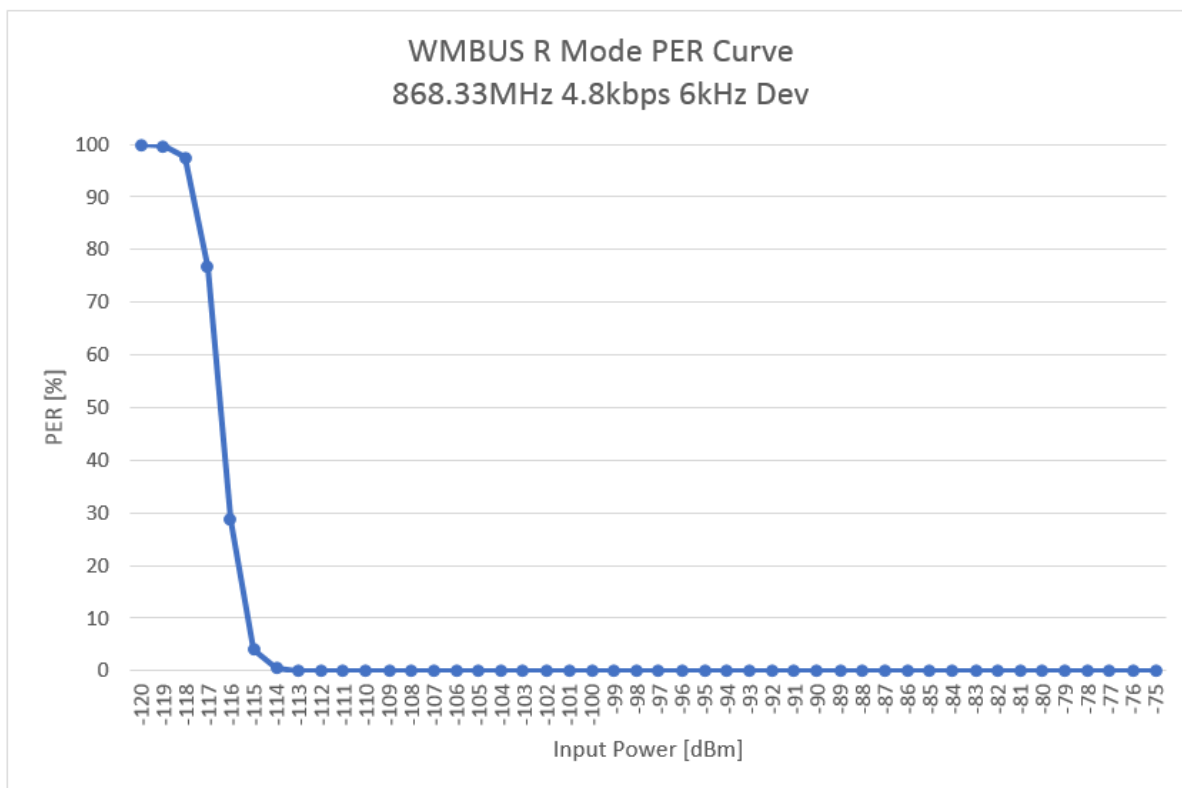**3.1.5 R Mode**

3.1.5.1 Receiver Sensitivity

Figure 3.40. EFR32FG1 R Mode Receiver Sensitivity PER Curve

Table 3.30. EFR32FG1 R Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.33 MHz	4.8 kbps	±6 kHz	80	-116.5
			20	-115.6
			1	-114.4

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

3.1.5.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

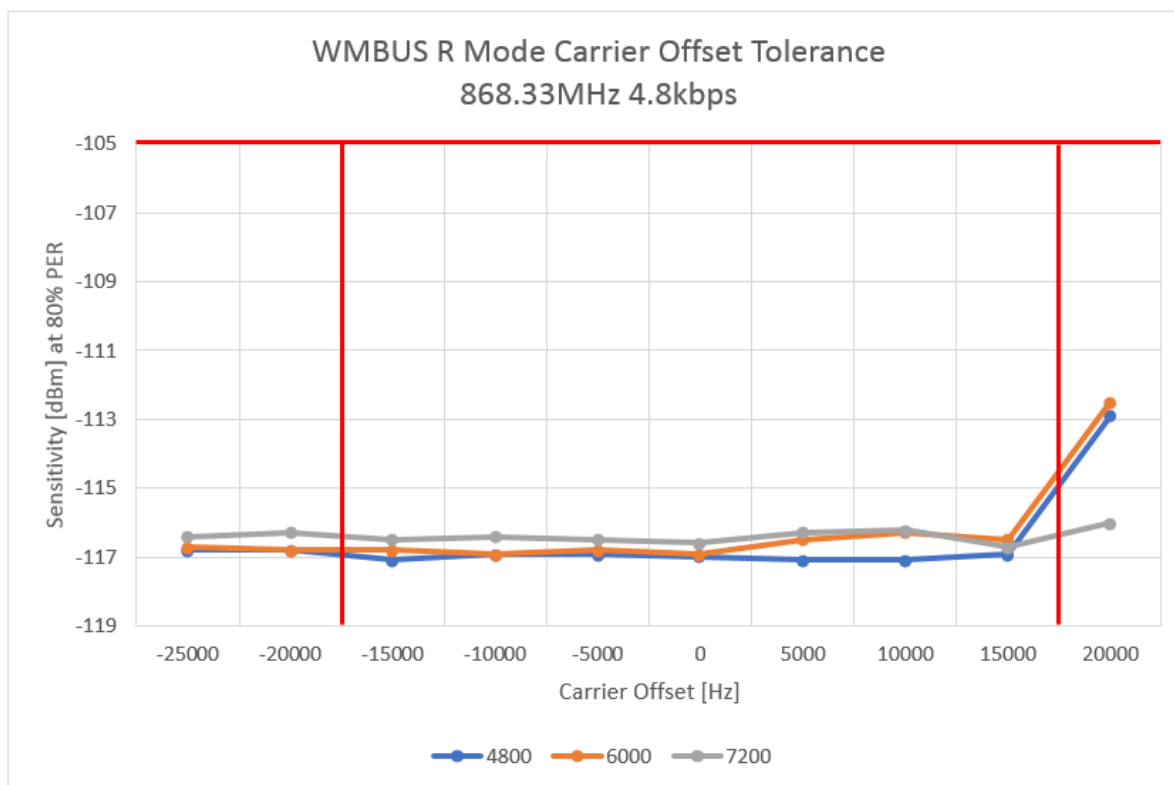FprEN 13757-4:2013 Frequency Tolerance Limits are ±20 ppm (±17 kHz).

Figure 3.41. EFR32FG1 R Mode Receiver Frequency Error Tolerance

3.1.5.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±1.5%.

FprEN 13757-4:2013 Chip Rate Tolerance is ±1.5 %.

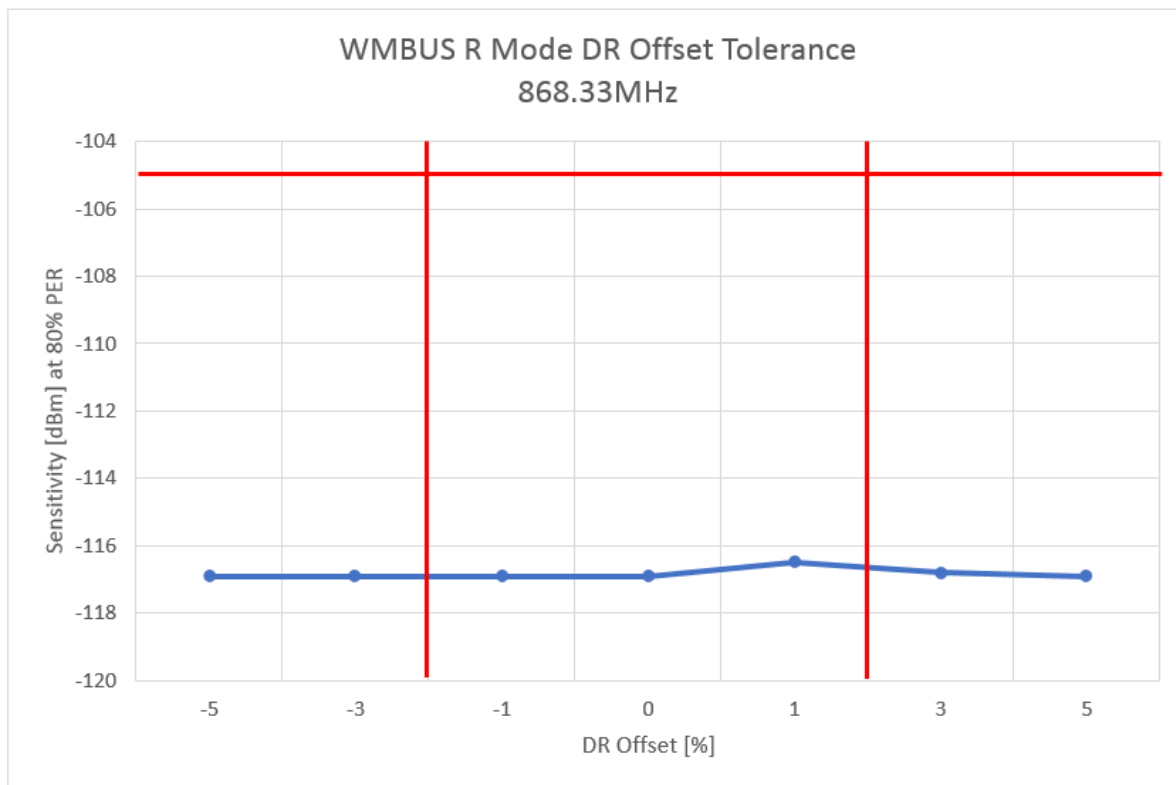FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

Figure 3.42. EFR32FG1 R Mode Receiver Data Rate Error Tolerance

3.1.5.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 R Mode FSK Deviation limits are ±1.2kHz.

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.
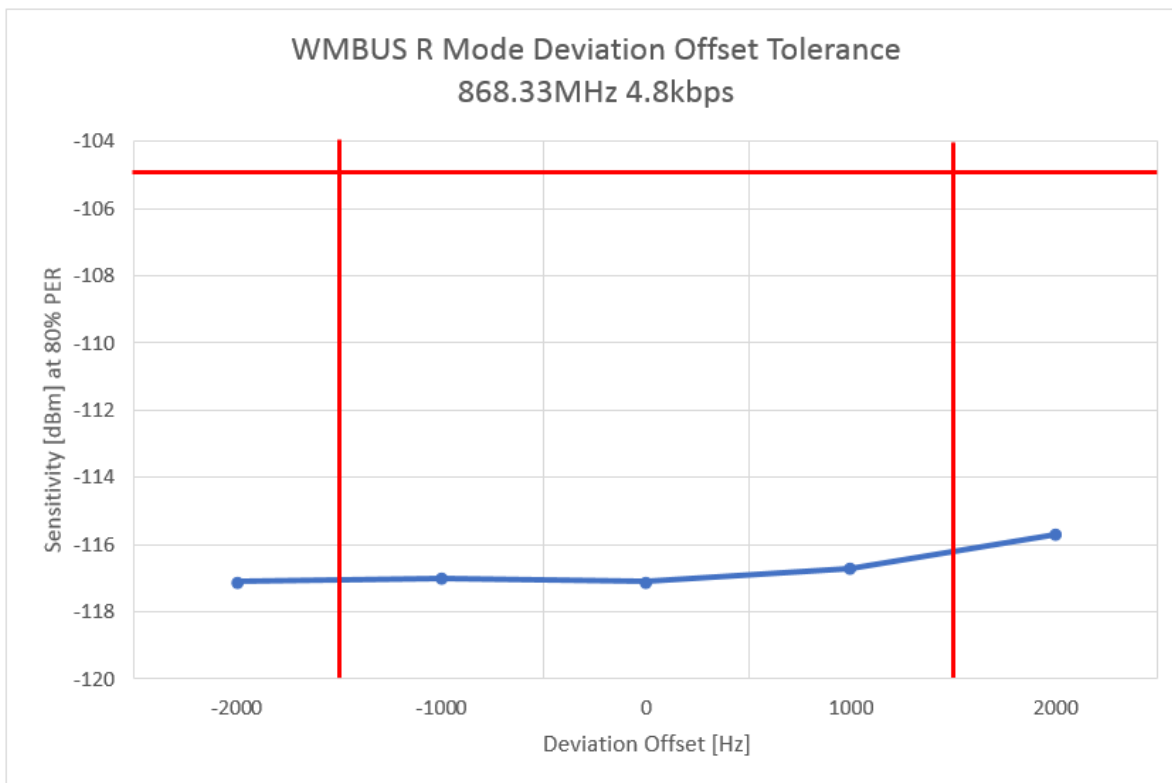

Figure 3.43. EFR32FG1 R Mode Receiver Deviation Error Tolerance

3.1.5.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.31. EFR32FG1 R Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±60 kHz	57 dB	>40 dB

Table 3.32. EFR32FG1 R Mode ETSI CAT II Blocking Performance [5.7]

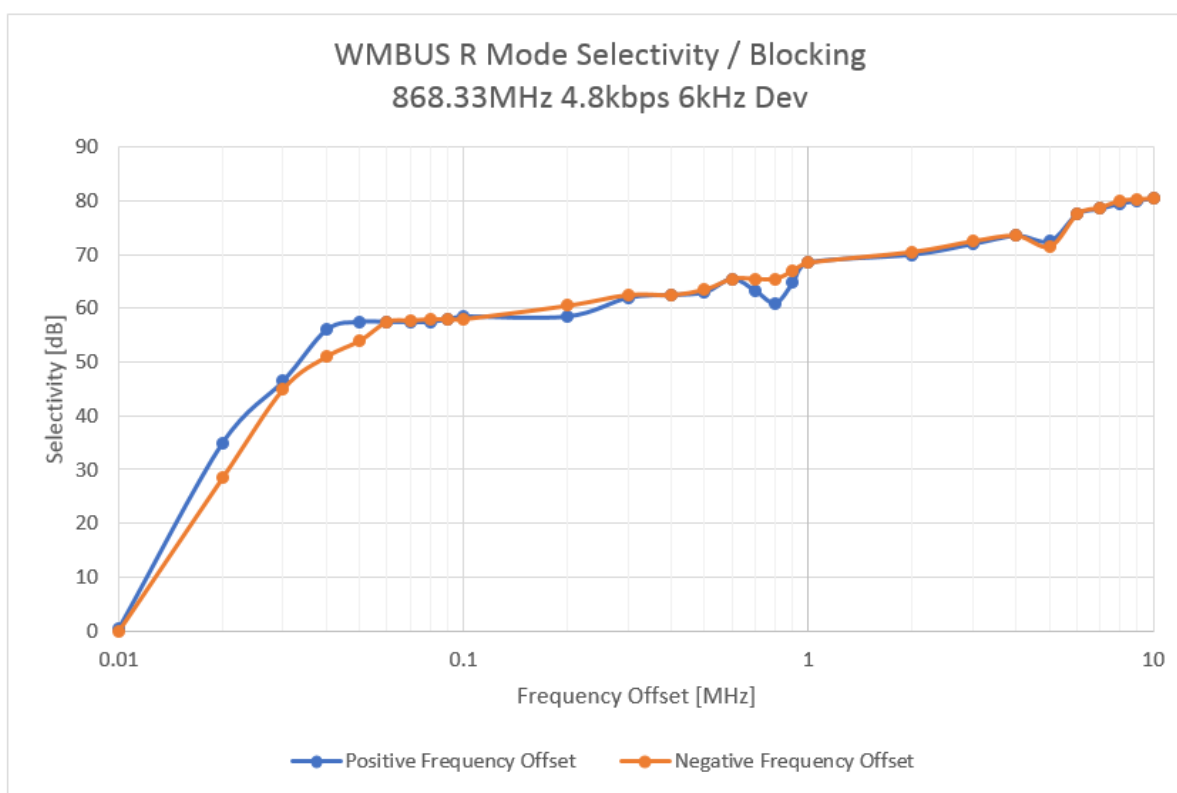| Frequency Offset	Measurement	Limit
±2 MHz	70 dB	> 34 dB
±10 MHz	80 dB	> 59 dB

Figure 3.44. EFR32FG1 R Mode Receiver Selectivity

3.1.5.6 Summary

Table 3.33. EFR32FG1 R Mode Summary

Mode	Parameter	Measurement Results	Comments
R	80% PER Sensitivity	-116.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±60 kHz Selectivity	57 dB	Meets WMBUS Specifications
	±2 MHz Blocking	70 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	80 dB	Meets ETSI CAT II Specifications

3.1.6 F Mode

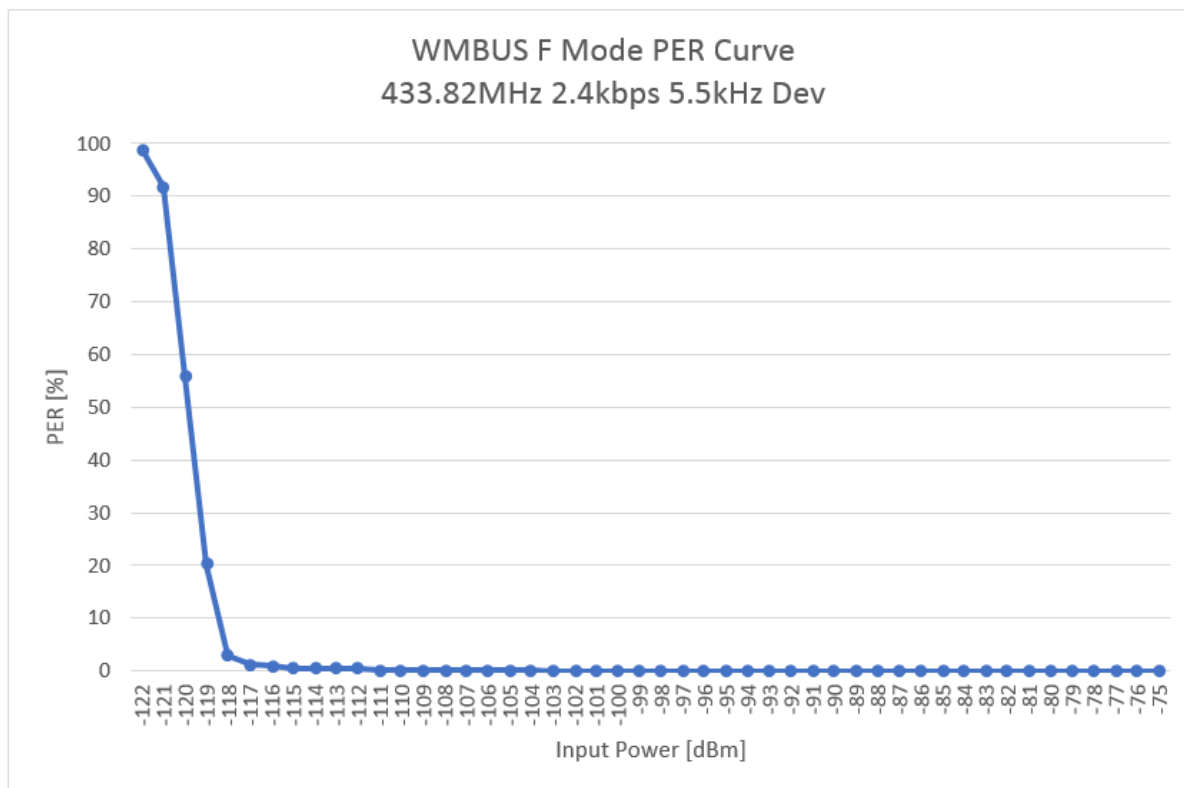#### 3.1.6.1 Receiver Sensitivity

Figure 3.45. EFR32FG1 F Mode Receiver Sensitivity PER Curve

Table 3.34. EFR32FG1 F Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
433.82 MHz	2.4 kbps	±5.5 kHz	80	-120.5
			20	-119.1
			1	-117.5

FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

3.1.6.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

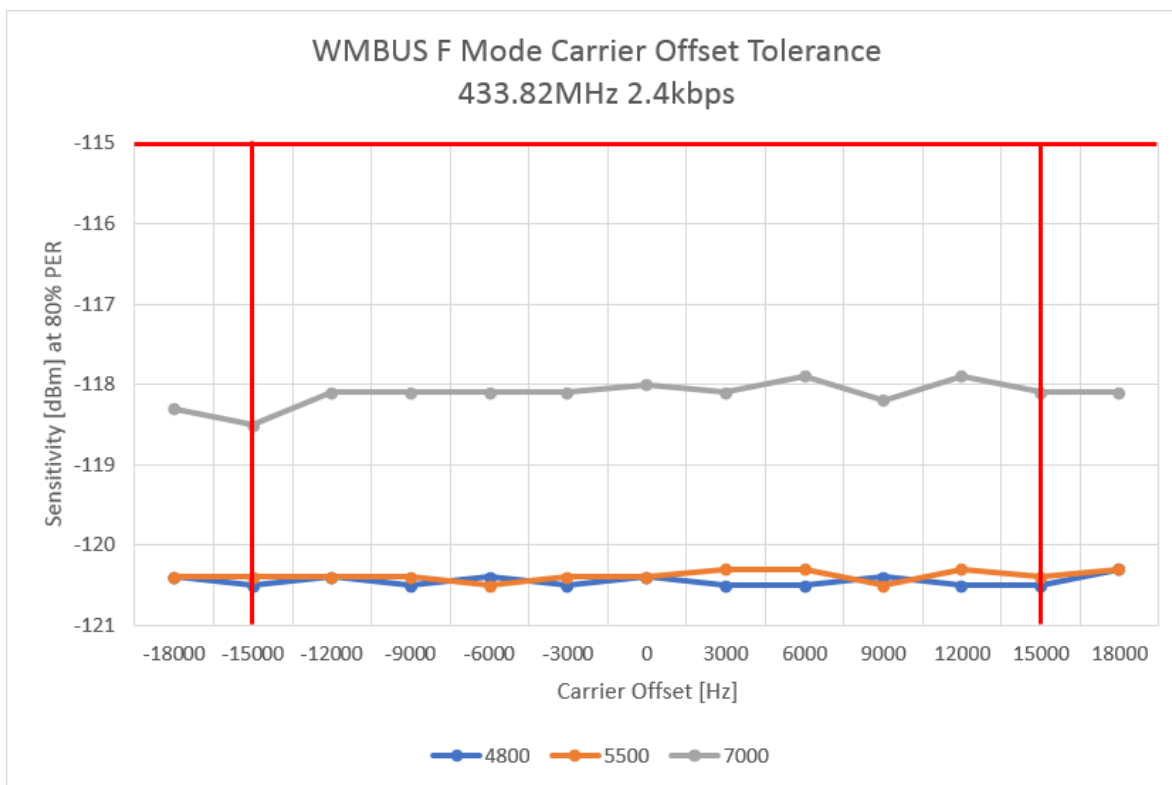FprEN 13757-4:2013 Frequency Tolerance Limits are ±16 ppm (±14 kHz).

Figure 3.46. EFR32FG1 F Mode Receiver Frequency Error Tolerance

3.1.6.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The data rate tolerance of the receiver is ±100ppm.

FprEN 13757-4:2013 Data Rate Tolerance is ±100 ppm.

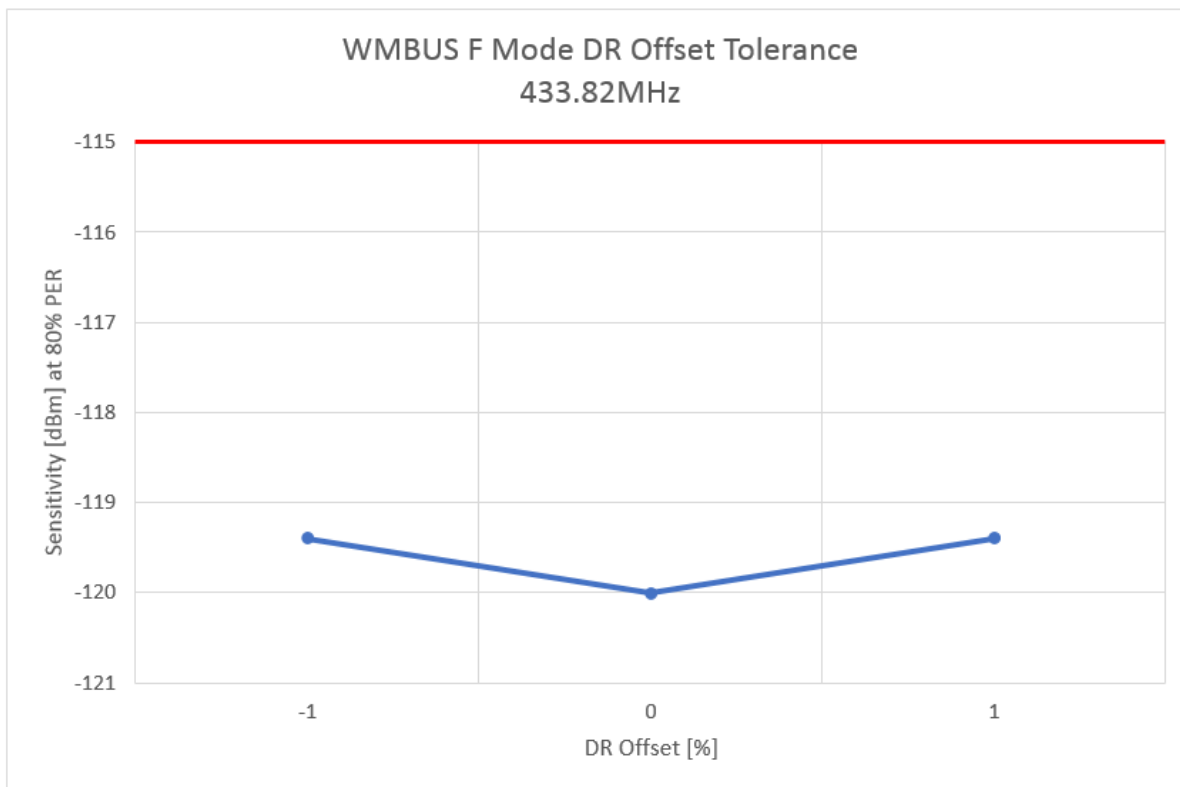FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

Figure 3.47. EFR32FG1 F Mode Receiver Data Rate Error Tolerance

3.1.6.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 F Mode FSK Deviation limits are -700 Hz & +1.5 kHz.

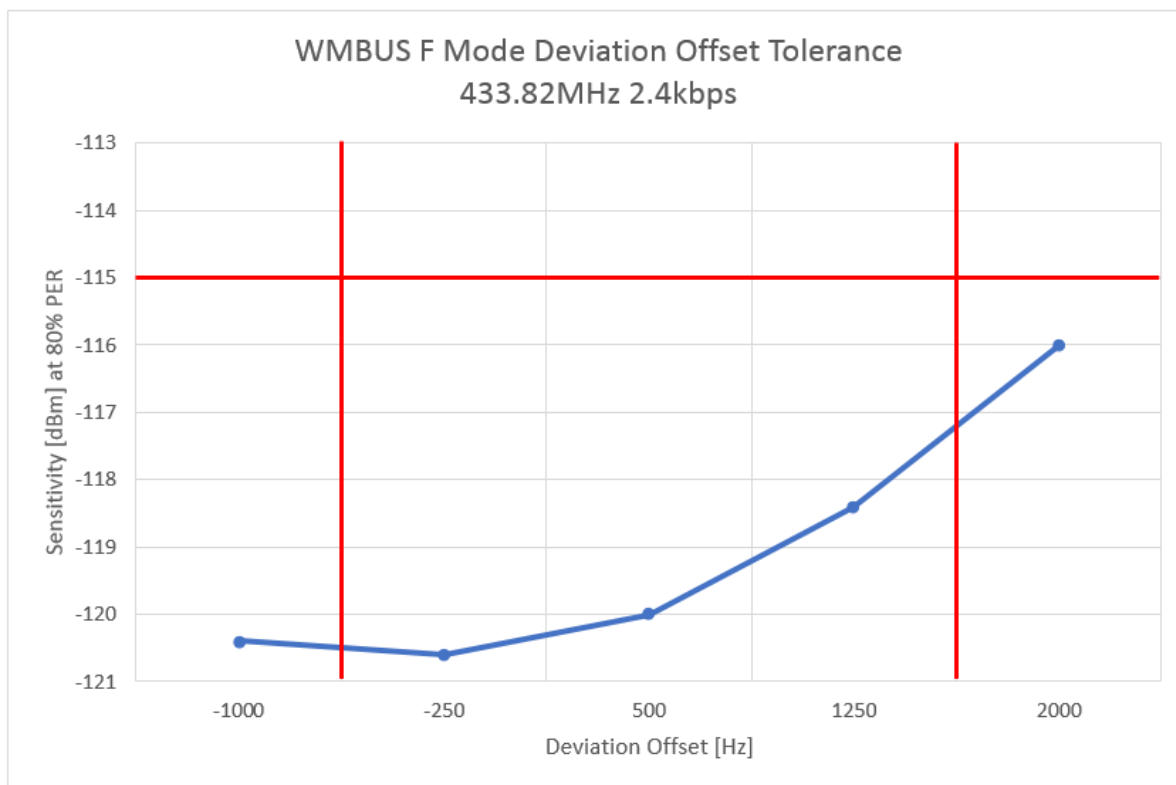FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

Figure 3.48. EFR32FG1 F Mode Receiver Deviation Error Tolerance

3.1.6.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±45 kHz.

Table 3.35. EFR32FG1 F Mode ETSI CAT II Blocking Performance [5.4]

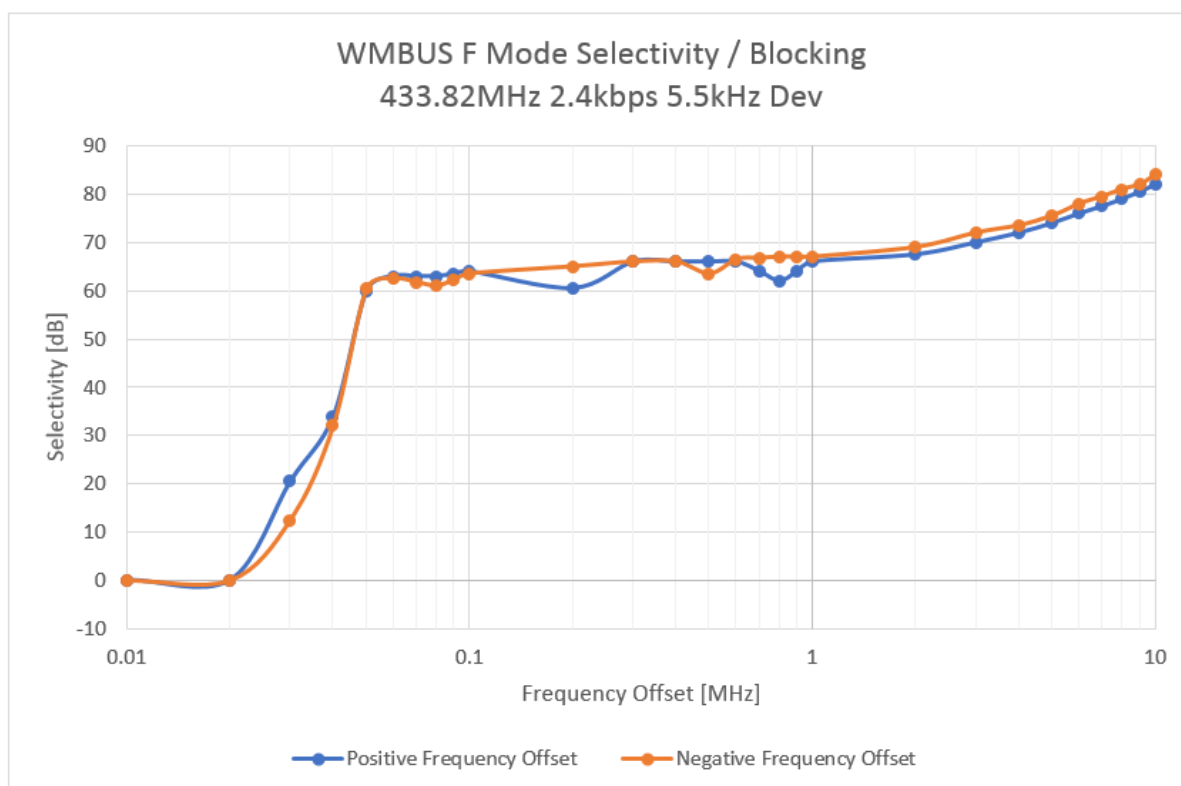| Frequency Offset	Measurement	Limit
±2 MHz	68 dB	> 35 dB
±10 MHz	83 dB	> 60 dB

Figure 3.49. EFR32FG1 F Mode Receiver Selectivity

3.1.6.6 Summary

Table 3.36. EFR32FG1 F Mode Summary

Mode	Parameter	Measurement Results	Comments
F	80% PER Sensitivity	-120.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 45 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	68 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	83 dB	Meets ETSI CAT II Specifications

3.2 EFR32FG12, EFR32FG13 and EFR32FG14

3.2.1 T Mode

3.2.1.1 From-Meter Receiver Sensitivity

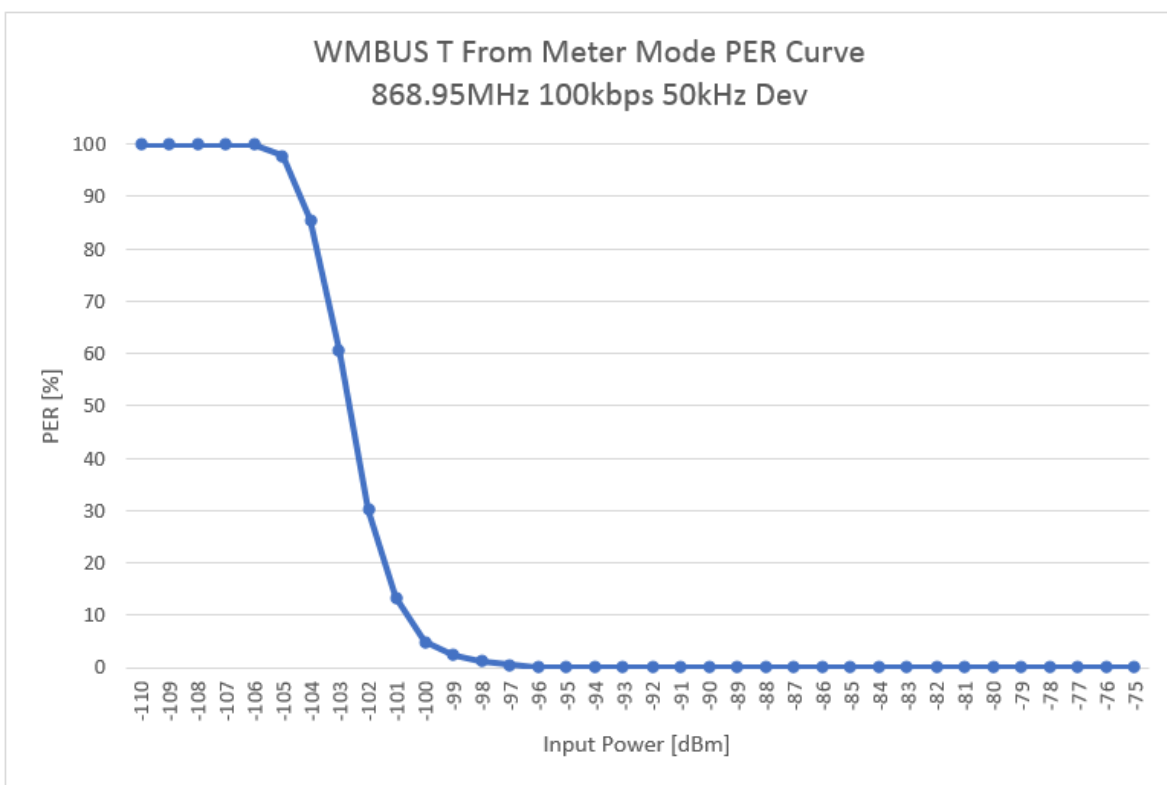**Figure 3.50. EFR32FG12/13/14 T From-Meter Mode Receiver Sensitivity PER Curve**

Table 3.37. EFR32FG12/13/14 T From-Meter Mode Measured Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.95 MHz	100 kbps	50 kHz	80	-103.7
			20	-101.5
			1	-98.4

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.2.1.2 From-Meter Receiver Frequency Error Tolerance

The following figures show the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

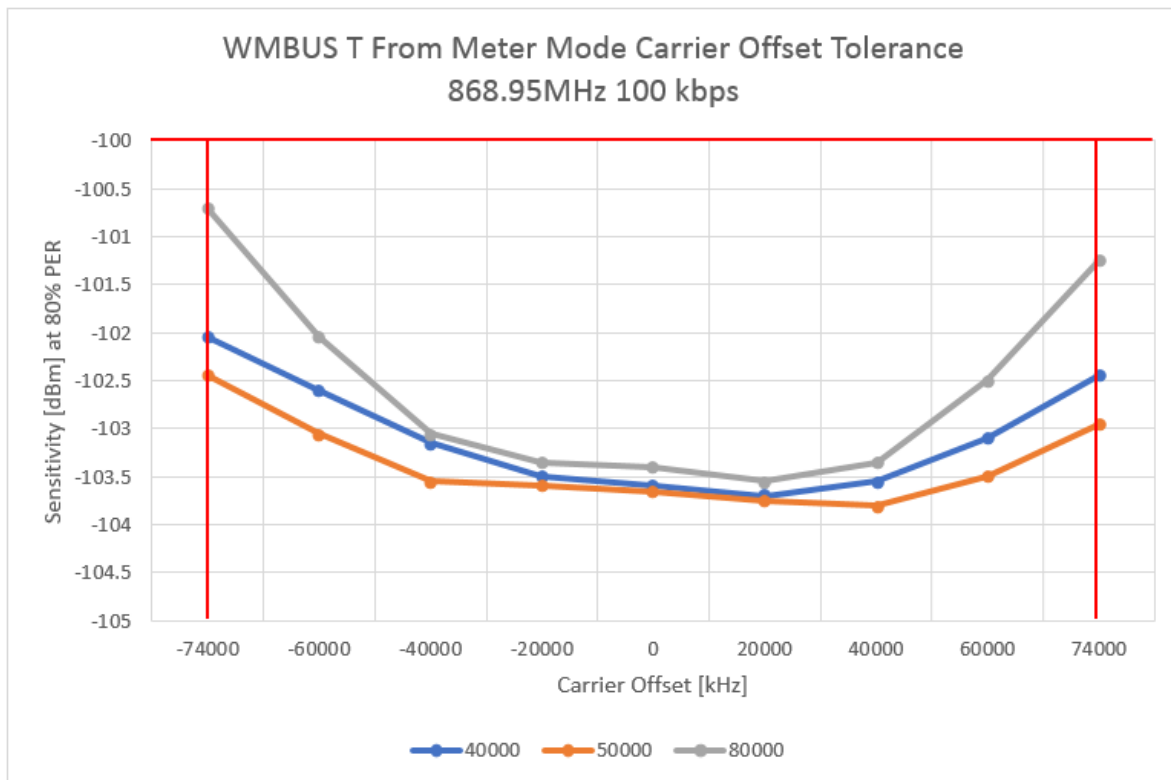Frequency tolerance limits are ±85 ppm (±74 kHz).

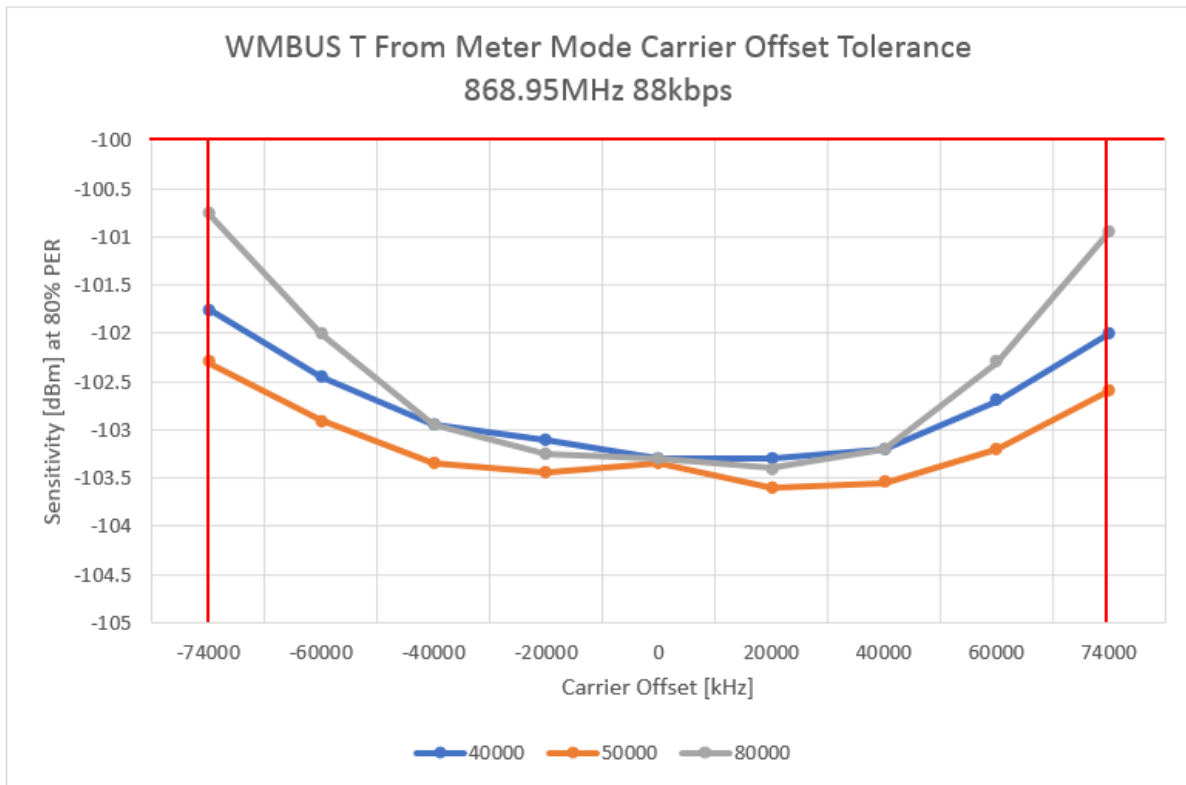**Figure 3.51. EFR32FG12/13/14 T From-Meter Mode 100kbps Receiver Frequency Error Tolerance**

Figure 3.52. EFR32FG12/13/14 T From-Meter Mode 88kbps Receiver Frequency Error Tolerance

Figure 3.53. EFR32FG12/13/14 T From-Meter Mode 112kbps Receiver Frequency Error Tolerance

3.2.1.3 From-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset.

FprEN 13757-4:2013 T Mode Acceptable header chip rate range is ±12 % (± 12 kcps).

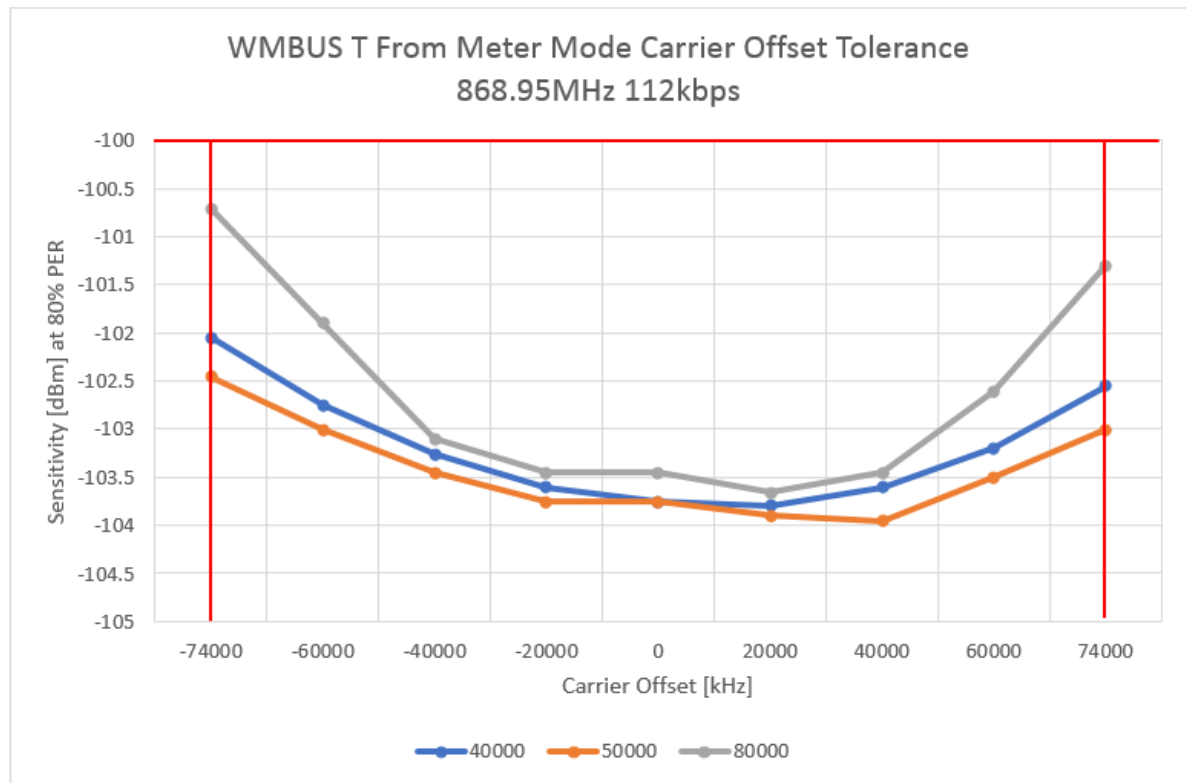FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
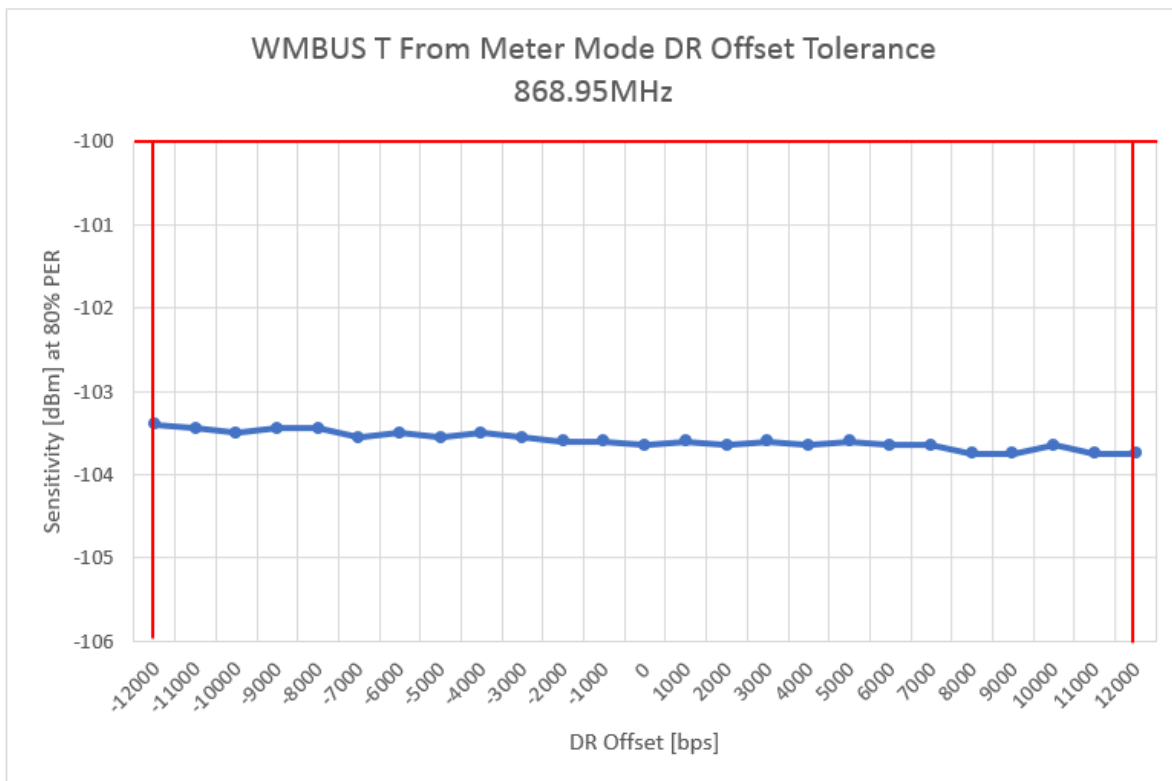
Figure 3.54. EFR32FG12/13/14 T From-Meter Mode Receiver Data Rate Error Tolerance

3.2.1.4 From-Meter Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 T Mode FSK Deviation limits are -10kHz & 30kHz.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
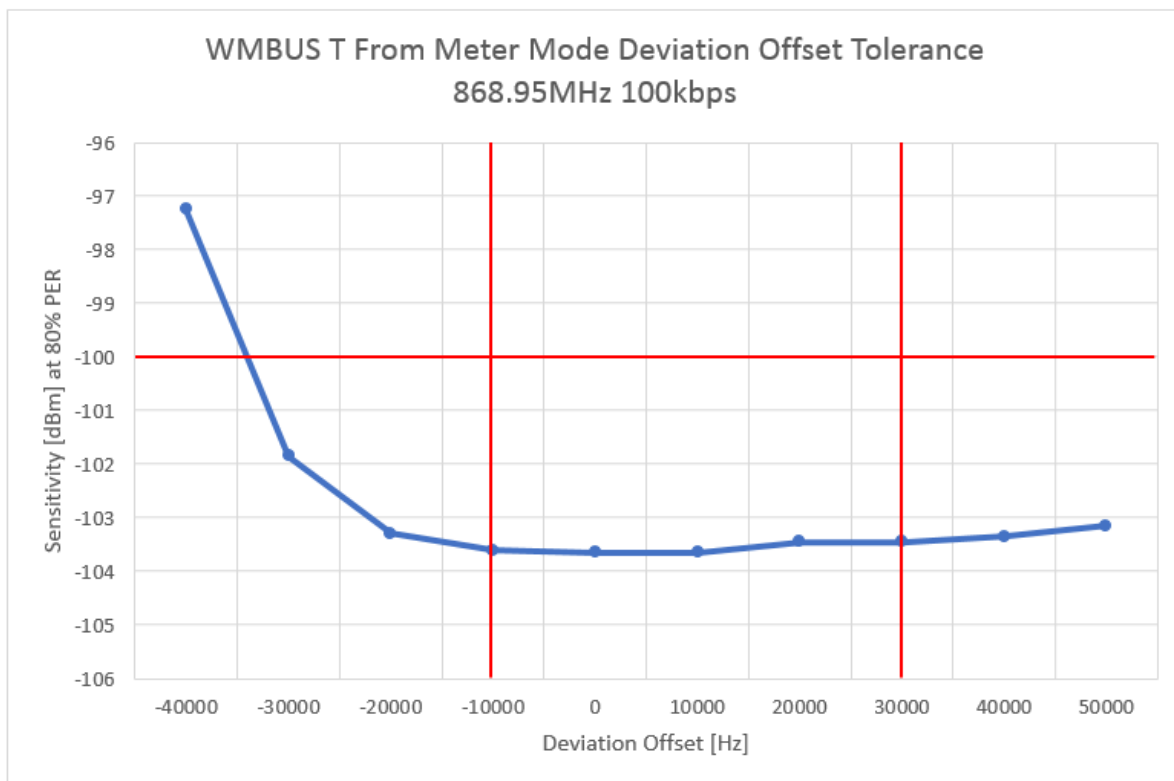
Figure 3.55. EFR32FG12/13/14 T From-Meter Mode Receiver Deviation Error Tolerance

3.2.1.5 From-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±400 kHz.

Table 3.38. EFR32FG12/13/14 T From-Meter Mode ETSI CAT II Blocking Performance [5.3]

Frequency Offset	Measurement	Limit
±2 MHz	56 dB	>22 dB
±10 MHz	74 dB	>47 dB
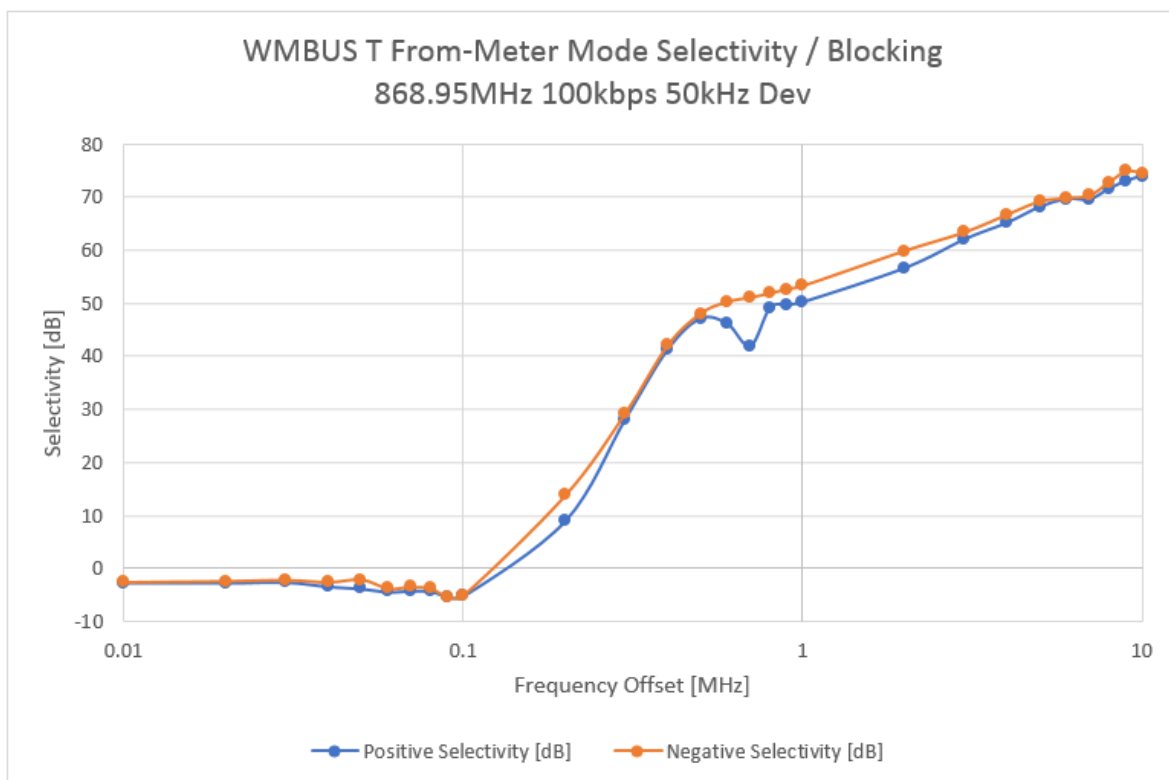
Figure 3.56. EFR32FG12/13/14 T From-Meter Mode Receiver Selectivity

3.2.1.6 To-Meter Receiver Sensitivity
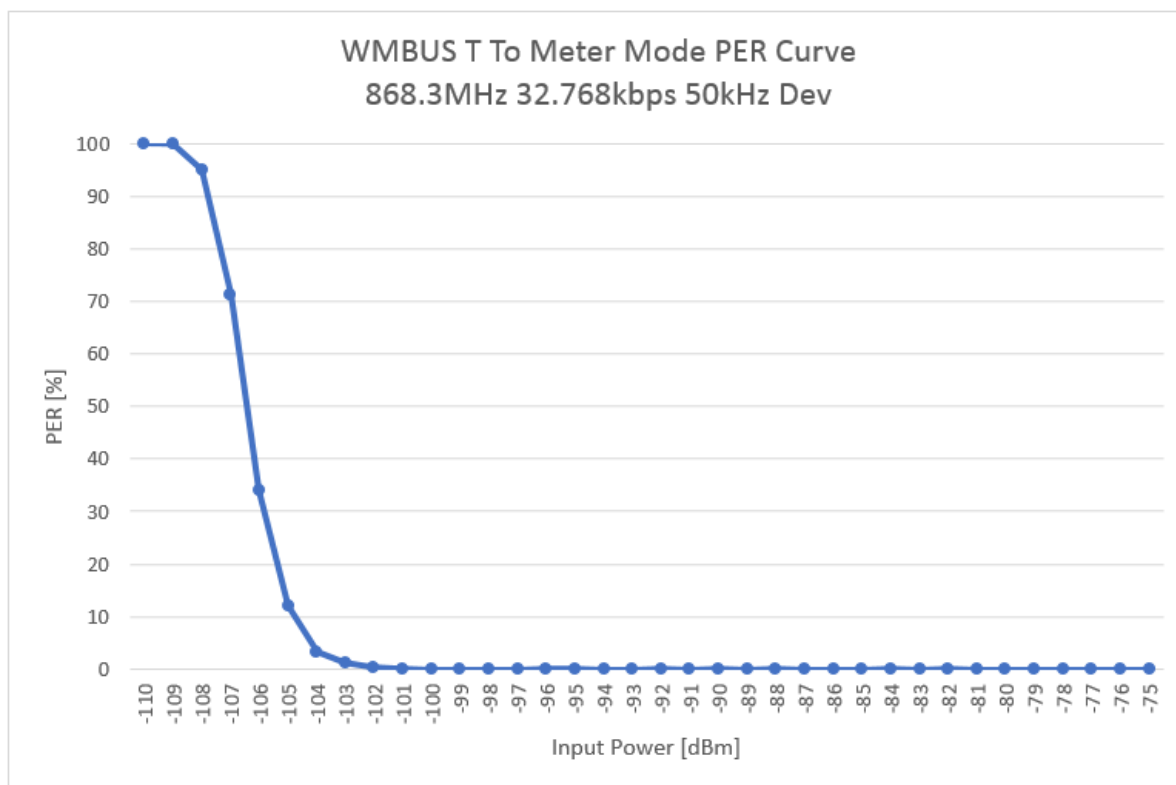
Figure 3.57. EFR32FG12/13/14 T To-Meter Mode Receiver Sensitivity PER Curve

Table 3.39. EFR32FG12/13/14 T To-Meter Mode Measured Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.3 MHz	32.768 kbps	50 kHz	80	-107.2
			20	-105.4
			1	-103.3

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.2.1.7 To-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm. The frequency tolerance limits are ±85 ppm (±74 kHz).
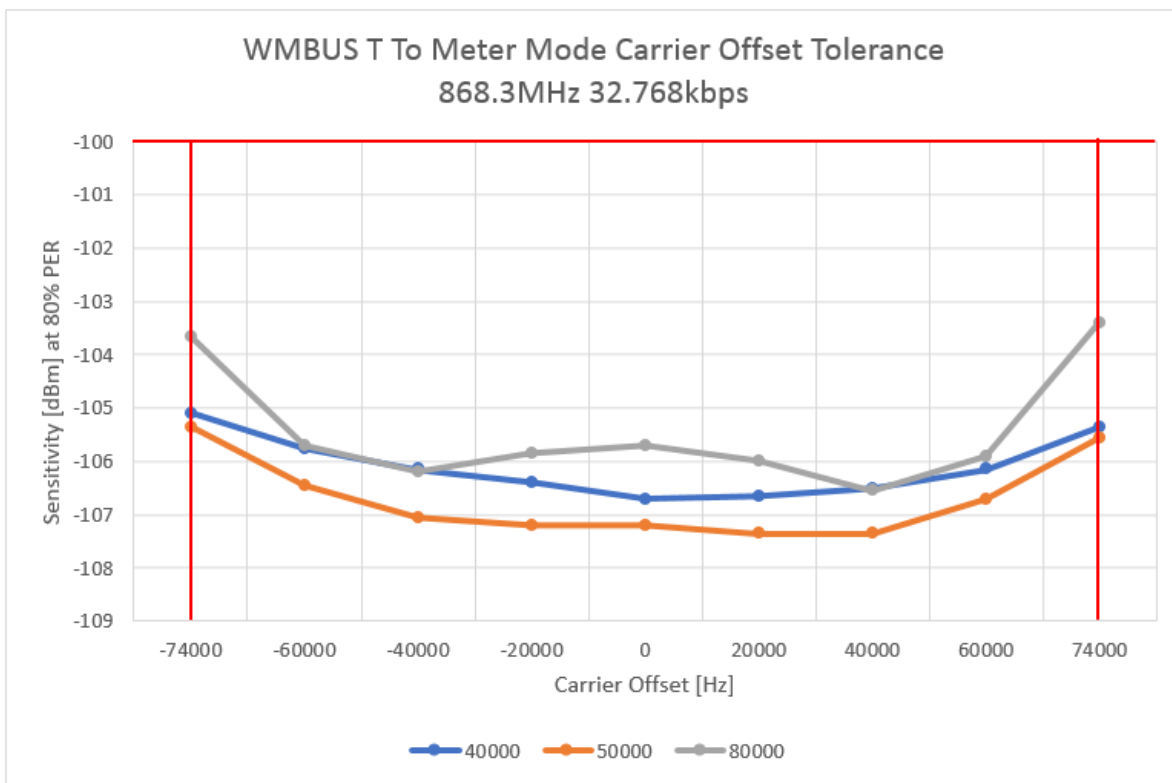
Figure 3.58. EFR32FG12/13/14 T To-Meter Mode Receiver Frequency Error Tolerance

3.2.1.8 To-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±2%. Therefore, the limit used is ± 655 bps.

FprEN 13757-4:2013 Receiver Acceptable Chip Rate Tolerance (Meter) is ±2 %.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
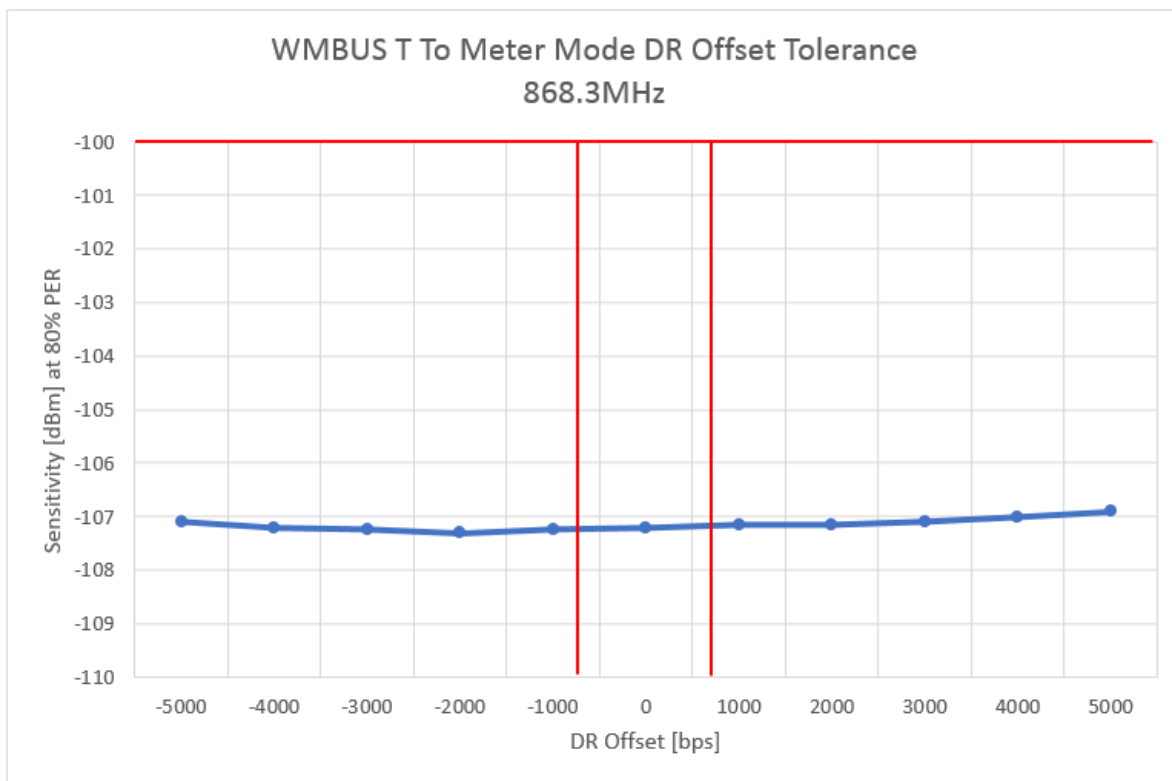
Figure 3.59. EFR32FG12/13/14 T To-Meter Mode Receiver Data Rate Error Tolerance

3.2.1.9 To-Meter Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 T Mode FSK Deviation limits are -10kHz & 30kHz.

FprEN 13757-4:2013 T Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
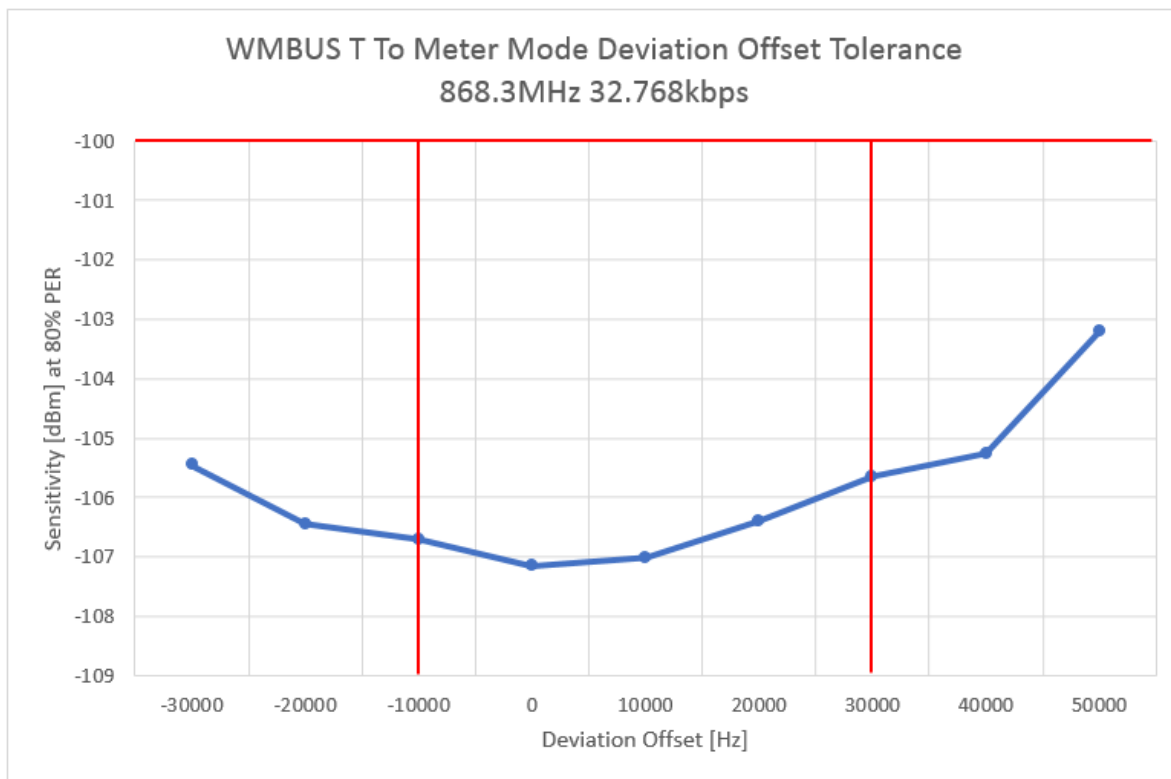
Figure 3.60. EFR32FG12/13/14 T To-Meter Mode Receiver Deviation Error Tolerance

3.2.1.10 To-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±250 kHz.

Table 3.40. EFR32FG12/13/14 T To-Meter Mode ETSI CAT II Blocking Performance [5.4]

Frequency Offset	Measurement	Limit
±2 MHz	63 dB	>22 dB
±10 MHz	78 dB	>47 dB
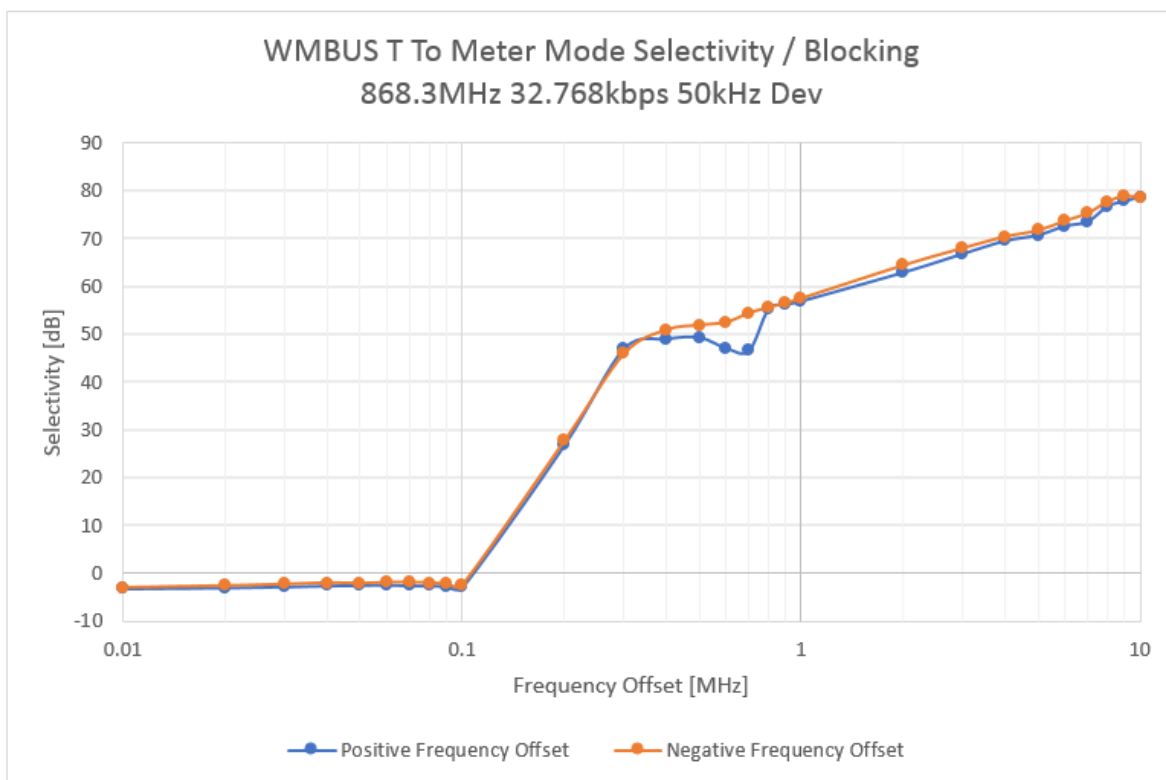
Figure 3.61. EFR32FG12/13/14 T To-Meter Mode Receiver Selectivity

3.2.1.11 Summary

Table 3.41. EFR32FG12/13/14 T Mode Summary

Mode	Parameter	Measurement Results	Comments
T1, T2	80% PER Sensitivity	(Meter-to-Other) -103.7 dBm (Other-to-Meter) -107.2 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	(Meter-to-Other) ± 400 kHz (Other-to-Meter) ± 250 kHz	Meets WMBUS Specifications
	2 MHz Blocking	(Meter-to-Other) 56 dB (Other-to-Meter) 63 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	(Meter-to-Other) 74 dB (Other-to-Meter) 78 dB	Meets ETSI CAT II Specifications

3.2.2 C Mode

3.2.2.1 From-Meter Receiver Sensitivity
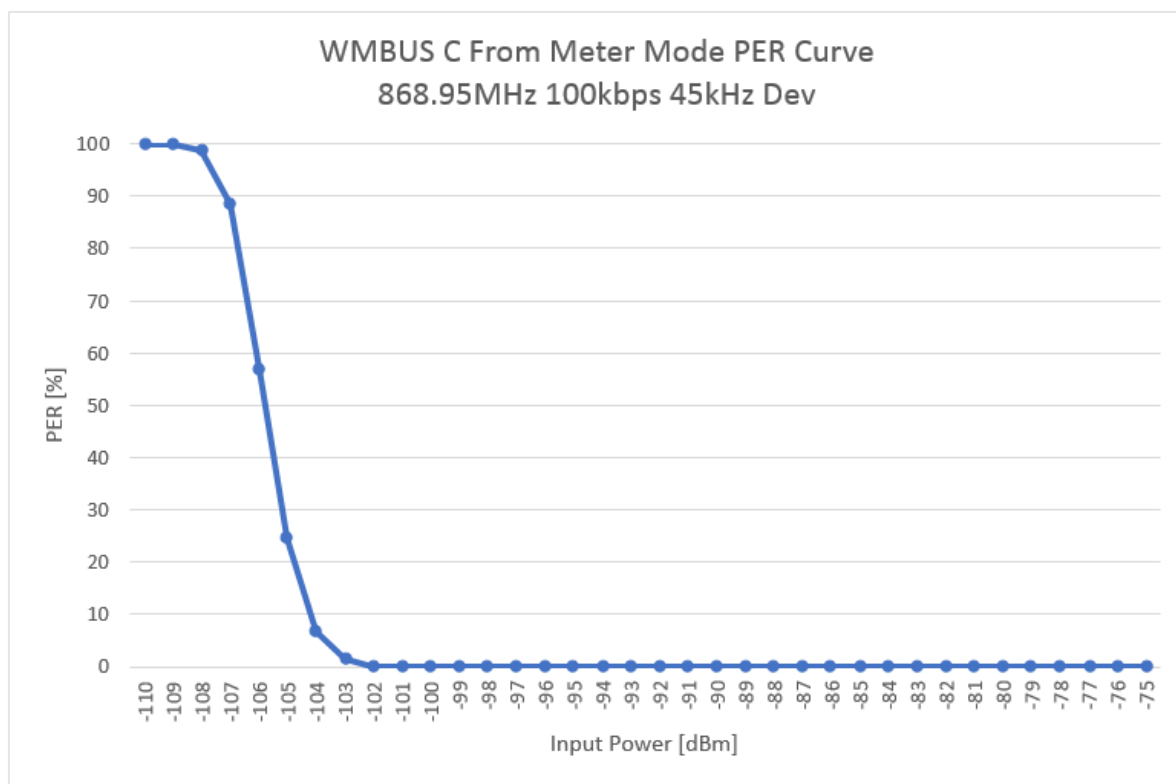
Figure 3.62. EFR32FG12/13/14 C From-Meter Mode PER Curve

Table 3.42. EFR32FG12/13/14 C From-Meter Mode 100kbps Measured Receiver Sensitivity

PER < %	Sensitivity dBm
80	-106.5
20	-104.7
1	-102.9

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.2.2.2 From-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (C1) will have ±25 ppm accuracy and worst case receive modes (C2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

The frequency tolerance limits are ±50 ppm (±43.5 kHz).
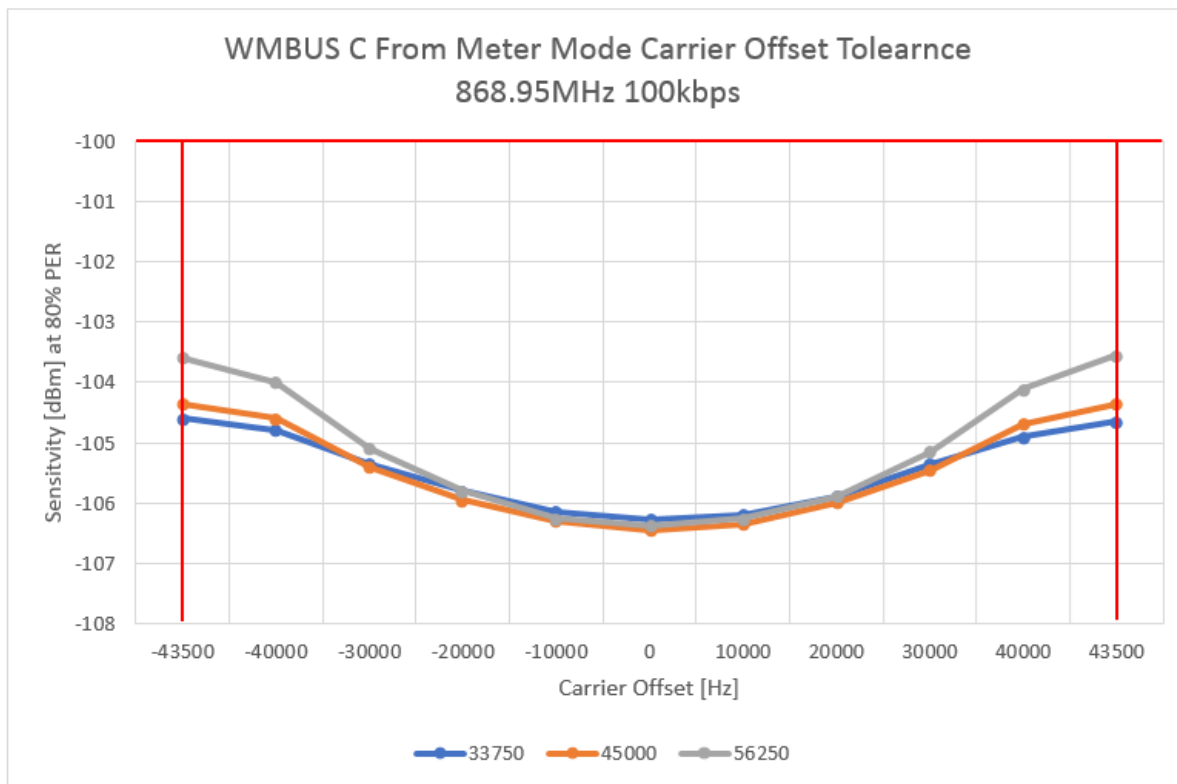
Figure 3.63. EFR32FG12/13/14 C From-Meter Mode Receiver Frequency Error Tolerance

3.2.2.3 From-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset in ppm.

FprEN 13757-4:2013 C From-Meter Mode Chip Rate Tolerance is ±100 ppm.

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
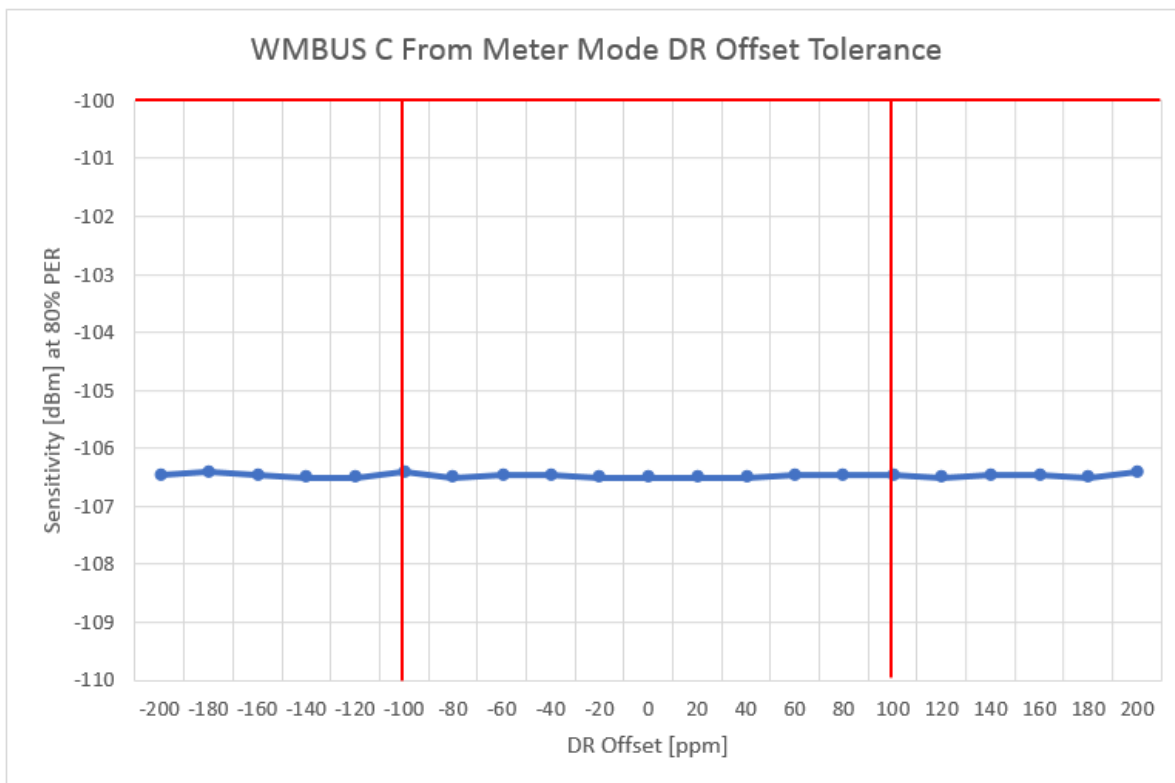
Figure 3.64. EFR32FG12/13/14 C From-Meter Mode Receiver Data Rate Error Tolerance

3.2.2.4 From-Meter Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 C From-Meter Mode FSK Deviation limits are ±11.25 kHz.

FprEN 13757-4:2013 C From-Meter Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
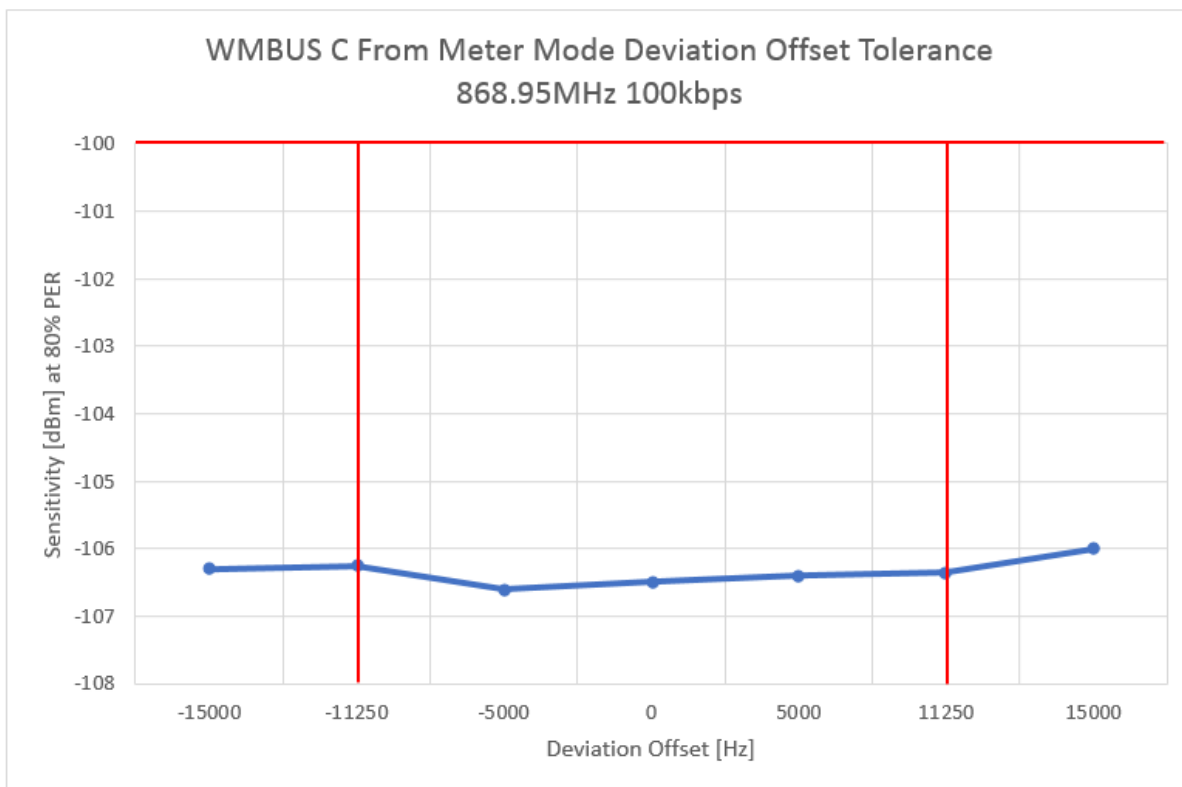
Figure 3.65. EFR32FG12/13/14 C-Mode From-Meter Mode Deviation Offset Tolerance

3.2.2.5 From-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±180 kHz.

Table 3.43. EFR32FG12/13/14 C From-Meter Mode ETSI CAT II Blocking Performance [5.5]

Frequency Offset	Measurement	Limit
±2 MHz	61 dB	>24 dB
±10 MHz	76 dB	>49 dB
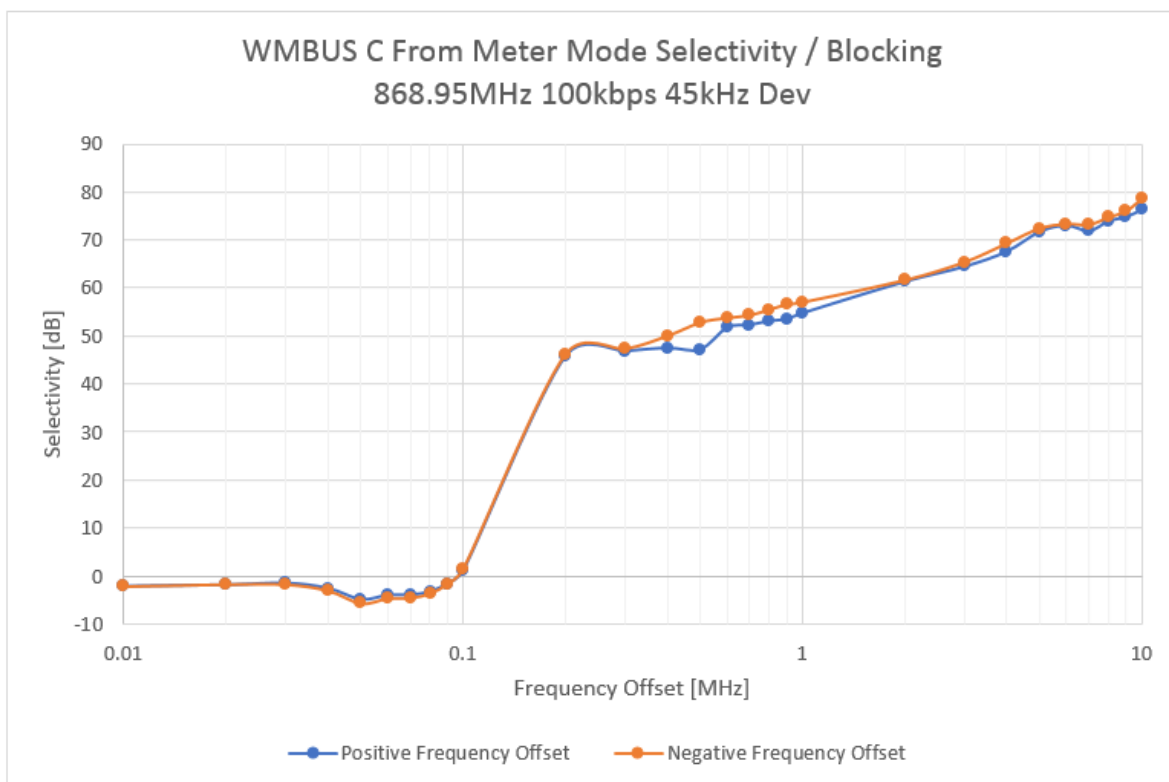
Figure 3.66. EFR32FG12/13/14 C From-Meter Mode Receiver Selectivity

3.2.2.6 To-Meter Receiver Sensitivity
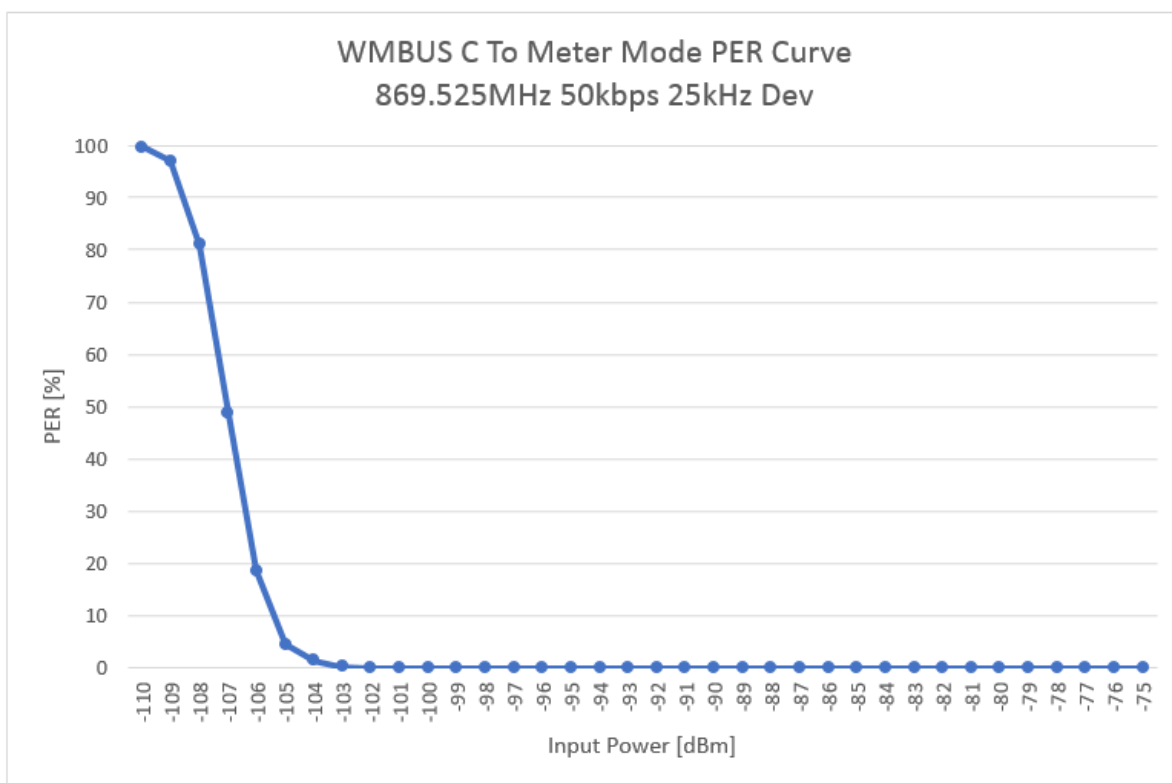
Figure 3.67. EFR32FG12/13/14 C To-Meter Mode PER Curve

Table 3.44. EFR32FG12/13/14 C To-Meter Mode Measured Receiver Sensitivity

PER < %	Sensitivity dBm
80	-108.1
20	-106.4
1	-104.6

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

3.2.2.7 To-Meter Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (C1) will have ±25 ppm accuracy and worst case receive modes (C2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.

The frequency tolerance limits are ±50 ppm (±43.5 kHz).
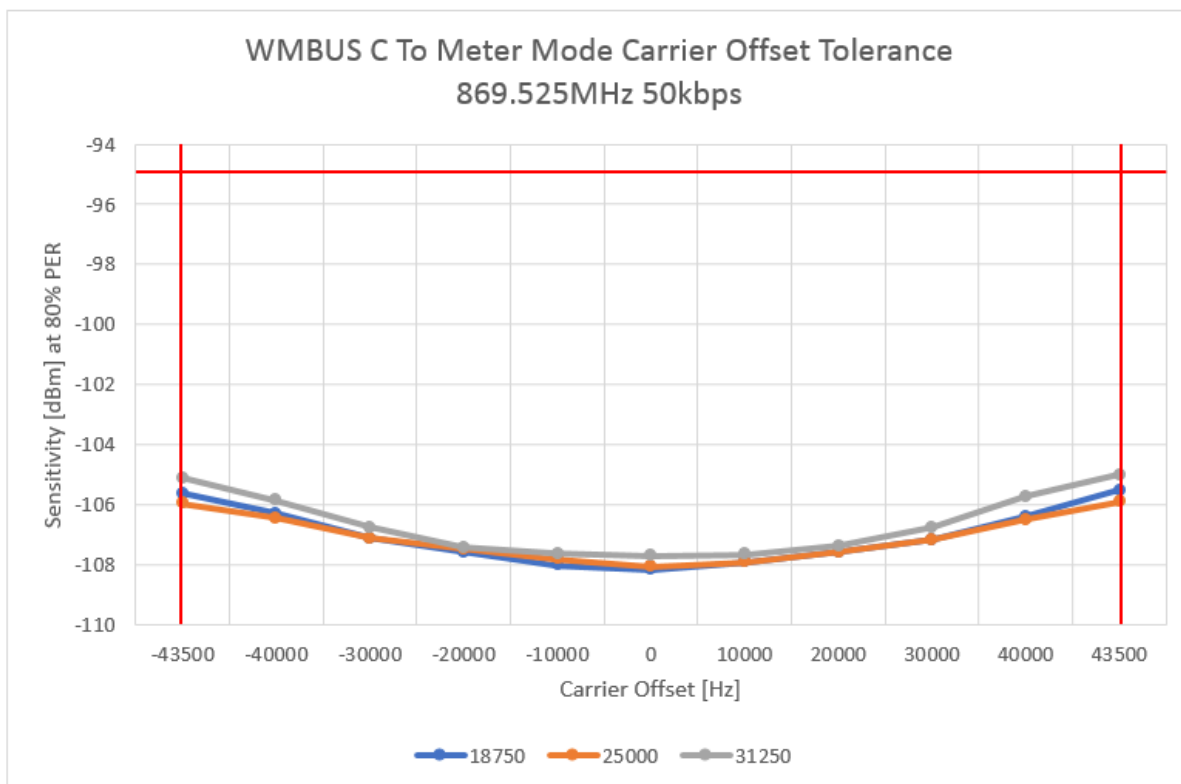
Figure 3.68. EFR32FG12/13/14 C To-Meter Mode Receiver Frequency Error Tolerance

3.2.2.8 To-Meter Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset in ppm.

FprEN 13757-4:2013 C To-Meter Mode Chip Rate Tolerance is ±100 ppm.

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.
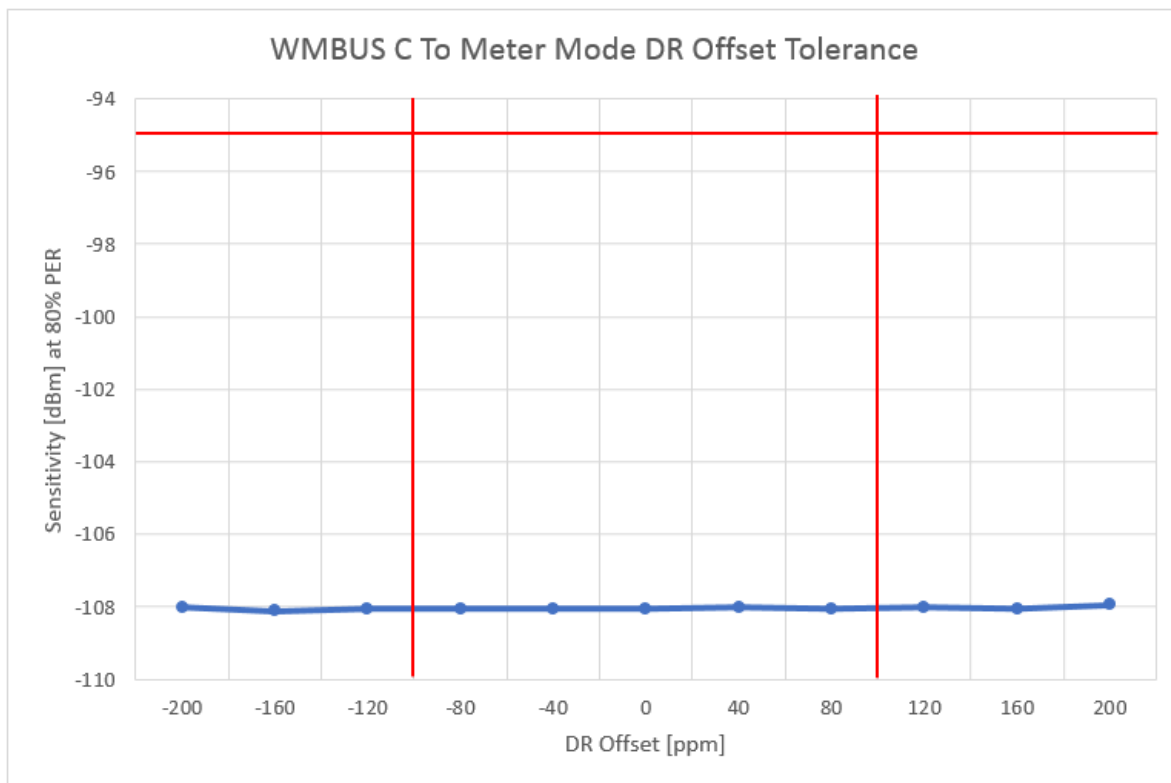
Figure 3.69. EFR32FG12/13/14 C-Mode To-Meter Mode Data Rate Offset Tolerance

3.2.2.9 To-Meter Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 C To-Meter Mode FSK Deviation limits are ±6.25 kHz.

FprEN 13757-4:2013 C To-Meter Mode Sensitivity (PER < 0.8) minimum is -95 dBm.
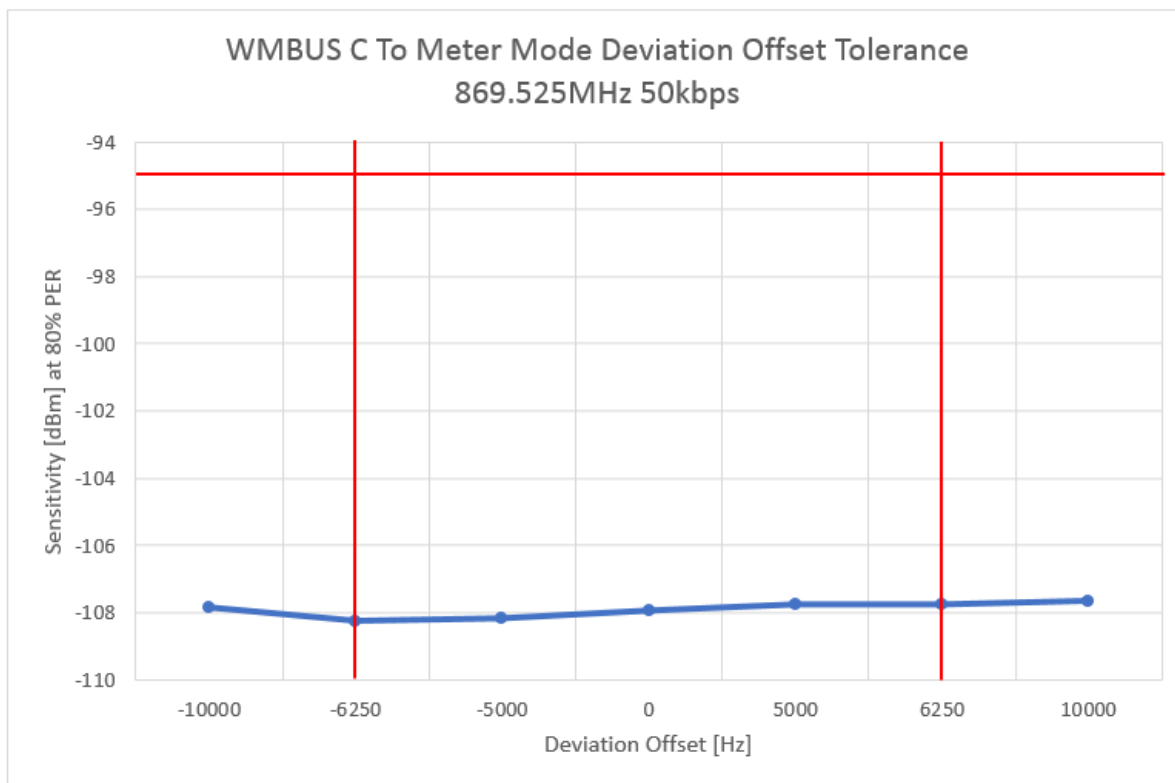
Figure 3.70. EFR32FG12/13/14 C-Mode To-Meter Mode Deviation Offset Tolerance

3.2.2.10 To-Meter Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±150 kHz.

Table 3.45. EFR32FG12/13/14 C To-Meter Mode ETSI CAT II Blocking Performance [5.6]

Frequency Offset	Measurement	Limit
±2 MHz	62 dB	>25 dB
±10 MHz	78 dB	>50 dB
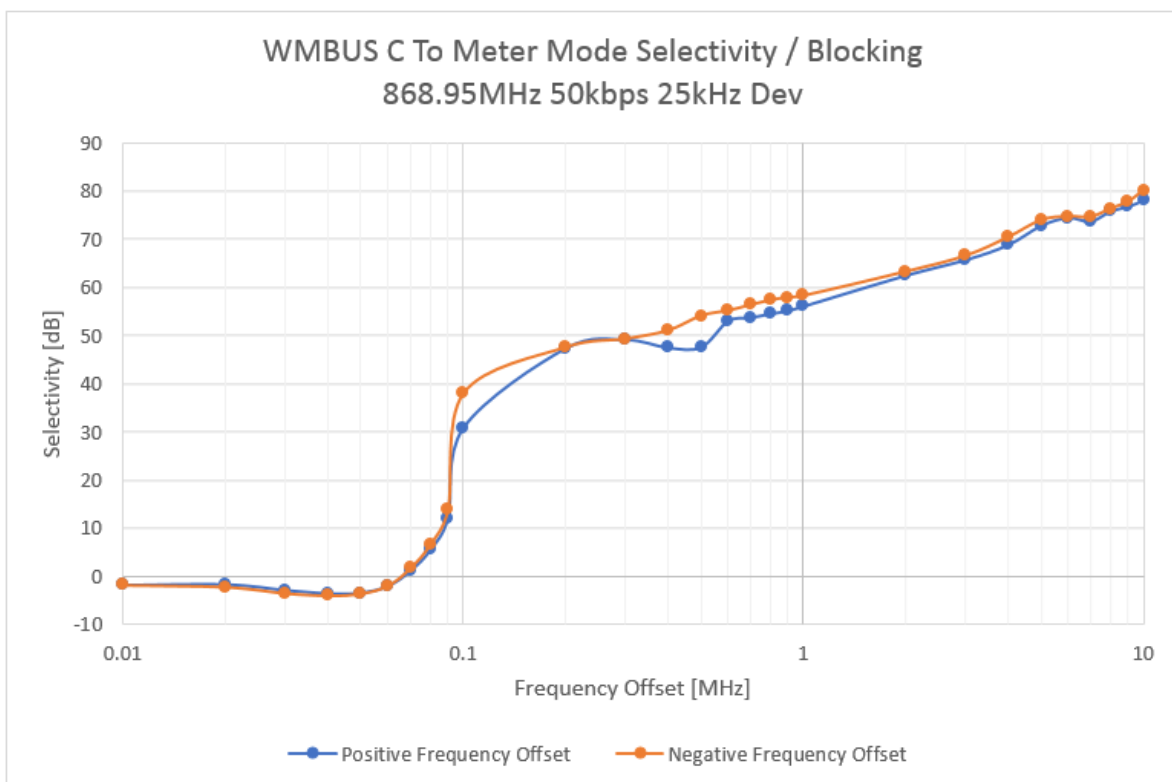
Figure 3.71. EFR32FG12/13/14 C To-Meter Mode Receiver Selectivity

3.2.2.11 Summary

Table 3.46. EFR32FG12/13/14 C Mode Summary

Mode	Parameter	Measurement Results	Comments
C1, C2	80% PER Sensitivity	(Meter-to-Other) -106.5 dBm (Other-to-Meter) -108.1 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	2 MHz Blocking	(Meter-to-Other) 61 dB (Other-to-Meter) 62 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	(Meter-to-Other) 76 dB (Other-to-Meter) 78 dB	Meets ETSI CAT II Specifications

3.2.3 N Mode

3.2.3.1 N2g Receiver Sensitivity
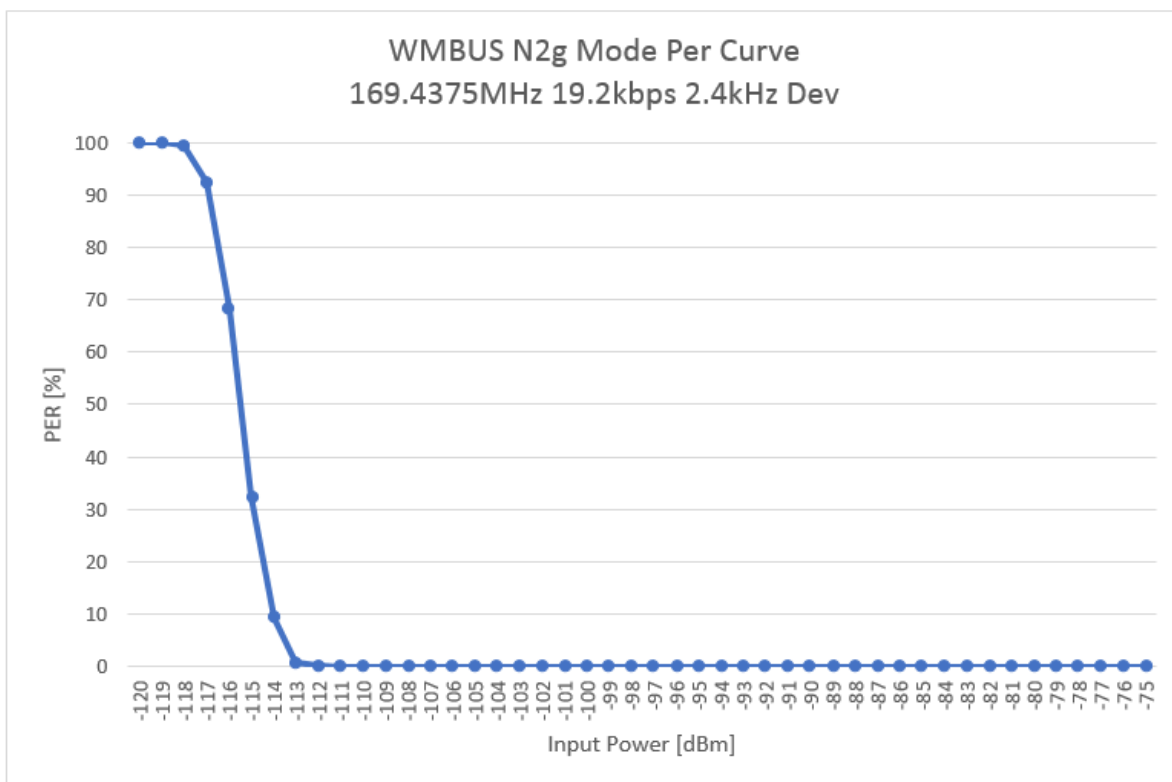
Figure 3.72. EFR32FG12/13/14 N2g Mode Receiver Sensitivity PER Curve

Table 3.47. EFR32FG12/13/14 N2g Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.4375 MHz	19.2 kbps	±2.4 kHz, ±7.2 kHz	80	-116.3
			20	-114.5
			1	-112.9

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

3.2.3.2 N2g Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Table 18 Mode N, Frequencies of the Wireless M-Bus specification indicates frequency tolerance of ±2.5 kHz. Therefore, the overall frequency error accounting for transmitter and receiver will be ±5 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

FprEN 13757-4:2013 N2g Mode Frequency Tolerance limits are ±5 kHz.
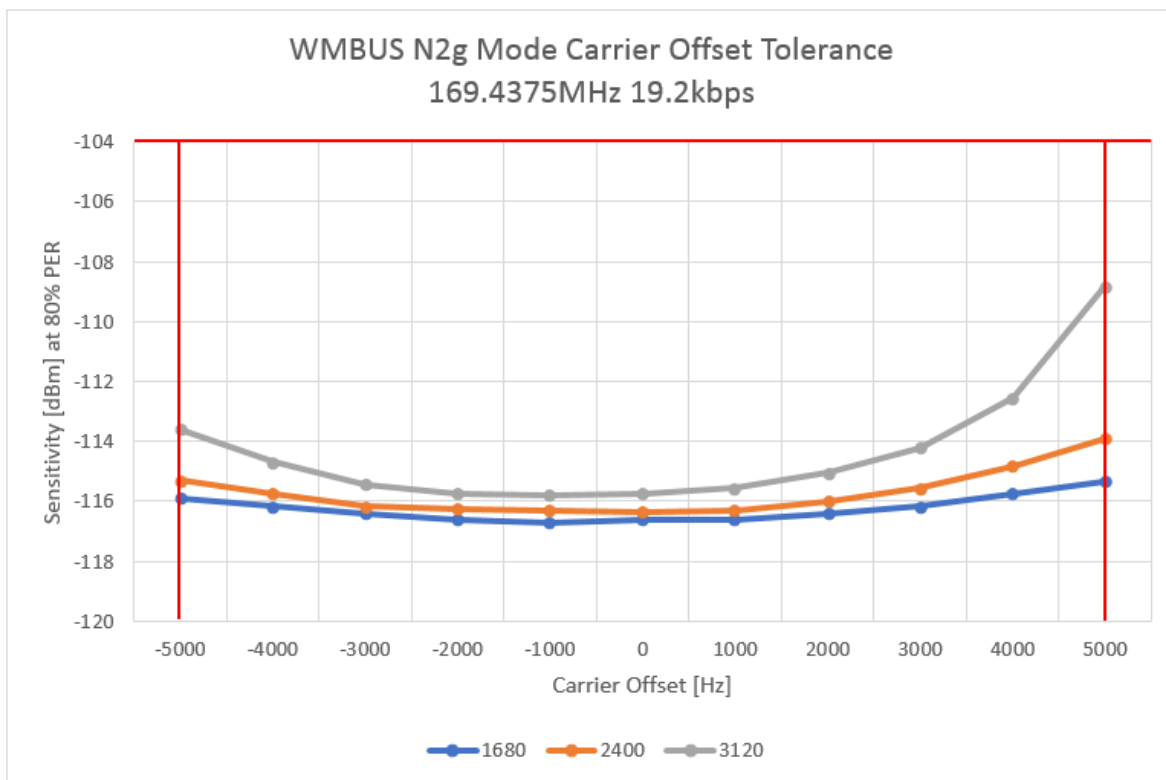
Figure 3.73. EFR32FG12/13/14 N2g Mode Receiver Frequency Error Tolerance

3.2.3.3 N2g Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N2g Mode Sensitivity (PER < 0.8) minimum is -104 dBm.

FprEN 13757-4:2013 N2g Mode Deviation Tolerance limits are ±720 kHz.
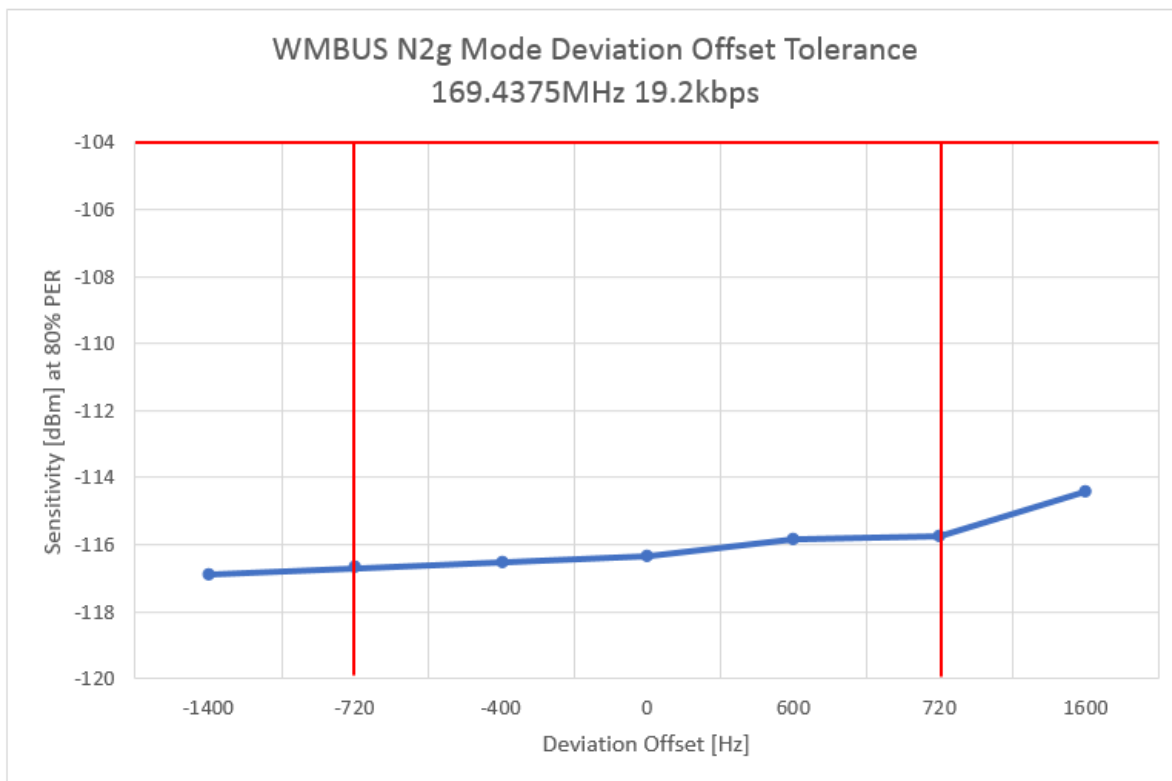
Figure 3.74. EFR32FG12/13/14 N2g Receiver Deviation Offset Tolerance

3.2.3.4 N2g Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.48. EFR32FG12/13/14 N2g Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±50 kHz	54 dB	>40 dB

Table 3.49. EFR32FG12/13/14 N2g Mode ETSI CAT II Blocking Performance [5.7]

Frequency Offset	Measurement	Limit
±2 MHz	63 dB	>33 dB
±10 MHz	81 dB	>58 dB
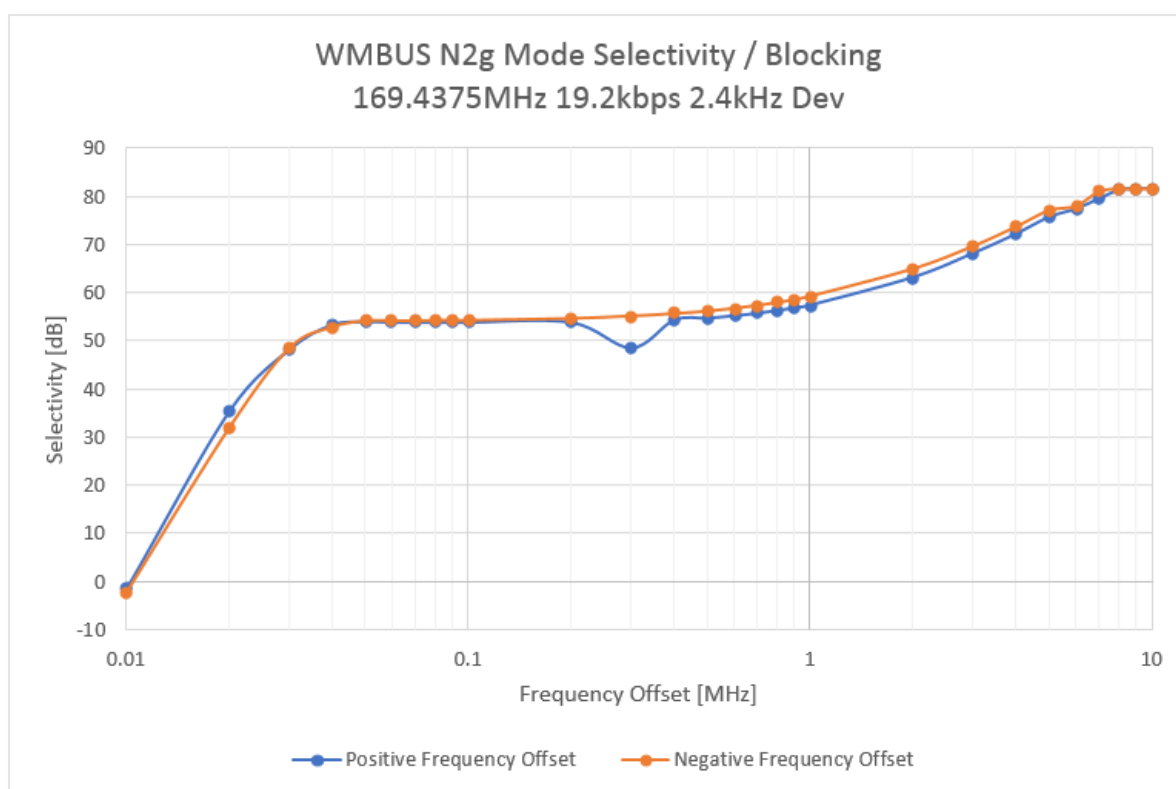
Figure 3.75. EFR32FG12/13/14 N2g Receiver Selectivity

3.2.3.5 N Mode Summary

Table 3.50. EFR32FG12/13/14 N2g Mode Summary

Mode	Parameter	Measurement Results	Comments
N2g	80% PER Sensitivity	-116.3 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	2 MHz Blocking	63 dB	Meets ETSI CAT II Specifications
	10 MHz Blocking	81 dB	Meets ETSI CAT II Specifications

3.2.3.6 N1a Receiver Sensitivity

Figure 3.76. EFR32FG12/13/14 N1a Mode Receiver Sensitivity PER Curve

Table 3.51. EFR32FG12/13/14 N1a Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.40625 MHz	4.8 kbps	±2.4 kHz	80	-119.6
			20	-117.9
			1	-116.4

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

3.2.3.7 N1a Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Table 18 Mode N, Frequencies of the Wireless M-Bus specification indicates frequency tolerance of ±1.5 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

FprEN 13757-4:2013 N1a Mode Frequency Tolerance limits are ±1.5 kHz.

Note: The ±1.5 kHz frequency offset tolerance is considered for the whole link.
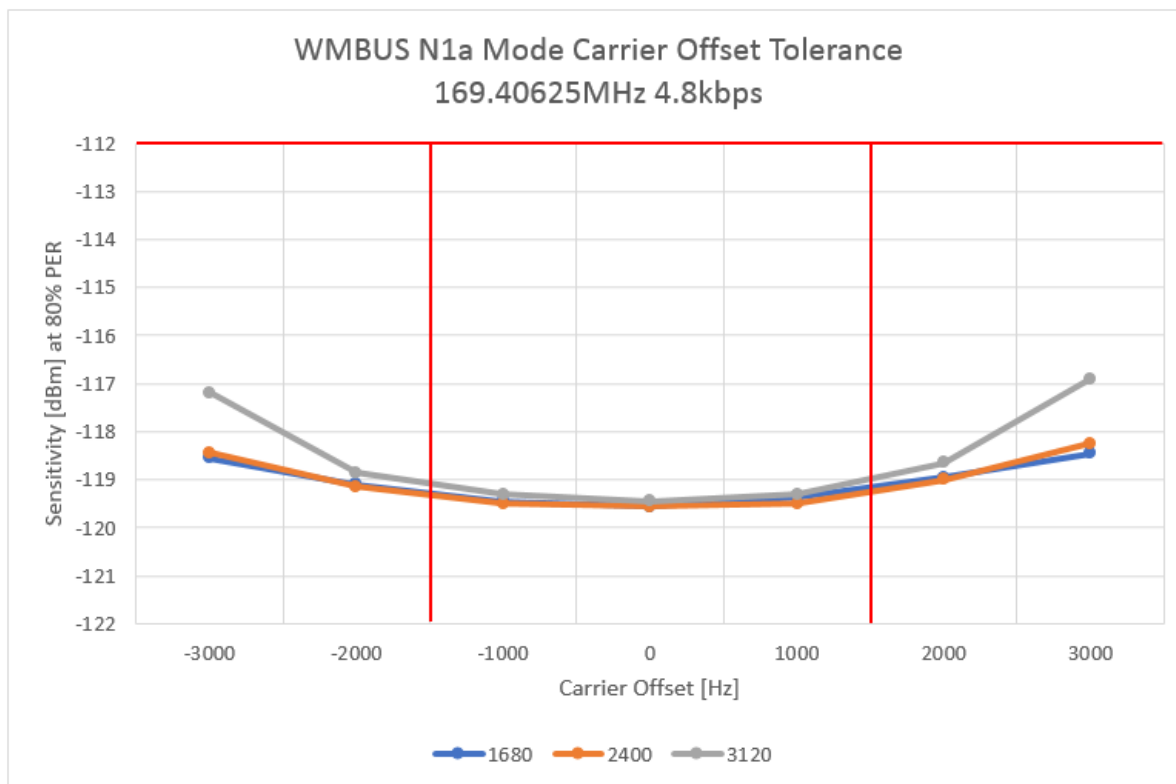
Figure 3.77. EFR32FG12/13/14 N1a Mode Receiver Frequency Error Tolerance

3.2.3.8 N1a Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N1a Mode Sensitivity (PER < 0.8) minimum is -112 dBm.

FprEN 13757-4:2013 N1a Mode Deviation Tolerance limits are ±720 kHz.
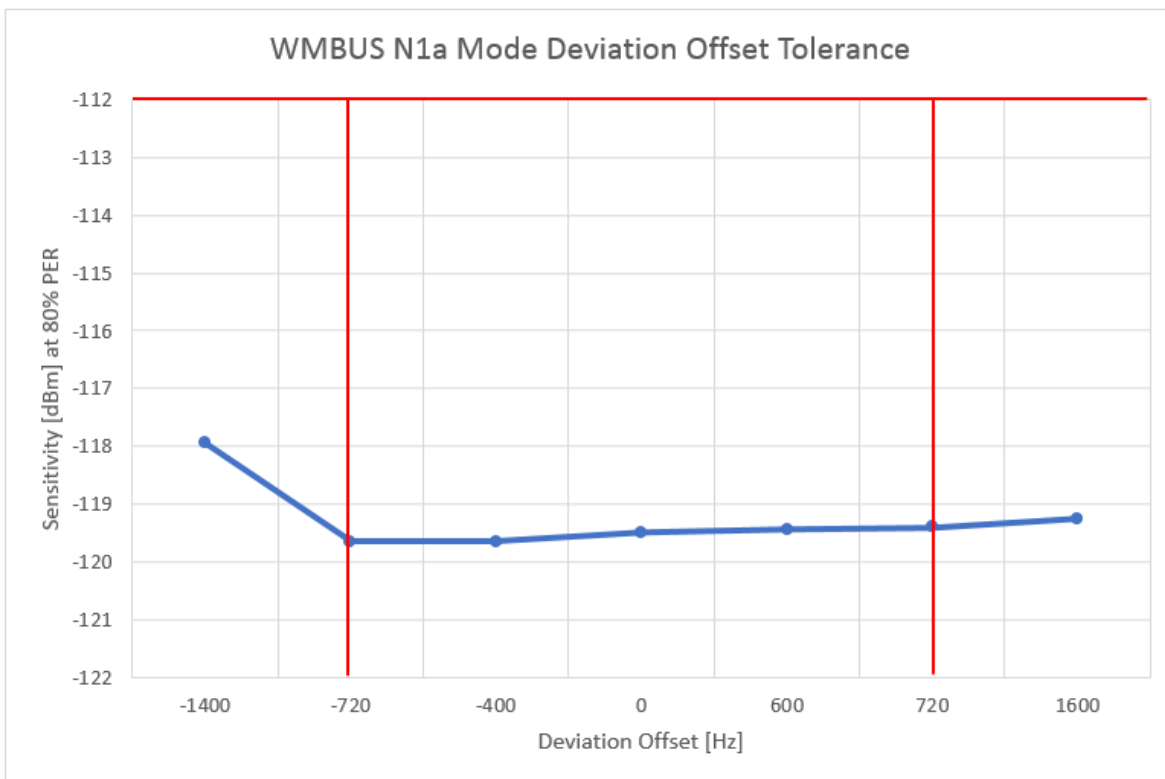
Figure 3.78. EFR32FG12/13/14 N1a Receiver Deviation Offset Tolerance

3.2.3.9 N1a Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.52. EFR32FG12/13/14 N1a Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±12.5 kHz	42 dB	> 40 dB

Table 3.53. EFR32FG12/13/14 N1a Mode ETSI CAT II Blocking Performance [5.7]

Frequency Offset	Measurement	Limit
±2 MHz	66 dB	> 36 dB
±10 MHz	85 dB	> 61 dB
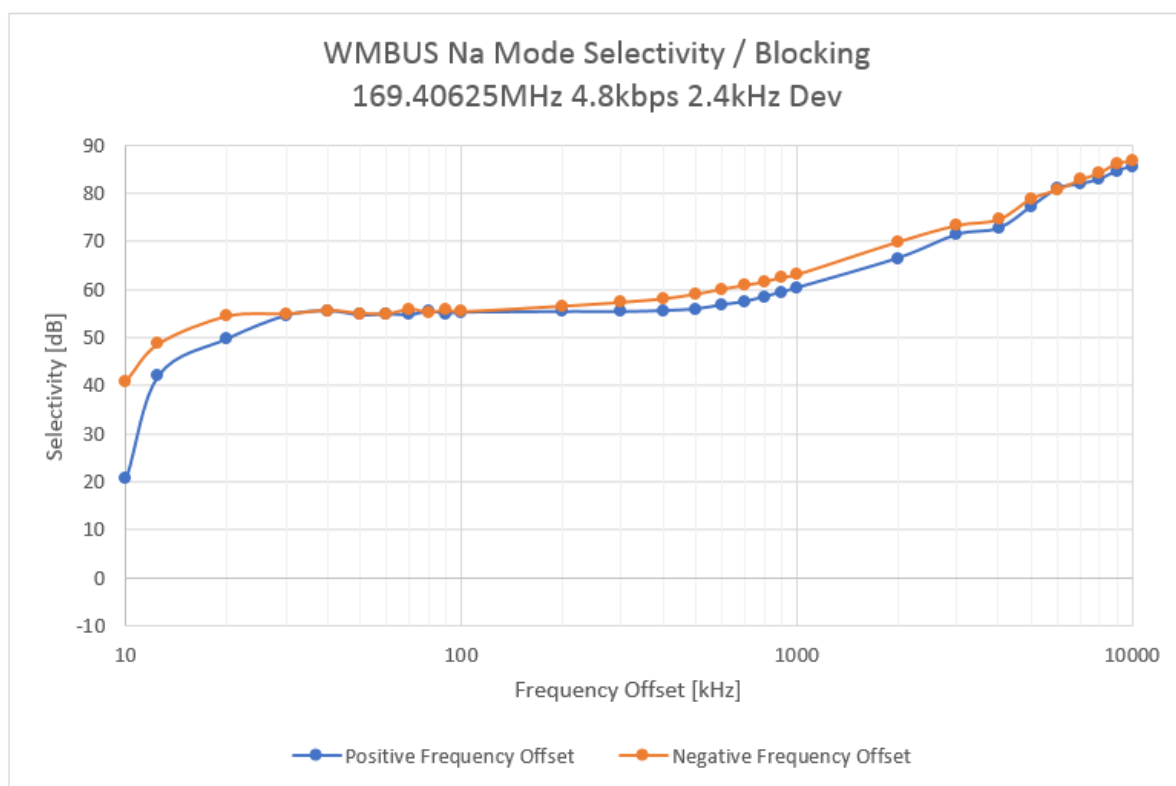
Figure 3.79. EFR32FG12/13/14 N1a Receiver Selectivity
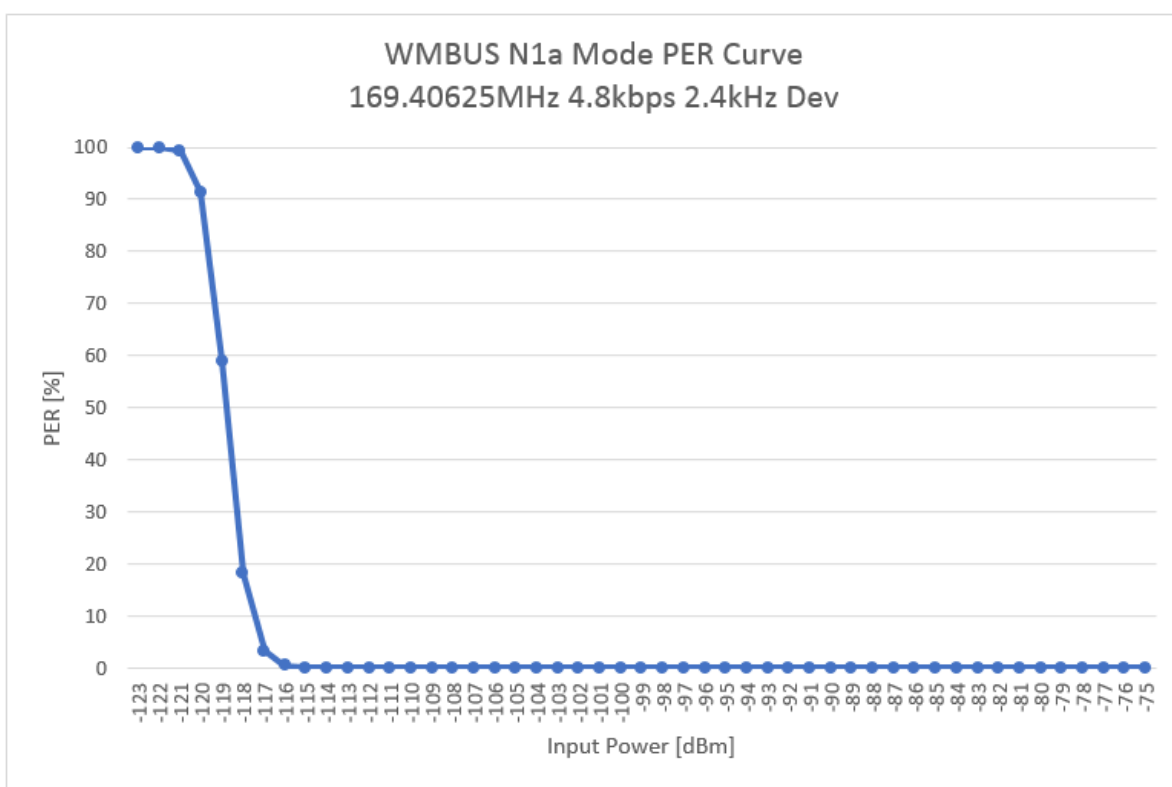
3.2.3.10 N1c Receiver Sensitivity

Figure 3.80. EFR32FG12/13/14 N1c Mode Receiver Sensitivity PER Curve

Table 3.54. EFR32FG12/13/14 N1c Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
169.43125 MHz	2.4 kbps	±2.4 kHz	80	-120.4
			20	-118.9
			1	-117.2

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

3.2.3.11 N1c Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Table 18 Mode N, Frequencies of the Wireless M-Bus specification indicates frequency tolerance of ±2 kHz. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

FprEN 13757-4:2013 N1c Mode Frequency Tolerance limits are ±2 kHz.

**Note:** The ±2 kHz frequency offset tolerance is considered for the whole link.
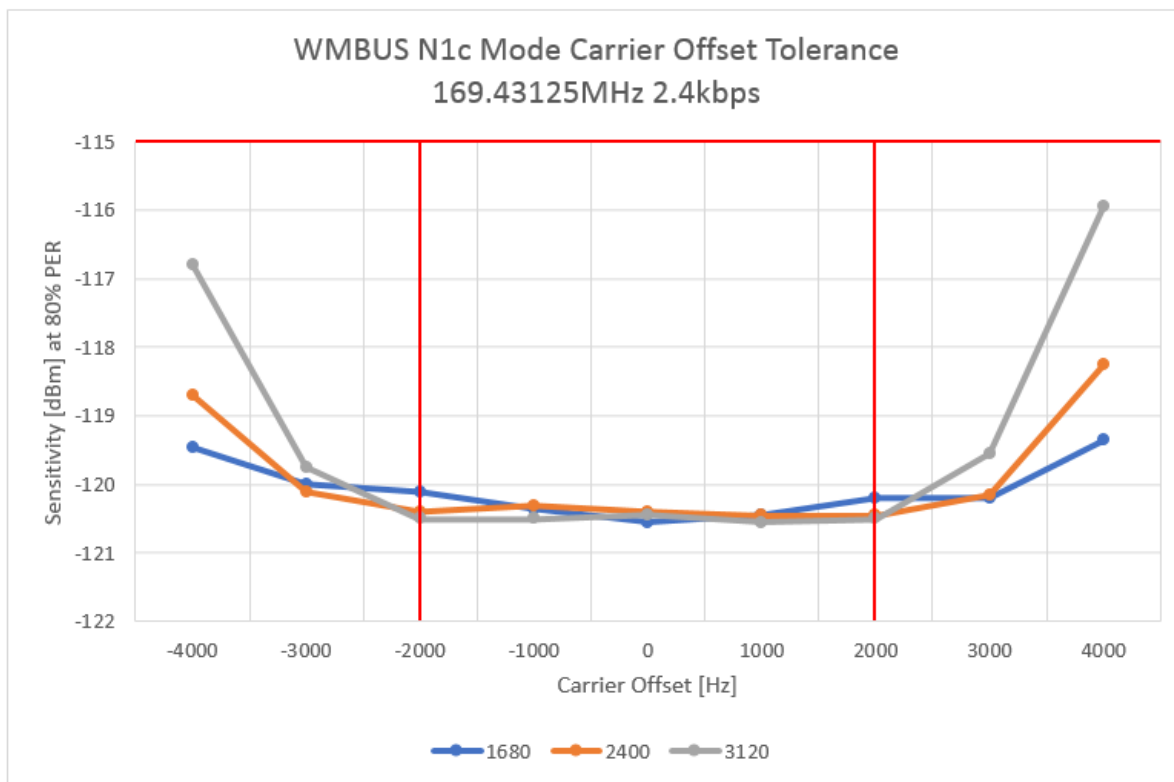
Figure 3.81. EFR32FG12/13/14 N1c Mode Receiver Frequency Error Tolerance

3.2.3.12 N1c Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capabilities of the receiver. Table 19 Mode N, Modulation and Timing of FrEN 13757-4:2013 specifies a deviation tolerance of ±30 % or ±720 Hz.

FprEN 13757-4:2013 N1c Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

FprEN 13757-4:2013 N1c Mode Deviation Tolerance limits are ±720 kHz.
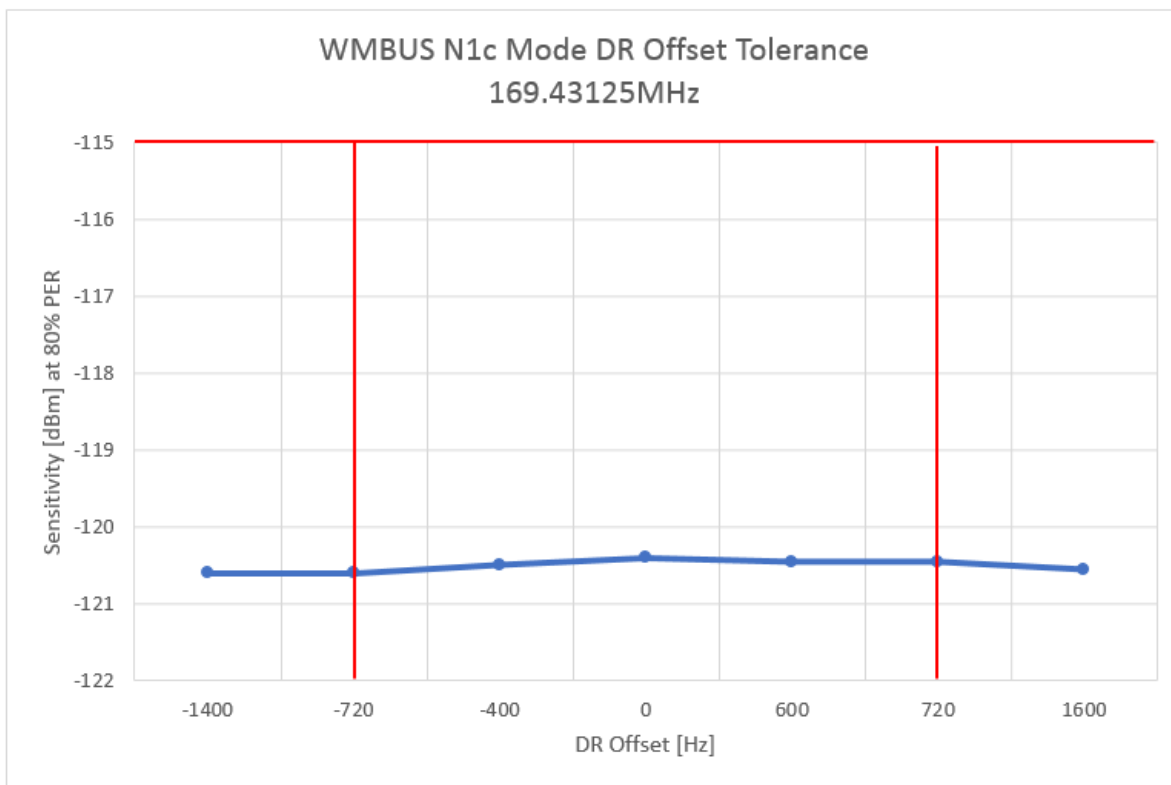
Figure 3.82. EFR32FG12/13/14 N1c Receiver Deviation Offset Tolerance

3.2.3.13 N1c Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.55. EFR32FG12/13/14 N1c Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±12.5 kHz	44 dB	> 40 dB

Table 3.56. EFR32FG12/13/14 N1c Mode ETSI CAT II Blocking Performance [5.7]

Frequency Offset	Measurement	Limit
±2 MHz	65 dB	> 36 dB
±10 MHz	86 dB	> 61 dB
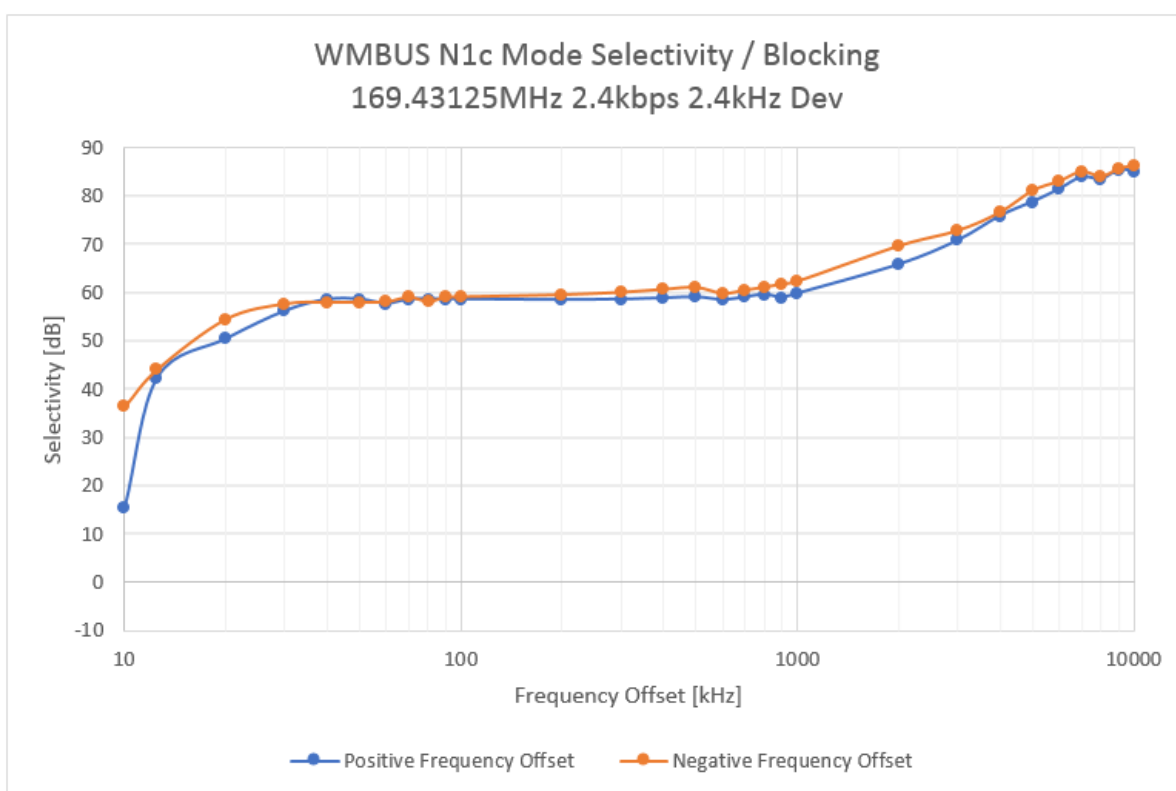
Figure 3.83. EFR32FG12/13/14 N1c Receiver Selectivity

3.2.3.14 Summary

Table 3.57. EFR32FG12/13/14 N2g Mode Summary

Mode	Parameter	Measurement Results	Comments
N2g	80% PER Sensitivity	-116.3 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	54 dB	Meets WMBUS Specifications
	±2 MHz Blocking	63 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	81 dB	Meets ETSI CAT II Specifications

Table 3.58. EFR32FG12/13/14 N1a Mode Summary

Mode	Parameter	Measurement Results	Comments
N1a	80% PER Sensitivity	-119.6 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	42 dB	Meets WMBUS Specifications
	±2 MHz Blocking	66 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	85 dB	Meets ETSI CAT II Specifications

Table 3.59. EFR32FG12/13/14 N1c Mode Summary

Mode	Parameter	Measurement Results	Comments
N1c	80% PER Sensitivity	-120.4 dBm	Meets WMBUS Specifications
	Freq. Offset, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±12.5kHz Selectivity	44 dB	Meets WMBUS Specifications
	±2 MHz Blocking	65 dB	Meets WMBUS Specifications
	±10 MHz Blocking	86 dB	Meets ETSI CAT II Specifications

3.2.4 S Mode

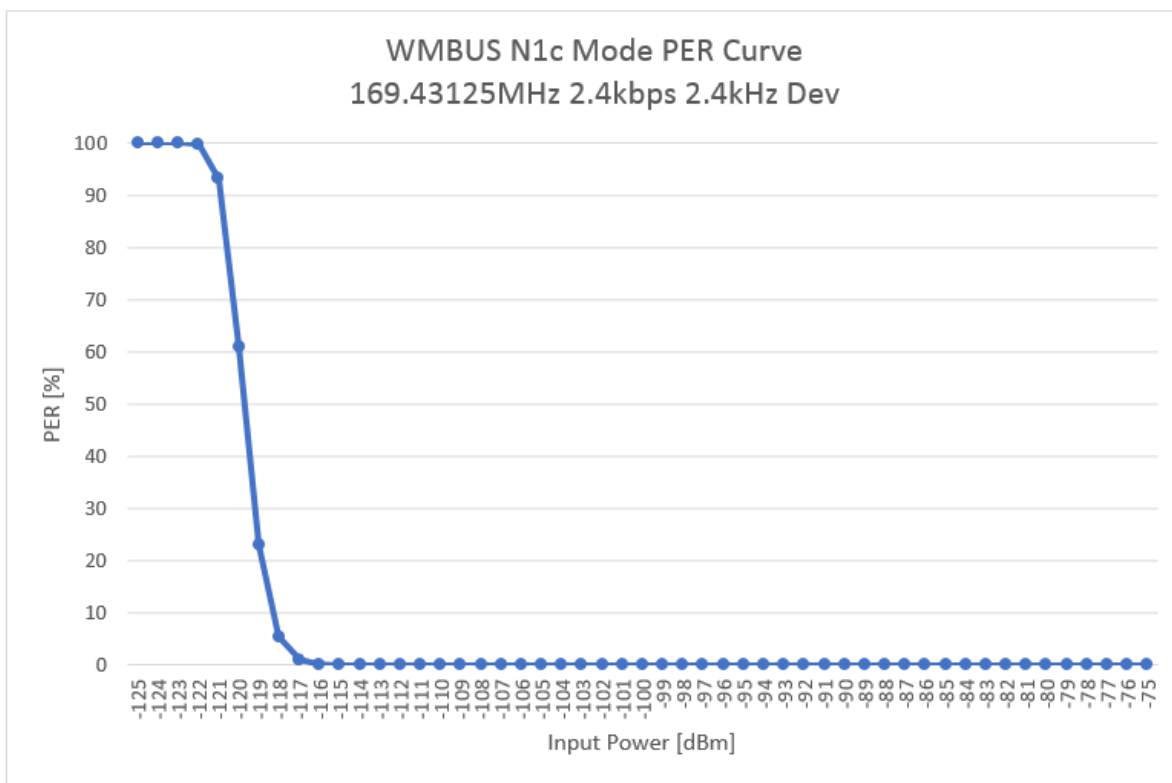**3.2.4.1 Receiver Sensitivity**
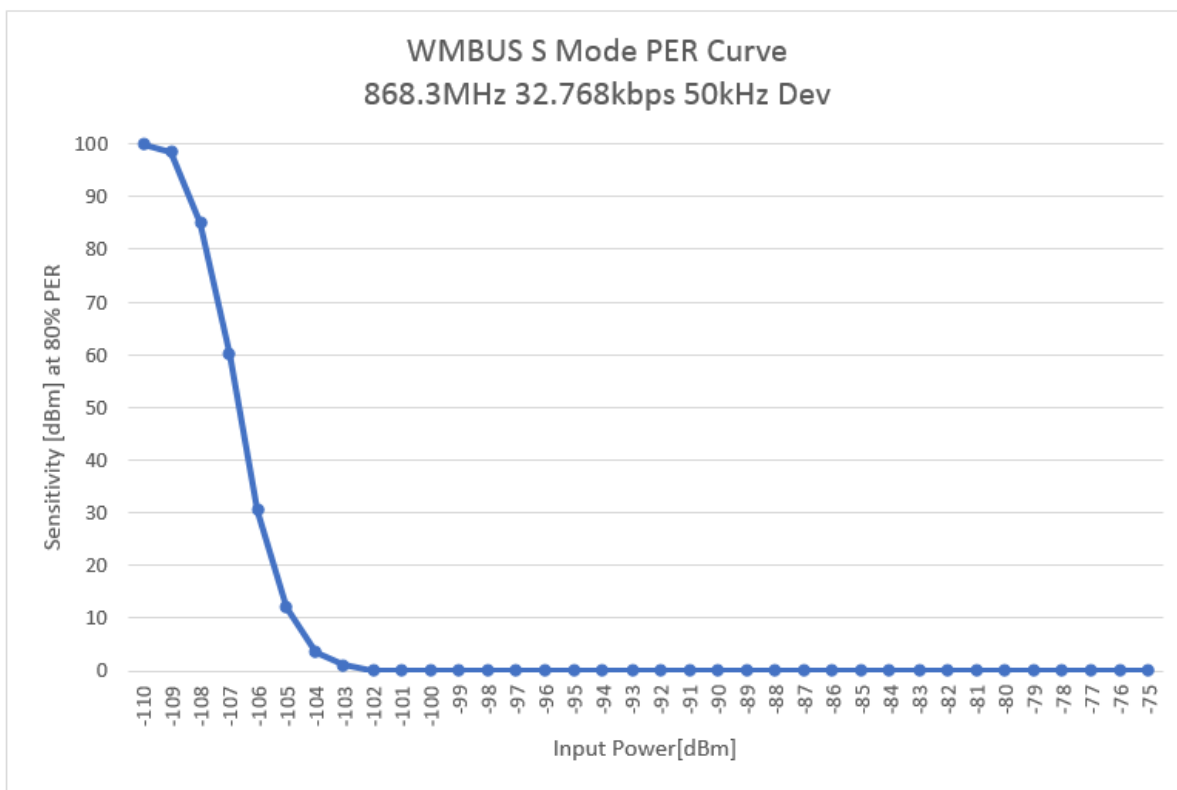
Figure 3.84. EFR32FG12/13/14 S Mode Receiver Sensitivity PER Curve

Table 3.60. EFR32FG12/13/14 S Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.3 MHz	32.768 kbps	±50 kHz	80	-107.5
			20	-105.6
			1	-103.0

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

3.2.4.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. Worst case transmitter (T1) will have ±60 ppm accuracy and worst case receive modes (T2) will have ±25 ppm accuracy. Therefore, the sum of the two numbers has been used to determine limits. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.

The frequency error tolerance limits are ±85 ppm (±74 kHz).

Figure 3.85. EFR32FG12/13/14 S Mode Receiver Frequency Error Tolerance

3.2.4.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±2%.

FprEN 13757-4:2013 Receiver Acceptable Chip Rate Tolerance (Meter) is ±2 %.

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
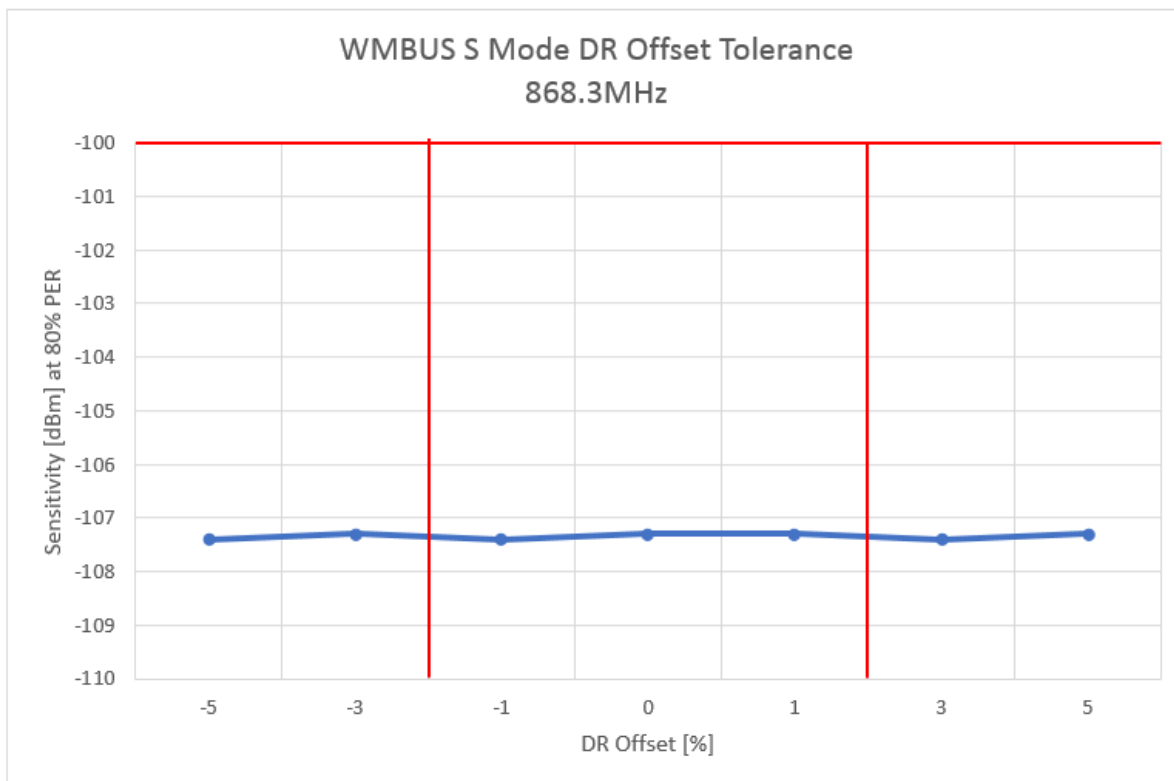
Figure 3.86. EFR32FG12/13/14 S Mode Receiver Data Rate Error Tolerance

3.2.4.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 S Mode FSK Deviation limits are -10kHz & 30kHz.

FprEN 13757-4:2013 S Mode Sensitivity (PER < 0.8) minimum is -100 dBm.
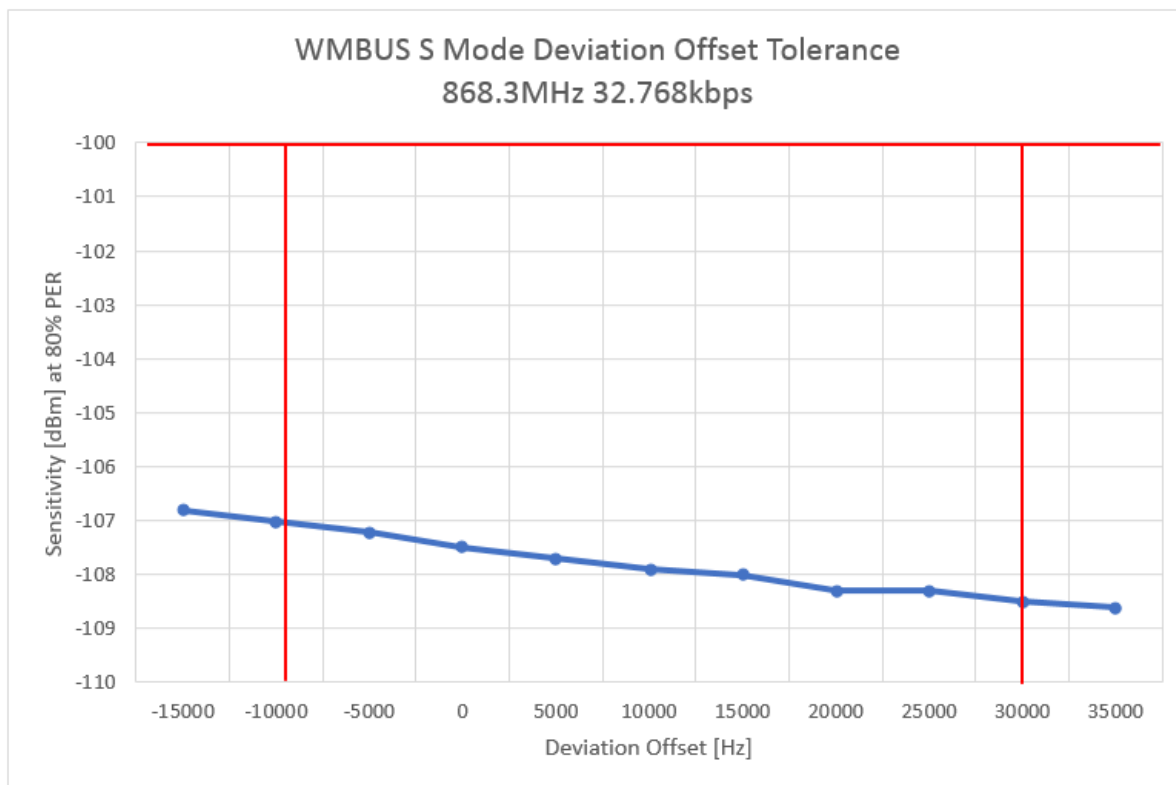
Figure 3.87. EFR32FG12/13/14 S Mode Receiver Deviation Error Tolerance

3.2.4.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±250 kHz.

Table 3.61. EFR32FG12/13/14 S Mode ETSI CAT II Blocking Performance [5.4]

Frequency Offset	Measurement	Limit
±2 MHz	63 dB	> 22 dB
±10 MHz	71 dB	> 47 dB
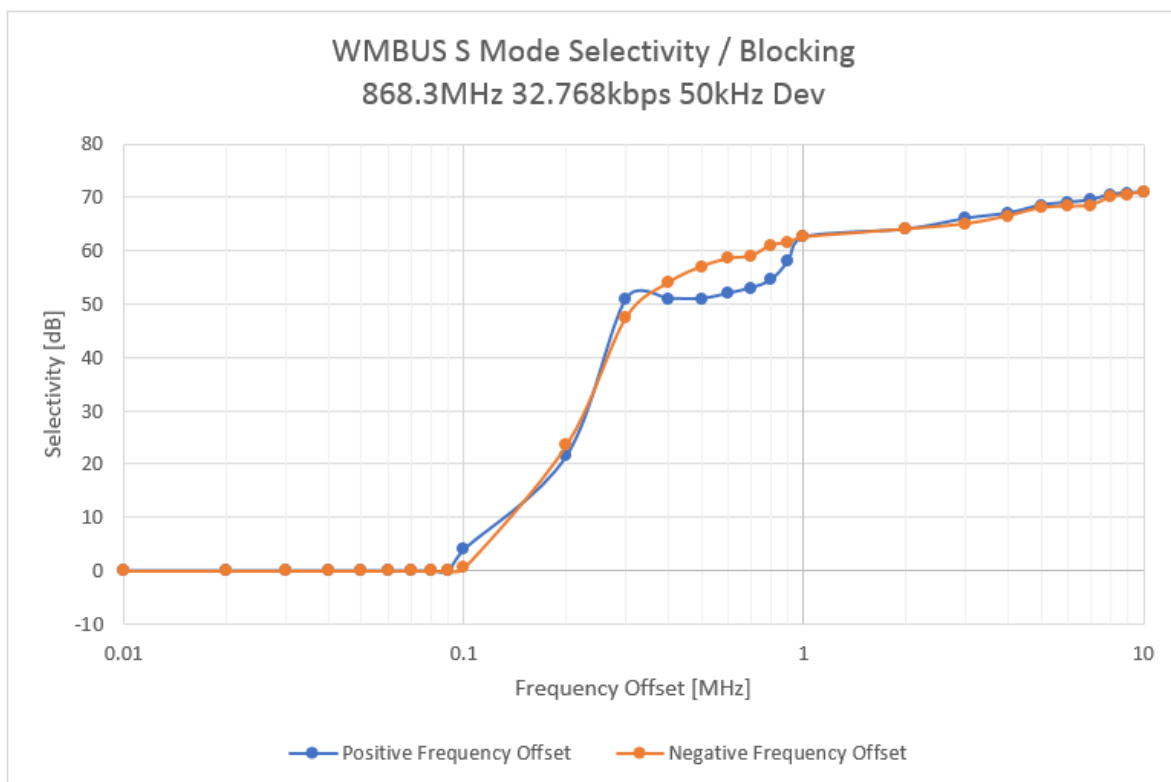
Figure 3.88. EFR32FG12/13/14 S Mode Receiver Selectivity

3.2.4.6 Summary

Table 3.62. EFR32FG12/13/14 S Mode Summary

Mode	Parameter	Measurement Results	Comments
S	80% PER Sensitivity	-107.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 250 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	63 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	71 dB	Meets ETSI CAT II Specifications

3.2.5 R Mode

3.2.5.1 Receiver Sensitivity

Figure 3.89. EFR32FG12/13/14 R Mode Receiver Sensitivity PER Curve

Table 3.63. EFR32FG12/13/14 R Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
868.33 MHz	4.8 kbps	±6 kHz	80	-116.5
			20	-115.3
			1	-113.4

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

3.2.5.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.
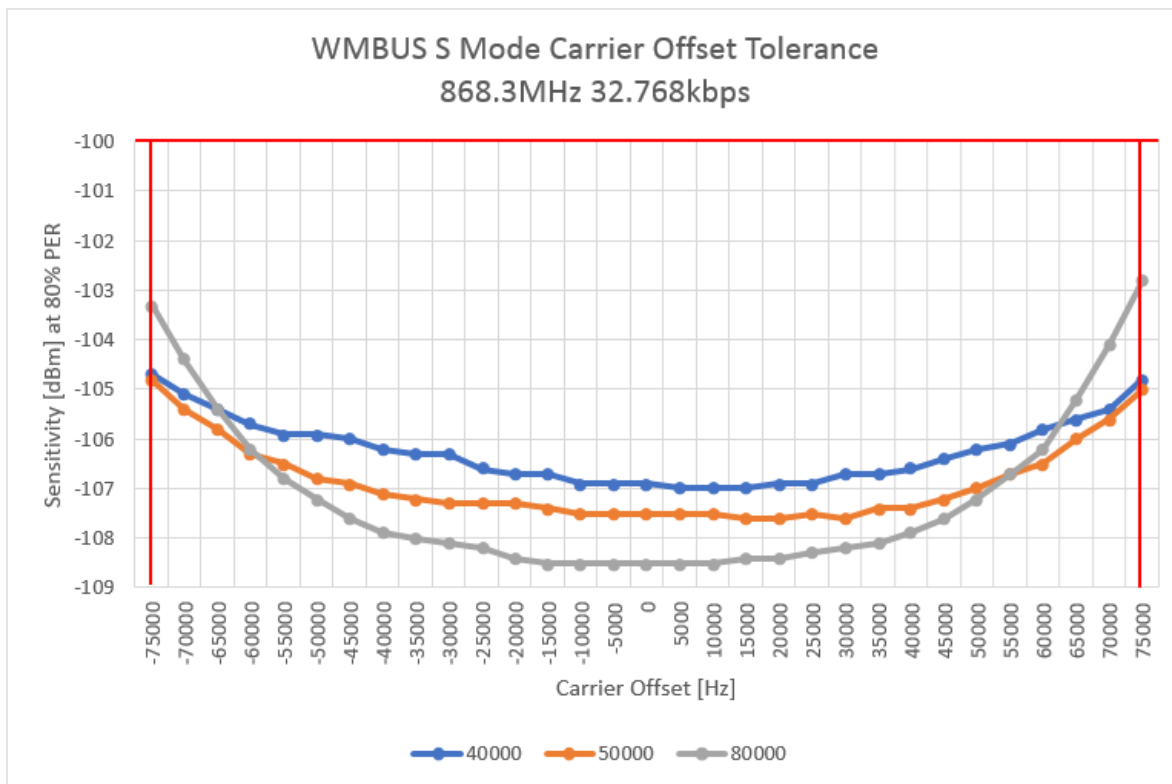
FprEN 13757-4:2013 Frequency Tolerance Limits are ±20 ppm (±17 kHz).

Figure 3.90. EFR32FG12/13/14 R Mode Receiver Frequency Error Tolerance

3.2.5.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The chip rate tolerance of the receiver is ±1.5%.

FprEN 13757-4:2013 Chip Rate Tolerance is ±1.5 % .

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

Figure 3.91. EFR32FG12/13/14 R Mode Receiver Data Rate Error Tolerance

3.2.5.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 R Mode FSK Deviation limits are ±1.2kHz.

FprEN 13757-4:2013 R Mode Sensitivity (PER < 0.8) minimum is -105 dBm.

Figure 3.92. EFR32FG12/13/14 R Mode Receiver Deviation Error Tolerance

3.2.5.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

Table 3.64. EFR32FG12/13/14 R Mode Adjacent Channel Selectivity Performance [1]

Adjacent Channel	Measurement	Limit
±60 kHz	53 dB	> 40 dB

Table 3.65. EFR32FG12/13/14 R Mode ETSI CAT II Blocking Performance [5.7]

| Frequency Offset	Measurement	Limit
±2 MHz	74 dB	> 34 dB
±10 MHz	94 dB	> 59 dB
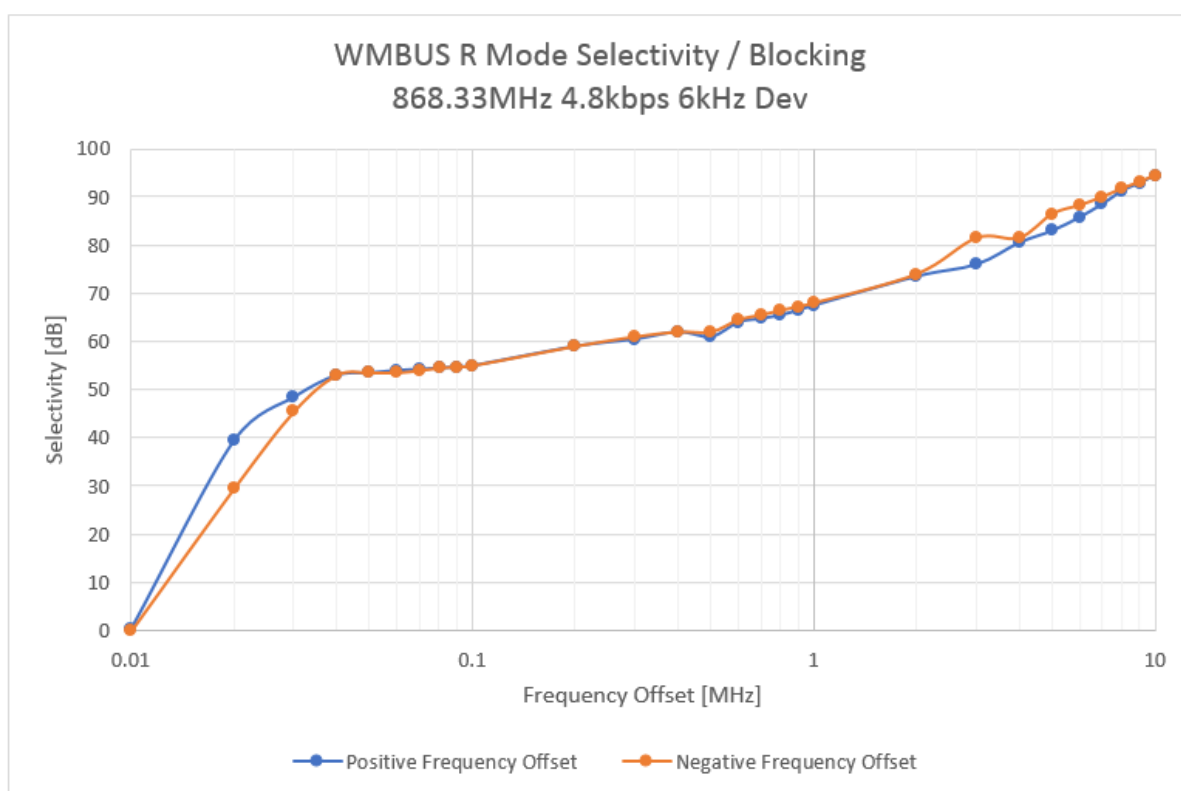
Figure 3.93. EFR32FG12/13/14 R Mode Receiver Selectivity

3.2.5.6 Summary

Table 3.66. EFR32FG12/13/14 R Mode Summary

Mode	Parameter	Measurement Results	Comments
R	80% PER Sensitivity	-116.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	±60 kHz Selectivity	53 dB	Meets WMBUS Specifications
	±2 MHz Blocking	74 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	94 dB	Meets ETSI CAT II Specifications

3.2.6 F Mode

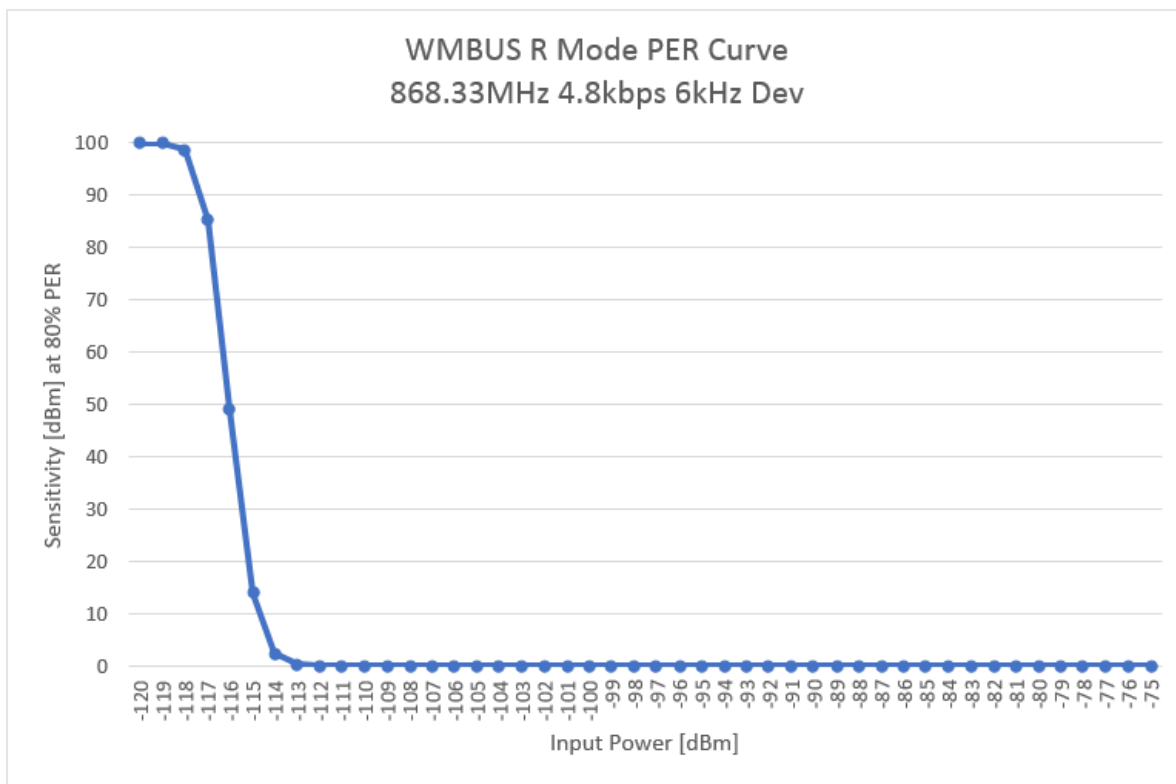#### 3.2.6.1 Receiver Sensitivity
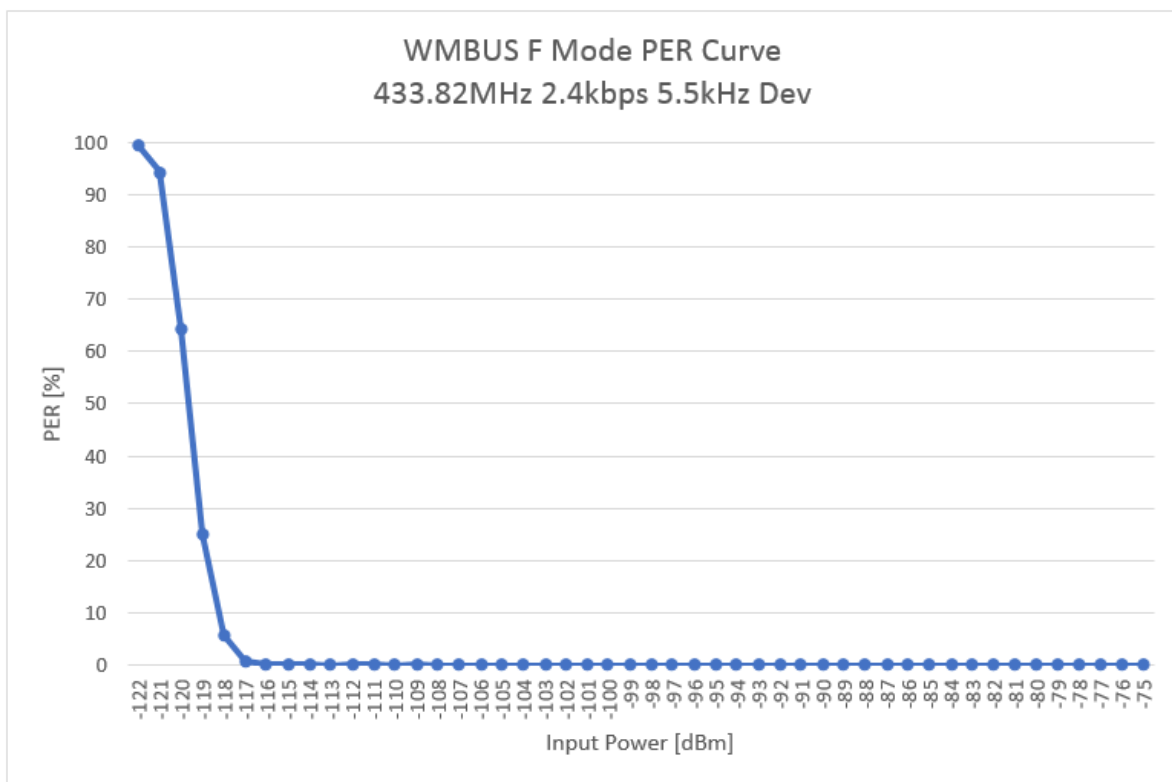
Figure 3.94. EFR32FG12/13/14 F Mode Receiver Sensitivity PER Curve

Table 3.67. EFR32FG12/13/14 F Mode Receiver Sensitivity

Frequency	Data Rate	Frequency Deviation	PER < %	Sensitivity dBm
433.82 MHz	2.4 kbps	±5.5 kHz	80	-119.5
			20	-118.6
			1	-117.2

FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

3.2.6.2 Receiver Frequency Error Tolerance

The figure below shows the frequency error offset capabilities of the receiver. The curves represent different frequency deviation corners [Hz].

FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.

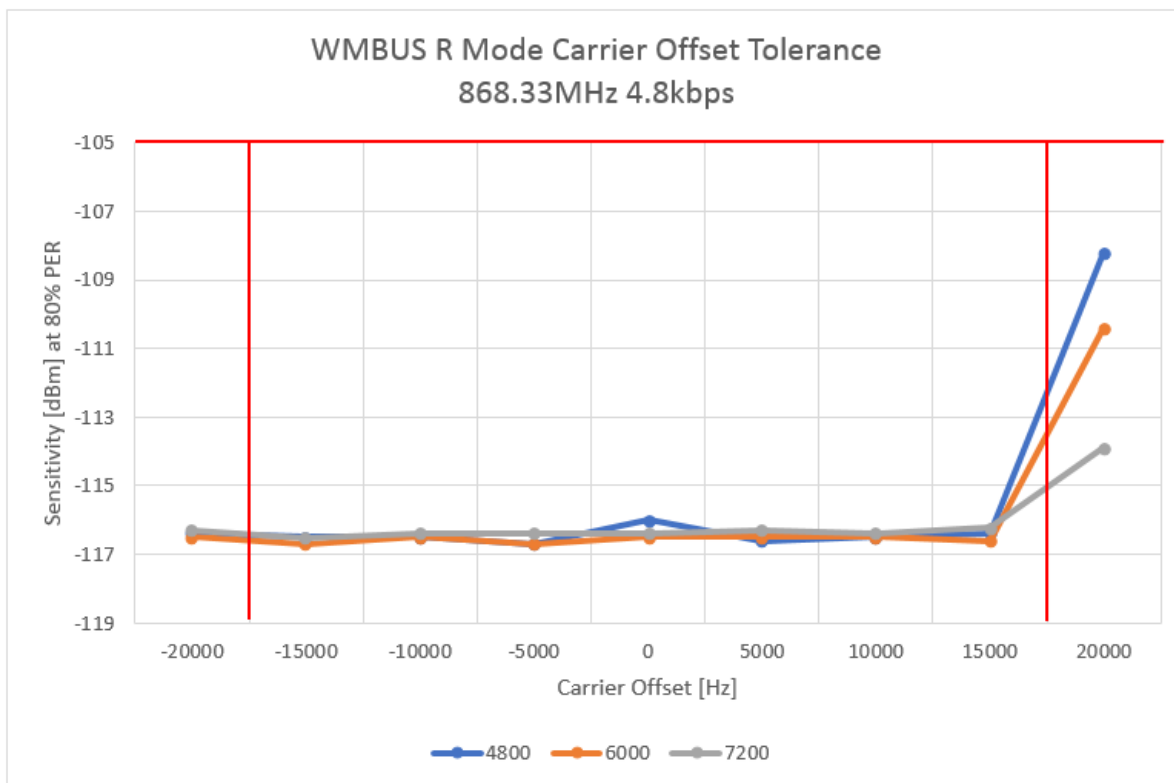FprEN 13757-4:2013 Frequency Tolerance Limits are ±16 ppm (±14 kHz).
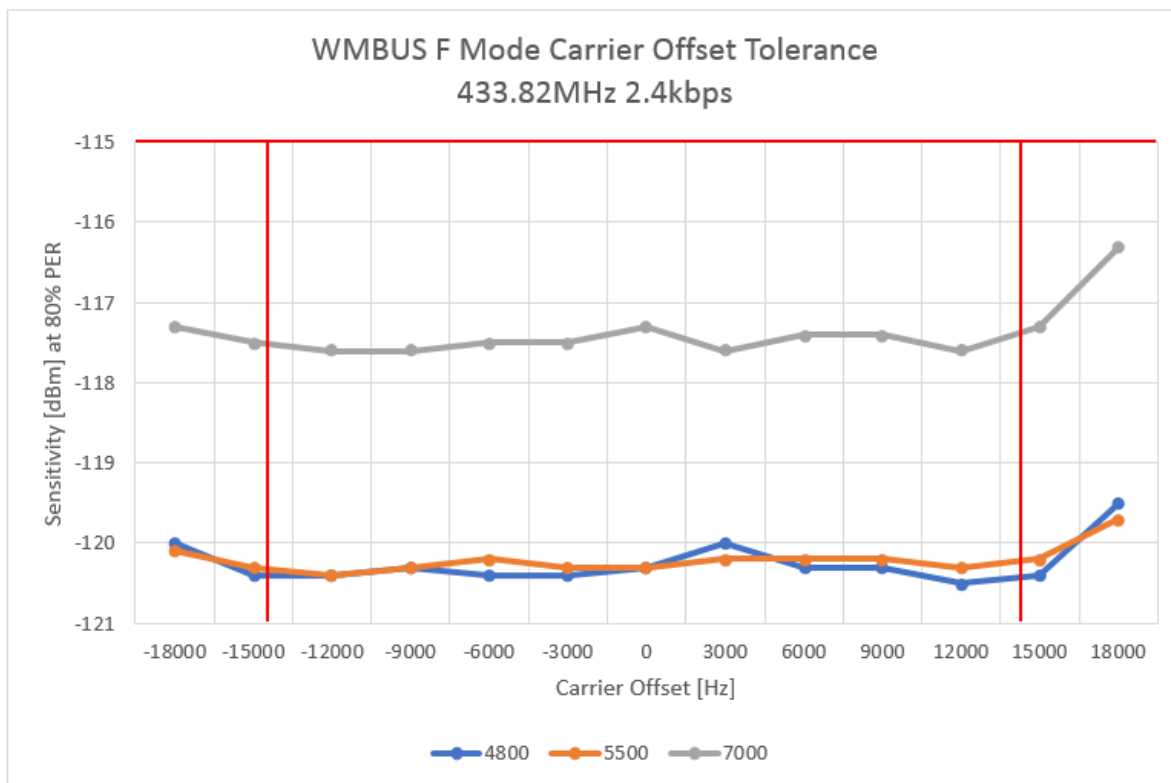
Figure 3.95. EFR32FG12/13/14 F Mode Receiver Frequency Error Tolerance

3.2.6.3 Receiver Data Rate Error Tolerance

The figure below shows the data rate error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus data rate offset. The data rate tolerance of the receiver is ±100 ppm.

FprEN 13757-4:2013 Data Rate Tolerance is ±100 ppm.

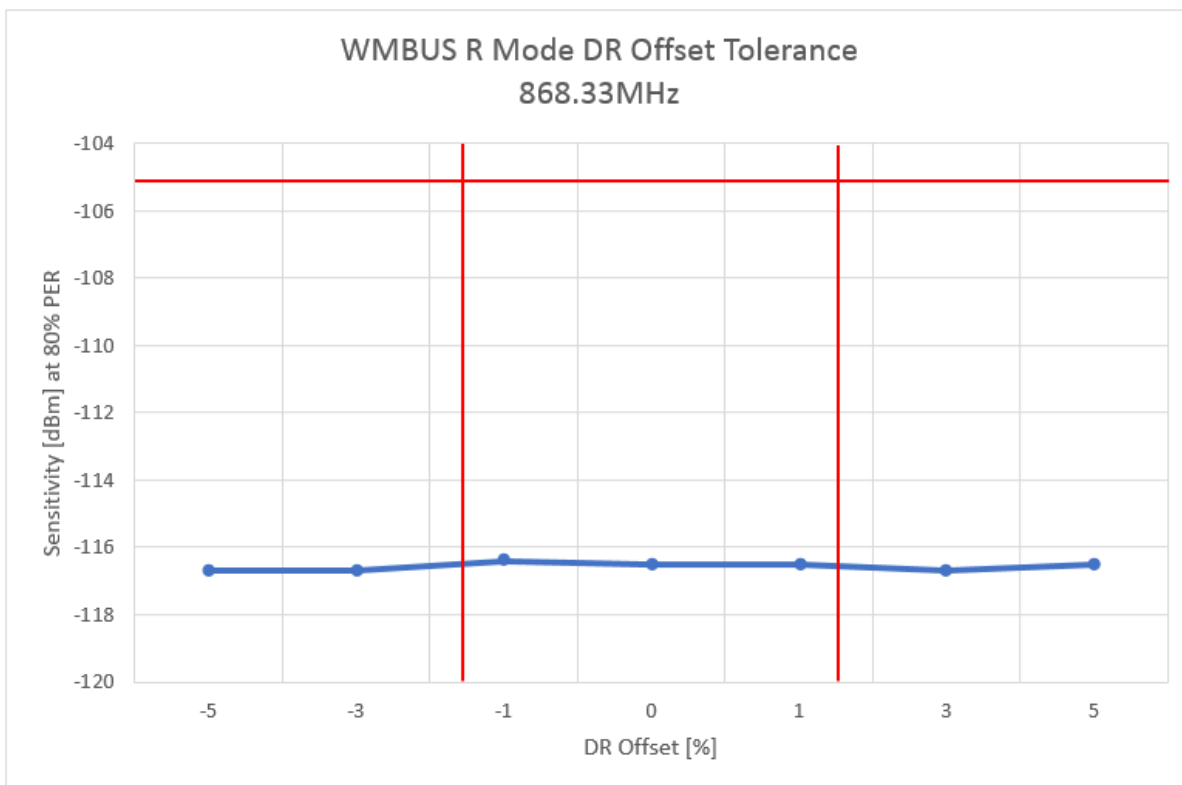FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.
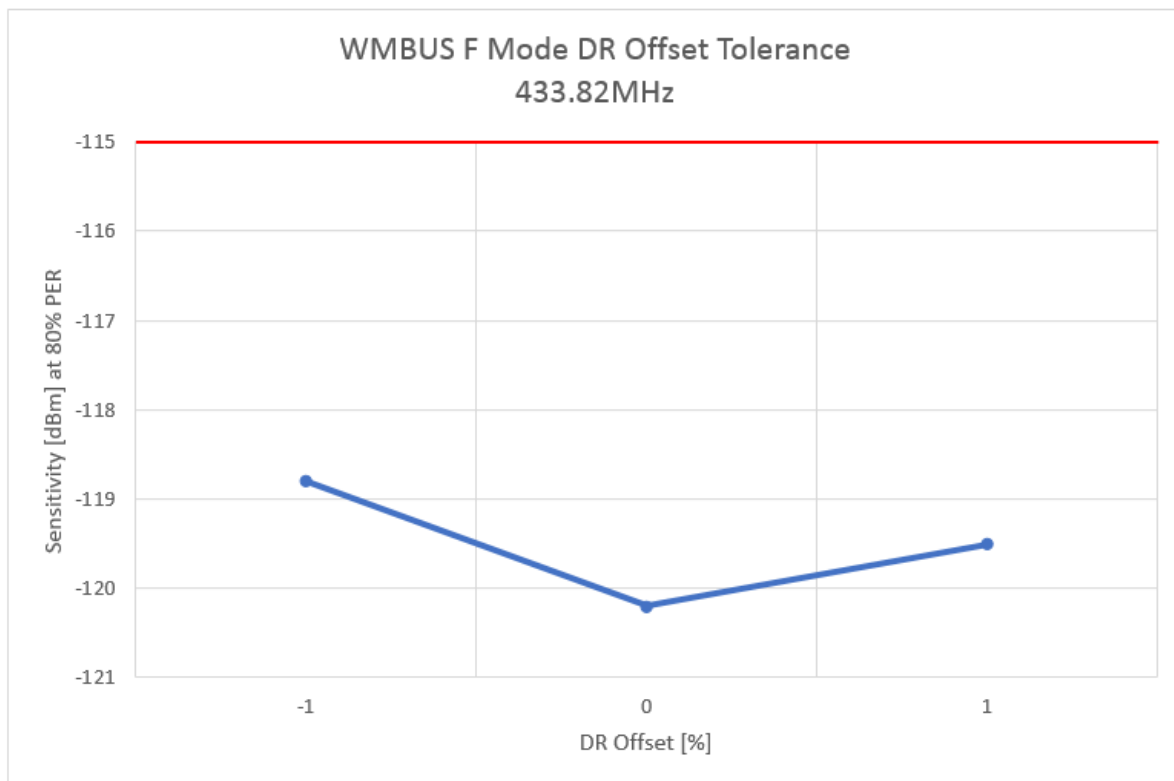
Figure 3.96. EFR32FG12/13/14 F Mode Receiver Data Rate Error Tolerance

3.2.6.4 Receiver Deviation Error Tolerance

The figure below shows the deviation error tolerance capability of the receiver. The plot shows the sensitivity of the receiver measured at 80% PER versus the deviation offset in Hz.

FprEN 13757-4:2013 F Mode FSK Deviation limits are -700Hz & +1.5kHz.

FprEN 13757-4:2013 F Mode Sensitivity (PER < 0.8) minimum is -115 dBm.
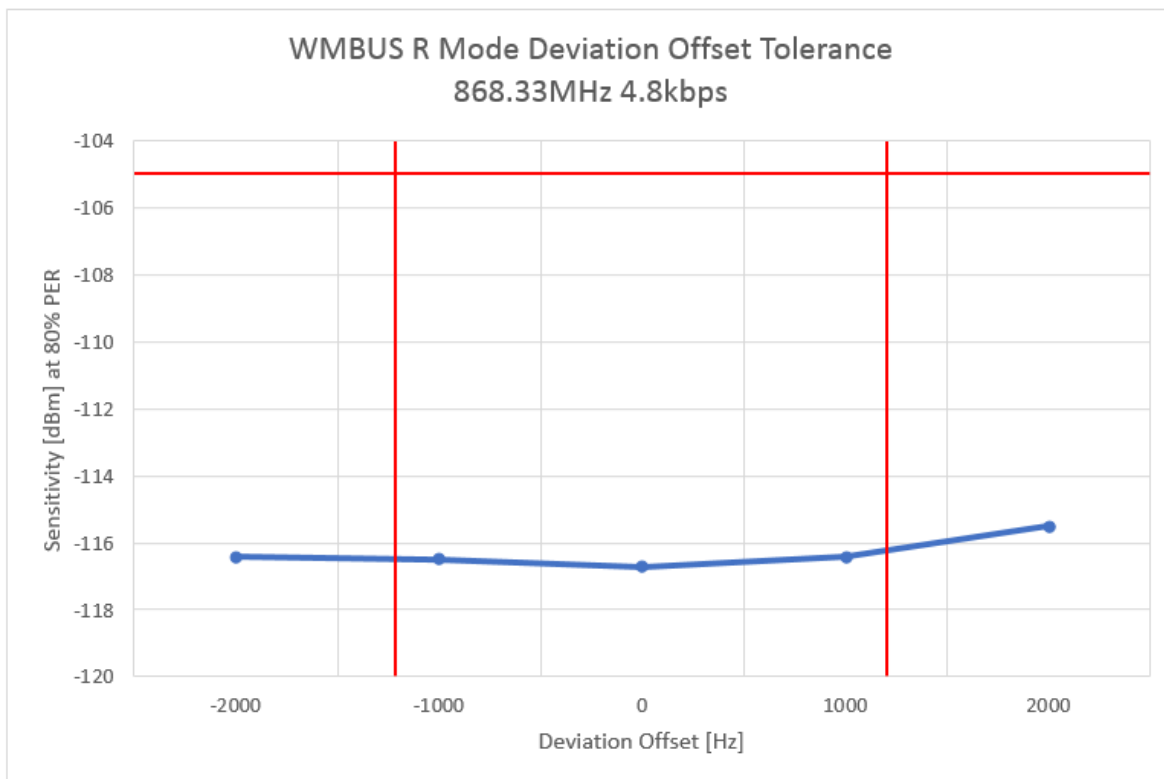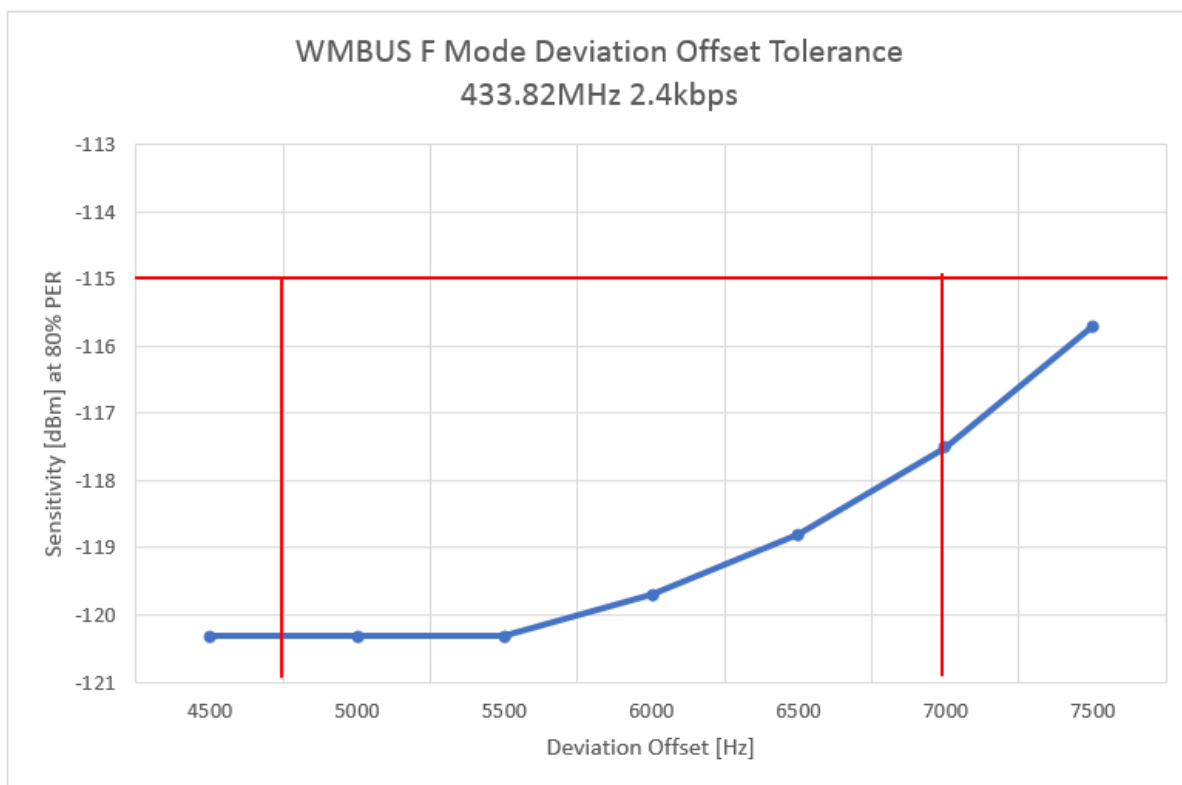

Figure 3.97. EFR32FG12/13/14 F Mode Receiver Deviation Error Tolerance

3.2.6.5 Receiver Selectivity/Blocking Performance

The figure below shows the selectivity and blocking performance of the receiver. The plots show receiver selectivity with blockers on both the positive and negative frequency offsets with respect to the receiver. Selectivity and blocking was measured at 20% PER at various frequency offsets.

The Wireless M-Bus specification for adjacent channel selectivity is > 40 dB. Wireless M-Bus does not specify channel spacing for T-mode, therefore the frequency that meets ACS specification for both positive and negative frequency offsets is ±30 kHz.

Table 3.68. EFR32FG12/13/14 F Mode ETSI CAT II Blocking Performance [5.4]

| Frequency Offset	Measurement	Limit
±2 MHz	71 dB	> 35 dB
±10 MHz	94 dB	> 60 dB
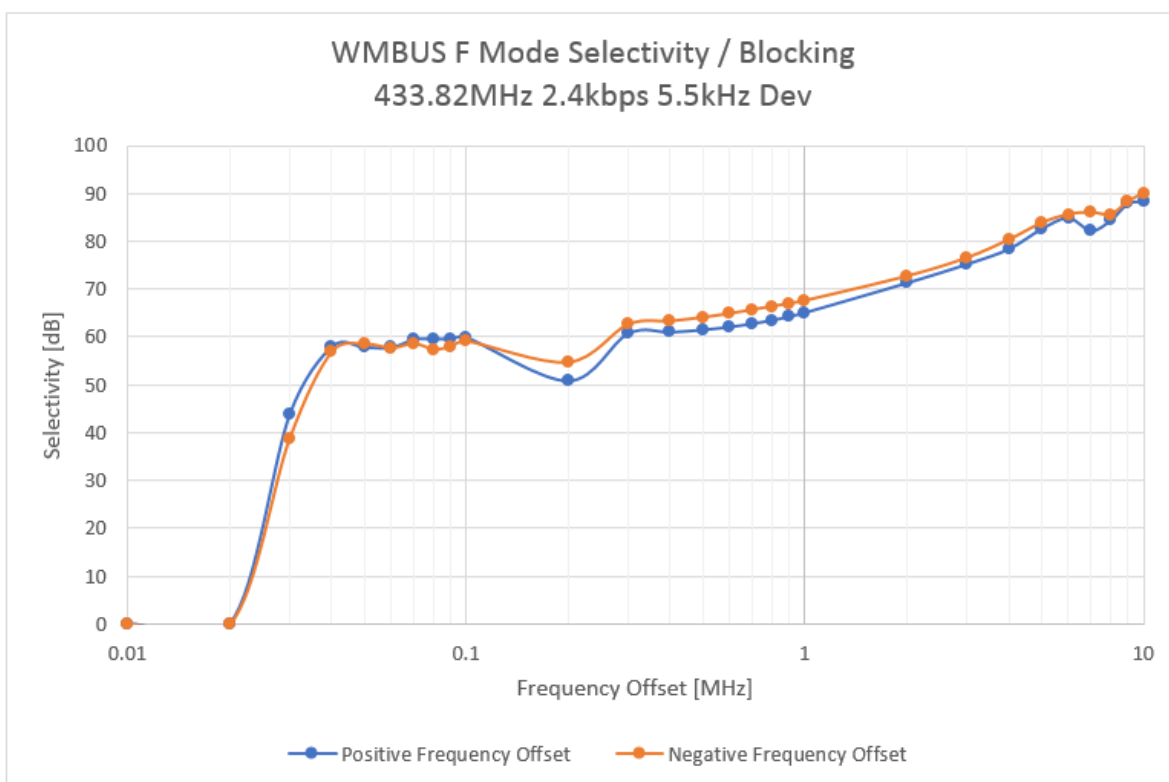
Figure 3.98. EFR32FG12/13/14 F Mode Receiver Selectivity

3.2.6.6 Summary

Table 3.69. EFR32FG12/13/14 F Mode Summary

Mode	Parameter	Measurement Results	Comments
F	80% PER Sensitivity	-119.5 dBm	Meets WMBUS Specifications
	Freq. Offset, Data Rate, Deviation Corners	Meets all corners	Meets WMBUS Specifications
	Adjacent Channel Selectivity > 40 dB	± 30 kHz	Meets WMBUS Specifications
	±2 MHz Blocking	71 dB	Meets ETSI CAT II Specifications
	±10 MHz Blocking	94 dB	Meets ETSI CAT II Specifications

4. Appendix

4.1 ETSI Maximum Useable Sensitivity

ETSI EN 300 220-1 V2.4.1 (2012-05) section 8.1.4 specifies that the maximum usable sensitivity limit for other receiver bandwidths than 16 kHz is given by:

$$S_p = 10 \log \frac{BW}{16} - 107 \, dBm$$

Equation 5.1. Receiver Sensitivity Limit [2]

S_p is the sensitivity in dBm and BW is the receiver bandwidth in kHz.

4.2 ETSI Blocking Limits

ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.4.3 specifies blocking levels should not be less than the values in the table below. For receiver bandwidths other than 16 kHz the limit shall be adjusted by a bandwidth compensation factor, A.

A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth [2, Section 8.1.4]

Table 4.1. ETSI Limits for Blocking [2]

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 84 dB – A
2	± 2 MHz	≥ 35 dB – A
3	± 2 MHz	≥ 24 dB – A
1	±10 MHz	≥ 84 dB – A
2	±10 MHz	≥ 60 dB – A
3	±10 MHz	≥ 44 dB – A

Note:
  1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.1 EFR32FG1

The following tables specify the minimum blocking requirements for receiver category 1, 2, and 3 for EFR32FG1 Wireless M-Bus PHY configurations.

4.2.1.1 T From-Meter Mode Blocking Limits

See section 4.3.1.1 T From-Meter Mode for PHY bandwidth compensation calculation.

Table 4.2. EFR32FG1 T From-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 71.1
2	± 2 MHz	≥ 22.1
3	± 2 MHz	≥ 11.1
1	±10 MHz	≥ 71.1
2	±10 MHz	≥ 47.1
3	±10 MHz	≥ 31.1
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.1.2 T To-Meter Mode Blocking Limits

See section 4.3.1.2 T To-Meter Mode for PHY bandwidth compensation calculation.

Table 4.3. EFR32FG1 T To-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 71.1
2	± 2 MHz	≥ 22.1
3	± 2 MHz	≥ 11.1
1	±10 MHz	≥ 71.1
2	±10 MHz	≥ 47.1
3	±10 MHz	≥ 31.1
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.1.3 C From-Meter Mode Blocking Limits

See section 4.3.1.3 C From-Meter Mode for PHY bandwidth compensation calculation.

Table 4.4. EFR32FG1 C From-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 73.1
2	± 2 MHz	≥ 24.1
3	± 2 MHz	≥ 13.1
1	±10 MHz	≥ 73.1
2	±10 MHz	≥ 49.1
3	±10 MHz	≥ 33.1

Note:

1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.1.4 C To-Meter Mode Blocking Limits

See section 4.3.1.4 C To-Meter Mode for PHY bandwidth compensation calculation.

Table 4.5. EFR32FG1 C To-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 74.3
2	± 2 MHz	≥ 25.3
3	± 2 MHz	≥ 14.3
1	±10 MHz	≥ 74.3
2	±10 MHz	≥ 50.3
3	±10 MHz	≥ 34.3

Note:

1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.1.5 N2g Mode Blocking Limits

See section 4.3.1.5 N2g Mode for PHY bandwidth compensation calculation.

Table 4.6. EFR32FG1 N2g Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 82.0
2	± 2 MHz	≥ 33.0
3	± 2 MHz	≥ 22.0
1	±10 MHz	≥ 82.0
2	±10 MHz	≥ 58.0
3	±10 MHz	≥ 42.0
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.1.6 N1a Blocking Limits

Table 4.7. N1a Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 85 dB
2	± 2 MHz	> 36 dB
3	± 2 MHz	> 25 dB
1	±10 MHz	> 85 dB
2	±10 MHz	> 61 dB
3	±10 MHz	> 45 dB
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.1.7 N1c Blocking Limits

Table 4.8. N1c Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 85 dB
2	± 2 MHz	> 36 dB
3	± 2 MHz	> 25 dB
1	±10 MHz	> 85 dB
2	±10 MHz	> 61 dB
3	±10 MHz	> 45 dB
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.1.8 S Mode Blocking Limits

Table 4.9. S Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 71 dB
2	± 2 MHz	> 22 dB
3	± 2 MHz	> 11 dB
1	±10 MHz	> 71 dB
2	±10 MHz	> 47 dB
3	±10 MHz	> 31 dB

Note:

1. $A = 10 \log (BW_{khz} / 16 \text{ kHz})$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.1.9 R Mode Blocking Limits

Table 4.10. R Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 83 dB
2	± 2 MHz	> 34 dB
3	± 2 MHz	> 23 dB
1	±10 MHz	> 83 dB
2	±10 MHz	> 59 dB
3	±10 MHz	> 43 dB

Note:

1. $A = 10 \log (BW_{khz} / 16 \text{ kHz})$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.1.10 F Mode Blocking Limits

Table 4.11. F Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 84 dB
2	± 2 MHz	> 35 dB
3	± 2 MHz	> 24 dB
1	±10 MHz	> 84 dB
2	±10 MHz	> 60 dB
3	±10 MHz	> 44 dB

Note:

1. $A = 10 \log (BW_{khz} / 16 \text{ kHz})$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.2 EFR32FG12, EFR32FG13 and EFR32FG14

4.2.2.1 T From-Meter Mode Blocking Limits

See section 4.3.2.1 T From-Meter Mode for PHY bandwidth compensation calculation.

Table 4.12. EFR32FG12/13/14 T From-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 71.1
2	± 2 MHz	≥ 22.1
3	± 2 MHz	≥ 11.1
1	±10 MHz	≥ 71.1
2	±10 MHz	≥ 47.1
3	±10 MHz	≥ 31.1

Note:
1. A = 10 log (BW_{khz} / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.2.2 T To-Meter Mode Blocking Limits

See section 4.3.2.2 T To-Meter Mode for PHY bandwidth compensation calculation.

Table 4.13. EFR32FG12/13/14 T To-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 71.2
2	± 2 MHz	≥ 22.2
3	± 2 MHz	≥ 11.2
1	±10 MHz	≥ 71.2
2	±10 MHz	≥ 47.2
3	±10 MHz	≥ 31.2

Note:
1. A = 10 log (BW_{khz} / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.2.3 C From-Meter Mode Blocking Limits

See section 4.3.2.3 C From-Meter Mode for PHY bandwidth compensation calculation.

Table 4.14. EFR32FG12/13/14 C From-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 73.0
2	± 2 MHz	≥ 24.0
3	± 2 MHz	≥ 13.0
1	±10 MHz	≥ 73.0
2	±10 MHz	≥ 49.0
3	±10 MHz	≥ 33.0

Note:

1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.2.4 C To-Meter Mode Blocking Limits

See section 4.3.2.4 C To-Meter Mode for PHY bandwidth compensation calculation.

Table 4.15. EFR32FG12/13/14 C To-Meter Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 74.3
2	± 2 MHz	≥ 25.3
3	± 2 MHz	≥ 14.3
1	±10 MHz	≥ 74.3
2	±10 MHz	≥ 50.3
3	±10 MHz	≥ 34.3

Note:

1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).

4.2.2.5 N2g Mode Blocking Limits

See section 4.3.2.5 N2g Mode for PHY bandwidth compensation calculation.

Table 4.16. EFR32FG12/13/14 N2g Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	≥ 82.0
2	± 2 MHz	≥ 33.0
3	± 2 MHz	≥ 22.0
1	±10 MHz	≥ 82.0
2	±10 MHz	≥ 58.0
3	±10 MHz	≥ 42.0
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4)		

4.2.2.6 N1a Blocking Limits

Table 4.17. N1a Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 85 dB
2	± 2 MHz	> 36 dB
3	± 2 MHz	> 25 dB
1	±10 MHz	> 85 dB
2	±10 MHz	> 61 dB
3	±10 MHz	> 45 dB
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.2.7 N1c Blocking Limits

Table 4.18. N1c Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 85 dB
2	± 2 MHz	> 36 dB
3	± 2 MHz	> 25 dB
1	±10 MHz	> 85 dB
2	±10 MHz	> 61 dB
3	±10 MHz	> 45 dB
Note:		
1. A = 10 log (BW$_{khz}$ / 16 kHz) BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.2.8 S Mode Blocking Limits

Table 4.19. S Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 71 dB
2	± 2 MHz	> 22 dB
3	± 2 MHz	> 11 dB
1	±10 MHz	> 71 dB
2	±10 MHz	> 47 dB
3	±10 MHz	> 31 dB
Note:		
1. $A = 10 \log (BW_{khz} / 16\ kHz)$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.2.9 R Mode Blocking Limits

Table 4.20. R Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 83 dB
2	± 2 MHz	> 34 dB
3	± 2 MHz	> 23 dB
1	±10 MHz	> 83 dB
2	±10 MHz	> 59 dB
3	±10 MHz	> 43 dB
Note:		
1. $A = 10 \log (BW_{khz} / 16\ kHz)$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.2.2.10 F Mode Blocking Limits

Table 4.21. F Mode Blocking Limits

Receiver Category	Frequency offset	Limit
1	±2 MHz	> 84 dB
2	± 2 MHz	> 35 dB
3	± 2 MHz	> 24 dB
1	±10 MHz	> 84 dB
2	±10 MHz	> 60 dB
3	±10 MHz	> 44 dB
Note:		
1. $A = 10 \log (BW_{khz} / 16\ kHz)$ BW is the receiver bandwidth (ETSI EN 300 220-1 V2.4.1 (2012-05) Section 8.1.4).		

4.3 Wireless M-Bus PHY Measurement Configuration

The following tables specify the measurement configuration for EFR32FG1x Wireless M-Bus PHY's. Each table contains PHY specific desired sensitivity levels for adjacent channel selectivity, blocking, and EMC immunity measurements as well as the bandwidth compensation factor described in section 4.2 ETSI Blocking Limits.

4.3.1 EFR32FG1

4.3.1.1 T From-Meter Mode

Table 4.22. EFR32FG1 T From-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.95
Modulation	2FSK
Frequency Deviation, [kHz]	±50
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	315.6
Useable Sensitivity Limit, [dBm] (See section 4.1 ETSI Maximum Useable Sensitivity)	-94.05
Blocking Desired Sensitivity, [dBm] (Useable Sensitivity Limit + 3dB) See section 4.4 ETSI Desired Level for Blocking Measurement	-91.05
EMC immunity Desired Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-54.0
Bandwidth Compensation (A), [dB] (See section 4.2 ETSI Blocking Limits)	12.95

4.3.1.2 T To-Meter Mode

Table 4.23. EFR32FG1 T To-Meter Mode Measurement Configuration

Parameter	Value
Parameter	
Center Frequency, [MHz]	868.3
Modulation	2FSK
Frequency Deviation, [kHz]	±45
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	315.6
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-94.05
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-91.05
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-54 dBm
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	12.95

4.3.1.3 C From-Meter Mode

Table 4.24. EFR32FG1 C From-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.95
Modulation	2FSK
Frequency Deviation, [kHz]	±45
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	198.024
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-96.07
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3dB) 4.4 ETSI Desired Level for Blocking Measurement	-93.07
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-56.0
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	10.93

4.3.1.4 C To-Meter Mode

Table 4.25. EFR32FG1 C To-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	869.525
Modulation	2FSK
Frequency Deviation, [kHz]	±25
Chip Rate, [kcps]	50
RX Filter Bandwidth, [kHz]	148.518
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-97.3
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3dB) 4.4 ETSI Desired Level for Blocking Measurement	-94.3
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-57.3
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	9.7

4.3.1.5 N2g Mode

Table 4.26. EFR32FG1 N2g Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.4375
Modulation	4FSK
Frequency Deviation, [kHz]	±2.4, ±7.2
Bit Rate, [kbps]	9.6
RX Filter Bandwidth, [kHz]	25.248
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-105.02
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-102.02
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-65.0
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	1.98

4.3.1.6 N1a Mode

Table 4.27. EFR32FG1 N1a Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.40625
Modulation	2FSK
Frequency Deviation, [kHz]	±2.4
Bit Rate, [kbps]	4.8
RX Filter Bandwidth, [kHz]	12.268
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-108.1
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3dB) 4.4 ETSI Desired Level for Blocking Measurement	-105.1
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40dB) See section 4.5 EMC Immunity Measurement Methodology	-68.1
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	-1.1

4.3.1.7 N1c Mode

Table 4.28. EFR32FG1 N1c Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.43125
Modulation	2FSK
Frequency Deviation, [kHz]	±2.4
Bit Rate, [kbps]	2.4
RX Filter Bandwidth, [kHz]	14.027
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-107.6
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-104.6
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-67.6
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	-0.6

4.3.1.8 S Mode

Table 4.29. EFR32FG1 S Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.3
Modulation	2FSK
Frequency Deviation, [kHz]	±50
Bit Rate, [kbps]	32.768
RX Filter Bandwidth, [kHz]	315.6
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-94
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-91
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-54
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	12.95

4.3.1.9 R Mode

Table 4.30. EFR32FG1 R Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.33
Modulation	2FSK
Frequency Deviation, [kHz]	±6
Bit Rate, [kbps]	4.8
RX Filter Bandwidth, [kHz]	19.920
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-106
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-103
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-66
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	1.0

4.3.1.10 F Mode

Table 4.31. EFR32FG1 F Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	433.82
Modulation	2FSK
Frequency Deviation, [kHz]	±5.5
Bit Rate, [kbps]	2.4
RX Filter Bandwidth, [kHz]	16.342
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-106.9
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-103.9
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-66.9
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	0.1

4.3.2 EFR32FG12, EFR32FG13 and EFR32FG14

4.3.2.1 T From-Meter Mode

Table 4.32. EFR32FG12/13/14 T From-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.95
Modulation	2FSK
Frequency Deviation, [kHz]	±50
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	313.6
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-94
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3dB) 4.4 ETSI Desired Level for Blocking Measurement	-91
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40dB) See section 4.5 EMC Immunity Measurement Methodology	-54
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	12.9

4.3.2.2 T To-Meter Mode

Table 4.33. EFR32FG12/13/14 T To-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.3
Modulation	2FSK
Frequency Deviation, [kHz]	±45
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	306.036
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-94.2
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-91.2
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-54.2 dBm
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	12.8

4.3.2.3 C From-Meter Mode

Table 4.34. EFR32FG12/13/14 C From-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.95
Modulation	2FSK
Frequency Deviation, [kHz]	±45
Chip Rate, [kcps]	100
RX Filter Bandwidth, [kHz]	199.583
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-96.0
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-93.0
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-56.0
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	10.96

4.3.2.4 C To-Meter Mode

Table 4.35. EFR32FG12/13/14 C To-Meter Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	869.525
Modulation	2FSK
Frequency Deviation, [kHz]	±25
Chip Rate, [kcps]	50
RX Filter Bandwidth, [kHz]	149.774
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-97.3
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-94.3
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-57.3
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	9.7

4.3.2.5 N2g Mode

Table 4.36. EFR32FG12/13/14 N2g Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.4375
Modulation	4FSK
Frequency Deviation, [kHz]	±2.4, ±7.2
Bit Rate, [kbps]	9.6
RX Filter Bandwidth, [kHz]	25
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-105.1
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-102.1
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-65.1
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	1.94

4.3.2.6 N1a Mode

Table 4.37. EFR32FG12/13/14 N1a Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.40625
Modulation	2FSK
Frequency Deviation, [kHz]	±2.4
Bit Rate, [kbps]	4.8
RX Filter Bandwidth, [kHz]	12.349
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-108.1
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-105.1
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-68.1
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	-1.1

4.3.2.7 N1c Mode

Table 4.38. EFR32FG12/13/14 N1c Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	169.43125
Modulation	2FSK
Frequency Deviation, [kHz]	±2.4
Bit Rate, [kbps]	2.4
RX Filter Bandwidth, [kHz]	14.008
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-107.6
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-104.6
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-67.6
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	-0.6

4.3.2.8 S Mode

Table 4.39. EFR32FG12/13/14 S Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.3
Modulation	2FSK
Frequency Deviation, [kHz]	±50
Bit Rate, [kbps]	32.768
RX Filter Bandwidth, [kHz]	306.036
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-94
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-91
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-54
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	12.8

4.3.2.9 R Mode

Table 4.40. EFR32FG12/13/14 R Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	868.33
Modulation	2FSK
Frequency Deviation, [kHz]	±6
Bit Rate, [kbps]	4.8
RX Filter Bandwidth, [kHz]	20.017
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-106
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-103
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-66
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	1.0

4.3.2.10 F Mode

Table 4.41. EFR32FG12/13/14 F Mode Measurement Configuration

Parameter	Value
Center Frequency, [MHz]	433.82
Modulation	2FSK
Frequency Deviation, [kHz]	±5.5
Bit Rate, [kbps]	2.4
RX Filter Bandwidth, [kHz]	16.403
Useable Sensitivity Limit, [dBm] 4.1 ETSI Maximum Useable Sensitivity	-106.9
Blocking Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 3 dB) 4.4 ETSI Desired Level for Blocking Measurement	-103.9
EMC immunity Reference Sensitivity, [dBm] (Useable Sensitivity Limit + 40 dB) See section 4.5 EMC Immunity Measurement Methodology	-66.9
Bandwidth Compensation (A), [dB] 4.2 ETSI Blocking Limits	0.1

4.4 ETSI Desired Level for Blocking Measurement

The following figure describes how the desired level is set for conducted blocking measurements according to ETSI EN 300 220-1 V2.4.1.

The reference sensitivity for a receiver with 16 kHz bandwidth is -107 dBm for 20% PER or 1% BER. The useable sensitivity for other receiver bandwidths is then calculated from section 8.1.4.
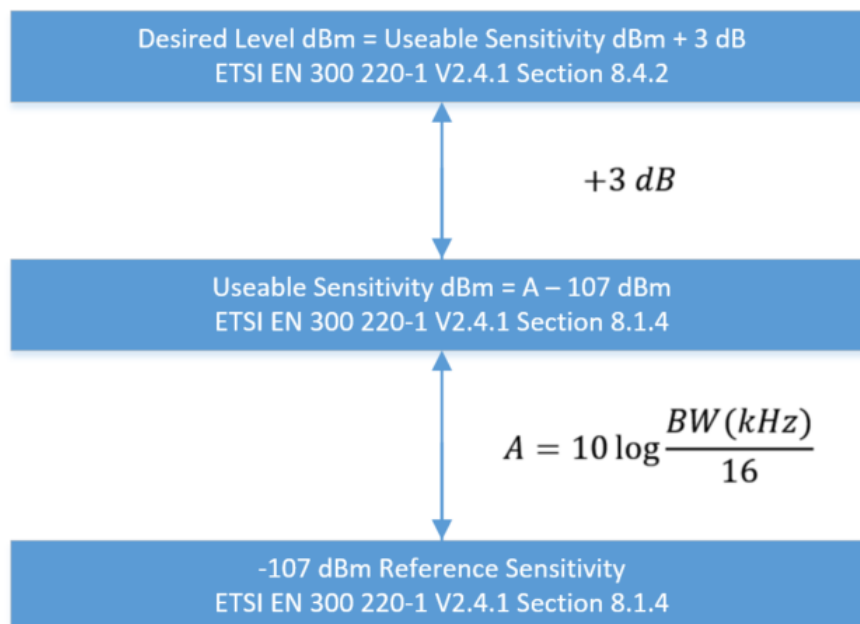

Figure 4.1. ETSI Desired Level for Blocking Measurement

4.5 EMC Immunity Measurement Methodology

4.5.1 Immunity Test

ETSI EN 301 489-1 V2.1.1 (2016-11) section 9.2 describes the EMC immunity test for radio frequency electromagnetic fields ranging from 80 MHz to 6 GHz [3].

4.5.2 Test Signal

ETSI EN 301 489-1 V2.1.1 (2016-11) specifies that a device under test with an antenna connector shall establish a communication link with the RF input signal by a shield transmission line such as a coaxial cable. Furthermore, the level of the wanted signal shall be set to approximately 40dB above the minimum level necessary to achieve receiver performance which meets the relevant specified performance criteria. The increased RF level of the input signal represents a normal operating signal and should be sufficient to avoid broadband noise generated from the EM disturbance [3].

The relevant specified performance criteria for the receiver is assumed to be a message acceptance ratio of 80% or 20% PER. This specification is consistent with ETSI EN 300 220-1 V2.4.1 Section 4.1.2 General Performance Criteria.

In the case of Wireless M-Bus validation, reference sensitivity is specified according to ETSI EN 300 220-1 V2.4.1 section 8.1.4 where useable sensitivity is defined as -107dBm at 20% PER for 16kHz bandwidth. For other receiver bandwidths, the useable sensitivity level is adjusted according to a compensation factor A – see section 4.1 ETSI Maximum Useable Sensitivity. From useable sensitivity level, the RF level will be increased by 40dB in accordance with ETSI EN 301 489-1 V2.1.1 in order to avoid broadband noise from EM disturbance.

4.5.3 Pass Criterion

ETSI EN 301 489-1 V2.1.1 (2016-11) section 6.1 specifies that the performance criteria for continuous phenomena applied to a receiver is as follows:

"During and after the test, the equipment shall continue to operate as intended. No degradation of performance or loss of function is allowed below a permissible performance level specified by the manufacturer when the equipment is used as intended. In some cases, this permissible performance level may be replaced by a permissible loss of performance."

Criterion	During test	After test
A	Operate as intended No loss of function No unintentional responses	Operate as intended No loss of function No degradation of performance No loss of stored data or user programmable functions

Figure 4.2. Provision of ETSI EN 301 489-1 V2.1.1 (2016-11) overruled by ETSI 301 489-4 V3.1.1 section 6.2 [4]

For a device under test to pass EMC immunity it must remain functional during the exposure but performance degradation is allowed. This requirement is assumed to be equivalent to PER ≤ 20%.

Therefore, the pass criterion is PER < 20% during AM exposure for the desired signal level great than or equal to 40dB above the 20% PER useable sensitivity level. The diagram below describes how the desired level is set for EMC immunity measurements.

Desired Level dBm = Useable Sensitivity + 40 dB
ETSI EN 301 489-1 V2.1.1

$+40\ dB$

Useable Sensitivity dBm = $A - 107$ dBm
ETSI EN 300 220-1 V2.4.1 Section 8.1.4

$$A = 10\log\frac{BW(kHz)}{16}$$

-107 dBm Reference Sensitivity
ETSI EN 300 220-1 V2.4.1 Section 8.1.4
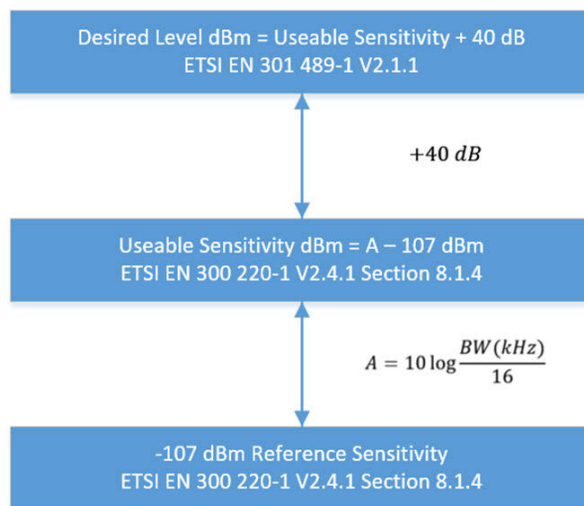
Figure 4.3. Pass Criterion

5. References

[1]   Communication systems for meters and remote readings of meters – Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands), FprEN 13757-4, March 2013.

[2]   Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW; Part 1: Technical characteristics and test methods, ETSI EN 300 220-1 V2.4.1, 2012.

[3]   ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/56/EU and the essential requirements of article 6 of Directive 2014/30/EU, ETSI EN 301 489-1 V2.1.1 (2016-11)

[4]   ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment; Harmonized Standard covering essential requirements of article 3.1(b) of Directive 2014/53/EU, ETSI EN 301 489-4 V3.1.1 (2016-11)

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