Instruction

Micro RF Link Tool

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Description:	The purpose of this document is to describe how to use the Micro RF Link tool on a device based on the 400-series chip.
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REVISION RECORD

Doc. Ver.	Date	By	Pages affected	Brief description of changes
1	20110124	TJC	ALL	Initial draft

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1 ABBREVIATIONS

Abbreviation	Explanation
DUT	Device Under Test
EOOS	Execute out of SRAM. Mode where the CPU executes code out of the 4K SRAM instead of the OTP which is the default mode.
IF	Intermediate Frequency. The IF is a frequency to which the carrier frequency is shifted as an intermediate step in reception
OTP	One Time Programmable Memory. The normal program memory (64kB) in the 400-series
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RxD	Received eXchange Data. UART RX pin
SOF	Start of frame indicator byte
TxD	Transmitted eXchange Data. UART TX pin
UART	A universal asynchronous receiver/transmitter (usually abbreviated UART)

2 INTRODUCTION

2.1 Purpose

The purpose of this document is to describe how to use the Micro RF Link tool on a device based on the 400-series chip. The purpose of the Micro RF Link is to be able to check the RF link on a device regardless of the contents in the OTP. The requirement for running this tool is that the programming interface and the UART0 interface must be accessible.

The Micro RF Link tool **cannot** be used for PVT or RF regulatory measurements.[1]

2.2 Audience and prerequisites

The audience of this document is developers within and outside Sigma Designs using the 400-series chip. No prerequisites are required prior to reading this document.

[1] Due to a small memory footprint the Micro RF Link Tool does not comply with e.g. transients regulations.

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3 MICRO RF LINK TOOL

3.1 General Description

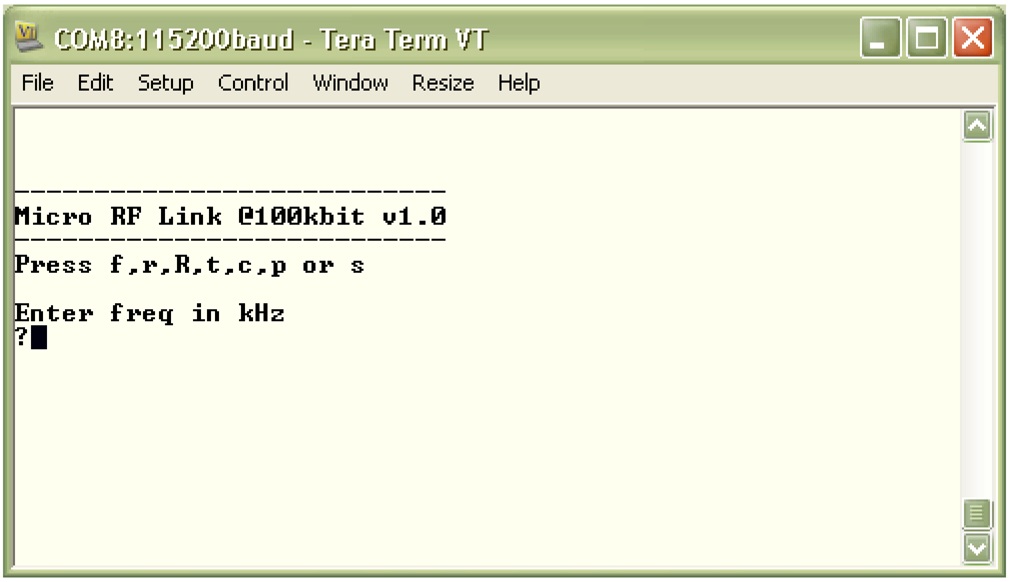

Figure 1: Micro RF Link

The purpose of the Micro RF Link tool is to be able to test and check the RF interface on a device[2]. The tool should be run on two (or more) devices simultaneously. When the tool has been programmed into the chosen devices one device is set in transmit mode and one (or more) devices are set in receive mode. The receiver(s) will then be able to measure the link performance.

In order to run the tool the chip must be programmed in a special EOOS (execute out of SRAM) mode. In this mode the chip ignores the contents of the OTP and executes code out the 4K SRAM. The 4K SRAM is then used for both program memory and data memory. The confined space places some constraints on the functionality of the tool. A few compromises have been needed in order to meet the small target:

1) No soft ramping of RF power in transmit mode.

   Normally it is needed to slowly ramp RF power up and down slowly when starting / stopping transmission to meet EU regulations. However this ramping has not been implemented in the link tool. The lack of soft ramping has no influence on communication quality. However it does mean that the Micro RF Link tool may not pass if it should be submitted to a FCC test.

2) Only one active RF channel (no frequency agility)

3) The Micro RF Link tool has been divided into 3 executables. On for each baudrate: One for testing 9.6kbit, one for testing 40kbit and finaly one for testing 100kbit.

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[2] Two versions are available: One for SD3402/ZM4101 and one for ZM4102 due to different IO configuration

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The Micro RF Link tool is a tool that runs entirely in the DUT. The tool requires connection to a terminal on a PC for communication. A good example of a terminal that works with Micro RF Link is Tera Term that can be downloaded from the internet. The Micro RF Link connects to the terminal using UART0 on the chip.

The link test is performed by transmitting a known frame format from the transmitter to the receiver. The frame format consists of preamble, SOF (start of frame), HomeID, NodeID, a byte counter and a sequence of pseudo random data. The seed of the pseudo random data is the counter value. The receiver accepts valid frames[3] and calculates the number of lost frames based on the counter value[4].

Based on the number of valid frames and the number of lost frames the receiver can estimate the success rate for receiving frames. The tool is also able to measure the RSSI strength of incoming frames or simply to perform instant RSSI measurements.

It is possible to set an arbitrary RF carrier frequency using the terminal. However it is strongly advised only to attempt tests at the target frequency of the device due to matching components, chip constraints, SAW filter etc. The Micro RF Link tool does **not** use XTAL calibration constants from production. Consequently there may be a small deviation at the RF frequency. Using the fine frequency input (kHz) it is possible to perform a manual calibration by tuning the frequency against a spectrum analyzer.

On the transmitter side it is possible to set the RF power level. It is also possible to transmit a constant carrier signal without modulation for measurement with spectrum analyzer or equivalent.

The Micro RF Link tool is controlled using a simple interface on the terminal. When the executable has been downloaded to the device then the terminal echoes as shown on Figure 1. In order to start an initial RF carrier frequency is needed.

After entering the RF frequency information the tool awaits commands. The available commands are:

f	for setting frequency
r	for accumulative receive mode
R	for rolling receive mode
t	for transmit mode
c	for transmit carrier mode
p	for setting transmit power
s	for displaying status

The individual commands are described in more details in the following chapters.

3.2 Setting RF frequency – The ‘f’ option

To change/set the RF frequency simply press ‘f’.

Note: The Micro RF Link tool automatically starts after reset as if pressing ‘f’.

[3] Valid frames are defined as frames that matches the transmitted format without any bit errors.

[4] Note: If more than one transmitter are enabled then the receiver will be unable to correctly estimate lost frames as the counter values will be mixed up.

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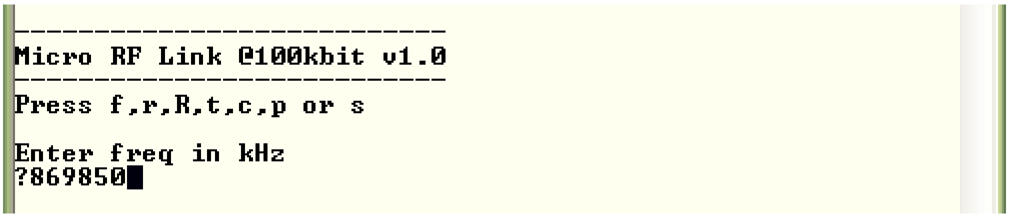

Figure 2: Setting RF Frequency

Enter the RF frequency for instance the EU 869.85MHz. When pressing enter the tool asks for highside/lowside IF.

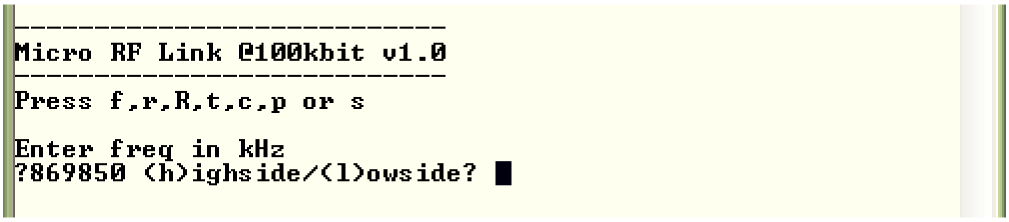

Figure 3: Selecting Highside / lowside IF

Highside/Lowside IF determines whether the receiver RF center frequency should be placed below or over the transmitted frequency. The receiver will be able to demodulate the signal regardless of this setting but the placement of the receiver frequency determines the RF spectrum and may have impact on receiver quality and co-existence. The normal setting for EU 869.85MHz 100kbit is highside. Simply press ‘h” and the Micro RF Link is now programmed with the new frequency. Note: if a RF frequency is chosen different than the standard RF frequency then the RF link tool may degrade performance or even respond with a “RF fail!” and restart. If the frequency selection was successful the prompt ‘:’ will be shown and the tool is ready to accept the next command.

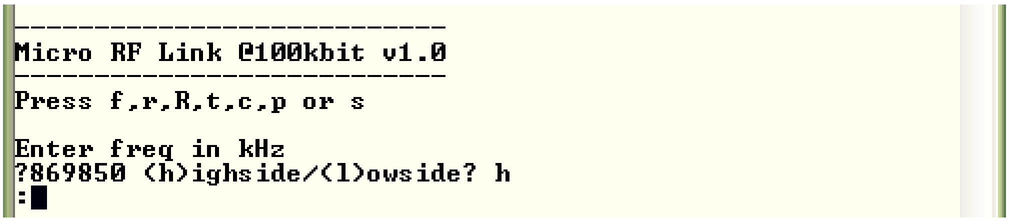

Figure 4: Successful Choice of RF frequency

3.3 RX accumulative mode – The ‘r’ option

The purpose of this mode is to test the link performance. Simply press ‘r’ to enter this mode.

The device goes into RX and waits for frames with valid format. Another device must be set in transmit mode in order to establish a link (refer to section 3.5).

After the first frame has been received the tool will begin to echo the success rate on the terminal 0-100%. The success rate will be calculated based on the accumulated number of frames received so far. By pressing ‘r’ again the statistics are cleared and the accumulation starts over.

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Figure 5: RX accumulative mode

By running in this mode for an extended period of time the performance can be checked with great precision. The tool actually supports up to 42949672 frames which corresponds to measurement over several days. By pressing ‘s’ the statistics for the measurement is displayed (number of frames and number of lost frames). Please refer to section 3.8.

3.4 RX rolling mode – The ‘R’ option

The purpose of this mode is to monitor fast variations when changing distance, antenna direction etc. Simply press ‘R’ to enter the mode.

The device goes into RX and waits for frames with valid format. Another device must be set in transmit mode in order to establish a link (refer to section 3.5).

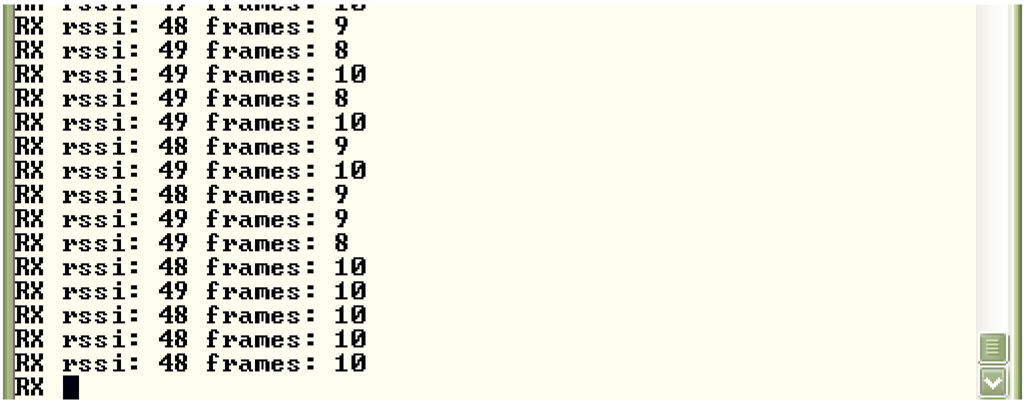

Figure 6: RX rolling mode. Example where some frames are lost.

For each time the sum of valid frames and lost frames equals or exceeds 10 frames then a new line is echoed to the screen showing the number of valid frames and the RSSI level of the last received frame. Note the RSSI steps are 1.5dB per LSB and higher RSSI means higher signal strength.

3.5 Transmit mode – The ‘t’ option

In order to transmit frames press ‘t’.

In transmit mode the device continuously sends test frames with the following format:

Preample	SOF	HomeId	NodeId	Counter	Pseudorandom pattern

Figure 7: Frame format of Test Frames

Where the preamble length is 24 bytes in 100kbit mode, 20 bytes in 40kbit mode and 10 bytes in 9.6kbit mode. The preamble byte is 0x55 (hex).

The SOF indicator is 0xF0, the HomeId 0xC00000 and the NodeId 0x01. Following the NodeId is a rolling counter of one byte and finally 12 bytes of pseudo random pattern. The pseudo random pattern is calculated based on the counter value so the receiver can detect for bit errors.

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The frames are transmitted almost back to back only interrupted by a small pseudo random period. The radio is switched off between the frames.

```
:
:t
TX 1019 frames
```

Figure 8: TX mode. The number of transmitted frames are echoed to the terminal

3.6 Transmit carrier mode – The ‘c’ option

Press ‘c’ to enter carrier mode. In this mode the device will continuously transmit a carrier on the chosen RF frequency without modulation.

```
:
:c
TX carrier
```

Figure 9: TX mode. Transmitting carrier

3.7 Setting transmit power – The ‘p’ option

In order to set the TX power level press ‘p’. The power can be set to any value between 0 and 32. The highest power level is 32.

```
:
:p
Enter power (0-32)
?32
:
```

Figure 10: Setting TX power

Note: The radio is not turned on in TX mode until pressing ‘t’ or ‘c’.

3.8 Displaying status – The ‘s’ option

The status option ‘s’ can be used to display information’s about the RF settings, the status of the last accumulative RX measurement and the current RSSI value.

```
RX 99%
:s

Frequency    : 869850 kHz h
TX power     : 32
Ok frames    : 22266
Lost frames  : 4
Success rate : 99%
PLL setting  : 8
Current RSSI : 40
---------------------------
:
```

Figure 11: Showing status

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Due to limited target code space the success rate is the truncated integer calculation. A more precise success rate can be calculated using a calculator and the number of ok frames and number of lost frames taken from the status command. The tool is able to receive up to 42949672 ok frames before restart which corresponds to several days of runtime.

The PLL setting shown in the status gives information on the PLL operating point. This is mainly of internal interest to Sigma engineers and it depends on the RF frequency and the chip production corner.

The RSSI indicated in the status is the current RSSI in the air when pressing ‘s’. By repeatedly pressing ‘s’ the RSSI in the air can sampled.

As in the RX rolling mode the RSSI steps are 1.5dB per LSB and higher RSSI means higher signal strength.

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