SmartLEWIS™ TRX

TDA5340

High Sensitivity Multi-Channel Transceiver

Wireless MBUS

Standard-compliant configuration set for the SmartLEWIS™ TRX Transceiver TDA5340

Application Note

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Wireless Control

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Protocol Examples
Revision History: 06/04/2012, Rev 1.0

Previous Revision:

Page	Subjects (major changes since last revision)
	Initial version (Rev 1.0)

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1 Introduction

This Application Note is a quick guide for Wireless MBUS. It will give all necessary basics to understand the different modes of Wireless MBUS and the corresponding Data Frame formats. It will not replace specification EN 13757-4 or related documents. To give a good starting point the necessary special function register configuration of the TDA5340 transceiver together with corresponding RF performance measurements are provided in this document / WMBus Support package.
The TDA5340 is an excellent choice for the Wireless MBUS standard due to the outstanding RF performance, flexibility and current consumption in active modes.

1.1 Basics in a nutshell

Wireless MBUS is a transmission standard for connecting metering devices (called “meter”) with other infrastructure which is necessary for read-out or transmit measured data (called “other”). Wireless MBUS can be used for measuring water, heat, gas, electricity and user specified goods. Transmission is done by using license free frequency bands to allow very cost effective solutions.

2 Wireless MBUS Details

The Wireless MBUS specification provides different modes for different purposes. They differ by transmission speed (4,8 to 100 kchip/s), encryption (“Manchester” or “3 from 6”) and some other aspects shown below.

2.1 Physical Layer

The following description of the PHY of the Wireless MBUS has to be seen as a summary out of the Wireless MBUS and ETSI specifications.

Related Specifications:
EN 13757-4
ETSI EN 300 220-1 V2.3.1

Wireless MBUS Mode	RF Centre Frequency [MHz]	Channel Bandwidth [kHz]	TX frequency variation [+/-kHz]	Modulation	Min Deviation [kHz]	Max Deviation [kHz]	Data Rate [kchips/s]	Coding	Transmission duty cycle [%]	Bidirectional
S1	868,3	600	50	2-FSK	40	80	32,768	Manchester	0,02	No
S2	868,3	600	22	2-FSK	40	80	32,768	Manchester	1	Yes
T1 and T2 (METER)	868,95	500	50	2-FSK	40	80	100	3 out of 6	0,1	No
T2 (OTHER)	868,3	600	22	2-FSK	40	80	32,768	Manchester	1	Yes
R2 (OTHER)	868,33	60	17	2-FSK	4,8	7,2	4,8	Manchester	1	Yes
R2 (METER)	868,03 +n*0,06	60	17	2-FSK	4,8	7,2	4,8	Manchester	1	Yes
C1 / C2 (METER)	868,95	500	22	2-FSK	43	47	100	NRZ	0,1	No / Yes
C2 (OTHER)	869,525	250	22	2-GFSK (BT =	23	27	50	NRZ	10	Yes
F	433,82	1740	70	2-FSK	4,8	7	2,4 / 4,8	NRZ	10	Yes

Figure 1 Physic layer summary of the supported W-MBUS mode

The N-Mode requires a center-frequency of 169 MHz which is not supported by the Infineon ISM-Band Transceiver TDA5340. Therefore no further explanations regarding the N-Mode are done in this document.

2.1.1 Pre/Post-amble and Synchronization sequences

Each frame starts with a preamble followed by a synchronization sequence, where the synchronization pattern indicates the start of the payload. In the following table the different preamble and synchronization sequences for each Wireless MBUS Mode supported by the TDA5340 are described.
Caution: The preamble and synchronization sequences are depicted on chip basis which means no additional coding will be applied to the patterns in Table 2-1.

Table 2-1 Preamble, Postamble and synch. sequence of selected wireless MBUS modes

Mode	**Preamble / Synch sequence (chips)**	**Postamble (chips)**
Mode S1	n × (01) 0001110110 10010110 $n \geq 279$	n × (01) $1 \leq n < 4$
Mode S2	n × (01) 0001110110 10010110 $n \geq 15$ or $n \geq 279$	n × (01) $1 \leq n < 4$
Mode T1 and T2 (METER)	n × (01) 0000111101 $n \geq 19$.	n × (01) $1 \leq n < 4$
Mode T2 (OTHER)	n * (01) 0001110110 10010110 $n \geq 15$.	n × (01) $1 \leq n < 4$
Mode R2	n × (01) 0001110110 10010110 $n \geq 39$.	n × (01) $1 \leq n < 4$
Mode C (transport layer A)	n x (01) 0101010000111101 0101010011001101 $n = 16$	
Mode C (transport layer B)	n x (01) 0101010000111101 0101010000111101 $n = 16$	
Mode F (transport layer A)	n × (01) 1111 0110 1000 1101 $n \geq 39$	
Mode F (transport layer B)	n × (01) 1111 0110 0111 0010 $n \geq 39$	

2.2 Data Link layer

Within the Data Link Layer the detailed content of the frames together with Error Control and Addressing is defined. But for further details please refer to the official Wireless MBUS specification EN 60870-5-2.
Even there are several Wireless MBUS Modes the Data Link Layer is valid for all defined modes in the PHY.

First block

L-field	C-field	M-field	A-field	CRC-field
1 byte	1 byte	2 bytes	6 bytes	2 bytes

Second Block

CI-field	Data-field	CRC-field
1 byte	15 bytes (if not the last block)	2 bytes

optional additional Block

Data-field	CRC-field
16 bytes (if not the last block)	2 bytes

2.2.1 L-Field

The Length-field is a one byte value that holds the length in bytes of the complete frame. The length-field itself and the CRC-fields will not be counted

2.2.2 C-field

The control-field is a one byte value which indicates the mode of the communication. Please have a look on some examples below, for further details regarding the C-field commands see EN 60870-5-2:

- C=06h: Mode T2
- C=46h: Mode T1
- C=44h: (SEND/NO REPLY)
- C=4Bh: (REQUEST/RESPOND)
- C=08h: (RESPOND)

2.2.3 M-field

The 2 byte Manufacturer-field is used to indicate the manufacturer of the device. Use 3 capital letters to make a unique manufacturer code and register it at DLMS (Link)

2.2.3.1 Generating the M-field

1. Choose 3 capital letters (calculated example is for “IFX”)
2. Have a look if your chosen 3 letter manufacturer-code is available at DLMS (Link) and register it there.
3. Count the alphabetical value of the three letters and calculate the 5 bit binary number.
    - 1st letter “I” is the 9th letter of the alphabet so “I”=9 decimal which is 01001 binary
    - 2nd letter “F” = 6 decimal or 00110
    - 3rd letter “X”=24 decimal or 11000
    - Associate all 3 binary numbers to a 15 bit binary number starting with the 1st letter:
    - 01001.00110.11000
    - There is 1 bit missing to complete the 16 bit M-field. This bit has to be associated to the leftmost position (most significant bit) and indicates if the address of the device in the A-field is worldwide unique or if it is only unique in the sending range of a meter (which is not recommended). A “0” indicates the address is unique. A “1” Is used for “soft addressing”
    - The M-field for “IFX” and a unique device address is now complete:
    - 0. 01001.00110.11000 binary number = 24D8 hex decimal.
    - Finally the two bytes have to be swapped (24.D8 → D8.24)

The Message Identifier (MID) screening feature of the TDA5340 can be used to filter out only expected Manufacturer ID’s. This means that the host controller will stay in a power saving mode as long as the right wireless MBUS Mode synchronization sequence and the expected M-field is received. The TDA5340 will generate an interrupt after the correct reception of the Manufacturer ID. At this time the host controller can read out the FIFO and take the length information for further processing and manipulation of the TDA5340 registers.

2.2.4 A-field

The Address-field is a 6 byte value to give a wireless MBUS-device a unique address. If the most significant bit is “0” you will have to give every single product you manufacture a unique A-field. If you want to use an Application Layer according to EN 13757-3 you will have to use a A-field generated by using a “Identification

number”, “version number” and “Device type information” as described at 5.4 , 5.6 and 5.7 of EN 13757-3:2004. If you plan to use a custom protocol which is allowed according to EN 19575-4:2005 feel free to do everything you want as long you can guarantee your A-field is unique.
Design hint: Use the 32-bit serial number of TDA 5340 which is guaranteed to be unique.

2.2.5 CRC-field

This 2 byte value is a CRC generated from the previous data blocks. The 16-bit CRC-polynomial is: $x^{16}+x^{13}+x^{12}+x^{11}+x^{10}+x^{8}+x^{6}+x^{5}+x^{2}+1$ the initial value is 0 and the final CRC has to be complemented.

2.2.6 CI-field

The Control-Information-field is a 1 byte value specifies the type of application layer used in the data field. See table below:

CI value	Designation	Remarks
51h	Data sent by Readout device to the meter without fixed header (do be defined)	For compability with EN 13757-3 Application Layer standard
71h	Reserved for alarm report	For compability with EN 13757-3 Application Layer standard
72h	EN 19757-3 Application Layer with short header	For compability with EN 13757-3 Application Layer standard
78h	EN 19757-3 Application Layer without header (to be defined)	For compability with EN 13757-3 Application Layer standard
7Ah	EN 19757-3 Application Layer with full header	For compability with EN 13757-3 Application Layer standard
81h	Relaying Application Layer	For future development
82h	For future use	For compability with CENELEC TC 205 standards
A0h - B7h	manufacturer specific application Layer	

2.2.7 Data-field

The Data-field contains data to be transmitted either by meter or by other. The Data-field may be completely customized when CI field is A0h – B7h or uses an application layer defined at EN 13757-3. The length of the Data-field will be in the 2nd Block 15 Bytes (if this is not the last block). Optional Blocks beyond the 2nd Block have a Data-field which has 16 Bytes. The first block does not have a Data-field. The last block (this may be the second block or an optional block) contains the rest of the bytes defined by the L-field. If the last block is the second block it is one byte less because of the CI-field.
Below you can find an example for a valid Frame consisting of 2 blocks:

First block

L-field	C-field	M-field	A-field	CRC-field
1 byte	1 byte	2 bytes	6 bytes	2 bytes
0F h	**44** h	**24DC** h	**04050607B101** h	**C7B0** h

Second Block or last Block

CI-field	Data-field	CRC-field
1 byte	5 bytes	2 bytes
78 h	**1314151617** h	**5817** h

3 10 Steps to get it running using the Explorer Tooling

The TDA5340 Explorer can only handle fixed number of payload bits, which means that data which are longer than the FIFO size can't be processed.

1. Download and Install the Software Tool (TDA5340_Explorer) and the Wireless MBUS support package.

2. Unzipp the files of the support package copy these files to your preferred location on your hard or network drive.

3. Connect the two TDA5340 Eval Boards via USB to the PC or Notebook and open two times the TDA5340 Explorer Software. Select in each explorer using the drop down box in the "Chip Control" a different board then press "Open" to establish a connection to the Eval Board (If the SIB Server is already running it might be necessary to do a right click on the SIB server icon in the task bar and select recreate device list).

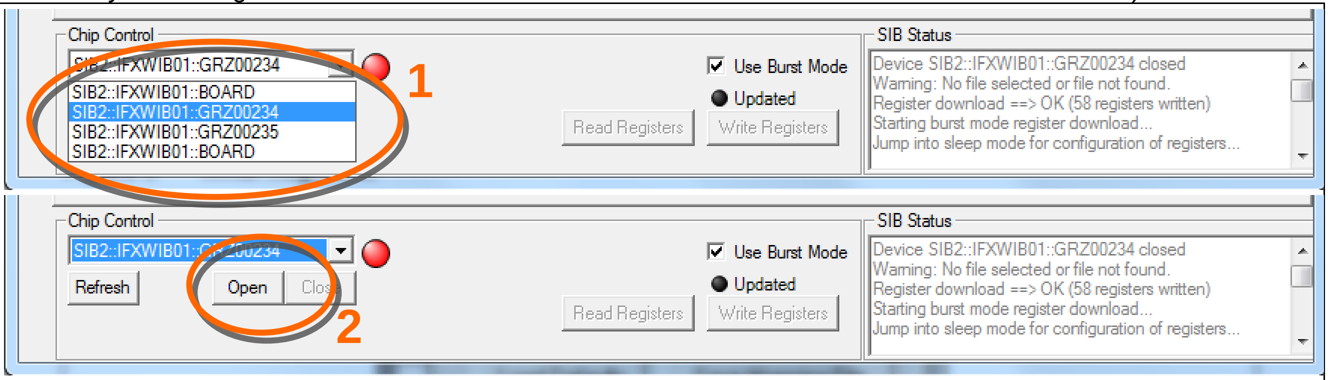

Figure 2 Select a board and Open communication channel

4. Within the specified Protocol folders the following files are of importance:

1. WMBUS_T1_RX_spi.def → T1 Mode Configuration File for receiver (output of Wizard)
2. WMBUS_T1_TX_spi.def → T1 Mode Configuration File for transmitter (output of Wizard)
3. WMBUS_FSK_T1Mode.tdf → T1 Mode Transmission data file
4. WMBUS_T2S2_RX_spi.def → T2/S2 Mode Configuration File for receiver (output of Wizard)
5. WMBUS_T2S2_TX_spi.def → T2/S2 Mode Configuration File for transmitter (output of Wizard)
6. WMBUS_FSK_T2S2Mode.tdf → T2/S2 Mode Transmission data file

5. In the TDA5340 Explorer load the Configuration File ("Registers" tab ➔ "Open" button in the "Register Map / SPI File Control" section, then select the desired file from the file dialog) in one Explorer the "ProtocolName_RX_spi.def" file and to in the other the "ProtocolName_TX_spi.def" file. Download on both Explorer tools the configuration to the Eval Board via the "Write Registers" button.

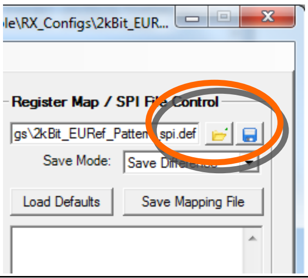

Figure 3 Open SPI File

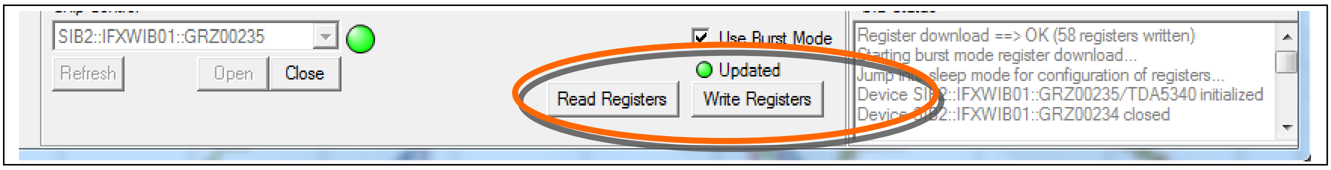

Figure 4 Write Registers

6. Connect the 50 Ohm Antenna to both Eval Boards
7. Change to the Explorer where the TX configuration file was loaded and switch to the “Explorer” tab. Open the Transmit pattern definition file for the used protocol.

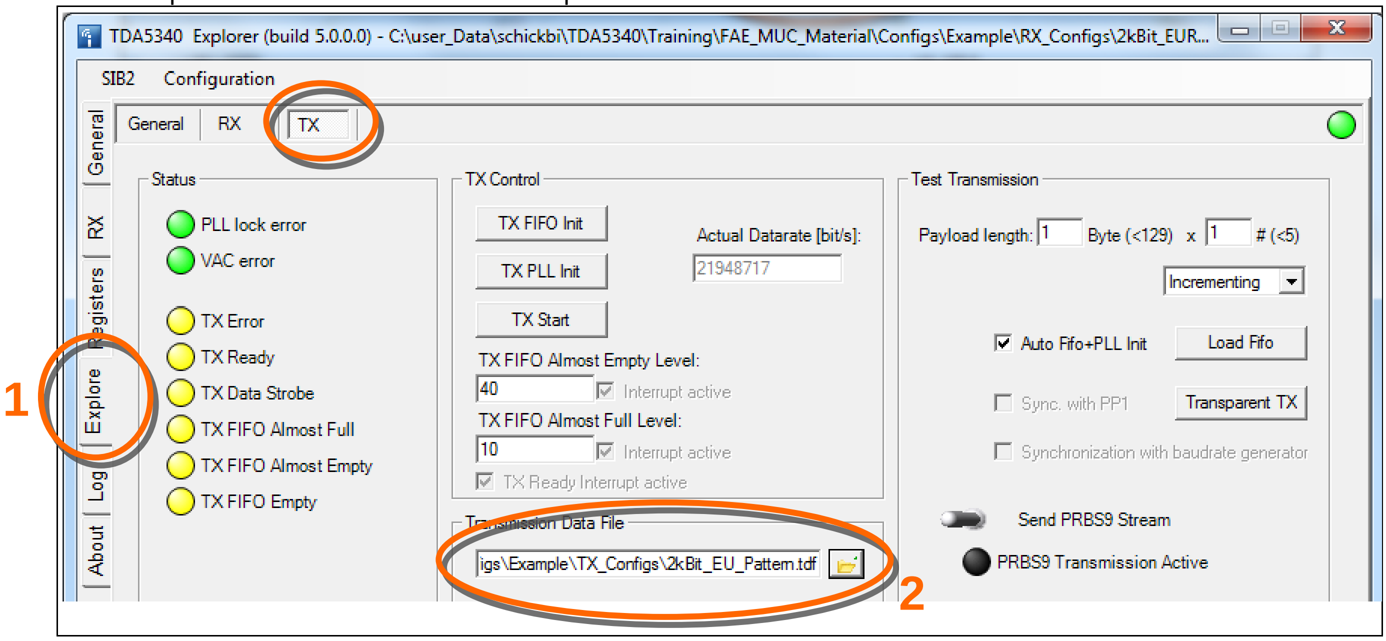

Figure 5 Open the transmission data file

8. Switch to the “Explorer” tab where the RX configuration file was loaded and activate the “Run” function. You can use the add-on function “Correctly received payload data” as shown below.

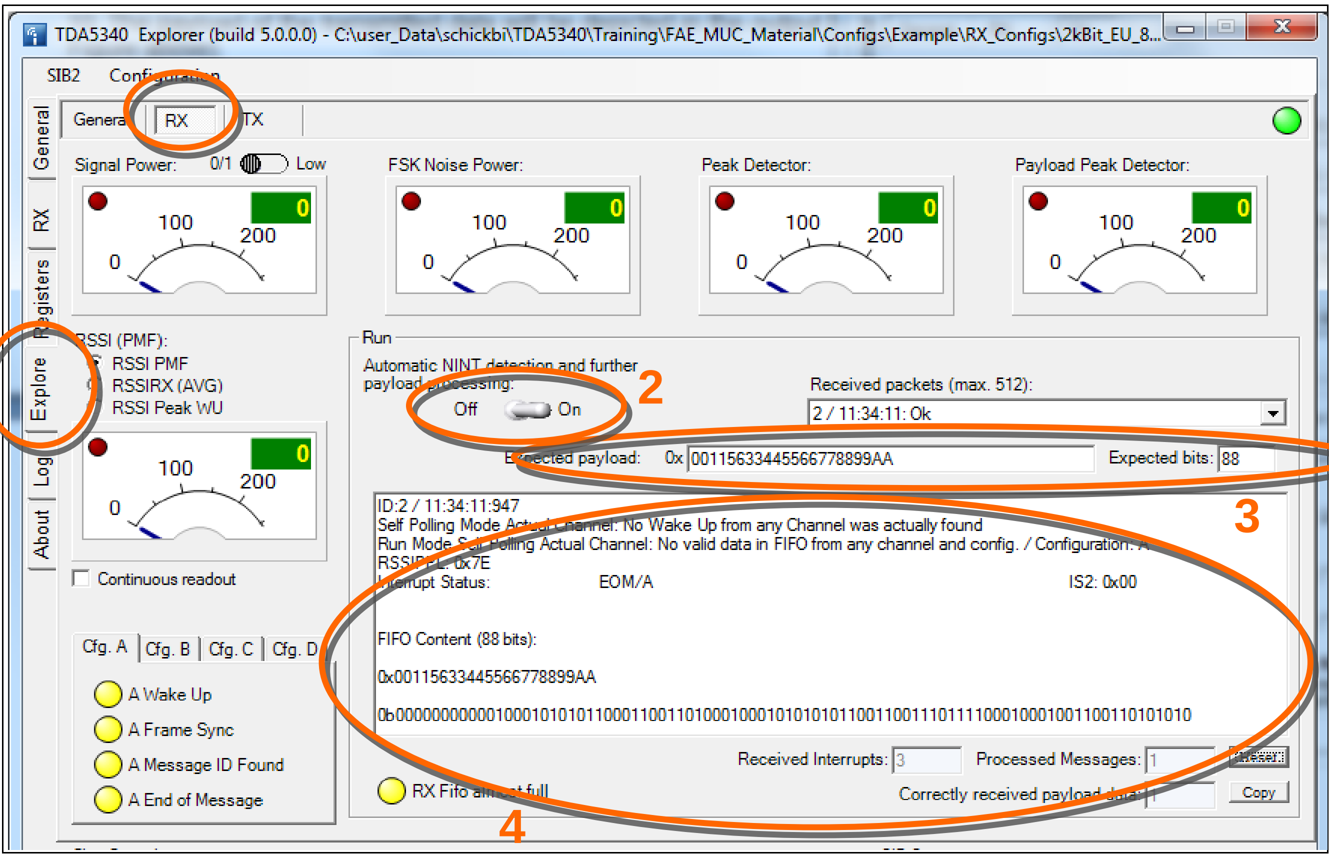

Figure 6 “Run” and “Correctly received payload data” Function

9. Trigger the RF transmitter to send out the WMBus protocol by pressing the Load FIFO button in the Explorer TX section.

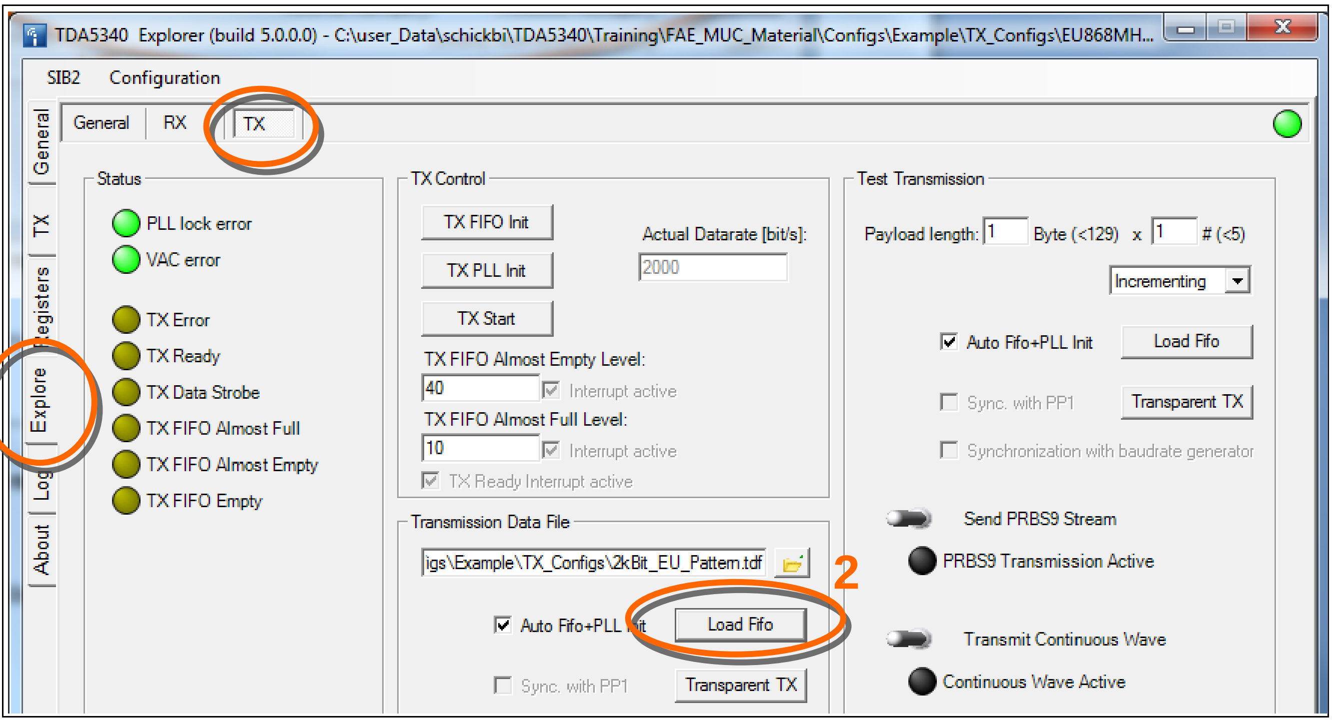

Figure 7 “Run” and “Correctly received payload data” Function

10. The payload of the transmitted data will be depicted in the output fields of the Explorer Tool (see section 4 in Figure above).

4 RF Performance

This chapter shows some receiver and transmitter measurements regarding ETSI compliance and performance.

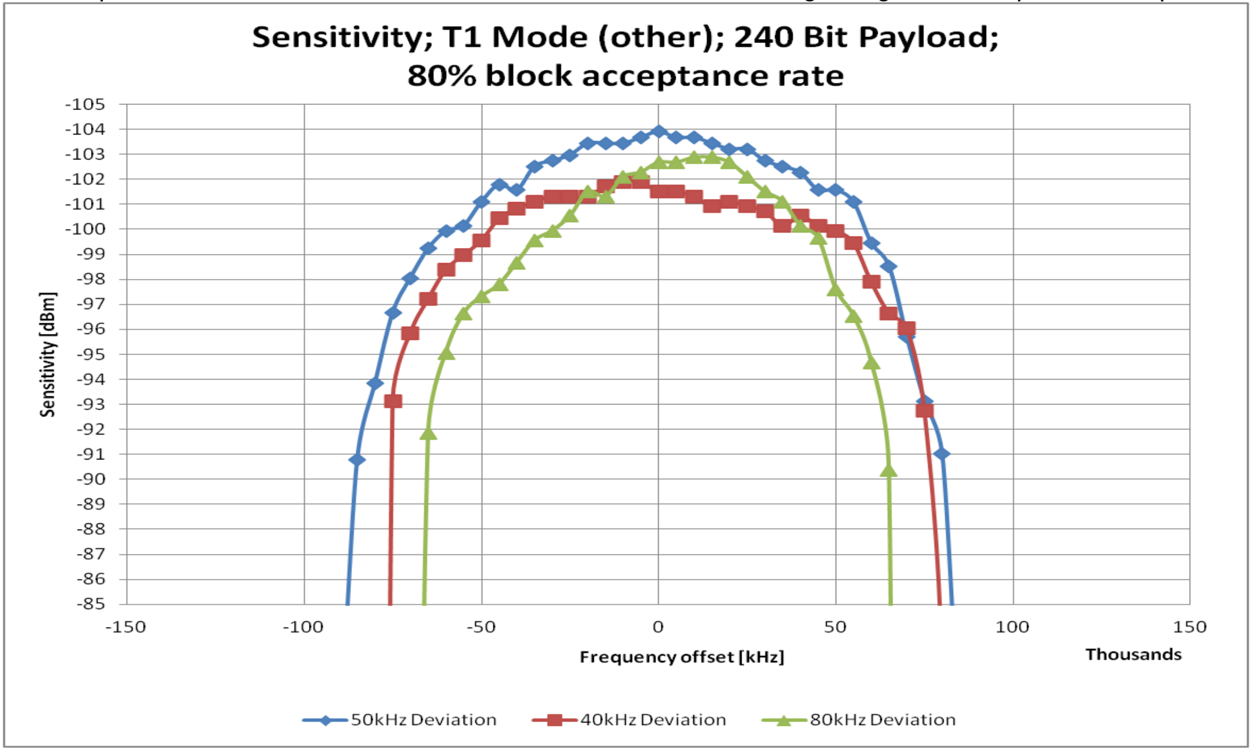

Figure 8 Receiver Sensitivity performance in T1 Mode (other) → 100kchips/s; 3 out of 6 coding

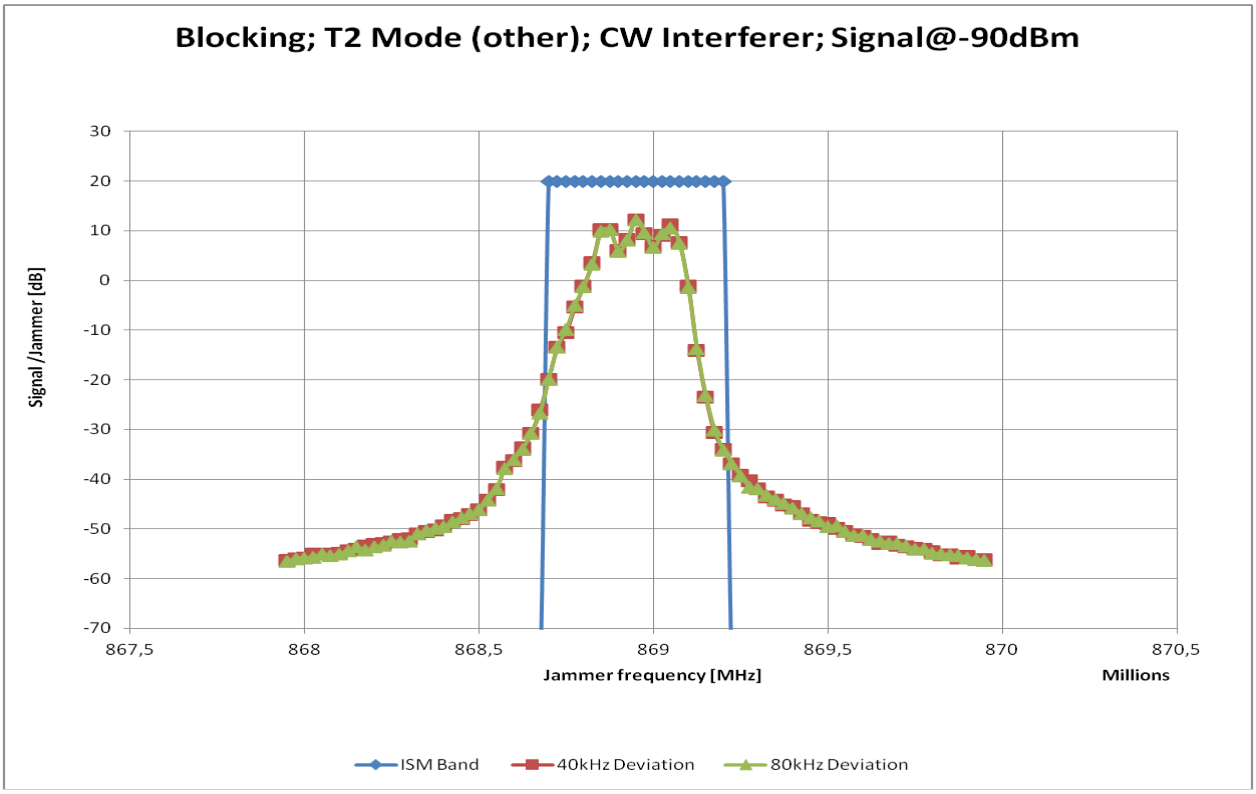

Figure 9 Receiver Blocking performance in T1 Mode (other)

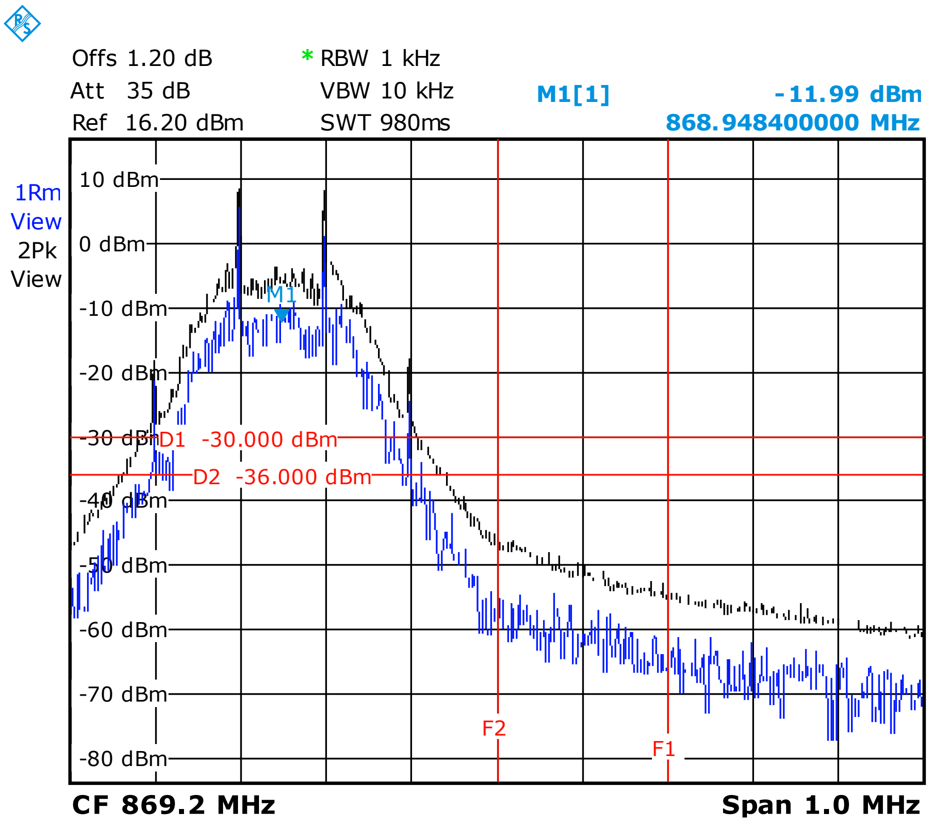

Figure 10 Transmit spectrum plot (T1 TX mode) 1kHz resolution BW

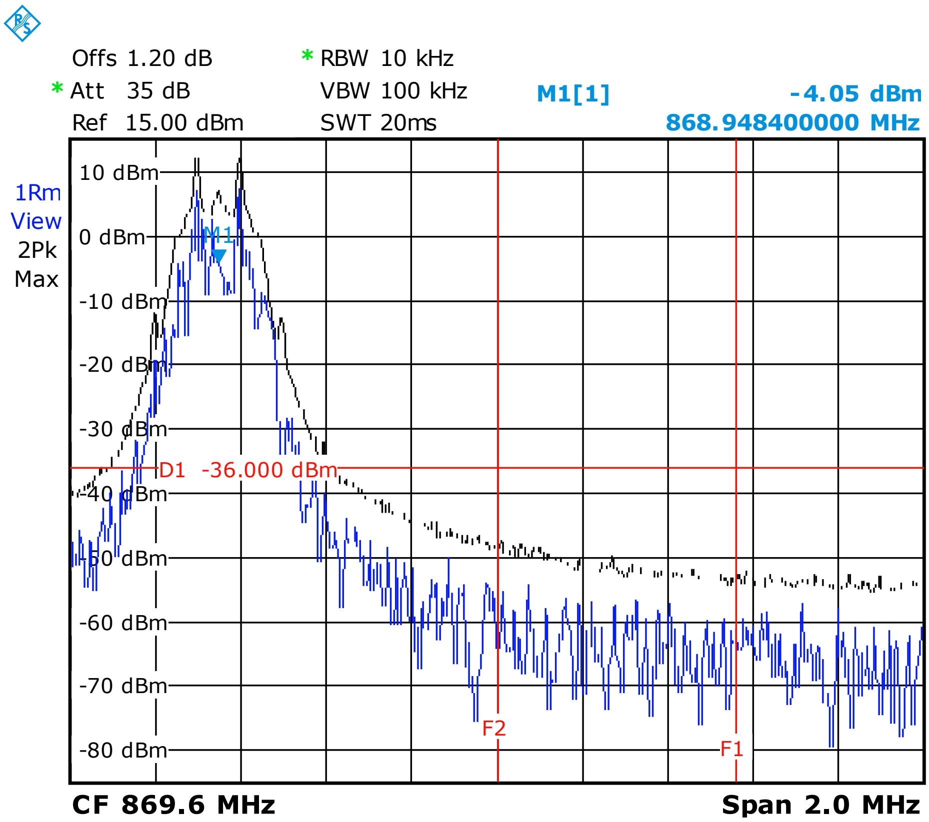

Figure 11 Transmit spectrum plot (T1 TX mode) 10kHz resolution BW

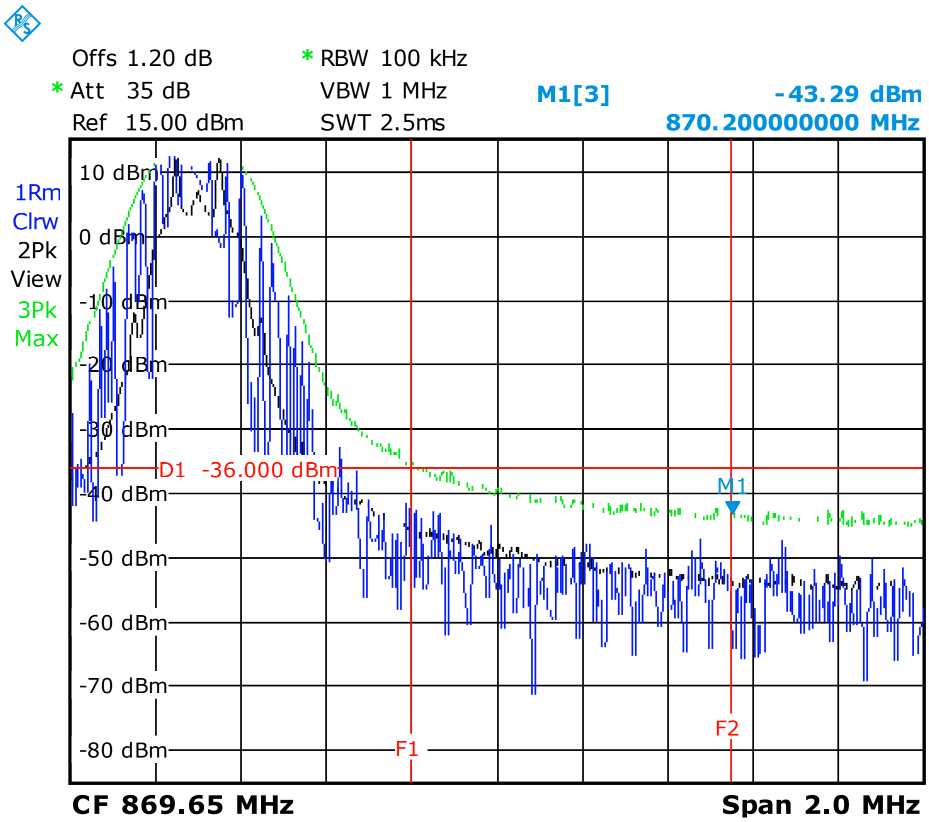

Figure 12 Transmit spectrum plot (T1 TX mode) 100kHz resolution BW

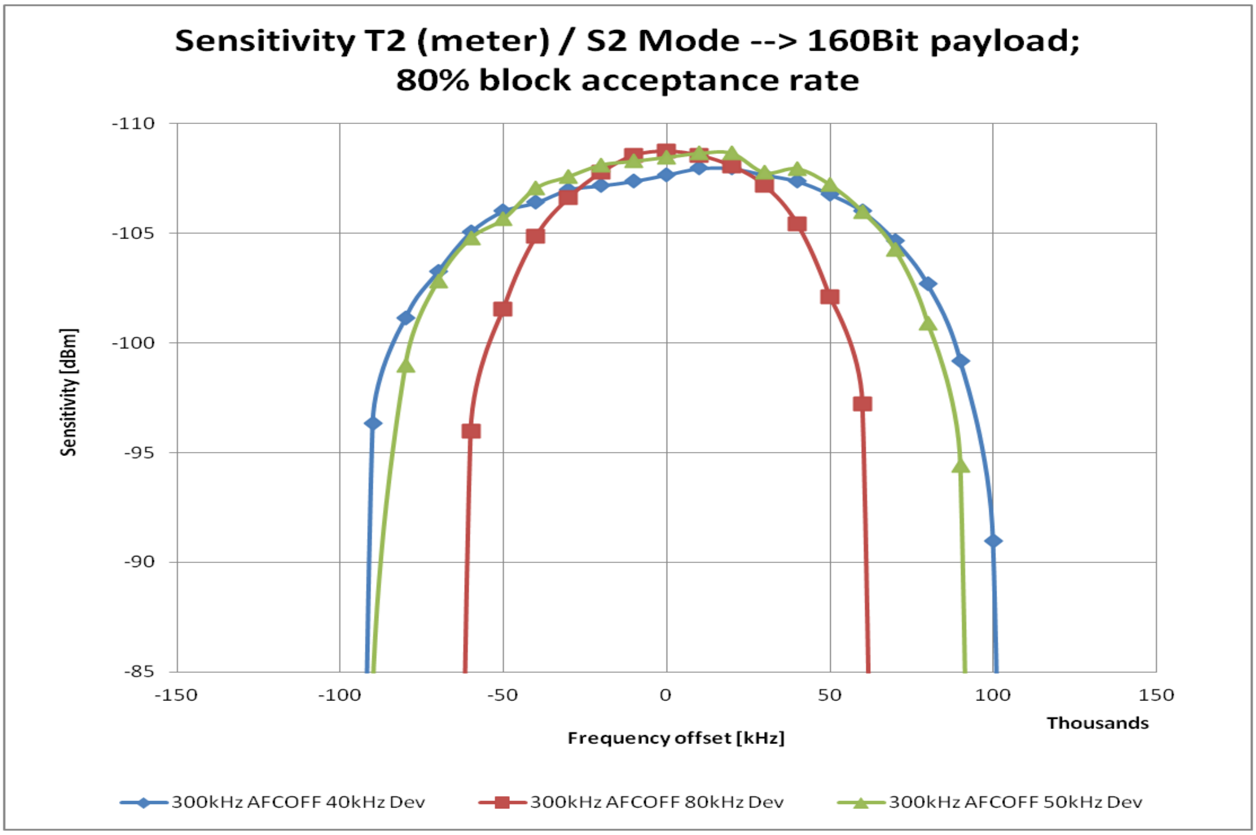

Figure 13 Receiver Sensitivity performance in T2 Mode (meter) → 32k768chips/s; Manchester coding

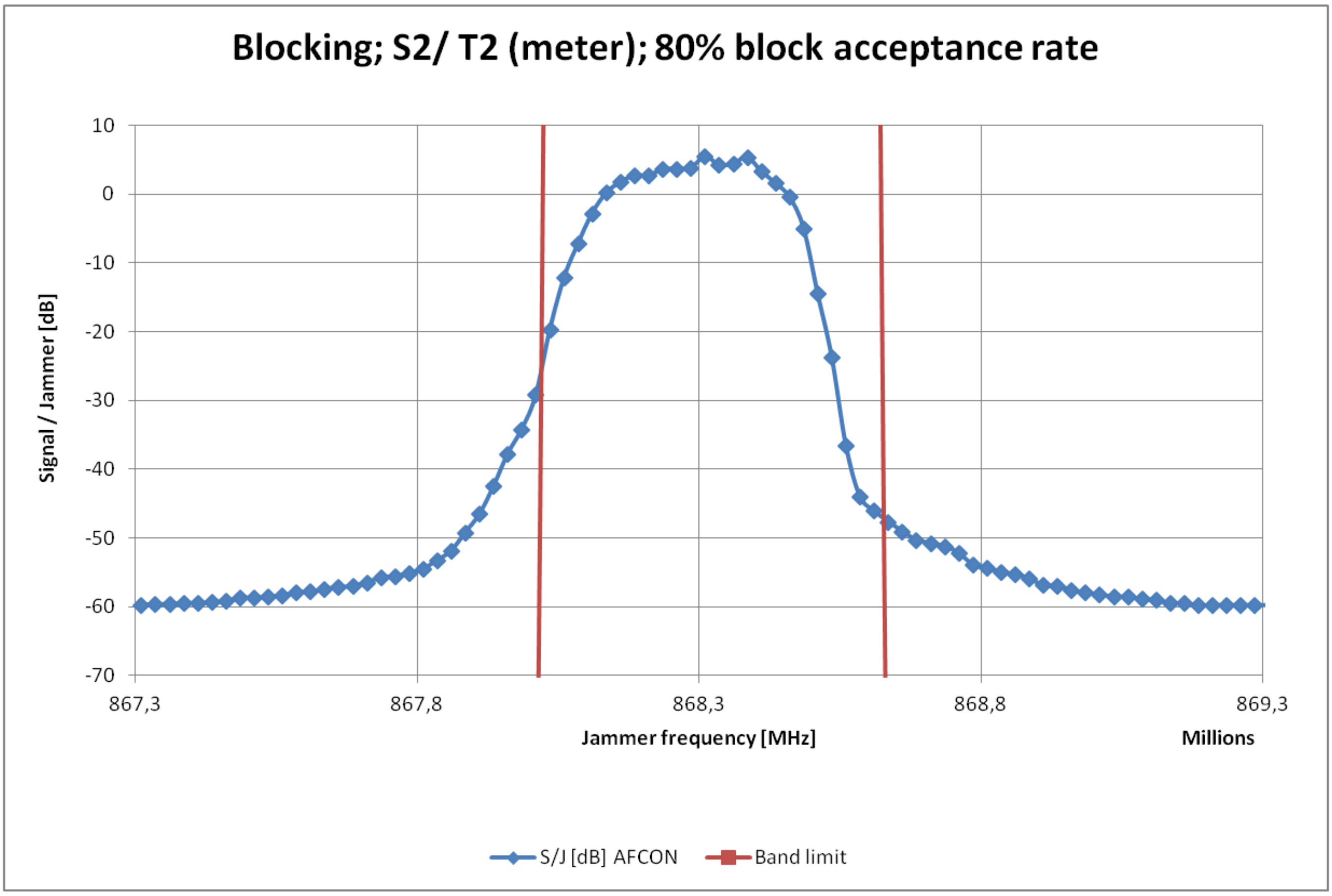

Figure 14 Blocking performance in T2 Mode (meter) → 32k768chips/s; Manchester coding

4.1 Conclusion

It can be seen that the TDA5340 has an excellent blocking performance which is close to the HR class defined by the wireless MBUS standard. In case of relaxed requirements on frequency offset or maximum frequency deviation, a tighter IF filter may be used which would provide even further improved adjacent band selection (better than 40 dB).

Regarding the Output spectrum measurements the TDA5340 does fulfill the ETSI spectrum mask without the need of an additional filtering after the power amplifier. One important frequency point is at 862MHz where the emissions must be below -54dBm /100kHz RBW.

All in all the TDA5340 shows excellent RF range performance, very high interfere immunity together with lowest current consumption in active modes (12.5mA RX and 22.5mA@13dBm TX).

The SFR register set configuration of the TDA5340 where these measurements are done is available on the Infineon web side under www.infineon.com/TDA5340.

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