SmartLEWIS™ TRX+

TDA5340

High Sensitivity Multi-Channel Transceiver

Protocol Examples for ISM Band Applications

Configuration Set for the SmartLEWIS™ Transceiver TDA5340

Application Note

Rev1.0, 13/01/2012

Wireless Control

Edition 13/01/2012

Published by
Infineon Technologies AG
81726 Munich, Germany

© 2012 Infineon Technologies AG
All Rights Reserved.

LEGAL DISCLAIMER

THE INFORMATION GIVEN IN THIS APPLICATION NOTE IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. INFINEON TECHNOLOGIES HEREBY DISCLAIMS ANY AND ALL WARRANTIES AND LIABILITIES OF ANY KIND (INCLUDING WITHOUT LIMITATION WARRANTIES OF NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

Infineon Technologies components may be used in life-support devices or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

Protocol Examples
Revision History: 13/01/2012, Rev 1.0
Previous Revision:

Page	Subjects (major changes since last revision)

Trademarks of Infineon Technologies AG

BlueMoon™, COMNEON™, C166™, CROSSAVE™, CanPAK™, CIPOS™, CoolMOS™, CoolSET™, CORECONTROL™, DAVE™, EasyPIM™, EconoBRIDGE™, EconoDUAL™, EconoPACK™, EconoPIM™, EiceDRIVER™, EUPEC™, FCOS™, HITFET™, HybridPACK™, ISOFACE™, I²RF™, IsoPACK™, MIPAQ™, ModSTACK™, my-d™, NovalithIC™, OmniTune™, OptiMOS™, ORIGA™, PROFET™, PRO-SIL™, PRIMARION™, PrimePACK™, RASIC™, ReverSave™, SatRIC™, SensoNor™, SIEGET™, SINDRION™, SMARTi™, SmartLEWIS™, TEMPFET™, thinQ!™, TriCore™, TRENCHSTOP™, X-GOLD™, XMM™, X-PMU™, XPOSYS™.

Other Trademarks

Advance Design System™ (ADS) of Agilent Technologies, AMBA™, ARM™, MULTI-ICE™, PRIMECELL™, REALVIEW™, THUMB™ of ARM Limited, UK. AUTOSAR™ is licensed by AUTOSAR development partnership. Bluetooth™ of Bluetooth SIG Inc. CAT-iq™ of DECT Forum. COLOSSUS™, FirstGPS™ of Trimble Navigation Ltd. EMV™ of EMVCo, LLC (Visa Holdings Inc.). EPCOS™ of Epcos AG. FLEXGO™ of Microsoft Corporation. FlexRay™ is licensed by FlexRay Consortium. HYPERTERMINAL™ of Hilgraeve Incorporated. IEC™ of Commission Electrotechnique Internationale. IrDA™ of Infrared Data Association Corporation. ISO™ of INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. MATLAB™ of MathWorks, Inc. MAXIM™ of Maxim Integrated Products, Inc. MICROTEC™, NUCLEUS™ of Mentor Graphics Corporation. Mifare™ of NXP. MIPI™ of MIPI Alliance, Inc. MIPS™ of MIPS Technologies, Inc., USA. muRata™ of MURATA MANUFACTURING CO., MICROWAVE OFFICE™ (MWO) of Applied Wave Research Inc., OmniVision™ of OmniVision Technologies, Inc. Openwave™ Openwave Systems Inc. RED HAT™ Red Hat, Inc. RFMD™ RF Micro Devices, Inc. SIRIUS™ of Sirius Sattelite Radio Inc. SOLARIS™ of Sun Microsystems, Inc. SPANSION™ of Spansion LLC Ltd. Symbian™ of Symbian Software Limited. TAIYO YUDEN™ of Taiyo Yuden Co. TEAKLITE™ of CEVA, Inc. TEKTRONIX™ of Tektronix Inc. TOKO™ of TOKO KABUSHIKI KAISHA TA. UNIX™ of X/Open Company Limited. VERILOG™, PALLADIUM™ of Cadence Design Systems, Inc. VLYNQ™ of Texas Instruments Incorporated. VXWORKS™, WIND RIVER™ of WIND RIVER SYSTEMS, INC. ZETEX™ of Diodes Zetex Limited.

Last Trademarks Update 2010-03-22

Table of Contents

1 Protocol Examples for the ISM Frequency Bands 5
1.1 Legislative Restriction 5
1.2 Jammer Immunity 5
1.3 Current Consumption 5

2 Tools 6
2.1 TDA5340 Explorer (Wizard tab) and Protocol Examples 6
2.2 Polling Strategy Excel Sheet 6
2.3 TDA5340 Explorer (Explore tab) 6
2.4 Download Information 6

3 10 Steps to get it running 7

4 Detailed Description of Protocol Examples 10
4.1 2 kbit ASK USA Pattern 10
4.2 2 kbit FSK EU Pattern 11
4.3 2 kbit FSK EU Pattern – Multi-Channel using 2 RF channels 12

5 Measurements 13

1 Protocol Examples for the ISM Frequency Bands

In general the RF protocol is always a compromise in terms of sensitivity, current consumption, data throughput, jammer immunity and regional legislative restrictions. The given protocol examples are typical compromises of the above mentioned parameters but of course can always be optimized towards a certain parameter.

1.1 Legislative Restriction

The USA pattern is defined to fulfill the FCC Part 15 requirements and take advantage out of the Duty Cycle Correction Factor. The Duty Cycle (FCC15.35) which is mentioned is related to Carrier ON time within a 100ms time slot.

This Duty Cycle Correction Factor allows the transceiver to send with higher output power then initially defined. In the equation below the calculation of the correction factor is depicted.

$$K_E = 20\log\left(\frac{T_X \; time \; on \; in \; a \; 100ms \; window}{100ms}\right)(dB)$$

The European equivalent to the FCC is called ETSI. This regulation framework allows in the 434MHz band (433.05 - 434.79MHz) an output power of 10mW if the transmitter has an ON/OFF Duty Cycle below 10% otherwise the output power is limited to 1mW.

1.2 Jammer Immunity

The immunity against jammers can be improved by several methods. The best method to achieve excellent immunity performance is the multi-channel concept. The receiver of the TDA5340 transceiver is able to handle this challenge in a very elegant way. The transceiver scans several Radio Frequency (RF) channels and processes the data without the need of a microcontroller. If a jammer appears on one of the channels the communication is possible on the other remaining channels.

In principle can be stated that the modulation technique has also a contribution to the receiver immunity performance. It can be stated that for limiter based receiver systems, Frequency Shift Keying (FSK) has a higher interferer immunity compared to OOK (On/Off Keying == ASK with 100% modulation index). During the OFF period of the signal the interferer can be directly seen on the Receive Signal Strength Indicator (RSSI) voltage. In FSK the signal is always present and the Interferer will be suppressed to a certain extend by the limiter effect.

1.3 Current Consumption

All protocols are designed with a Wake up Pattern (WUP), SYNC Pattern, Telegram Start Identifier (TSI) and Payload Data. The most important part to reduce the average current consumption in the receive mode is the WUP frame, which allows the transceiver to perform a polling strategy. Polling means that the TDA5340 transceiver is alternately changing from active mode (RXRUN Mode) to sleep mode within a specified time period. This polling strategy allows the transceiver to reduce the active time significantly and of course the average current consumption. The TDA5340 transceiver is able to handle this polling method by itself (autonomous receive) and just alerts the microcontroller by an Interrupt if the appropriate WUP or TSI Pattern or EOM (End of Message) were found.

2 Tools

To get the defined protocols properly running, Infineon provides a toolset which helps the developer to verify his work and to see that the transceiver is correctly configured.

2.1 TDA5340 Explorer (Wizard tab) and Protocol Examples

The pre-defined pattern of the protocol examples are all implemented in the so called TDA5340 Explorer (use the Wizard pages), which is a GUI describing all registers of the TDA5340 transceiver in a way that is easy to understand (TDA5340_Explorer).

For all of the protocol examples described below the configuration files are available and are part of this package.

The given protocol examples can be used as they are or to ease up your development as starting point for your customizations.

2.2 Polling Strategy Excel Sheet

The above mentioned polling strategy is also described in an Excel sheet which automatically calculates the required ON and OFF timings for the given protocol. Infineon also provides this Excel sheet in this package (see file "PollingStrategy__SP_Timings__IFXrefPattern2_MC__2012_01_23").

2.3 TDA5340 Explorer (Explore tab)

For working with our evaluation boards, the configurations and transmit files that are built within the Wizard can be downloaded to the transceiver by the TDA5340 Explorer software.

The Explore tab provides the basic functionality of the RX and TX portion of the transceiver. Also some basic functionality to react on the occurrence of an interrupt and read out the FIFO automatically, when using the "Run" function. For your test purpose a fixed payload data can be used, and then the add-on function "Correctly received payload data" can be used to provide a vey easy method for a MER measurement (Message Error Rate).

Limitations of the TX portion within the explorer tab:

- No generation of multichannel messages (only manually by loading different frequencies on the Wizard page)
- Gaps between messages are not allowed

2.4 Download Information

The latest documentation and other helpful information can be downloaded from our product homepage (TDA5340).

3 10 Steps to get it running

1. Download and install the above mentioned Software Tool (TDA5340_Explorer).

2. Use the unzipped files from folder \TDA5340_Protocol_Example_V1.0\ and 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).

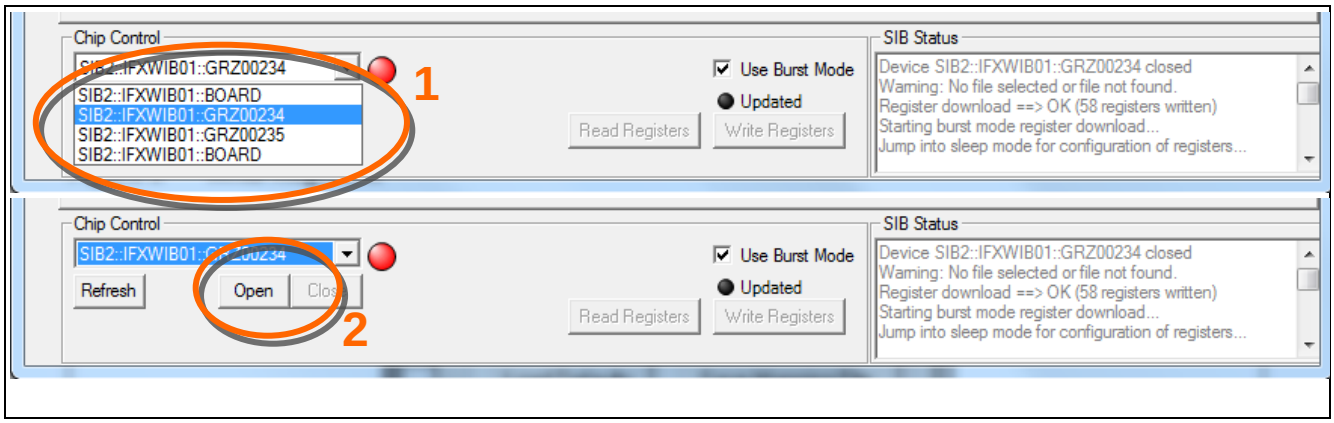

Figure 1 Select a board and Open communication channel

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

a. ProtocolName_RX_spi.def → Configuration File for virtual receiver (output of Wizard)
b. ProtocolName_TX_spi.def → Configuration File for virtual transmitter (output of Wizard)
c. ProtocolName.tdf → Transmission data file
d. PollingStrategy__SP_Timings__IFXrefPattern2_MC__2012_01_23 → Polling Strategy XLS Sheet

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 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.

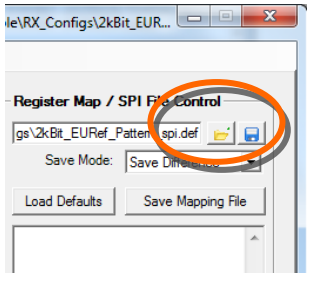

Figure 2 Open SPI File

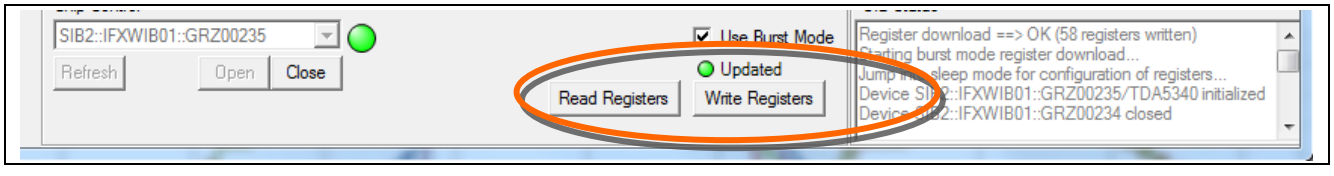

Figure 3 Write Registers

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.

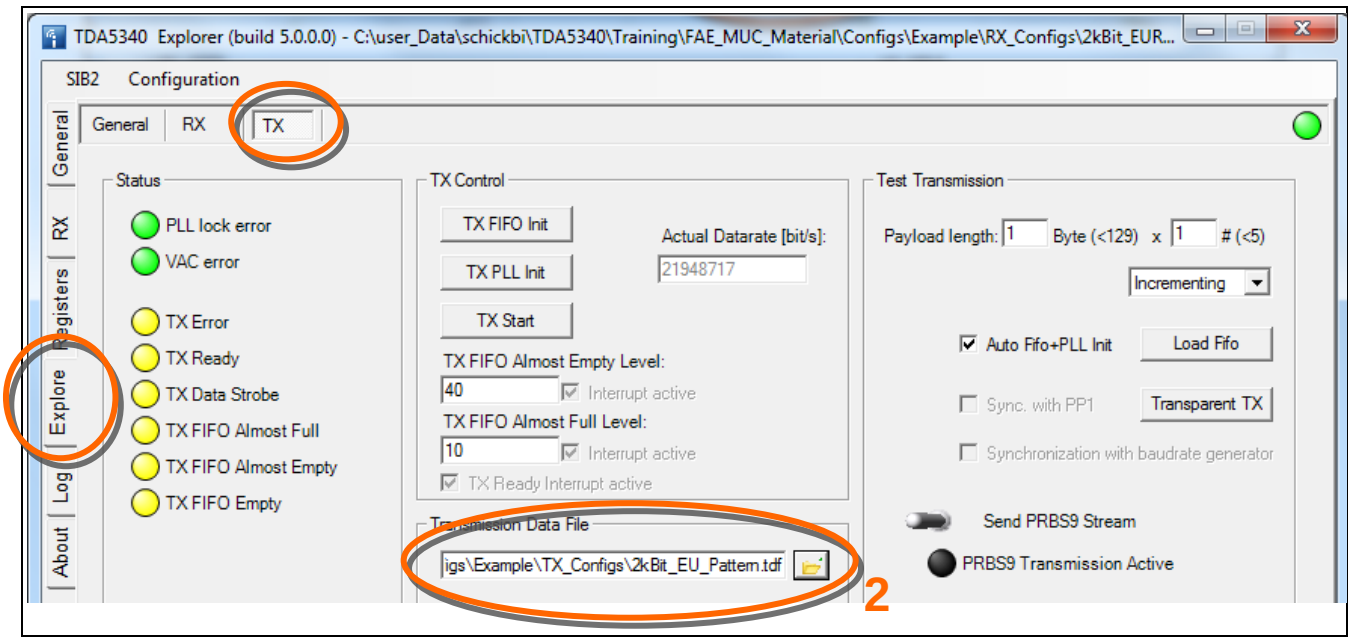

Figure 4 Open the transmission data file

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 described above.

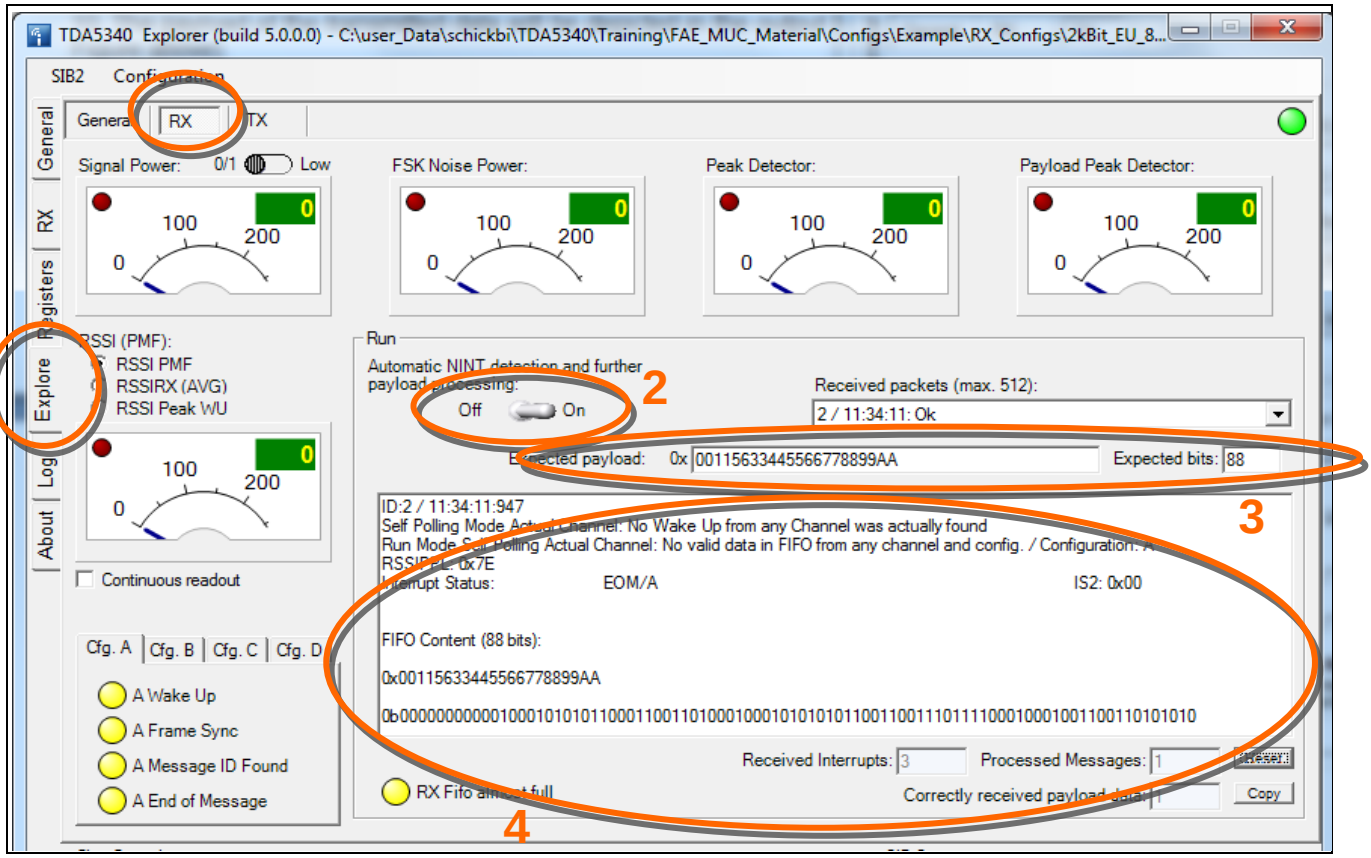

Figure 5 “Run” and “Correctly received payload data” Function

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

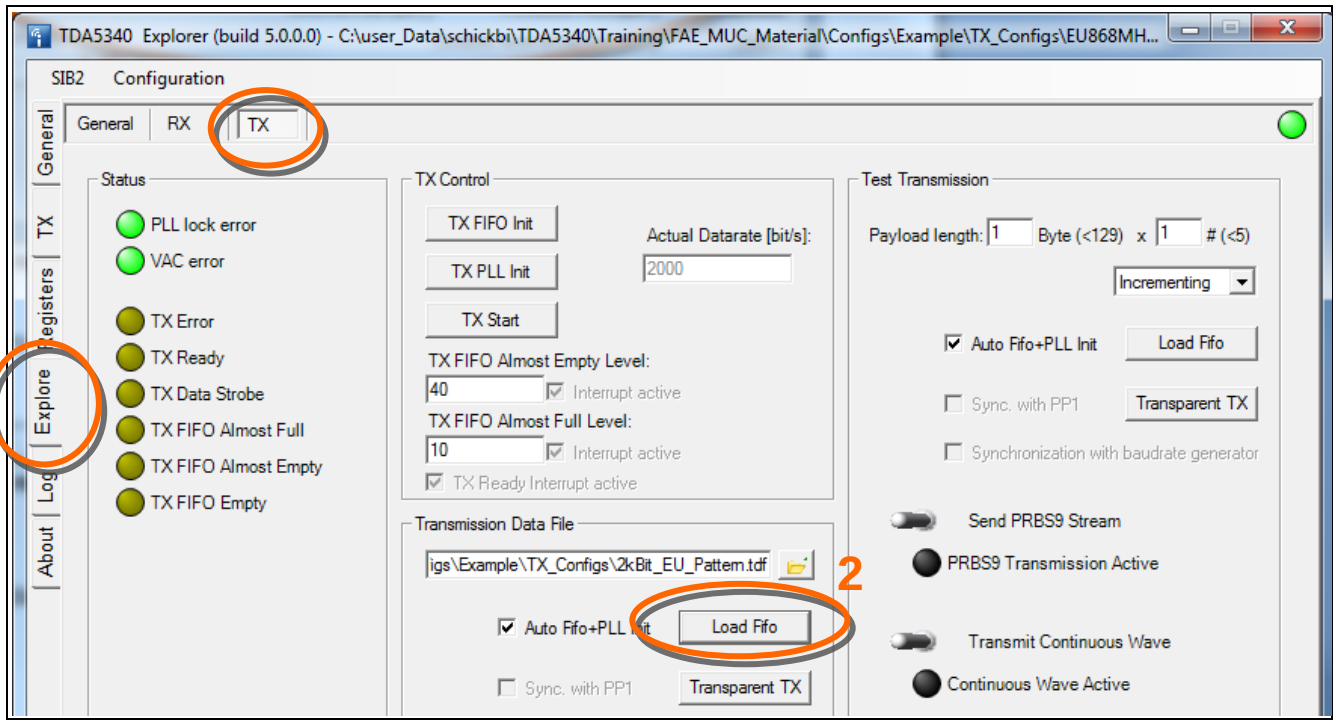

Figure 6 “Run” and “Correctly received payload data” Function

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

4 Detailed Description of Protocol Examples

4.1 2 kbit ASK USA Pattern

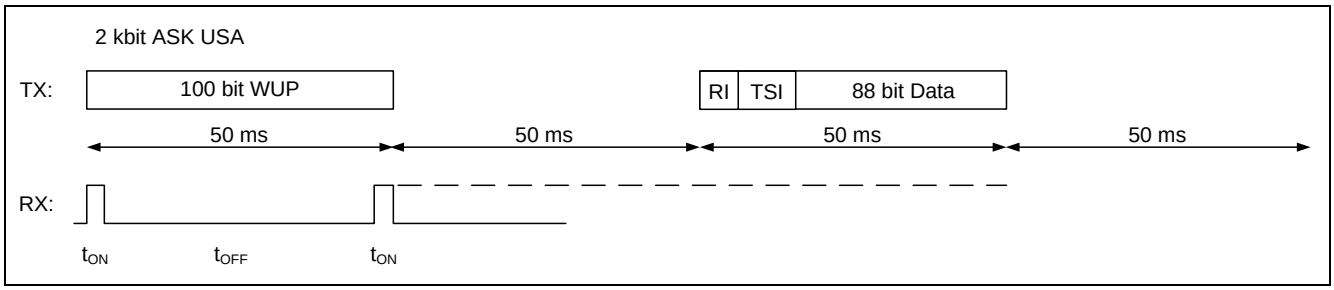

Figure 7 2 kbit ASK USA Pattern

File Names:

RX configuration: 2kBit_USARef_Pattern_AGC_ON_RX_spi
TX configuration: USA_2kBit_TX_spi
TX data file: 2kBit_USA_Pattern

Modulation:	ASK
Data Rate:	2 kbit
Channel frequency:	315.00 MHz
Coding:	Manchester
WUP Data:	100 bit all 0
SYNC Data:	4 bit → all 0
TSI Data:	8 bit → 00010101
Payload:	11 byte data (could be modified for different applications)

Main target: typical application case with high sensitivity

Ultra Fast Fallback to Sleep Mode (UFFB):

RX sensitivity:	-110 dBm
Average RX current of TDA5340:	0.78 mA
FCC Duty Cycle factor for TX:	12.04 dB

TX configuration:

TX output power (peak):	10 dBm
TX active current:	8,8 mA

4.2 2 kbit FSK EU Pattern

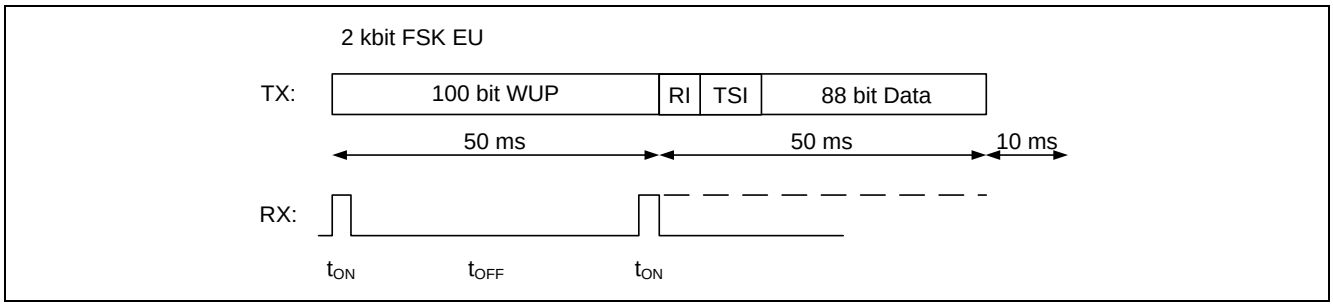

Figure 8 2 kbit FSK EU Pattern

File Names:

RX configuration: 2kBit_EURef_Pattern_AGC_ON_RX_spi
TX configuration: EU_2kBit_TX_spi
TX data file: 2kBit_EU_Pattern

Modulation:	FSK
Data Rate:	2 kbit
Channel frequency:	433.92 MHz
FSK Deviation:	+/- 35 kHz
Coding:	Manchester
WUP Data:	100 bit all 0
SYNC Data:	4 bit → all 0
TSI Data:	8 bit → 00010101
Payload:	11 byte data (could be modified for different applications)

Main target: typical application with high sensitivity, higher immunity against jammer

Ultra Fast Fallback to Sleep Mode (UFFB):

RX sensitivity:	-112.3 dBm
Average RX current of TDA5340:	0.78 mA

TX configuration:

TX output power:	10 dBm
TX active current:	12,5 mA

4.3 2 kbit FSK EU Pattern – Multi-Channel using 2 RF channels

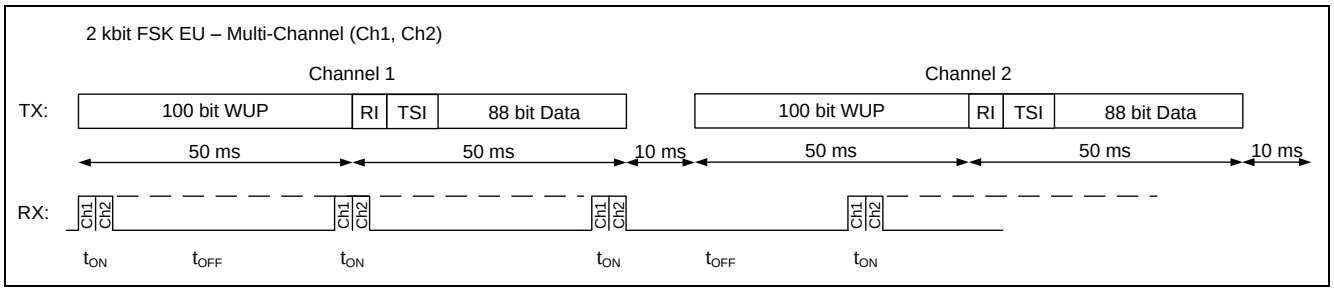

Figure 9 2 kbit FSK EU Pattern – Multi-Channel

File Names:

RX configuration: 2kBit_Ref_PatternMC_AGC_ON_RX_spi
TX configuration: EU_2kBit_TX_spi
TX data file: 2kBit_EU_Pattern

Modulation:	FSK
Data Rate:	2 kbit
Channel frequency:	Ch1: 433.92 MHz
	Ch2: 434.42 MHz
FSK Deviation:	+/- 35 kHz
Coding:	Manchester
WUP Data:	100 bit all 0
SYNC Data:	4 bit → all 0
TSI Data:	8 bit → 00010101
Payload:	11 byte data (could be modified for different applications)

Main target: typical application with high sensitivity, even higher immunity against jammer
Ultra Fast Fallback to Sleep Mode (UFFB):

RX sensitivity:	-112,3 dBm
Average RX current of TDA5340:	1,4 mA

TX configuration:

TX output power:	10 dBm
TX active current:	12,5 mA

5 Measurements

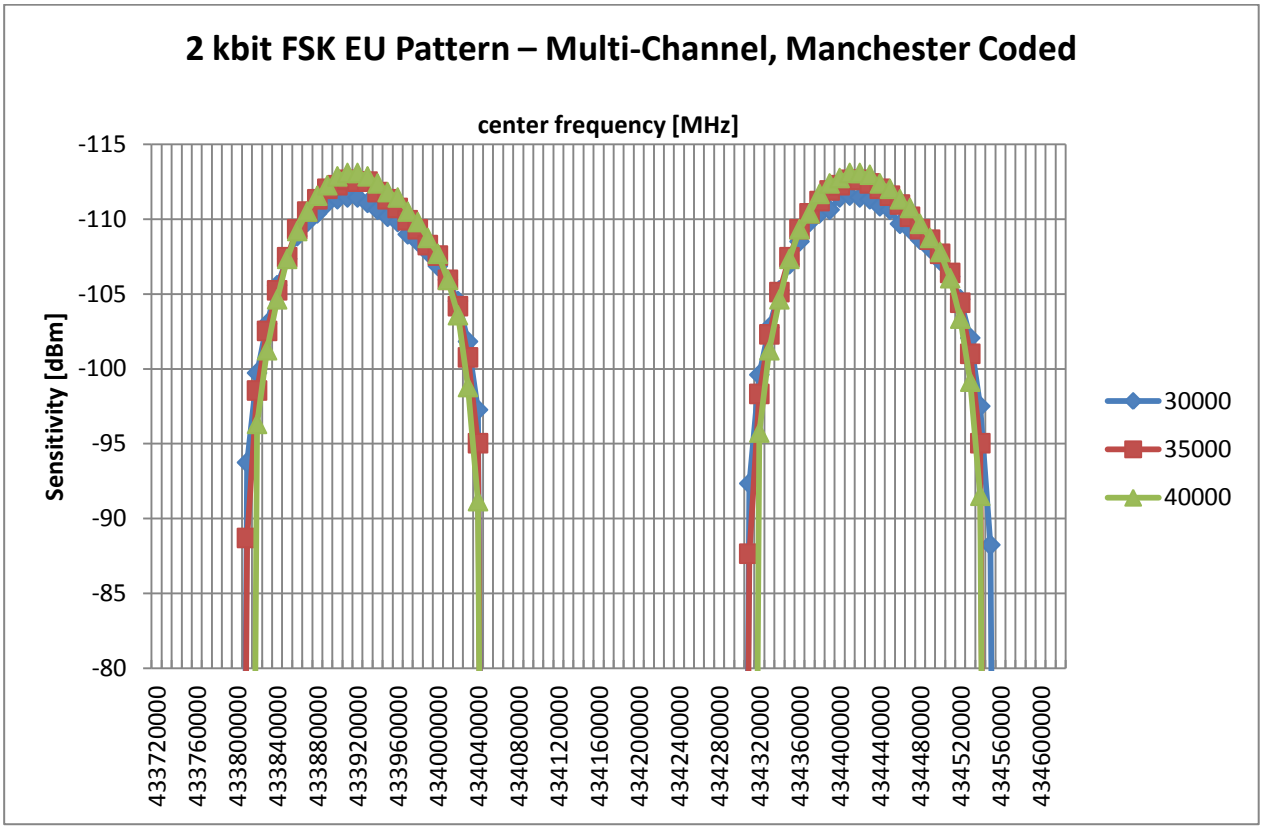

Figure 10 Sensitivity vs. frequency Offset and FSK Deviation, 2 kbit FSK EU Pattern – Multi-Channel

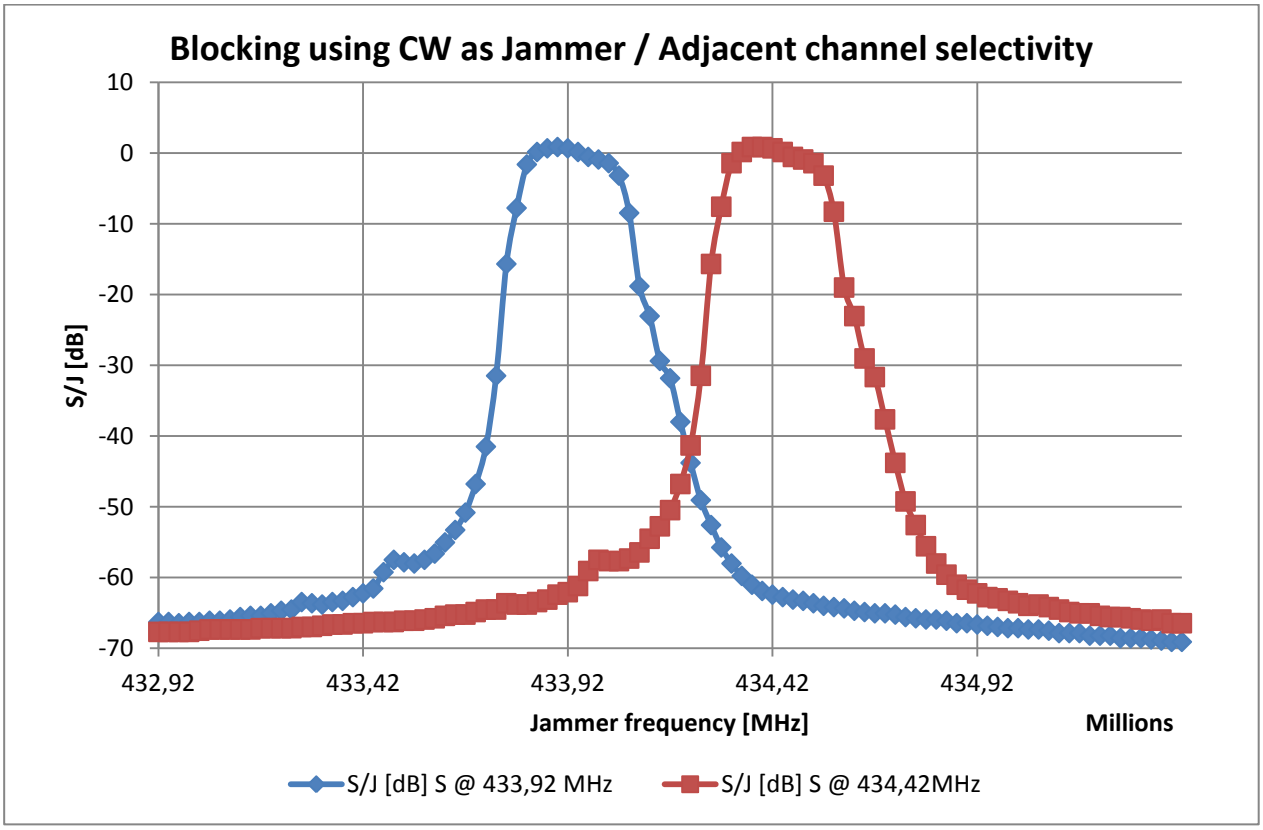

Figure 11 Blocking with Continuous Wave Jammer, 2 kbit FSK EU Pattern @ -90dBm – Multi-Channel

w w w . i n f i n e o n . c o m

Published by Infineon Technologies AG