# MKW01 Demonstration Application User's Guide

User's Guide

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## Chapter 1
## Introduction



## Chapter 2
## MKW01 Radio Utility application



## Chapter 3
## Wireless UART



## Chapter 4
## Simple Range Demonstration application

## About this book

This guide provides a detailed description of the MKW01 demonstration applications. For more details about the MKW01 MCU, see the appropriate reference manual and/or data sheet.

## Audience

This document is intended for application developers using the MKW01 MCU, and the demonstration applications can be used as a starting point for developing proprietary applications.

## Organization

This document is divided into four chapters, as follows:

- Chapter 1, “Introduction” – this chapter shows you how to import a project into the IAR, load an application to the board, and set up the virtual COM port, to run the demonstration applications.
- Chapter 2, “MKW01 Radio Utility application” – provides details on how to run the Radio Utility application, and explains available transceiver configurations.
- Chapter 3, “Wireless UART” – The Wireless UART demonstration application uses the Freescale KW01-MRB to communicate over the air from one board to another at typematic rates.
- Chapter 4, “Simple Range Demonstration application” – The Simple Range Demonstration runs as a standalone application without any user interface, which allows you to perform dynamic range tests.

## Revision history

The following table summarizes the changes made to this document since the previous release.

**Revision history**

| Rev. number | Date | Substantive changes |
|---|---|---|
| 1 | 02/2014 | Initial release. |
| 2 | 05/2015 | Added Chapter 3, “Wireless UART,” and Chapter 4, “Simple Range Demonstration application.” Added Section 2.6, “Packet Handler tab” in Chapter 2, “MKW01 Radio Utility application.” |
| 2.1 | 06/2015 | Updated the Revision history table with differences between the two earlier revisions. |

## Definitions, acronyms, and abbreviations

The following table defines the acronyms and abbreviations used in this document.

**Definitions, acronyms, and abbreviations**

| | |
|---|---|
| API | Application Program Interface |
| BDM | Background Debug Module |
| dBm | Decibels referred to one milliwatt |
| EVB | Evaluation Boards |
| EVK | Evaluation Kit |
| GUI | Graphical User Interface |
| IDE | Integrated Development Environment |
| LP | Low Power |
| MCU | Microcontroller Unit |
| OTA | Over-the-Air |
| PC | Personal Computer |
| PCB | Printed Circuit Board |
| S19 | S-Record. *.S19* or *.srec* are file extensions used for the Freescale binary image format. The *.S19* or *.srec* files encapsulate the binary image as a list of ASCII records. Each record contains length, address, data, and checksum fields. The 16-bit address field allows for a memory space up to 64 KB. The S19/srec can be generated using CodeWarrior IDE, and it is the product from the linking process. The S19/srec does not contain additional information for the debugger (such as where to look for the source files). |
| TX | Transmitter |
| RX | Receiver |
| FEI | Frequency Error Indicator |
| AFC | Automatic Frequency Control |
| SYNC | Synchronization |
| FIFO | First Input First Output |
| CRC | Cyclic Redundancy Check |

## References

The following sources were referenced to when creating this document:

*[1] Freescale MKW01 Data Sheet (MKW01Z128)*

*[2] Freescale MKW01 Reference Manual (document number MKW01XXRM)*

*[3] Freescale MKW01 Development Hardware Reference Manual (document number KW01DHRM)*

# Chapter 1
# Introduction

The Freescale Simple Media Access Control (SMAC) is incorporated into the Freescale MKW01 demonstration applications. The SMAC demonstration applications are provided as *.zip* files.

After the files are extracted, you can find the necessary files and project folder structure to run the demo applications on IAR Embedded Workbench for ARM v7.10.

## 1.1 Importing the project

The SMAC demo applications are delivered as *.zip* files, and must be imported into a development tool to generate the code to be downloaded to the board.

### 1.1.1 Importing the project to IAR v7.10

This section shows how to import the Connectivity Test demonstration application. There are two ways to import the project:

1. Open IAR Embedded Workbench for ARM v7.10.
2. Select Open, and then Workspace from the File menu, and locate the folder where the project was extracted, as shown in Figure 1-1.

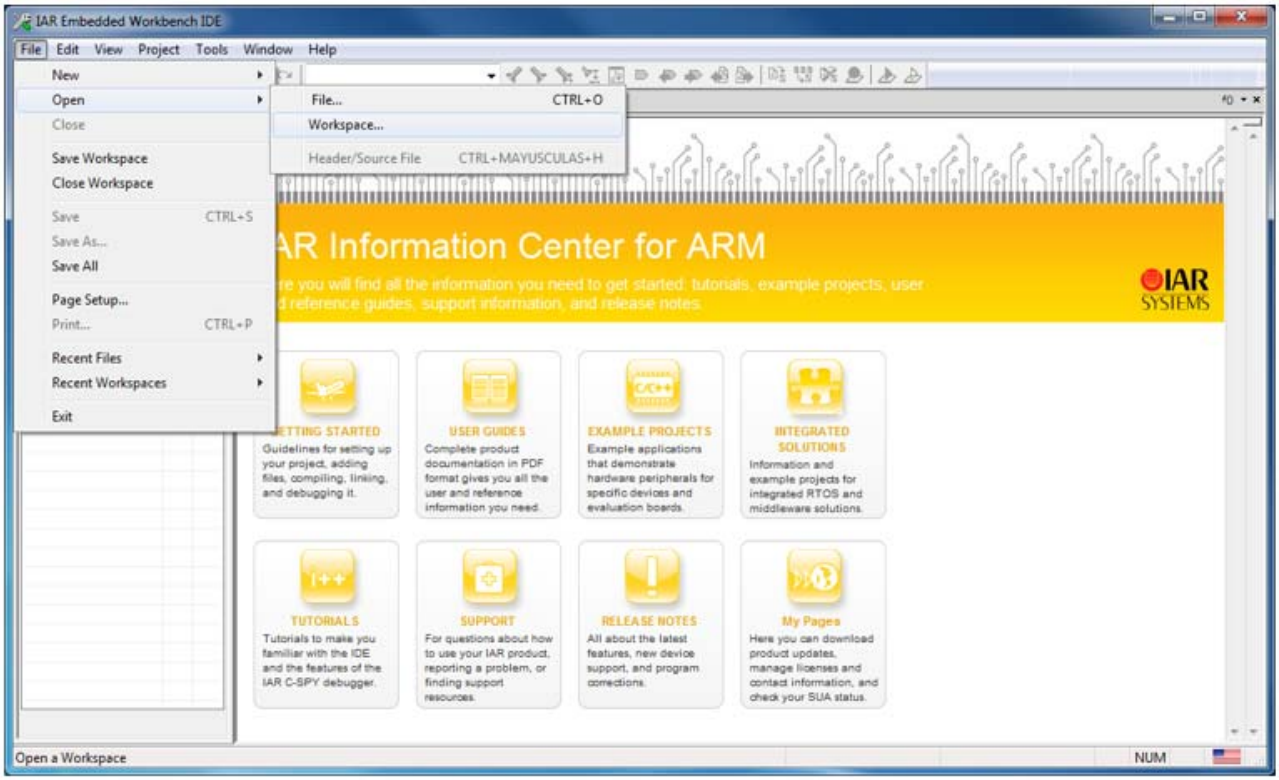


**Figure 1-1. Opening a workspace in IAR**

3. Select the project (*Radio Utility.eww*) and click Open, as shown in Figure 1-2.

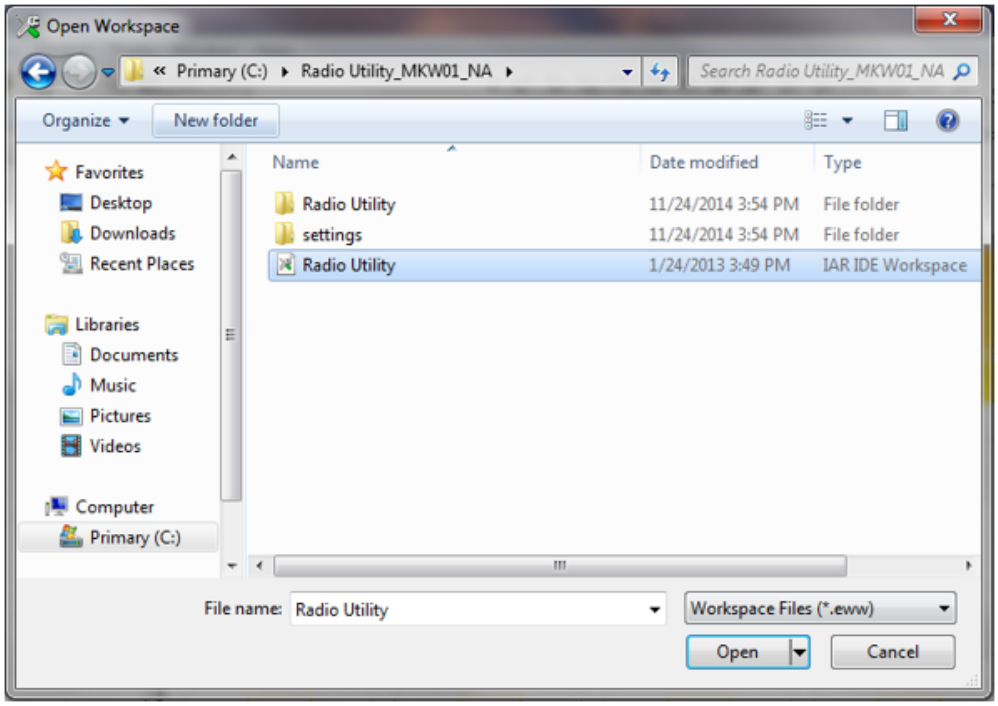


**Figure 1-2. Selecting the workspace file for IAR**

The second way to import a project is as follows:

1. Open IAR Embedded Workbench for ARM v7.10.
2. Locate the folder where the project was extracted.
3. Select the project (*Radio Utility.eww*), and drag-and-drop it into the IAR Embedded Workbench workspace, as shown in Figure 1-3.

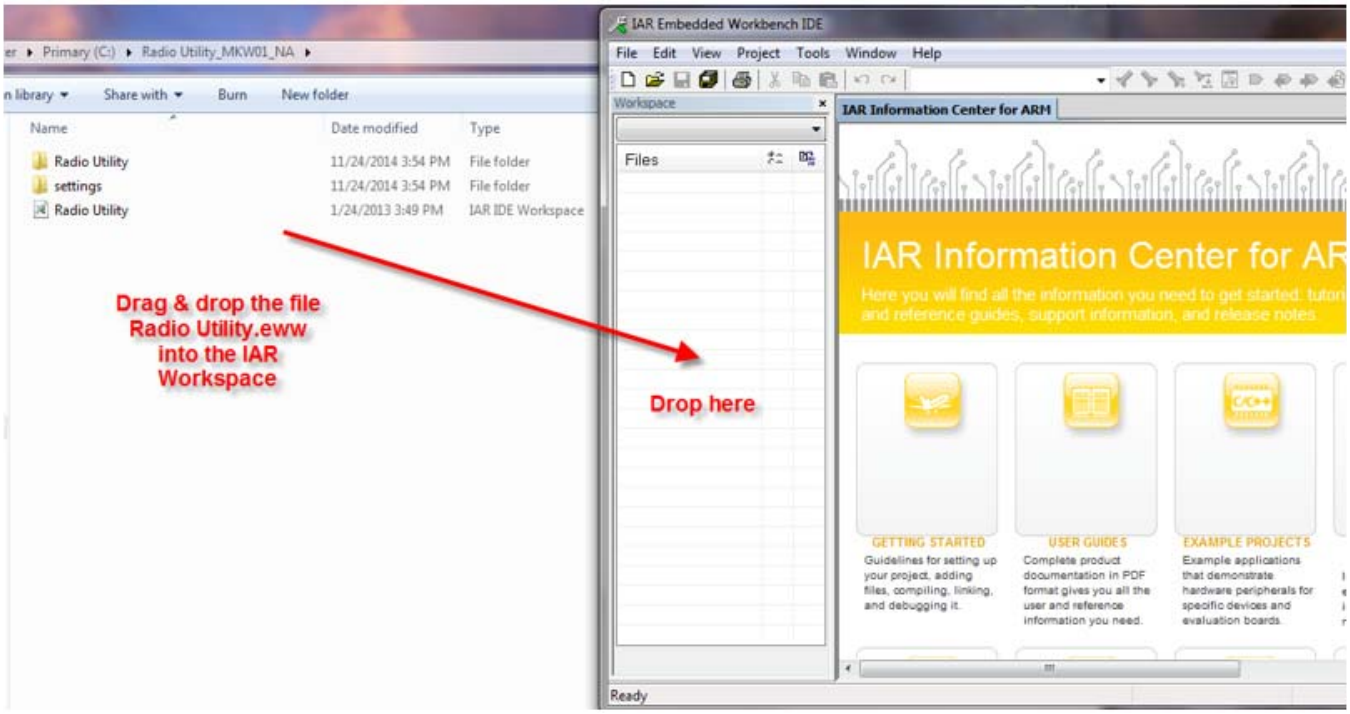


**Figure 1-3. Selecting the workspace file for IAR**

## 1.2 Loading an application into the board

After a project is imported into the IDE, you can build and load the application into the board. This example uses the connectivity test, but it also works with all currently available SMAC applications.

### 1.2.1 Building and loading an application into the board with IAR

1. From the IAR Embedded Workbench main window, select the previously imported project.
2. Make sure that you are using the correct debugger driver (J-Link / J-Trace is set as a default driver).
   — To change it, right-click the project, and click Options, as shown in Figure 1-4.

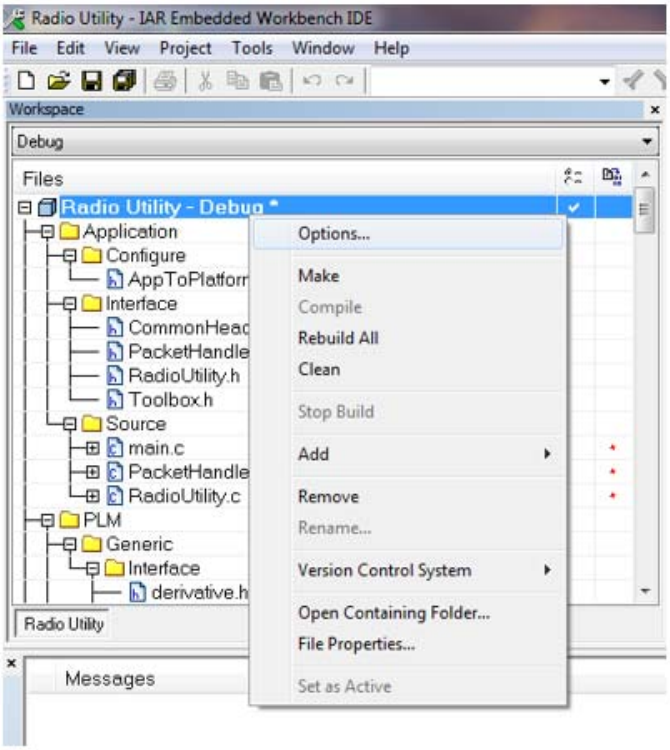


**Figure 1-4. Selecting the workspace file for IAR**

— Go to Debugger, and select the correct driver, as shown in Figure 1-5.

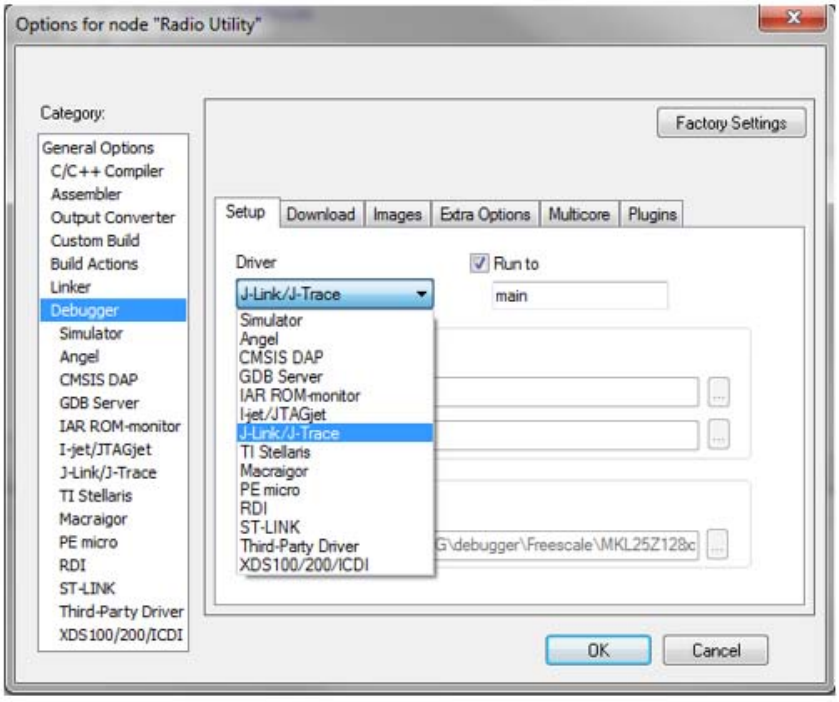


**Figure 1-5. Selecting the debugger driver**

3. Select the previously imported project, and click the Make button, as shown in Figure 1-6.


**Figure 1-6. Building a project in IAR**

If no errors were encountered during the build process, connect the mini USB to the target.

4. Click the Download and Debug button, as shown in Figure 1-7.


**Figure 1-7. Downloading and debugging an application in IAR**

After the Flash memory is programmed, the Default / Main debugger window appears.

5. To run the application, click the Go button, as shown in Figure 1-8.


**Figure 1-8. Running an application in IAR**

**NOTE**

To stop the debugger, click the following button:


**Figure 1-9. Stopping the debugger in IAR**

## 1.3 Virtual COM port setup

This section describes how to set up the UART / USB Virtual COM port for the Wireless UART.

1. Connect each board to a USB cable and a USB port (one PC USB for each board).
2. Open the terminal for each board, and make sure the COM port is set for 38400, 8, N, 1, and no flow control, as shown in Figure 1-10.

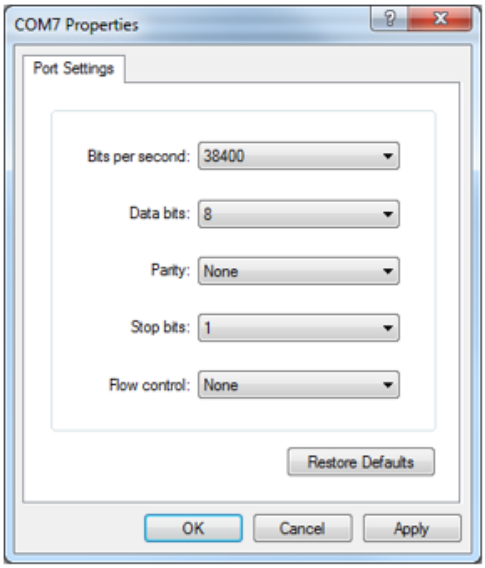


**Figure 1-10. COM port setup**

3. Set the properties by clicking File menu – Properties – Settings – ASCII Setup, as shown in Figure 1-11.

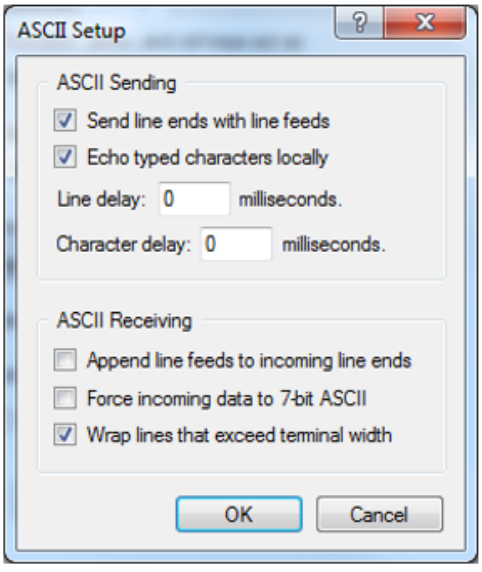


**Figure 1-11. ASCII setup**

## 1.4 Supported hardware

The demo applications shown in this document are designed to run on the Freescale MKW01-based KW01 Modular Reference Board (KW01-MRB), which can work standalone, or plugged into the TWR-RF board.

For more information about the TWR-RF system, see the appropriate Freescale Tower system and Modular Development Platform documentation at freescale.com/tower.

## 1.5 MKW01 software

Download the project file for the respective demonstration application from the Freescale web site. Download and install the USB2SER drivers, available at freescale.com/usb2ser.

## 1.6 Hardware considerations

The KW01-MRB can be connected to the computer in two ways:

- Connected directly to the PC via the mini USB connector (J16) of the MRB.
- Mounted on the TWR-RF board (when using this setup, the cable from the PC should be connected to the mini USB connector (J2) of the TWR-RF board).

The jumper configurations needed for each of the above setups are different, and they are explained in the following table.

**Table 1-1. Jumper settings for the USB connected directly to MRB**

| Header | Jumpers for standalone operation | Jumpers for TWR-RF operation |
|---|---|---|
| J3 | not installed | not installed |
| J4 | not installed | not installed |
| J5 | do not install jumpers | do not install jumpers |
| J6 | not installed | not installed |
| J7 | 1 – 2 | 1 – 2 |
| J8 | 1 – 2 | 1 – 2 |
| J9 | not installed | not installed |
| J10 | not installed | not installed |
| J12 | not installed | not installed |
| J12 | 1 – 2 | 1 – 2 |
| J13 | 3 – 4 | 3 – 4 |
| J13 | 1 – 2 | 1 – 2 |
| J13 | 3 – 4 | 3 – 4 |
| J13 | 5 – 6 | 5 – 6 |
| J13 | 7 – 8 | 7 – 8 |

**Table 1-1. Jumper settings for the USB connected directly to MRB (continued)**

| Header | Jumpers for standalone operation | Jumpers for TWR-RF operation |
|---|---|---|
| J17 | 1 – 2 | 2 – 3 |
| J17 | 4 – 5 | 5 – 6 |
| J17 | 7 – 8 | 7, 8, 9 – does not matter |
| J17 | 10 – 11 | 11 – 12 |
| J17 | 13 – 14 | 14 – 15 |
| J18 | not installed | not installed |

The jumpers on the J17 route the UART lines either to the onboard mini USB, or to that on the TWR-RF, depending on the settings in Table 1-1.

**Figure 1-12. MRB board**


**Figure 1-13. MRB board mounted on the TWR-RF board**

Note that the only differences are the settings of the J17 and the USB connector used.

# Chapter 2
# MKW01 Radio Utility application

## 2.1 Radio Utility introduction

The Freescale MKW01 Radio Utility application interacts with the transceiver built into the MKW01. It allows for complete configuration of the radio, transmitter, receiver, and packet error rate (PER) tests, using the Packet Handler tab.

**NOTE**

This document covers the following modules:

- MRB-KW019030JA
- MRB_KW019032EU
- MRB-KW019032NA

Three versions of the MKW01 Radio Utility GUI are available:

- Radio Utility GUI_JA – calculates the values for 30 MHz reference, and defaults to the Japan band frequency (for use with MRB-KW019030JA).
- Radio Utility GUI_EU – calculates the values for 32 MHz reference, and defaults to the Europe band frequency (for use with MRB-KW019032EU).
- Radio Utility GUI_NA (US) – calculates the values for 32 MHz reference, and defaults to the US band frequency (for use with MRB-KW019032NA).

## 2.2 MKW01 Radio Utility application

The MKW01 Radio Utility application provides a tool to evaluate the RF performance of the MKW01 using the KW01-MRB and TWR-RF systems. The MKW01 Radio Utility application is a PC GUI-based application that works through a PC USB port, and supports the following MKW01 features and settings:

- Receiver, transmitter, and stand-by operation modes, common transceiver settings:
  - RF frequency
  - FSK or OOK modulation
  - Modulation shaping
- Output power
- Power amplifier output port
- Receiver settings:
  - RX filter bandwidth
  - OOK receiver mode settings

  - RSSI
  - LNA sensitivity
- Packet transmission. Save the Transmit log files.
- Packet reception. Save the Receive log files.

For ease of operation, the MKW01 Radio Utility tab contains a menu bar with the following buttons / functions:

- Save – allows saving of MKW01 configuration files (*.ncfg*). The configuration files contain a snapshot of the MKW01 Radio Utility application settings.
- Open – allows opening of MKW01 configuration files (*.ncfg*).
- Connect / Disconnect – connects or disconnects the MKW01 to / from the host PC.
- Reset – resets the MKW01 configuration registers to the default recommended values.
- Help – displays the Radio Utility version and a link to the documentation.

**NOTE**

Open, Save, and Reset are available only for the Radio Utility tab.

The MKW01 Radio Utility tab contains the following tabs:

- Common – sets the function options common for both the Transmit and Receive modes.
- Transmitter – sets the function options available only in the Transmit mode.
- Receiver – sets the function options available only in the Receive mode.
- Packet Handler – allows users to evaluate sent and received packets between two transceivers. See Section 2.6, “Packet Handler tab” for more information.

## 2.3 Starting the MKW01 Radio Utility GUI

To start the MKW01 Radio Utility GUI, perform the following tasks:

1. Ensure that the Radio Utility firmware has been flashed to each MRB; if the GUI connects to the MRB, the Radio Utility firmware is loaded in the MRB, the regional version can be ascertained by the default frequency. If the GUI does not connect to the MRB, or if the regional version of the firmware is not desired, then the desired *.srec* file should be flashed to the MRB using CodeWarrior or IAR.
2. Ensure that the PC has the USB2SER drivers installed.
3. Prior to starting the GUI, connect one KW01-MRB to a USB cable, and then to a USB port on the PC. Ensure that the board is powered on, and that the COM port is recognized in the Device Manager. Press the Reset button momentarily.
4. Run the Radio Utility application executable, and wait for the main window to appear, as shown in Figure 2-1. The default settings vary by region, and may be different to those shown.

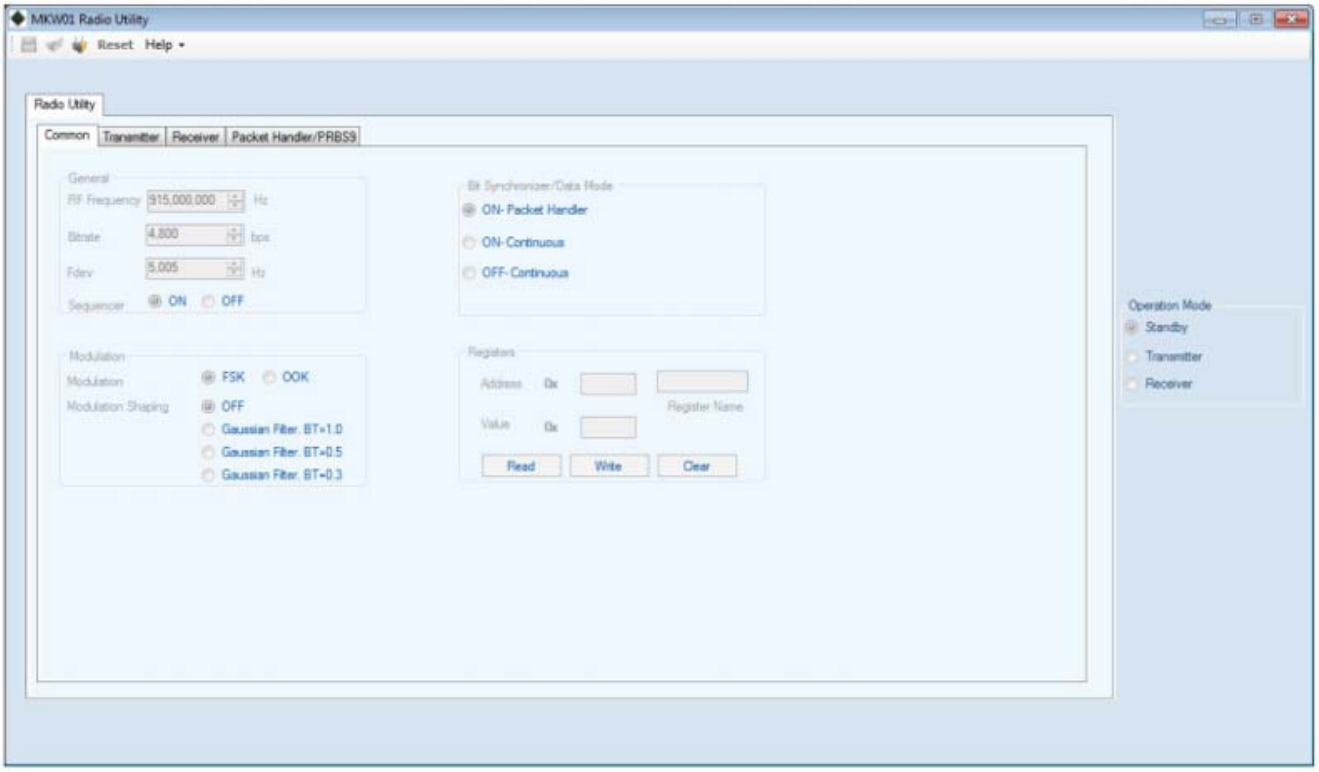


**Figure 2-1. Main window startup**

**NOTE**

If you are running a test that requires more than one board, the boards must be connected to the same USB hub on the PC.

5. Click the Connect button in the main window to start running the application, as shown in Figure 2-2.

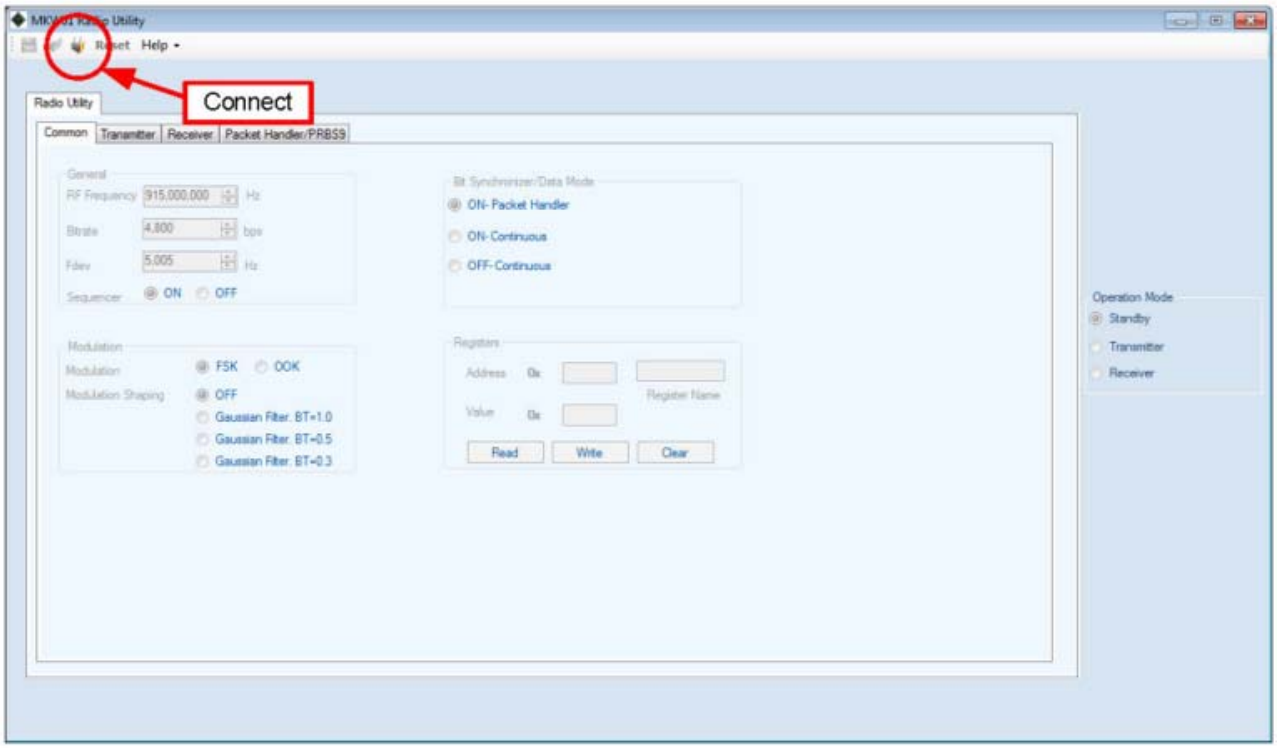


**Figure 2-2. Main window Connect button**

If the connection was successful, the main window appears, as shown in Figure 2-3.

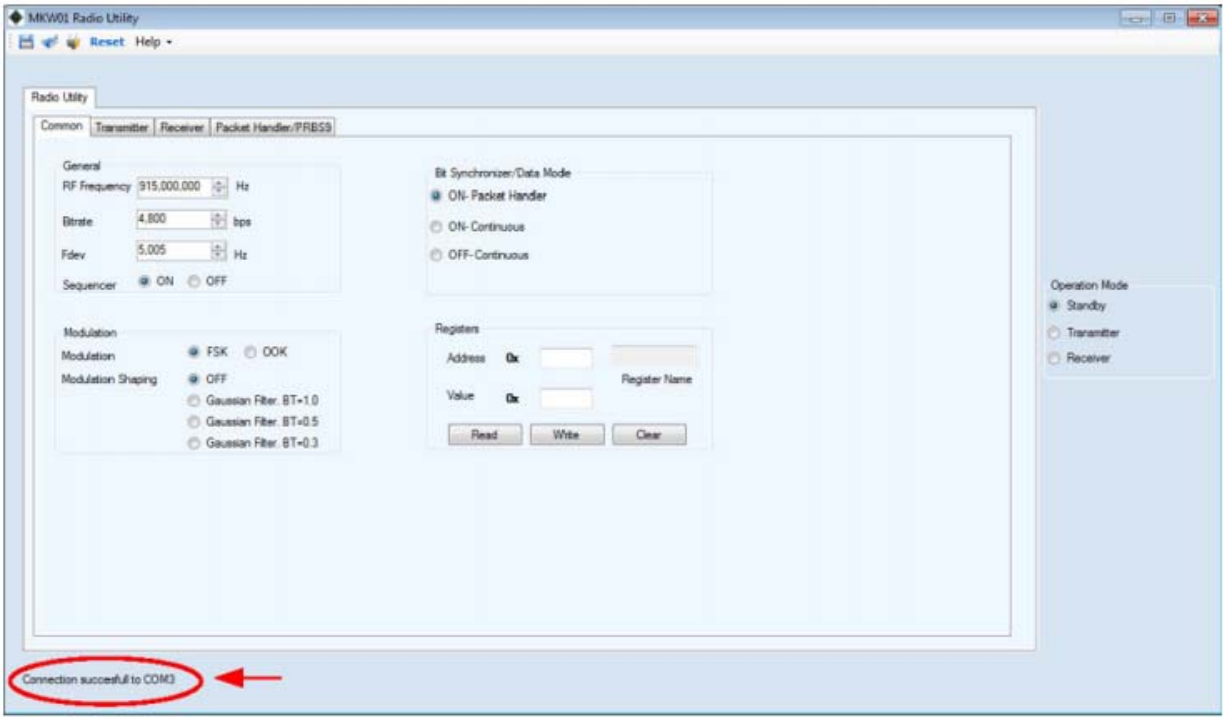


**Figure 2-3. Radio Utility successful connection**

The MKW01 Radio Utility automatically detects the COM port to which the board is connected. The port is displayed in the bottom left corner of the main window, as shown in Figure 2-3.

**NOTE**

Some software versions will fail to connect on the first attempt, and will connect normally when the Connect icon is clicked for the second time. If the MKW01 Radio Utility does not find a device attached to the port, the “Connection could not be established” message appears, as shown in Figure 2-4. Verify the USB connections, cycle the power to the boards, and ensure that they are powered on. Then restart the Radio Utility application, and click the Connect button again.

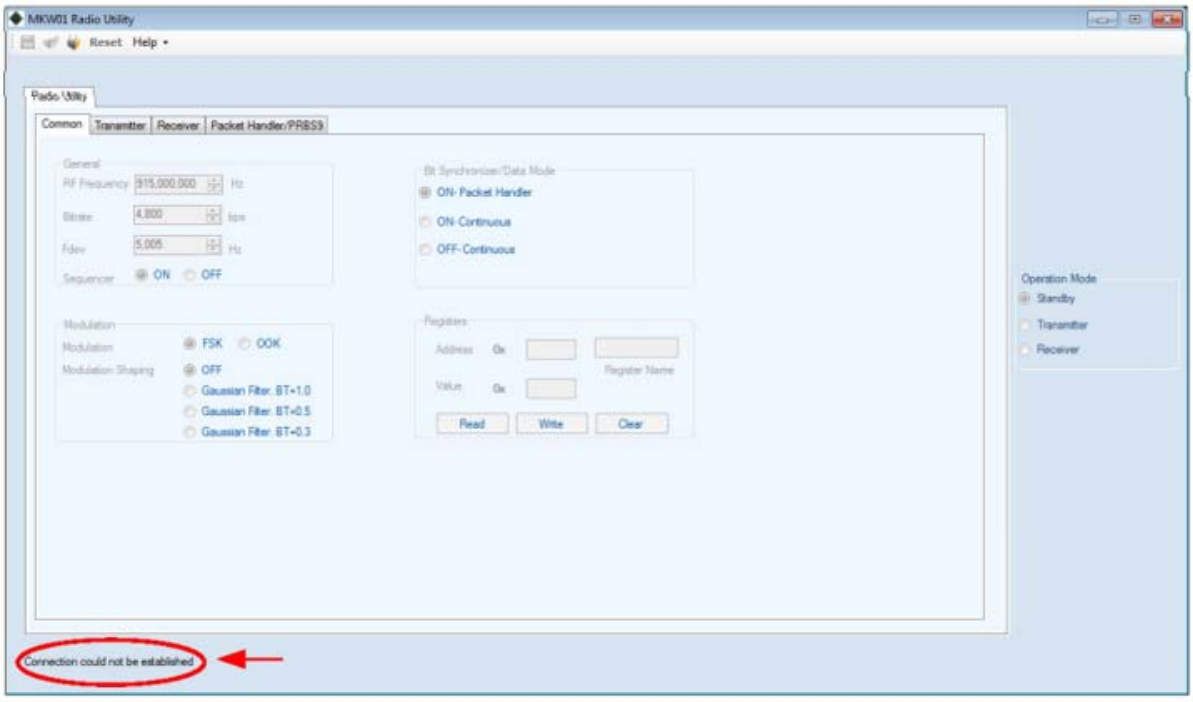


**Figure 2-4. Connection not established**

If the board is powered off while it is connected to the MKW01 Radio Utility, the “The connection was lost, try again” message appears, as shown in Figure 2-5.

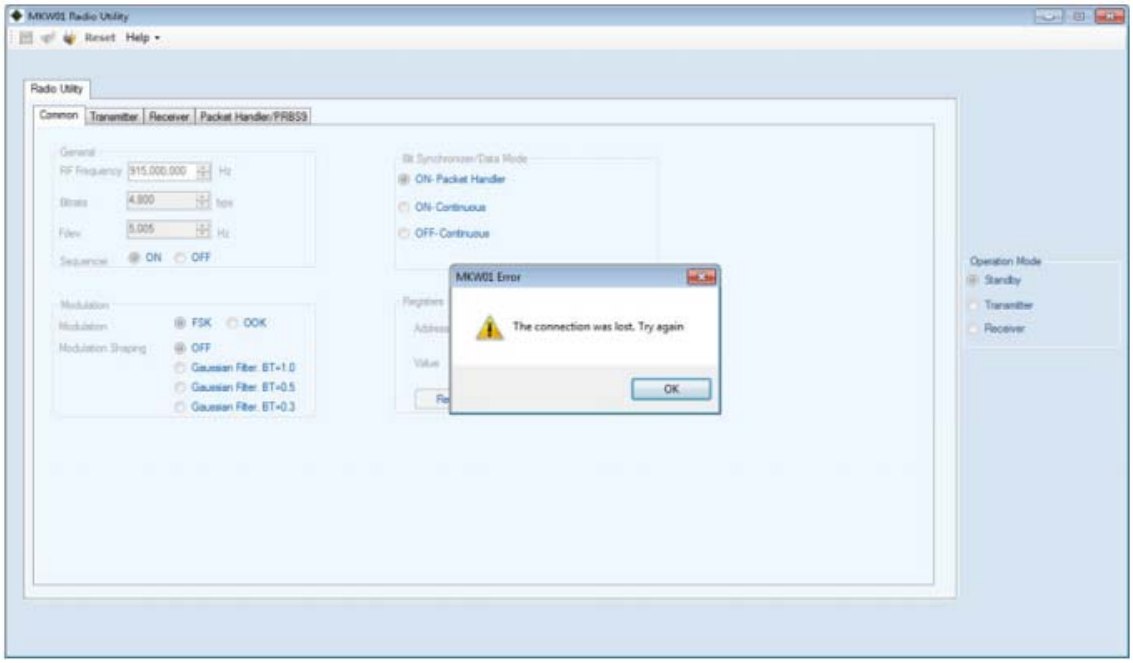


**Figure 2-5. Connection lost**

## 2.4 MKW01 Radio Utility usage overview

The MKW01 Radio Utility tab offers three operational modes, located on the right side of the main window:

- Standby – the radio is in a low-power mode, and no changes are registered with the radio.
- Transmitter – the transmitter is active. You can change the values in either the Common or Transmitter tabs, and the changes are automatically updated in the radio.
- Receiver – the receiver is active. You can change the values in either the Common or Receiver tabs, and the changes are automatically updated in the radio.

The available settings appear under the following three tabs:

- Common – sets the function options for both the Transmit and Receive modes.
- Transmitter – sets the function options available only in the Transmit mode.
- Receiver – sets the function options available only in the Receive mode.

### 2.4.1 Common tab options

The Common tab (Figure 2-6) provides several display areas that allow you to set numerous options and settings. You can set the operating frequency, modulation mode, modulation shaping, and data mode in this tab. These values affect both the Transmit and Receive modes.

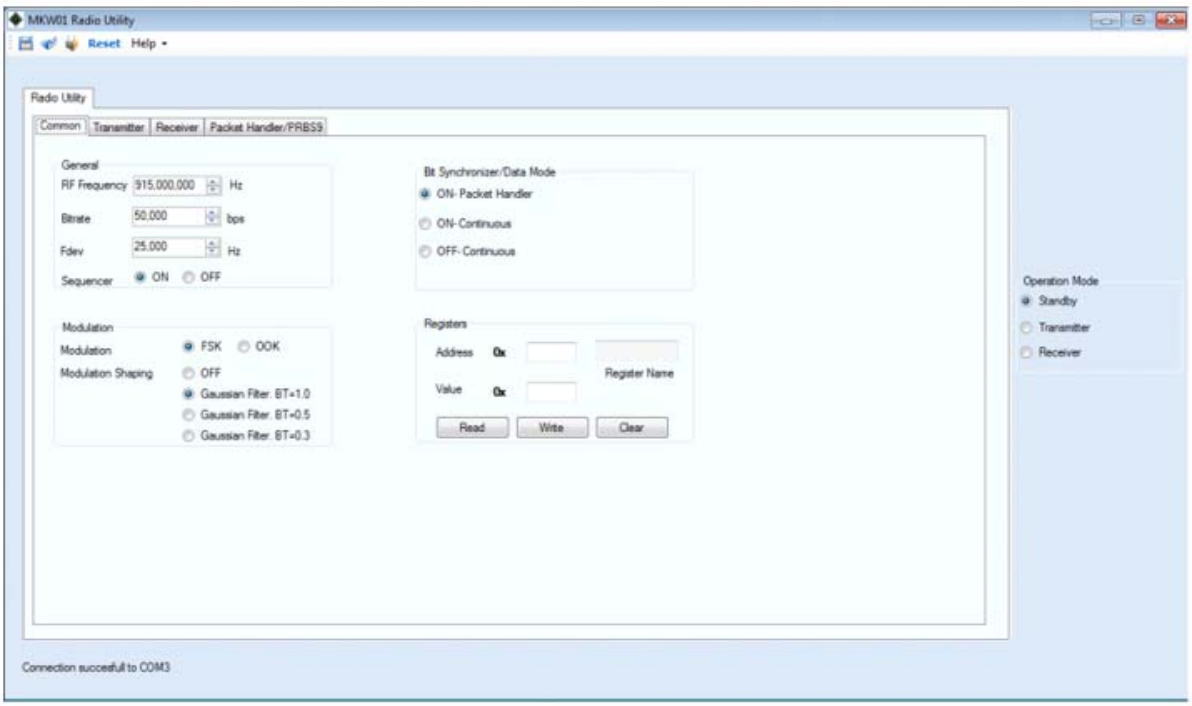


**Figure 2-6. Common tab**

### 2.4.1.1 General

As shown in Figure 2-7, use the General menu to set the following parameters:

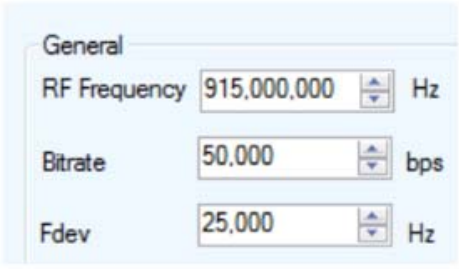


**Figure 2-7. General display area**

- RF Frequency – sets the carrier frequency in Hz. The valid ranges are:
  - 290,000,000 – 340,000,000
  - 424,000,000 – 510,000,000
  - 868,000,000 – 1020,000,000
- Bitrate – sets the data stream to be transmitted in bits per second (bps). The valid ranges are:
  - FSK modulation range is 600 – 300,000 bps. (The Bitrate and Fdev are constrained to each other in a ratio of 4.5:1 to 1:5.5, and it highlights in red when a parameter needs to be changed. See Figure 2-8.)

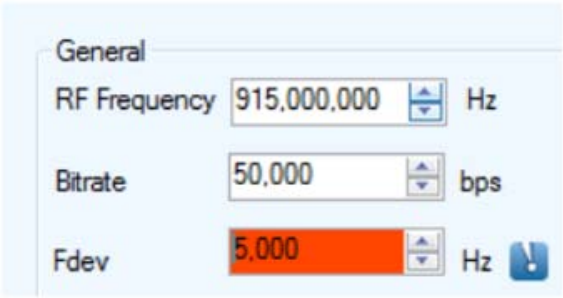


**Figure 2-8. General display area highlighting an invalid parameter**

  - OOK modulation range is 600 – 32,768 bps.
- Fdev (frequency deviation) – the frequency deviation must exceed 600 Hz. To ensure proper modulation in FSK, the following limits apply:
  - 500 kHz ≥ (Fdev + BR / 2)
- Sequencer (OFF or ON) – when the sequencer is ON, the circuit takes care of the sequence of events, so that the transition timing is optimized from one operating mode to another.

**NOTE**

Freescale recommends that the sequencer is always ON.

### 2.4.1.2 Modulation

Using the Modulation menu (Figure 2-9 and Figure 2-10), the following modulation and modulation-shaping options are available in the Transmit and Receive modes:

- FSK – enables or disables the Frequency Shift Keying modulation type. In the FSK modulation (Figure 2-9), the following filters are available:
  - OFF – enables or disables the Gaussian shaping.
  - Gaussian Filter. BT=1.0
  - Gaussian Filter. BT=0.5
  - Gaussian Filter. BT=0.3

The Gaussian filters filter the modulation stream.


**Figure 2-9. Modulation display area (FSK)**

- OOK – enables or disables the ON-OFF Keying modulation type (Packet Handler must be ON). In the OOK modulation (Figure 2-10), the following filters are available:
  - Filtering with fCutoff=BR
  - Filtering with fCutoff=2*BR

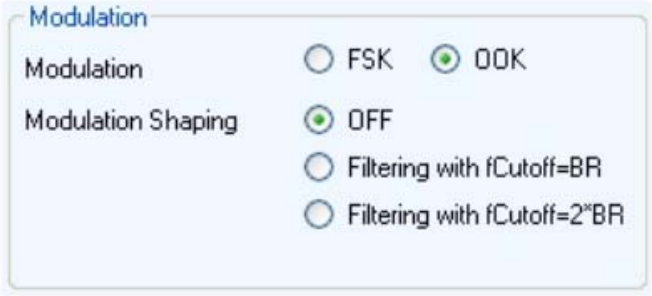


**Figure 2-10. Modulation display area (OOK)**

### 2.4.1.3 Bit Synchronizer / Data Mode

When using the Bit Synchronizer / Data Mode menu (Figure 2-11), the following options are available:

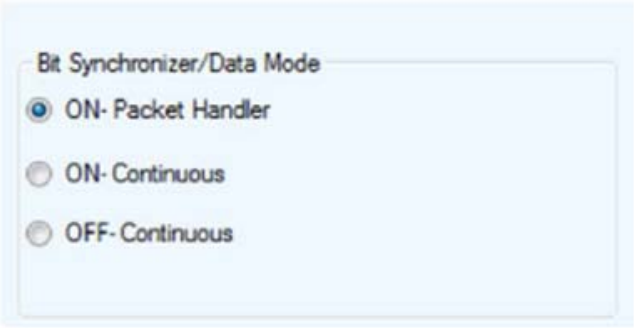


**Figure 2-11. Bit Synchronizer / Data Mode display area**

- ON-Packet Handler – bit synchronizer is ON, and the data mode is ready to send data.
- ON-Continuous – bit synchronizer is ON, and the data mode is set to continuous.
- OFF-Continuous – bit synchronizer is OFF, and the data mode is set to continuous.

### 2.4.1.4 Registers

The Registers menu (Figure 2-12) allows you to either write or read the radio registers.


**Figure 2-12. Register settings display area**

The following options are available:

- Address – enter the register address value (in hex). Only two digits can be entered in the field.
- Register Name – according to the value set in the Address field, the Register Name field displays the name of the register.
- Value – this field displays the register value (in hex). Only two digits can be entered.
- Read button – reads the value of the register entered in the Address field. When this action is performed, the Value field is disabled.

If the register cannot be read, the following warning message appears:

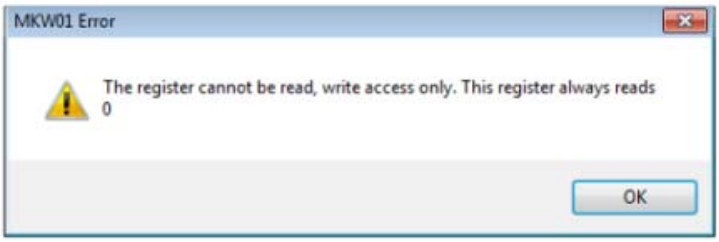


**Figure 2-13. Read error**

- Write button – writes the values entered in the Address and Value fields to the register. If the register is a read-only register, the following error message appears:

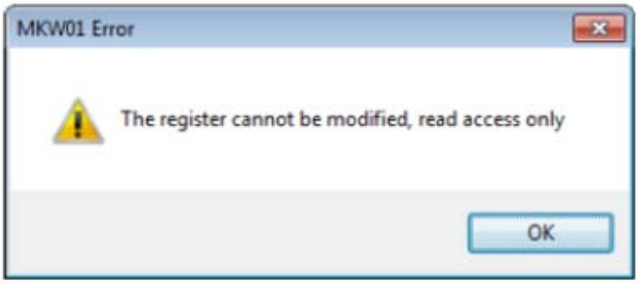


**Figure 2-14. Write error**

- Clear button – Clears the Address, Value, and Register Name fields.

If nothing is entered in either the Address or Value fields, the following message appears.

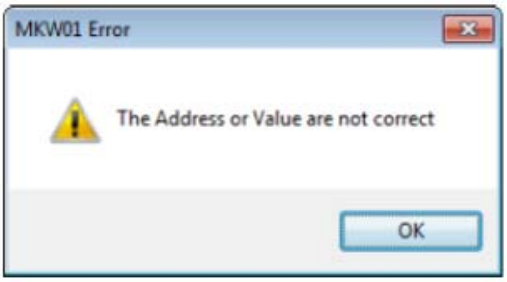


**Figure 2-15. Field error**

**NOTE**

When writing to a register value, the GUI reflects the settings change. If the value introduced is not correct, the following message appears: “Be sure the introduced data is correct.“

## 2.4.2 Transmitter tab options

The Transmitter tab (Figure 2-16) allows users to configure the output power level and the output port.

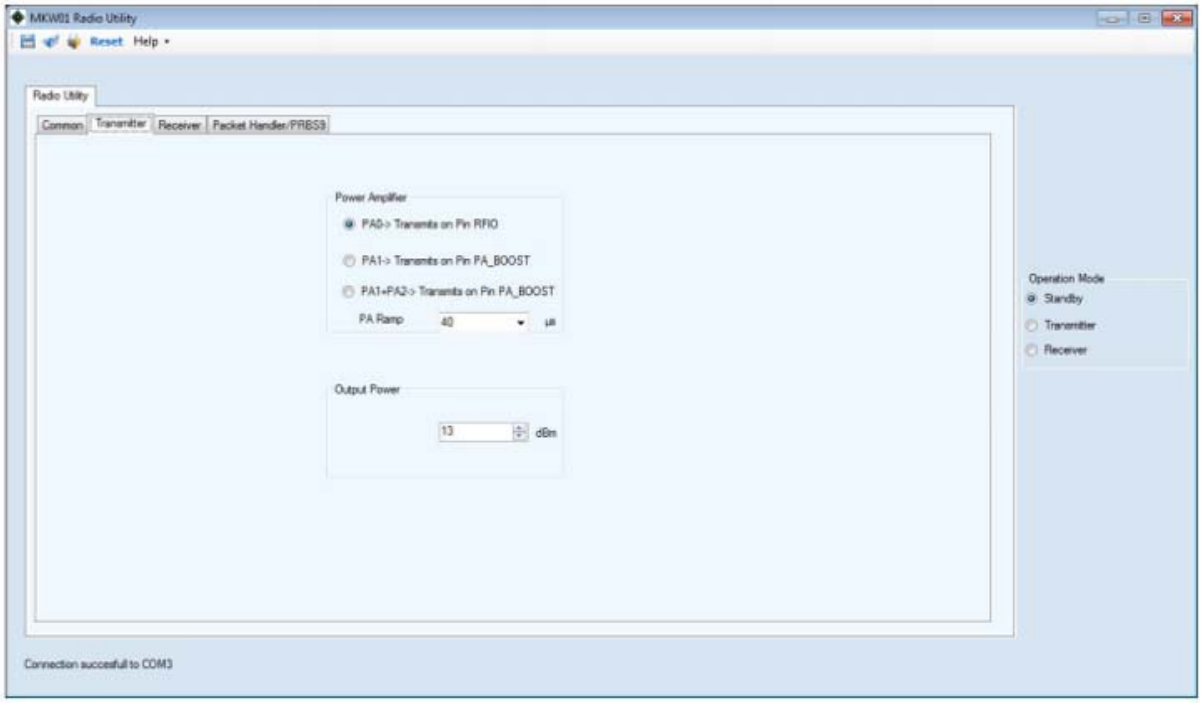


**Figure 2-16. Transmitter tab**

### 2.4.2.1 Power Amplifier

In the Power Amplifier display area (Figure 2-17), the following options are available:

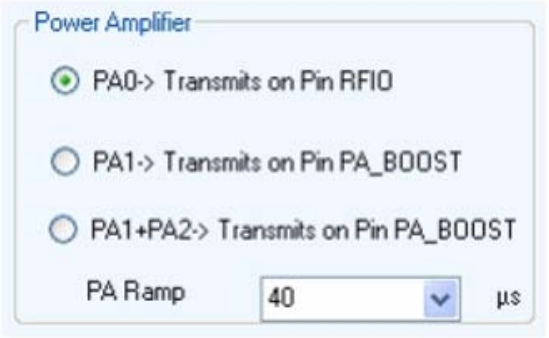


**Figure 2-17. Power Amplifier display area**

- When PA0 is selected, the RFIO output port is enabled.
- When PA1 is selected, the PA_BOOST output port is enabled, and the output power ranges from –18 to +13 dBm.
- When the PA1 + PA2 option is selected, the maximum output power is enabled.
- The PA_BOOST port and the output power range is 14 to +17 dBm.
- The PA Ramp setting allows you to configure the transmitter start-up time.

**NOTE**

When the PA0 is enabled, and the J2 (RFIO) is the transmit output, there will be signal leakage on the J1 (PA_BOOST).

When the PA1 or PA1 + PA2 are enabled, and the J1 (PA_BOOST) is the transmit output, there will be signal leakage on the J2 (RFIO).

#### 2.4.2.2 Output Power

The Output Power (in dBm) display area (Figure 2-18) allows you to set the output power. The valid range is from –18 to +17 dBm, depending on the selected power amplifier options. The Output Power window is constrained, and will not allow a level outside of the specified range to be entered. (-18 to +13 dBm in the PA0 or PA1 mode or +14 to +17 dBm in the PA1+PA2 mode).


**Figure 2-18. Output Power display area**

### 2.4.3 Receiver tab options

In the Receiver tab, various display areas provide you with several parameters to be set. See the *MKW01 Data Sheet* and *MKW01 Reference Manual* for further information about each of these parameters.

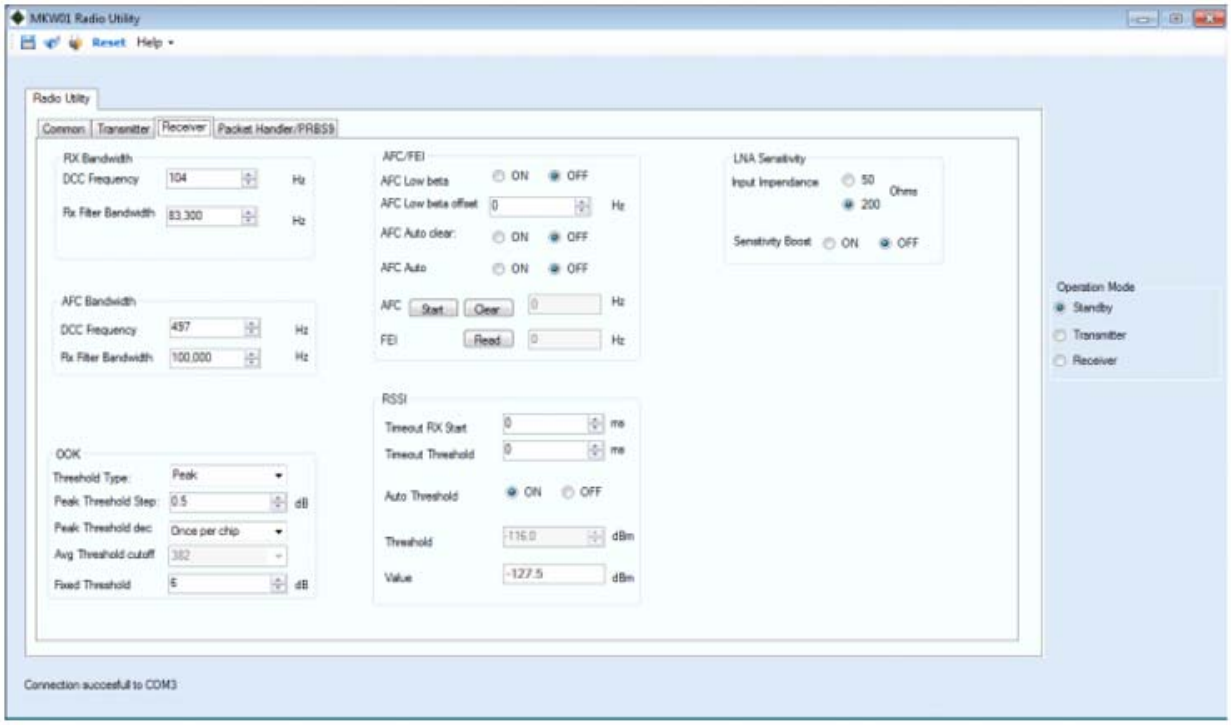


**Figure 2-19. Receiver tab**

### 2.4.3.1 RX bandwidth

The channel filter filters out the noise and interferers outside the channel. The default value of the single-side filter bandwidth is dependent upon the regional GUI used. The minimum receive filter bandwidth is 2604 Hz, and the maximum is 500 kHz.

DC cancellation is required to remove any DC offset generated by the receive mode. The default value of the cut-off frequency is automatically set to 4 % of the selected receiver bandwidth, but can be adjusted up or down.

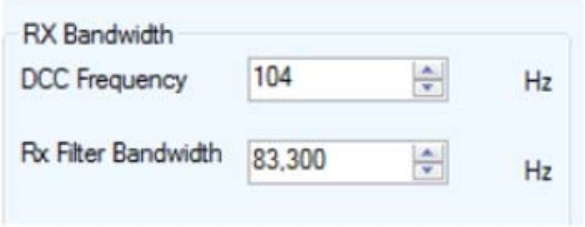


**Figure 2-20. RX Bandwidth display area**

### 2.4.3.2 AFC bandwidth

The AFC can be enabled to be performed automatically at receiver startup, in this case, the channel filter used by the receiver during the AFC can be set in the menu, as shown in Figure 2-21:


**Figure 2-21. AFC Bandwidth display area**

- The DDC Frequency depends on the RX Filter Bandwidth selected.
- The minimal value for the RX Filter Bandwidth is 2604 Hz, and the maximal value is 500,000 Hz.

### 2.4.3.3 OOK threshold

The OOK threshold options (Figure 2-22) determine the sensitivity of the OOK receiver.

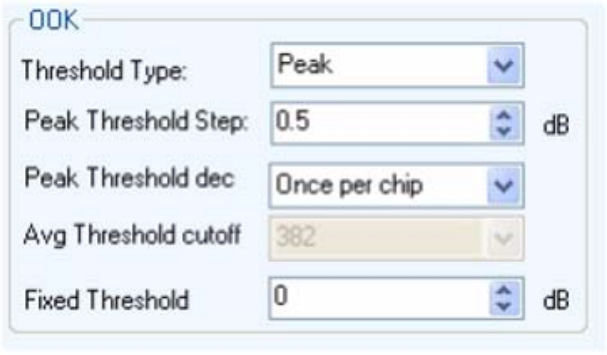


**Figure 2-22. OOK display area**

- When the OOK modulation is selected, the following items are relevant:
  - Threshold Type has three options: Peak, Fixed, and Average.
  - Peak Threshold Step valid range is 0 – 6.
  - Fixed Threshold valid range is 0 – 255.
  - The GUI automatically updates the average threshold cut-off value.

### 2.4.3.4 AFC / FEI

The Automatic Frequency Correction (AFC) and Frequency Error Indicator (FEI) options provide information about the frequency error of the local oscillator, compared to the carrier frequency. The AFC is based on the FEI. By default, the AFC is ON each time the receiver is enabled. For narrow band systems, Freescale recommends performing the AFC. The MKW01 has a dedicated AFC for these Low beta systems.


**Figure 2-23. AFC / FEI display area**

- AFC Low beta – optimizes the setup for low-modulation index systems.
- AFC Auto clear – this is valid only if the AFC Auto is ON. The AFC register is cleared before a new AFC is performed.
- AFC Auto – performs the AFC each time the receiver is enabled.
- Start button – reads the AFC value. If the AFC Auto is OFF, this value is taken just one time.
- Clear button – starts the AFC evaluation from the previously corrected frequency.
- Read button – reads the value of the FEI.

### 2.4.3.5 RSSI display area

When using the RSSI display area (Figure 2-24), the following options are available:

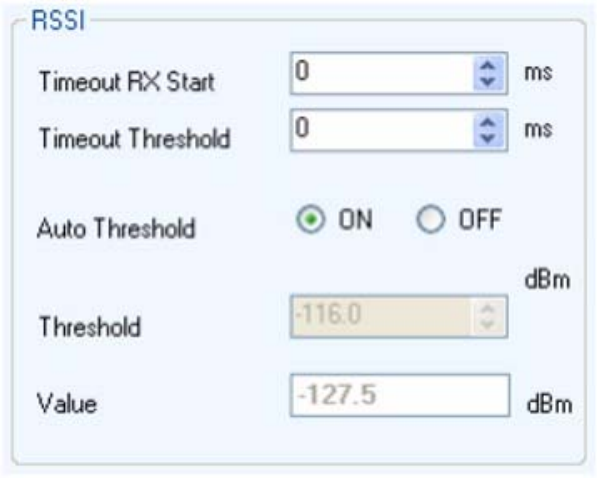


**Figure 2-24. RSSI display area (Auto Threshold ON)**

- The Timeout RX Start and Timeout Threshold valid range is 0 – 850.
- When Auto Threshold is OFF (Figure 2-25), the Threshold field is available for you to enter data.


**Figure 2-25. RSSI data entry area (Auto Threshold OFF)**

- The Value field is read-only.
- The GUI automatically updates the values dynamically during receive.

### 2.4.3.6 LNA sensitivity display area

The MKW01 incorporates a low-noise amplifier (LNA), which uses a common-gate topology. This allows for flat response over the entire frequency range, and it is designed to have an input impedance of approximately 50 Ω or 200 Ω. Testing should be performed in the circuit to determine, which setting gives the best performance, regardless of circuit impedance. Use the sensitivity boost to reduce the noise floor in the receiver. Use the LNA Sensitivity display area (Figure 2-26) to select these options. Testing has shown that the best sensitivity is achieved using the 200 Ω setting with the MRB circuitry.


**Figure 2-26. LNA Sensitivity display area**

## 2.5 Spectrum analyzer captures

The measurements shown in this section were obtained using a spectrum analyzer measuring the KW01-MRB and the TWR-RF motherboard.

**NOTE**

Default settings vary with region, and the signal spectrum may be different than that shown.

### 2.5.1 Standby mode

Because the radio is in the Receive mode, there is little or no energy captured in the selected channel band. Figure 2-27 shows the Standby mode.


**Figure 2-27. Standby mode spectrum analyzer capture**

### 2.5.2 Continuous transmit

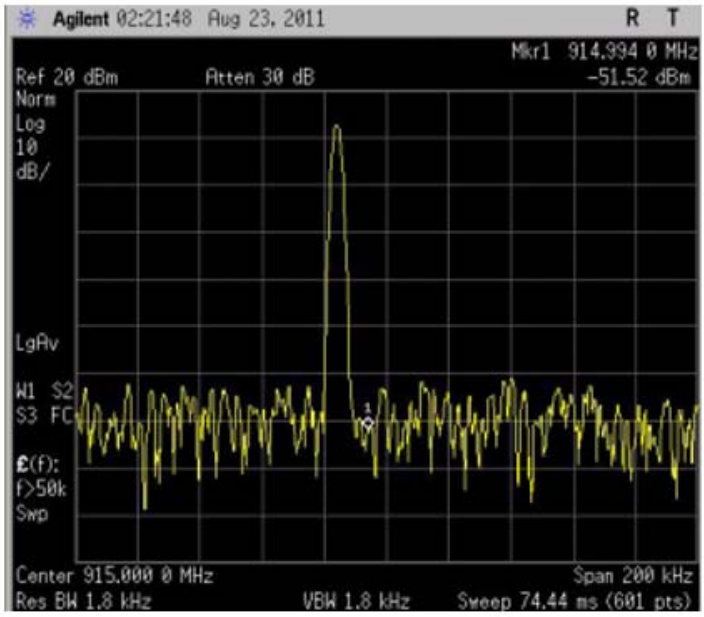


**Figure 2-28. Continuous transmit**

### 2.5.3 Modulation FSK (with modulation shaping OFF)

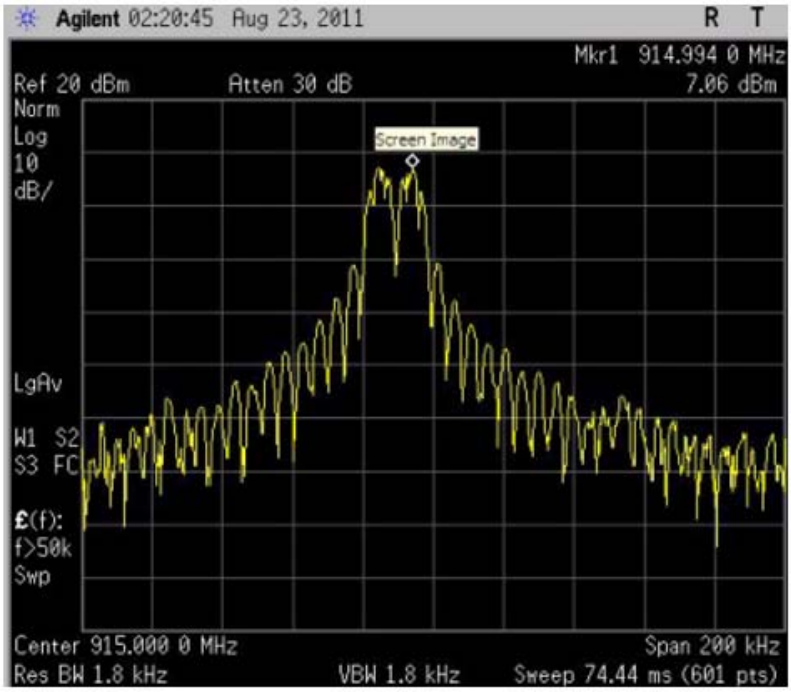


**Figure 2-29. Transmit with modulation FSK (with modulation shaping OFF)**

## 2.5.4 Transmit with modulation FSK (gaussian filter BT = 1.0)

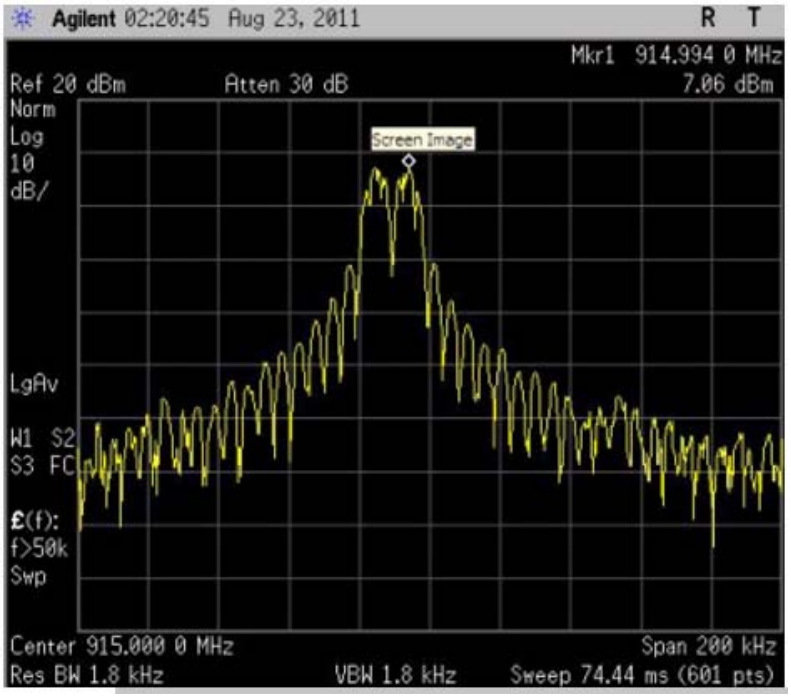


**Figure 2-30. Transmit with modulation FSK (gaussian filter BT = 1.0)**

## 2.5.5 Modulation OOK (OFF)

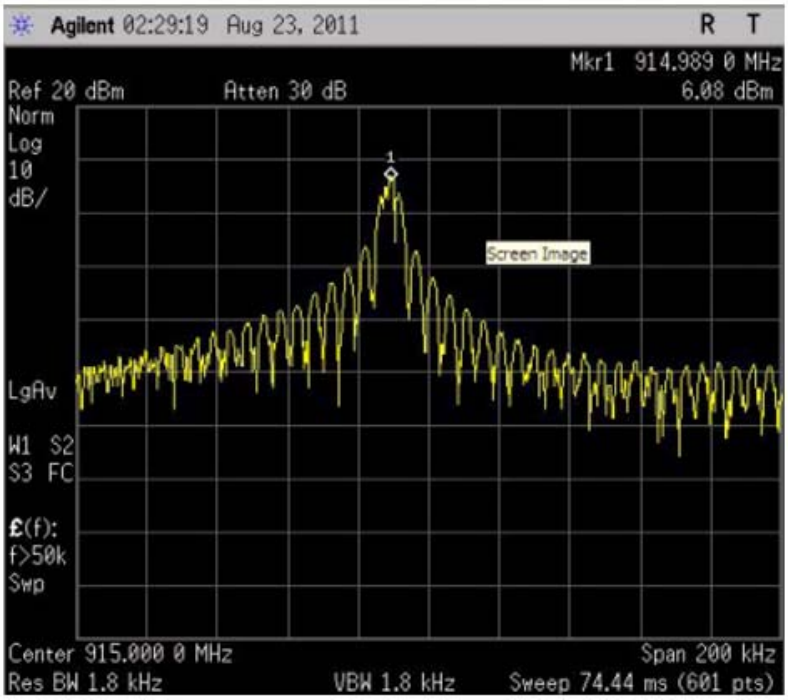


**Figure 2-31. Transmit with modulation OOK (OFF)**

### 2.5.6 Modulation OOK (filtering with fcutoff = BR)

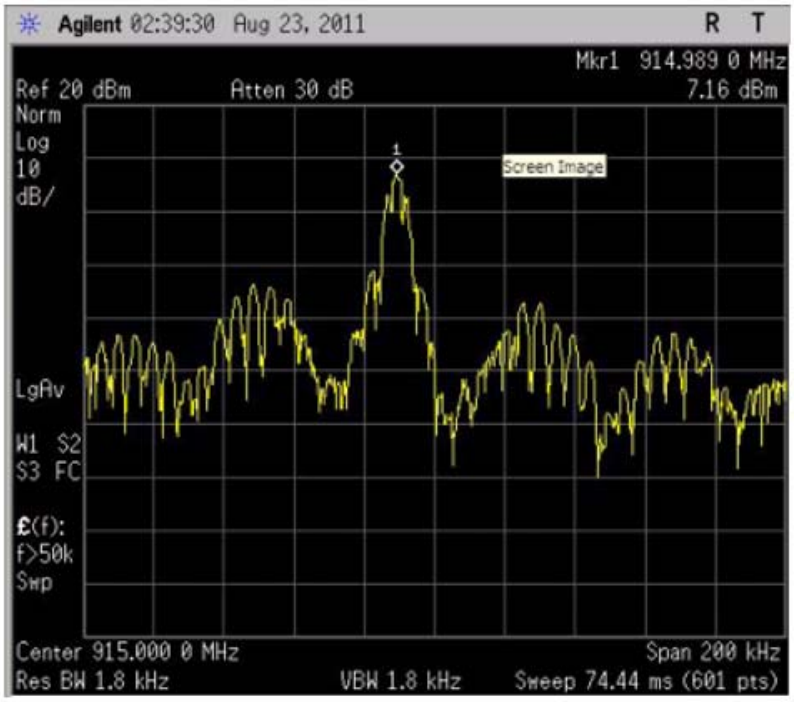


**Figure 2-32. Transmit with modulation OOK (filtering with fcutoff = BR)**

## 2.6 Packet Handler tab

### 2.6.1 Introduction

The Packet Handler tab (Figure 2-33) allows you to test point-to-point communications link between two sets of KW01-MRB + TWR-RF boards. The Packet Handler tab allows users to run a packet error test (PER). There must be two instances of the MKW01 Radio Utility application running on either the same PC, or on two different PCs. When using only one PC, the two RF-TWR boards should be run on the same USB HUB.

The MKW01 Radio Utility packet handler application performs the following packet-oriented tasks:

- Preamble and Sync word generation
- CRC calculation and check
- Displaying messages in hexadecimal and ASCII code
- Inter-packet RX delay handling

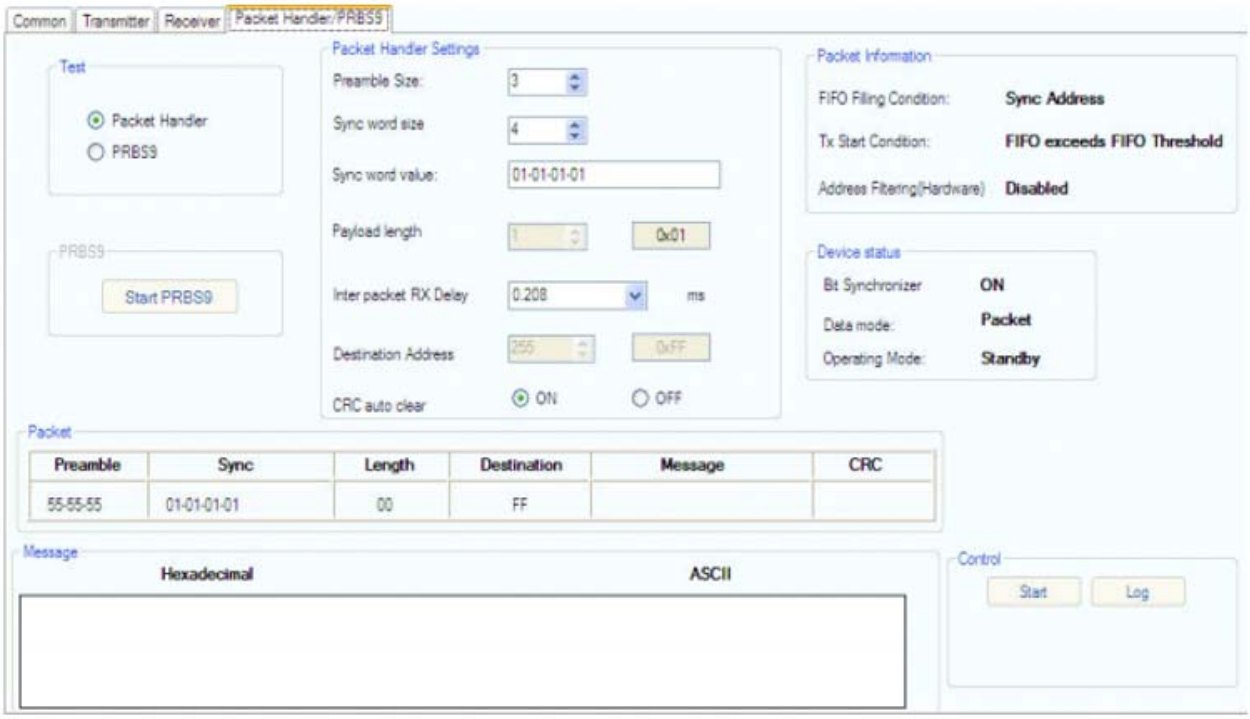


**Figure 2-33. Packet Handler tab**

**NOTE**

The Packet Handler works only when the Packet Handler option (Figure 2-34) is selected from the Radio Utility common window (Figure 2-1).


**Figure 2-34. Packet Handler enabled**

## 2.6.2 Building the packet

The following sections describe all the display areas and options available under the Packet Handler tab.

### 2.6.2.1 Packet Handler settings

Using the display area (as shown in Figure 2-35), you have the following options to build a packet:

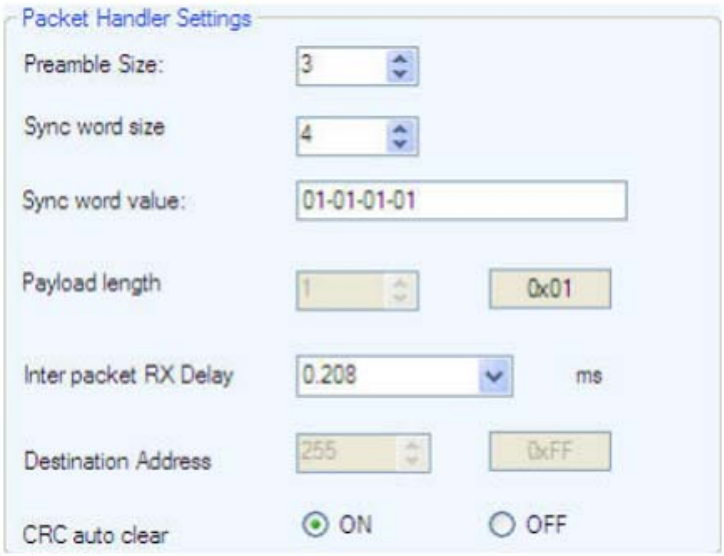


**Figure 2-35. Packet Handler settings**

- Preamble Size – defines the size of the preamble to be sent to the receiver. The default value is 3, but the value range is 2 – 40.
- Sync word size – sets the word size. The default value is 4, and the value range is 1 – 7.
- Sync word value – shows the word that is going to be sent in the package. This word can be modified with any value. However, if the value is not correct, the GUI updates with a predefined string automatically.
- Payload length – indicates the length of the payload, including the destination address and message. This value is displayed in decimal and hexadecimal forms.
- Inter packet RX Delay – sets the time that the receiver stays in the Wait mode. The values are calculated each time the bitrate is updated.
- CRC auto clear – when this function is OFF, the buffer is not cleared. If this option is ON, the buffer is cleared, and it is able to restart and receive a new packet.
- Destination Address – this field is available only in the Transmit mode. The value range is 1 – 255. This value is displayed in decimal and hexadecimal forms.

### 2.6.2.2 Packet Information

The Packet Information display area is for information purposes only. There are no configuration options in this display area.


**Figure 2-36. Packet Information display area**

- FIFO Filling Condition – the FIFO block behaves like a shift register, continuously comparing the incoming data with its internally-programmed Sync word. It will fill the FIFO only when a match is detected, and the SyncAddress interrupt occurs.
- TX Start Condition – the radio starts the transmission after the FIFO exceeds the FIFO threshold.
- Address Filtering (Hardware) – disabled.

### 2.6.2.3 Packet

The Packet display area shows how the package is constructed, with all the options selected.


**Figure 2-37. Packet content**

The following options are available:

- Preamble – shows the preamble in the payload, according to the preamble size selected.
- Sync – displays the sync word that will be sent.
- Length – this option is visible only when Variable packet format is selected. This is the length of the message.
- Destination Address – This is displayed only when the MKW01 is in the Transmit mode. It indicates the address of the RX.
- CRC – this is calculated by the MKW01 Radio Utility application, and is displayed when the Start button is clicked.

### 2.6.2.4 Message

The Message display area consists of the Hexadecimal and ASCII display areas, as shown in Figure 2-38.


**Figure 2-38. Message display area**

- Hexadecimal – allows you to enter the message in a hexadecimal form. Every two digits are considered one byte. The MKW01 Radio Utility automatically translates the message to ASCII, and only hexadecimal input is accepted. If you enter an invalid value, it will not be registered.
- ASCII – allows you to enter the message in ASCII. The MKW01 Radio Utility automatically translates the message to a hexadecimal form.

These values cannot be left empty. The following error message appears when you try to transmit an empty packet:

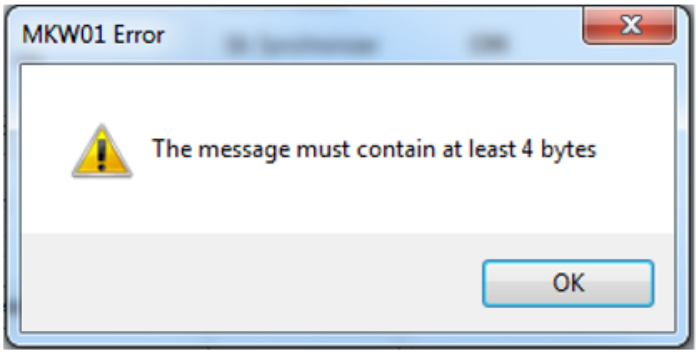


**Figure 2-39. Transmit error message**

### 2.6.2.5 Device status

This Device status display area (Figure 2-40) shows the values selected under the Common tab from the Radio Utility main window (Figure 2-1).


**Figure 2-40. Device status area**

- Bit Synchronizer – ON or OFF
- Data mode – packet or continuous

- Operating Mode – Standby, Transmit, or Receive (Note that when it is not in the Packet mode, it displays “Standby,” even when it is in the Transmit or Receive modes.)

#### 2.6.2.6 Control

The Control display area allows you to start packet transmit or receival. This display area displays different options, according to the operation mode selected. The following figure shows the Control display area in the Standby mode.


**Figure 2-41. Control display area (Standby)**

- Start button – starts the Transmit or Receive, based on the operation mode. While the PER test is running, no changes are allowed in the GUI, until the test is complete.
- Log button – pops up the log window for either Transmit or Receive modes.

##### 2.6.2.6.1 Transmit

The Control display area in the Transmit mode (Figure 2-42) allows you to start the packet transmit.

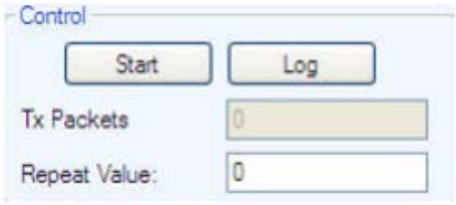


**Figure 2-42. Control display area (Transmit)**

- TX Packets – displays the number of packets transmitted.
- Repeat Value – allows you to define how many packets are sent by the transmitter.

##### 2.6.2.6.2 Receive

The Control display area in the Receive mode (Figure 2-43) allows you to start the packet receival. It also shows how the packet is constructed with all the options.


**Figure 2-43. Control display area (Receive)**

- RX Packets – displays the number of packets received.

### 2.6.2.7 PacketLog window control

The PacketLog window has four options, as shown in Figure 2-44.

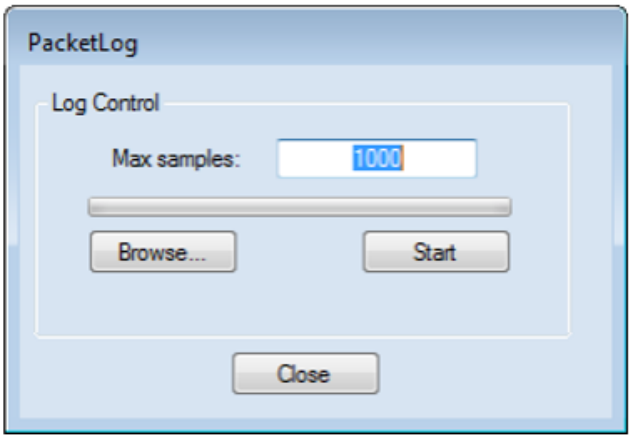


**Figure 2-44. PacketLog window**

- Max samples – you can define the number of samples to be logged.
- Browse button – allows you to choose where the log file is saved (Figure 2-45).
- Start button – starts the log file.
- Close button – closes the log window.

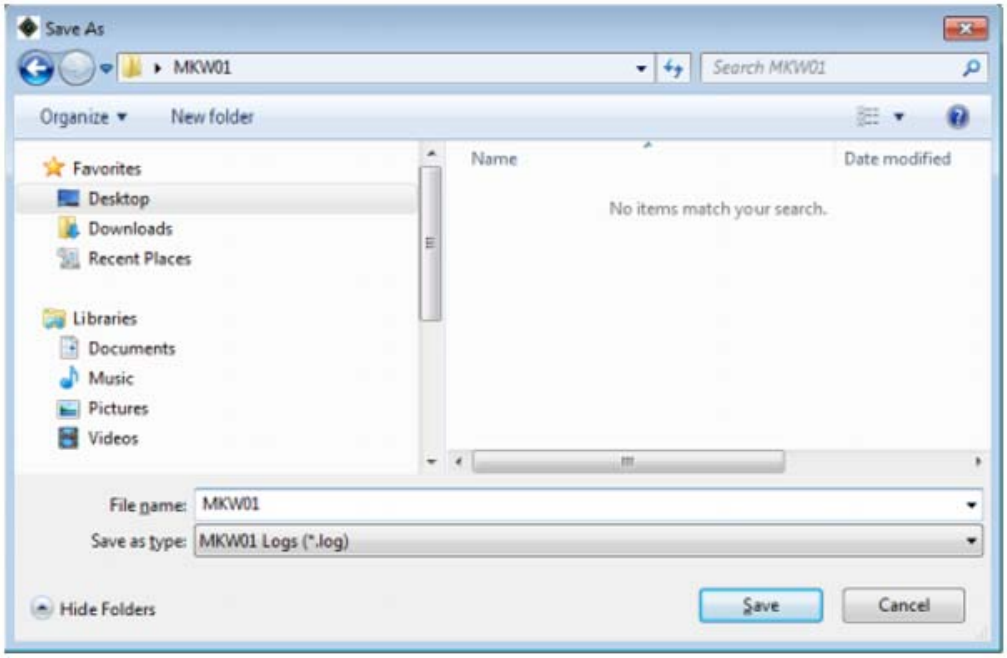


**Figure 2-45. Log save window**

The log contains the following data:

- Time – the time the data was received
- Mode – TX or RX
- RSSI – only in the Receive mode
- PckMax – the total number of packages that will be received / transmitted
- Pck – the number of received / transmitted packages
- Preamble size – the actual preamble size
- Sync word
- Length
- Destination address – only in the Transmit mode
- Message – hexadecimal code
- CRC – only in the Transmit mode

The log is being written until you click the STOP button in the Packet Handler window.

### 2.6.2.8 PRBS9

This option transmits a signal modulated with a PN9 code pseudorandom bit stream for spectrum testing. To enable this option, you must select the PRBS9 option, as shown in Figure 2-46. Then, click the START PRBS9 button to start the transmission, and STOP PRBS9 button to end the transmission.


**Figure 2-46. Test window**

To start this test, click the START PRBS9 button, as shown in Figure 2-47.


**Figure 2-47. PRBS9 start test**

**NOTE**

When the PRBS9 test is running, the Packet Handler option is disabled.

# Chapter 3
# Wireless UART

The Wireless UART demonstration application uses the Freescale KW01-MRB to communicate over the air from one board to another at typematic rates. This allows you to implement the UART-to-Wireless communication bridge.

The following demonstration is a simplified example, and the code cannot be used as a cable replacement as it is. If a cable replacement is the goal, then queues, buffers, and other constructs must be added to increase the reliability and efficiency of this demonstration.

The Wireless UART application includes the PAN ID and Address ID filtering. Only boards with the same PAN ID are able to communicate with each other. You can choose the Destination Address ID for each message. The application implements the acknowledge messages over the air (OTA). However, this feature is optional, and can be disabled at compile time.

The interface implemented to use this application is a terminal-based serial interface that uses menus to navigate through the application functionality.

## 3.1 Generating the Wireless UART application

The Wireless UART demonstration requires at least two boards to perform the over-the-air (OTA) communication.

Import the application to each board using the steps shown in Chapter 1, “Introduction”.

## 3.2 Compiling and loading the Wireless UART application

To compile and load the demonstration application into the evaluation boards, see Section 1.2, “Loading an application into the board”.

## 3.3 Starting the Wireless UART application

To start the Wireless UART, perform the following tasks:

1. Configure the COM Port, as shown in Section 1.3, “Virtual COM port setup”.
2. Connect each board to a USB cable and a USB port (one PC USB port for each board), and ensure they are enabled (as shown in Section 1.3, “Virtual COM port setup”).
3. Press the reset button once on both boards. The terminal displays the text shown in Figure 3-1.

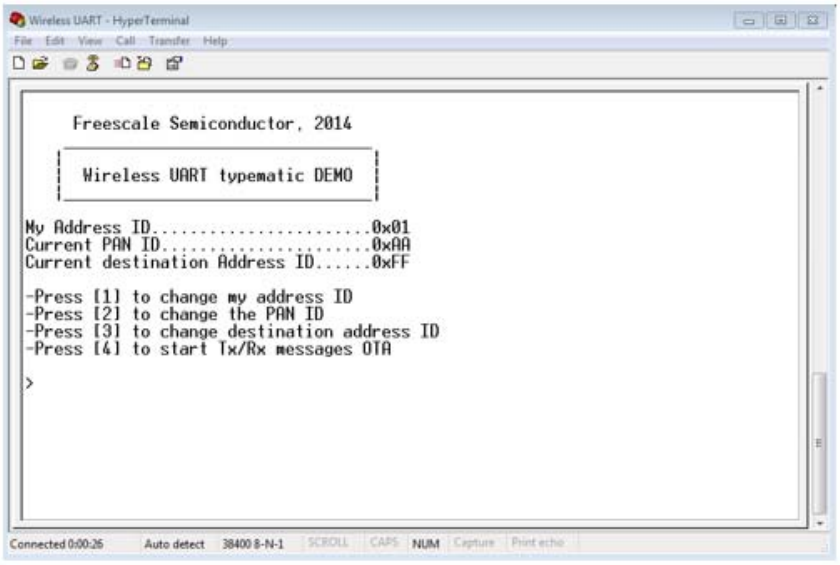


**Figure 3-1. Wireless UART start screen**

## 3.4 Entering My Address ID, PAN ID, and Destination Address ID

The My Address ID field is defined at compile time, and filters the incoming messages. If the incoming message is a broadcast message (destination address ID = 0xFF), or if it has its destination address equal to My Address ID, the message is processed by the application as a received message. Otherwise, the message is ignored.

The My Address ID, PAN ID, and Destination Address ID can be changed by following the directions from the main menu. The default values for these three fields are selected at compile time.

1. To change the My Address ID value, press “1” from the main menu screen, and the My Address ID string appears, as shown in Figure 3-2.

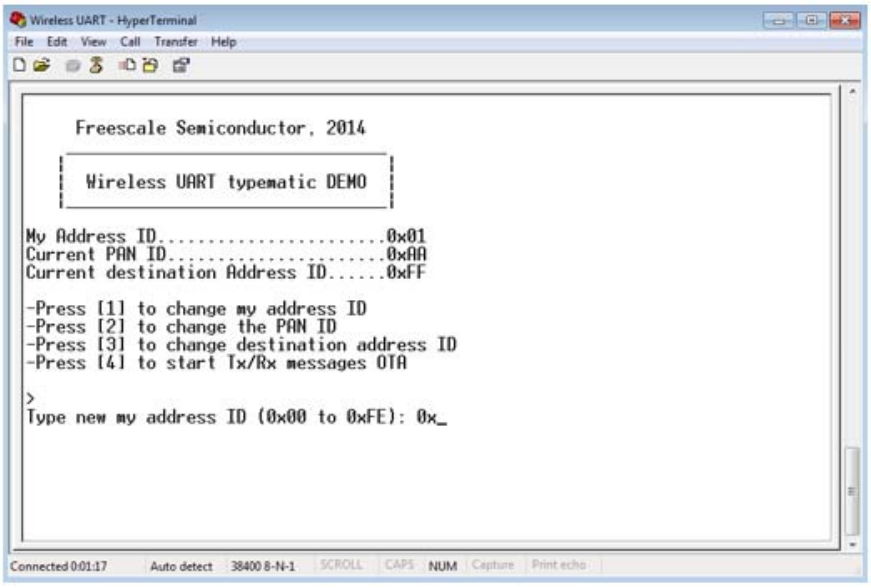


**Figure 3-2. My Address ID string**

2. To change the PAN ID value, press “2” from the main menu screen, and the PAN ID string will appear, as shown in Figure 3-3.

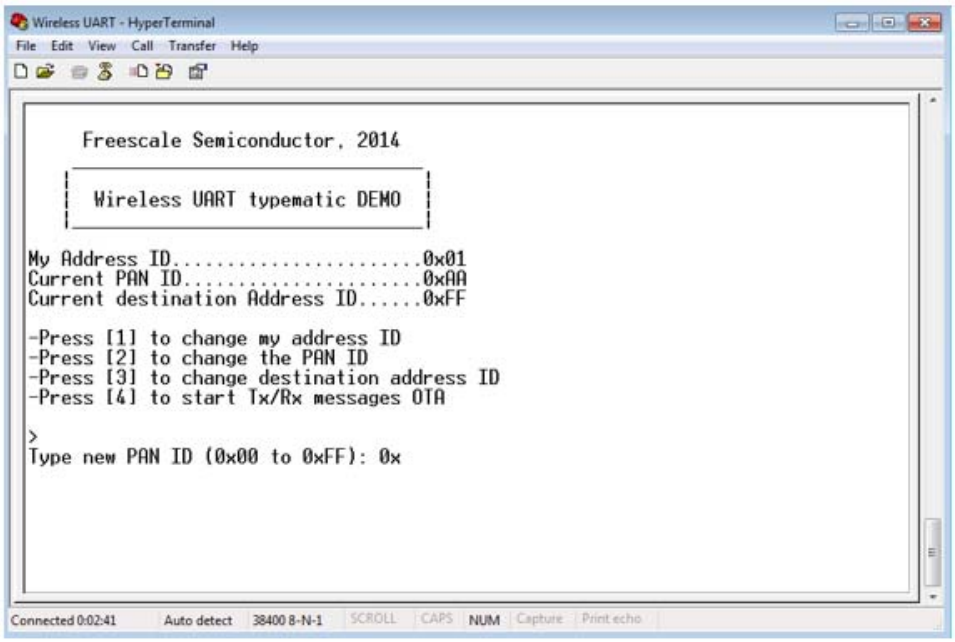


**Figure 3-3. PAN ID string**

3. To change the Destination Address ID, press “3” from the main menu, and the Address ID string will appear, as shown in Figure 3-4.

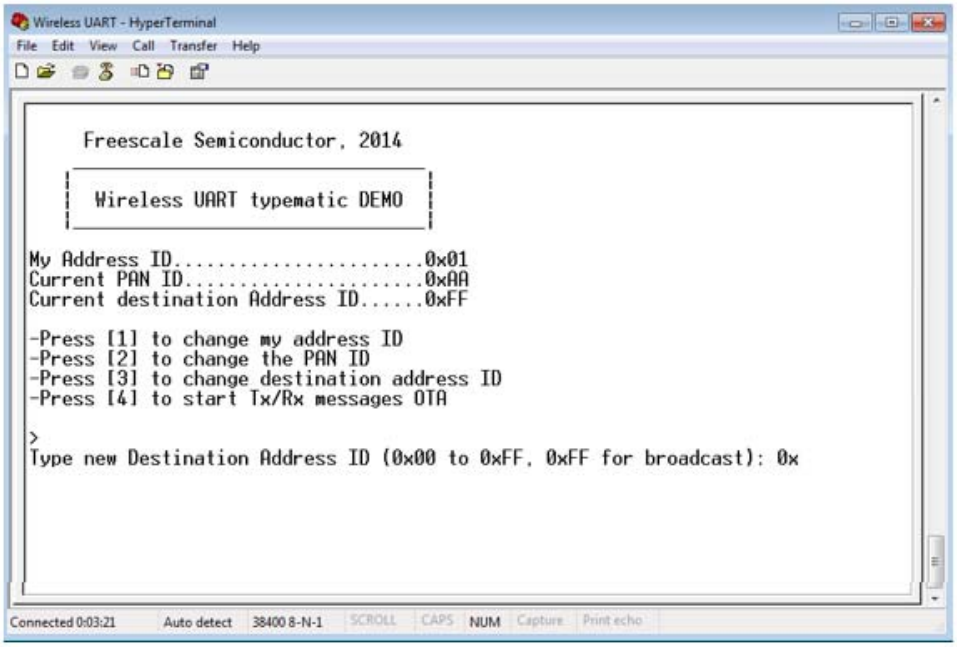


**Figure 3-4. Destination Address ID string**

4. If valid values were entered, and both boards have correct values (same PAN ID and a valid Destination Address ID), you are ready to start sending or receiving messages over the air. Press “4” in the main menu. The screen will be cleared, and the Typing Message screen will appear, as shown in Figure 3-5.

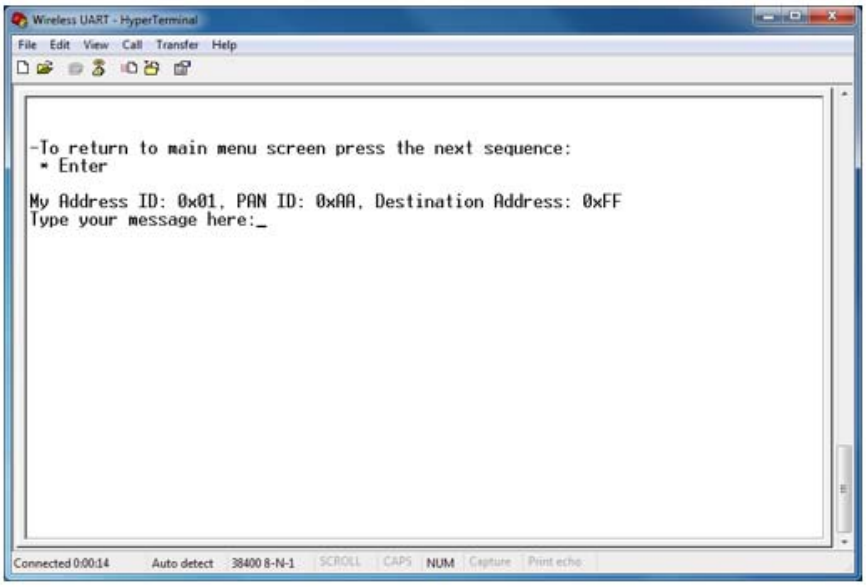


**Figure 3-5. Wireless UART Typing Message screen**

This screen allows you to send the data that is typed into one HyperTerminal window, and see all the received messages displayed in the other HyperTerminal window.

5. After both boards are configured and set in the Typing Message screen, type some characters into the HyperTerminal session (board 1) window (Figure 3-6), and the typed message will appear in the other HyperTerminal session (board 2) window (Figure 3-7).

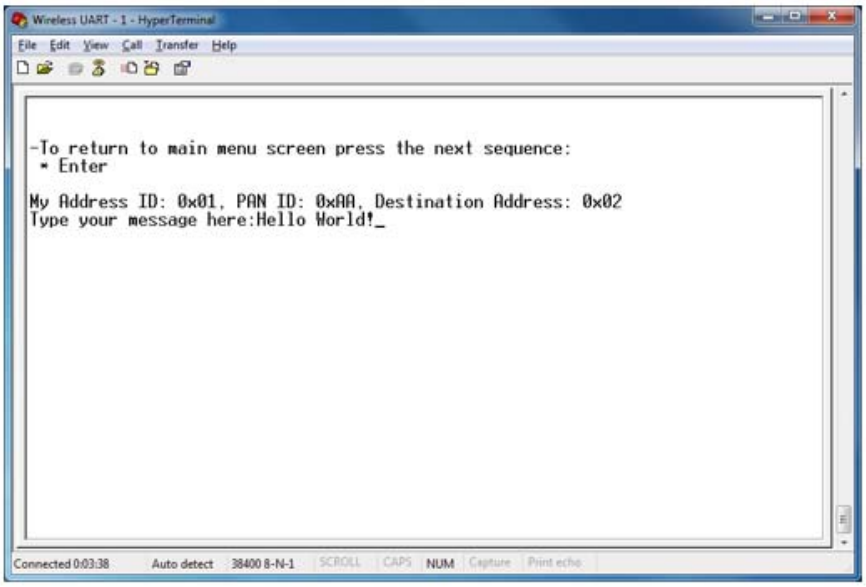


**Figure 3-6. Typing message in board 1**

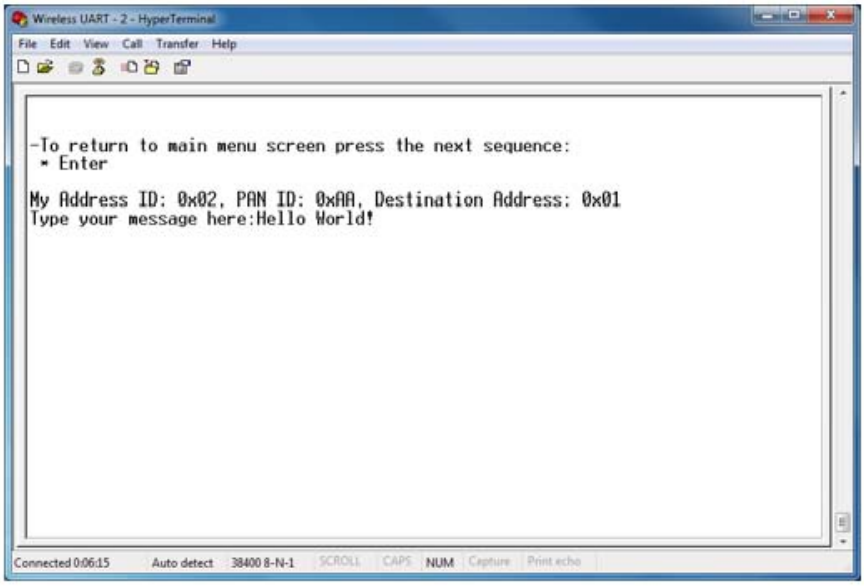


**Figure 3-7. Received message in board 2**

6. To return to the main menu, enter the following character sequence: “*” + “Enter”

Because the Wireless UART demonstration is a two-way communication protocol, the boards retry their packets up to three times if an acknowledgement is not received. This application highlights a very basic

SMAC wireless UART implementation, and because it is a basic demonstration application, it is not intended for large file transfers.

**NOTE**

You can disable the configuration mode, so that the application defaults directly to the Typing Message window (Figure 3-5), with the default values for My Address ID, PAN ID, and Destination Address ID already loaded. This option is included for users who do not need to change the ID values.

# Chapter 4
# Simple Range Demonstration application

The simple range demonstration runs as a standalone application, without any user interface, which allows you to perform dynamic range tests.

The Simple Range Demonstration consists of two nodes:

- TX node
- RX node

## 4.1 Generating the Simple Range Demonstration application

The Simple Range Demonstration requires at least two boards to perform the over-the-air communication. Import the application to each board following the steps shown in Chapter 1, “Introduction”.

## 4.2 Configuring the application (TX and RX nodes)

The device type that the application will be working on is configured in the application configuration file (*ApplicationConf.h*):

- Select **gTxNode_c** for the transmitter:

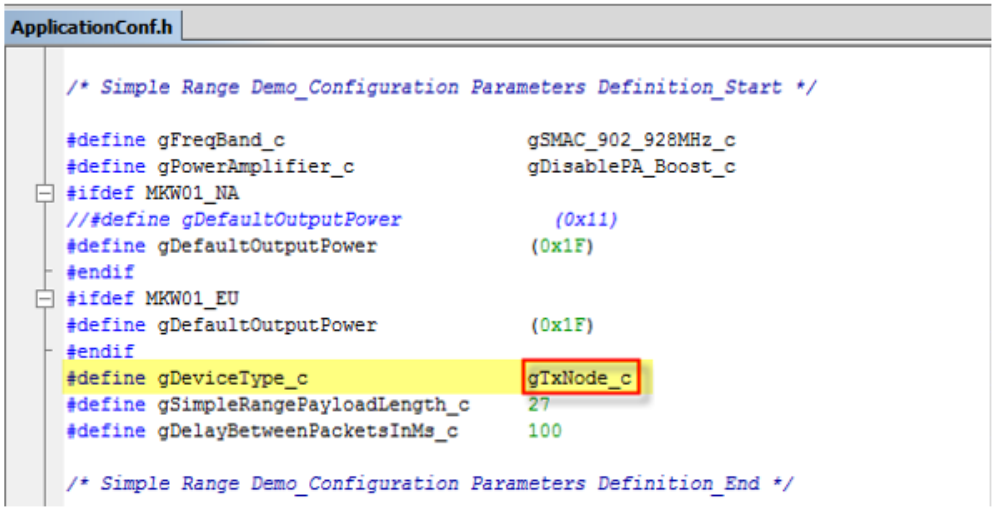


**Figure 4-1. Selecting TX node**

- Select **gRxNode_c** for the receiver:

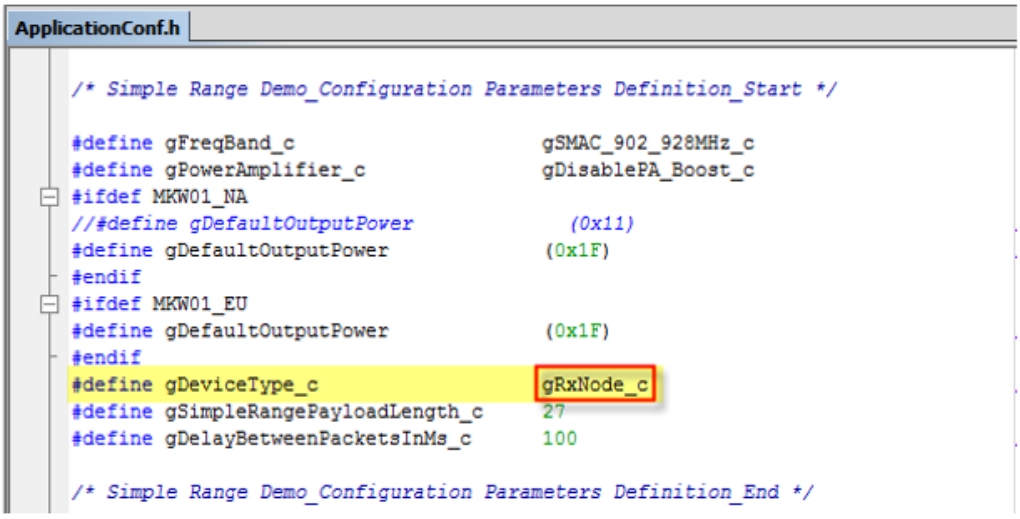


**Figure 4-2. Selecting RX node**

Other settings can be changed in the application configuration file as follows:

- Payload length – this variable sets the length of the PDU. The minimum value is 27 B, and the maximum value is 253 B (need to modify the **gSimpleRangePayloadLength_c**)
- Delay between packets in milliseconds – this variable sets a delay for transmitting / receiving packets. The minimum value is 10 ms, and the maximum value is 600 ms. (Need to modify **gDelayBetweenPacketsInMs_c)**
- Default output power – the default output power is set to the maximum output power (13dBm when TX via RFIO; 17 dBm when TX via PA_BOOST) (Need to modify **gDefaultOutputPower**)

## 4.3 Compiling and loading the Simple Range Demonstration application

To compile and load the demonstration application into the evaluation boards, see Section 1.2, “Loading an application into the board”.

- For the transmitter node, compile and load the application with **gTxNode_c** specified in *ApplicationConf.h.*
- For the receiver node, compile and load the application with **gRxNode_c** specified in *ApplicationConf.h.*

**NOTE**

To power the board, connect the mini USB cable from the PC to the RF-TWR only (avoid connecting the mini USB to the MRB-MKW01).

## 4.4 Running the Simple Range Demonstration

The application starts running right after the boards are powered on. All LEDs are lit to indicate that the application has started.

- On the TX node, the LEDs will soon turn off, and LED2 (labeled D3) starts to toggle every time the node sends a packet.
- On the RX node, the LEDs will soon turn off, and LED1 (labeled D4) starts to toggle every time the node receives a packet.

## 4.5 Changing transmission line output power

To change the PA_BOOST while the application is running, use SW3 and SW4 on the TX node, as follows:

- Push SW4 to use the output on PA1 + PA2. LED1 will remain lit to indicate that the PA_BOOST is enabled (17 dBm TX).
- Push SW3 to use the output on RFIO (PA_BOOST disabled). LED1 is dim to indicate that the output selected is RFIO (13 dBm TX).

## 4.6 Default configuration

The Simple Range Demonstration runs with the following default settings:

**Table 4-1. Default settings**

| Feature | Default Value |
|---|---|
| Center frequency | NA (915 MHz) |
| – | EU (866.525 MHz) |
| – | JA (924.4 MHz) |
| Bit rate | 50 Kbps |
| Frequency deviation | 25 kHz |
| RxBw | 83.33 kHz |
| Modulation | FSK |
| Filter | BT_1 |
| Output power | Max (13 dBm for RFIO; 17 dBm for PA_BOOST) |
| PA_BOOST | Disabled (RFIO output) |
| SMAC transmission | Broadcast |