SX1230-11SKA

User's Guide: Advanced Mode

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1 Introduction

The SX1230 is a single chip transmitter IC designed for operation in the licence free ISM bands between 290 and 1020 MHz. The SX1230 is capable of operation either with or without an external companion microcontroller and features four internally de-bounced digital input pins to enable direct connection to switchgear for wireless remote control applications. Examples of both types of applications are shown below:

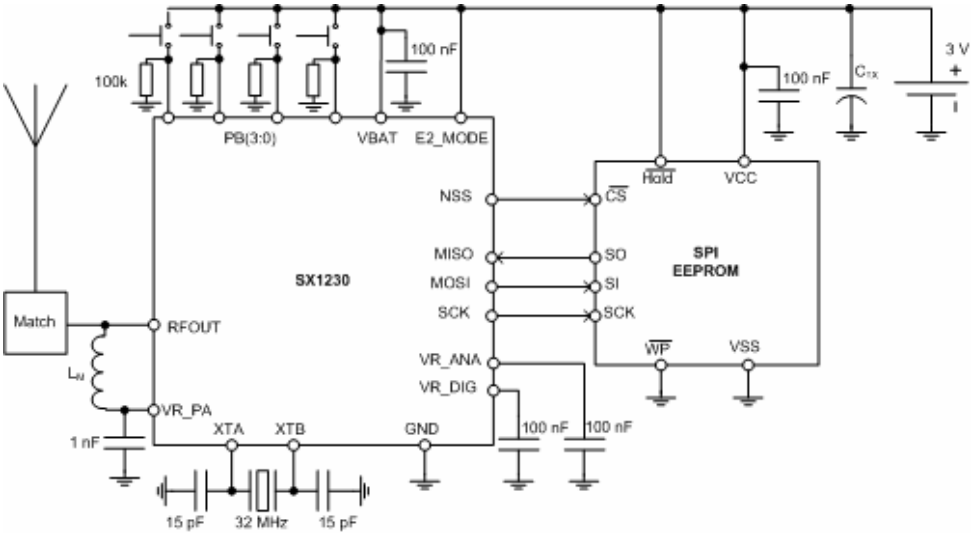


Figure 1. SX1230 Stand Alone Operation with Companion E²PROM

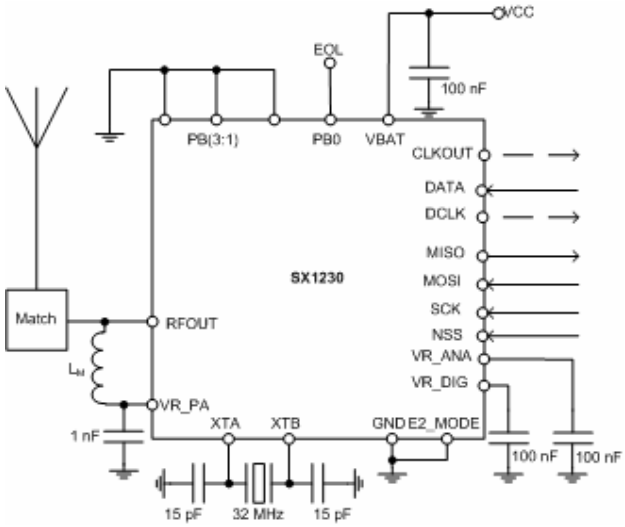


Figure 2. SX1230 Connections for Microcontroller Based Operation

The SX1230 main features include:

- +17 dBm to -18 dBm Programmable output power
- 1.8 to 3.7V Operating range with internal voltage regulation allowing constant RF performance
- Narrow and wide-band operation
- (G)FSK, (G)MSK and both filtered and unfiltered OOK operation.
- Support of bit rates from 1.2 to 600 kbps.
- Low battery detection
- Integrated RC timer for timer / wake-up applications
- Low phase noise -95 dBc/Hz at 50 kHz offset.
- -40°C to +85°C Temperature Range

2 Getting Started

2.1 Kit Contents

As illustrated in the figure below, the SX1230-11SKA Evaluation kit is composed of:

- SX1230SKA board
- SX1211SKA board
- SX1230-11SKA CDROM including all necessary PC software and documentation
- A CR2032 Cell for operation of the SX1230SKA in stand alone mode, in conjunction with the companion E^2PROM.

Figure 3: SX1230-11SKA Contents (CR2032 Cell not Shown)

2.2 Installation

The software for the SX1211SKA and SX1230SKA must each be installed individually. The installation process for each is identical.

SX1211SKA Advanced Mode Software Installation

1- Put the CDROM in your computer and browse the contents of the CD.
2- Open the "sx1211starterkitsetupweb.exe" manually. It can be found in the \Installers sub directory of the CD-ROM.
3- Follow installation guidelines until the process is completed. Please note that .NET Framework 2.0 and the FTDI USB driver will be automatically installed if not detected on your computer.
4- Connect the SX1211SKA board to the PC via the USB interface.
5- Launch "SX1211SKA" from the Start menu.
6- Click on "Connect" button in toolbar or in File menu.
7- SX1211SKA is now installed and ready to be used.

SX1230SKA Advanced Mode Software Installation

8- Put the CDROM in your computer and browse the contents of the CD.
9- Open the "sx1230starterkitsetupweb.exe" manually. It can be found in the \Installers sub directory of the CD-ROM.
10- Follow installation guidelines until the process is completed. Please note that .NET Framework 2.0 and the FTDI USB driver will be automatically installed if not detected on your computer.
11- Connect the SX1230SKA board to the PC via the USB interface.
12- Launch "SX1230SKA" from the Start menu.
13- Click on "Connect" button in toolbar or in File menu.
14- SX1230SKA is now installed and ready to be used.

3 Hardware Description

SX1230SKA and SX1211SKA boards are summarised in this chapter. Please refer to the schematics and layout provided in the document for further information about each hardware implementation.

3.1 SX1230SKA Overview

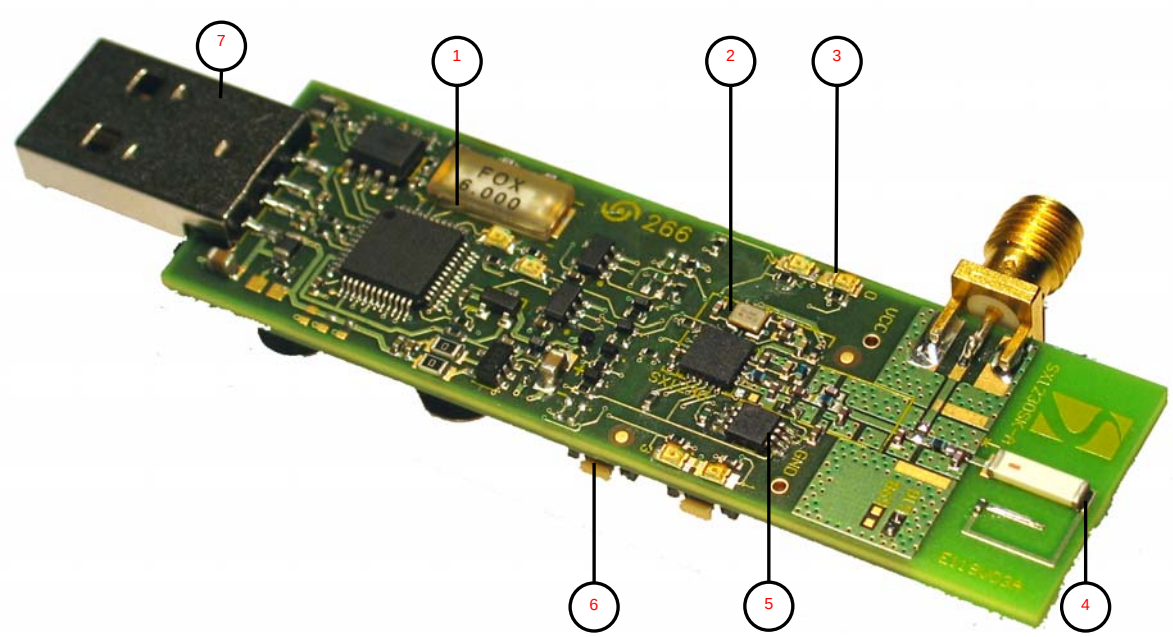


Figure 4: SX1230SKA, 868 and 915 MHz Band, Board Picture

The SX1230SKA is a USB based evaluation tool, which sees the SX1230 reference design (2) connected to a host PC via an FTDI USB to SPI bridge (1) and USB type 'A' connection (7). The SX1230SKA can also operate with in stand alone mode when battery powered. In this mode the initial configuration of the radio is downloaded from the first 77 bytes of the companion E^2PROM (5). In response to a user push button input (6) a specific payload may be transmitted. The LED (3) corresponding to that button press illuminates to indicate transmission.

For operation in the 868 MHz and 915 MHz bands the RF link between SX1230SKA and SX1211SKA is established through a ceramic antenna to give a realistic impression of the range and other performances attainable in a miniaturised application.

3.2 SX1211SKA Overview

The SX1211SKA features the SX1211 reference design (1) and is also interfaced via an FTDI bridge (6) to the USB type 'A' interface (5) of a host PC. Unlike the SX1230SKA, it has no provision for operation disconnected form the USB port. Indication of transmission and reception is indicated on a pair of LEDs (4). The same type of ceramic antenna is employed (2) and optional provision for an SMA connector (not populated) is provided for laboratory testing.

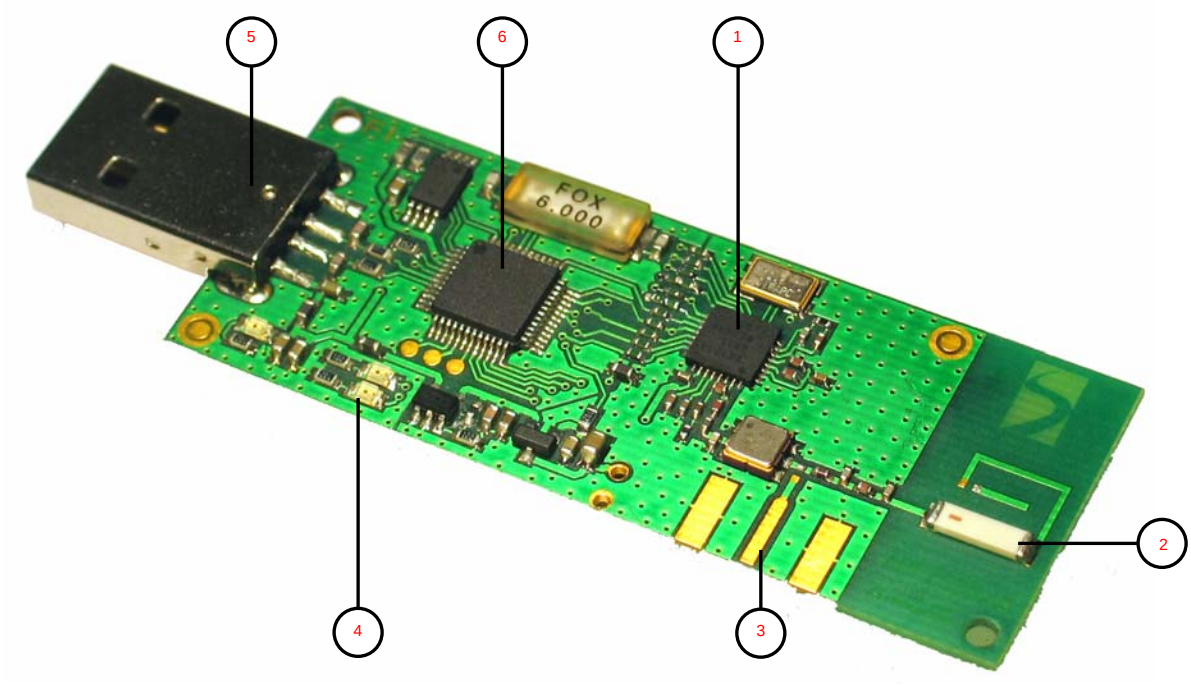


Figure 5: SX1211SKA Board Picture

4 Quick Start Guide: MCU Mode

With both SX1230SKA and SX1211SKA software installed, follow the sequence below to establish communication between the SX1230 as transmitter and the SX1211 as receiver.

4.1 SX1211SKA Quick Start

1. Plug the SX1211SKA into the USB port of the computer.

2. Run the SX1211 User Interface software Start > All Programs > SX1211SKA > SX1211SKA

3. The SX1211SKA should connect automatically to the User Interface Software. If not, then click on the USB connect short-cut button, located in the top left hand corner of the window.

4. Once connected the SX1211SKA shows the default configuration of the SX1211 register settings upon power-up.

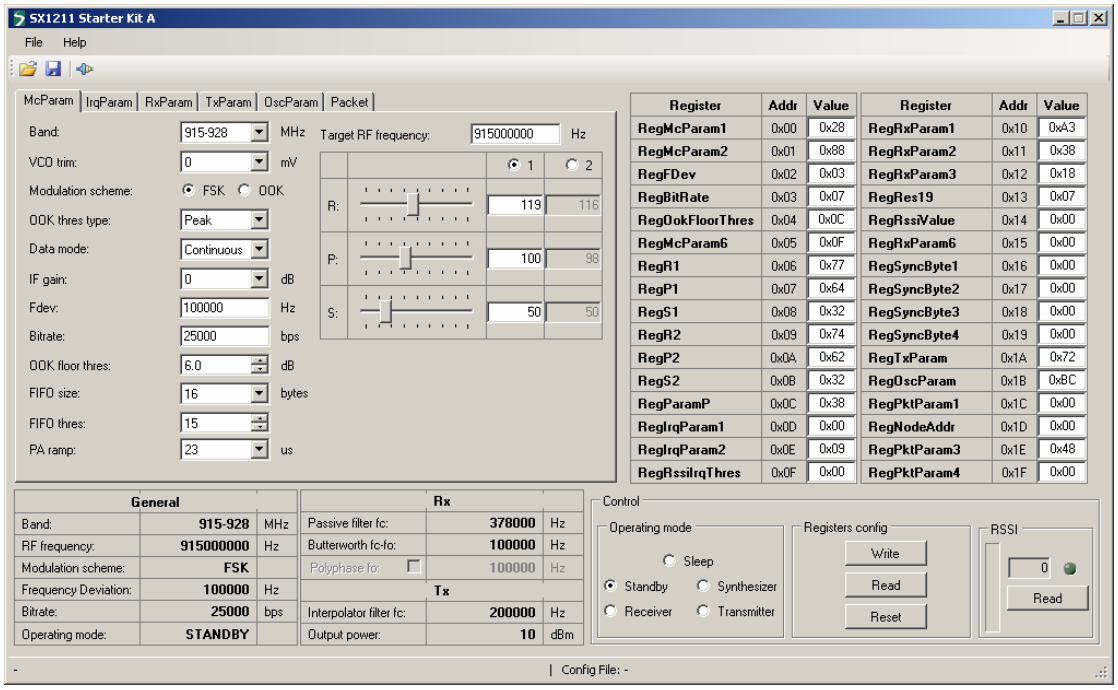


Figure 6. SX1211 User Interface, Default Settings

5. Once connected the SX1211SKA shows the default configuration of the SX1211 register settings upon power-up (as shown in *Figure 6*).

6. The settings for communication between SX1211SKA and SX1230 SKA are located on the installation CD-ROM provided with the kit. Use the File > Open from the menu bar, or the open short-cut button to load a configuration file.

7. Load the "XXX_SX1211_pingpong.cfg" file from the "SX1211 Demo Files" folder on the CD-ROM. Where XXX corresponds to the frequency band of the SX1211SKA (either 868 or 915 MHz).

8. The display will then appear as shown in *Figure 7*. These are the link parameters which match those which will be programmed to the SX1230SKA.

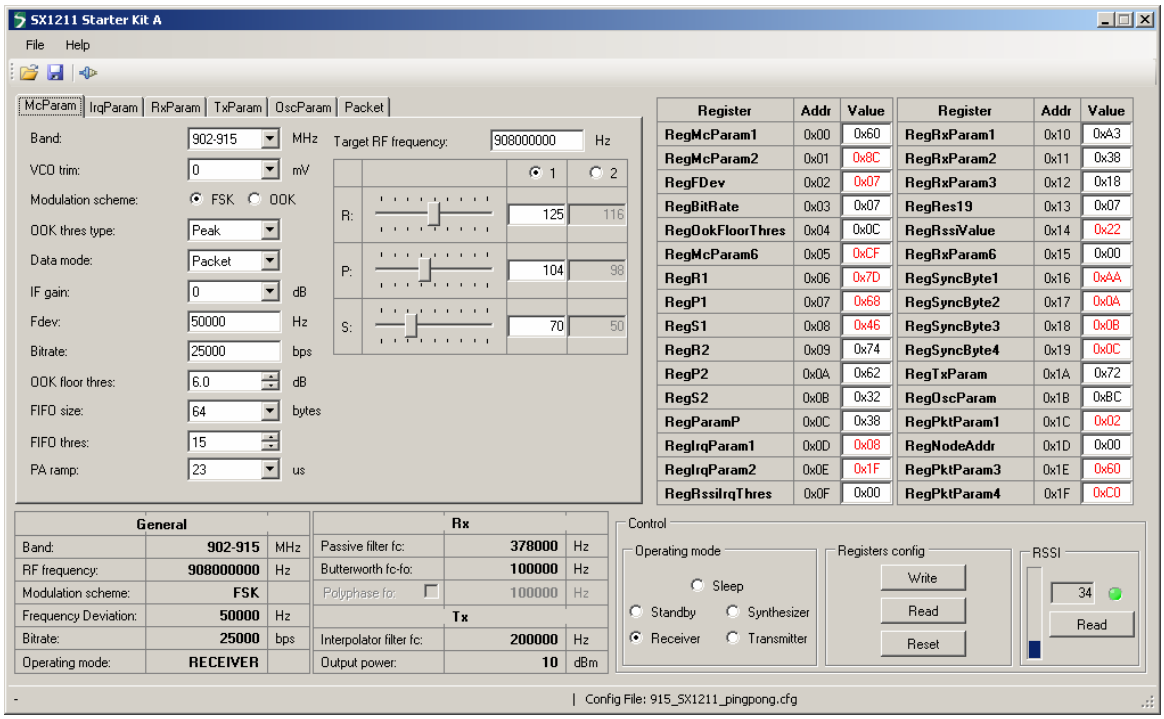


Figure 7. The New SX1211 Configuration: Ready to be Written

9. By clicking on the write button in the 'Registers config' section, the new register values are written to the SX1211 registers. If successful, the red values in the hexadecimal register summary table will turn black. As a double check, the register read button may be pressed – the values presented on the user interface should remain unchanged.

10. Click on the 'Packet' tab to access the packet testing portion of the program. Within this window a pre-defined packet structure is already configured. It remains simply to click the 'Reception' radio button and press the Start button. At this point the SX1211SKA enters packet receive mode and is now listening for valid packets. At this juncture the SX1230SKA transmitter must be configured.

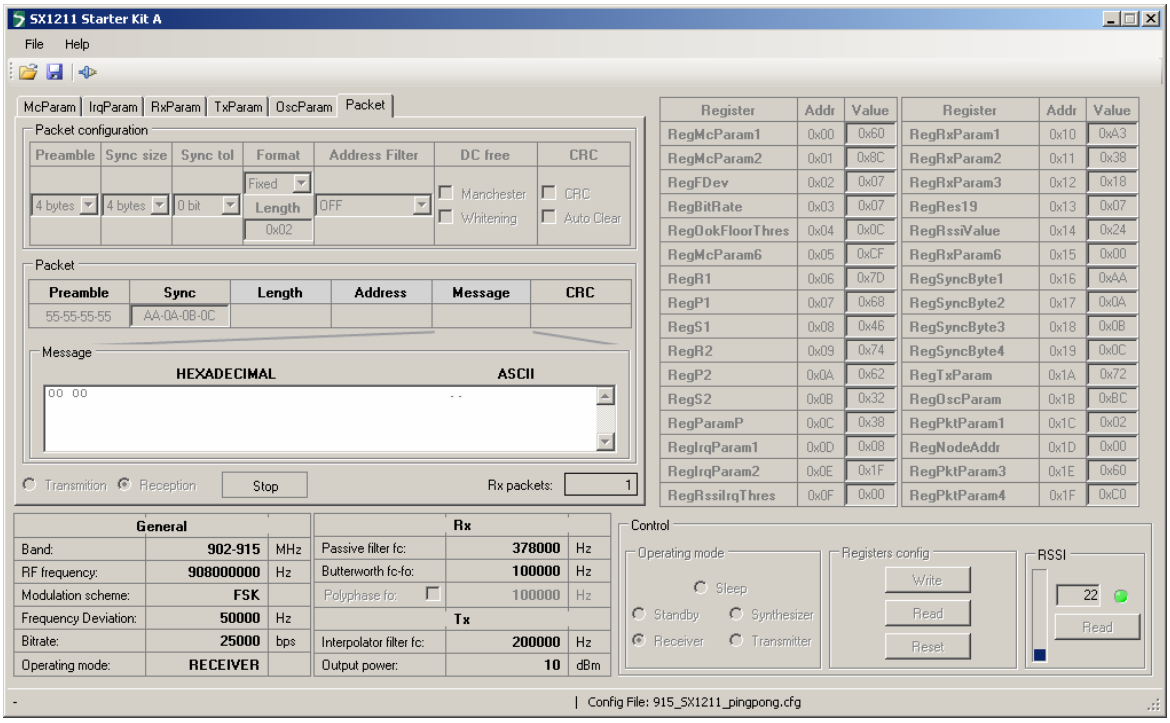


Figure 8. The SX1211SKA User Interface whilst in Packet Receiver Mode

4.2 SX1230SKA Quick Start

1. Plug the SX1230SKA into the USB port of the computer.

2. Run the SX1230 User Interface software Start > All Programs > SX1230SKA > SX1230SKA

3. The SX1230SKA should connect automatically to the User Interface Software. If not, then click on the USB connect short-cut button, located in the top left hand corner of the window.

4. Once connected the SX1230SKA shows the default configuration of the SX1230 register settings upon power-up (see *Figure 9*).

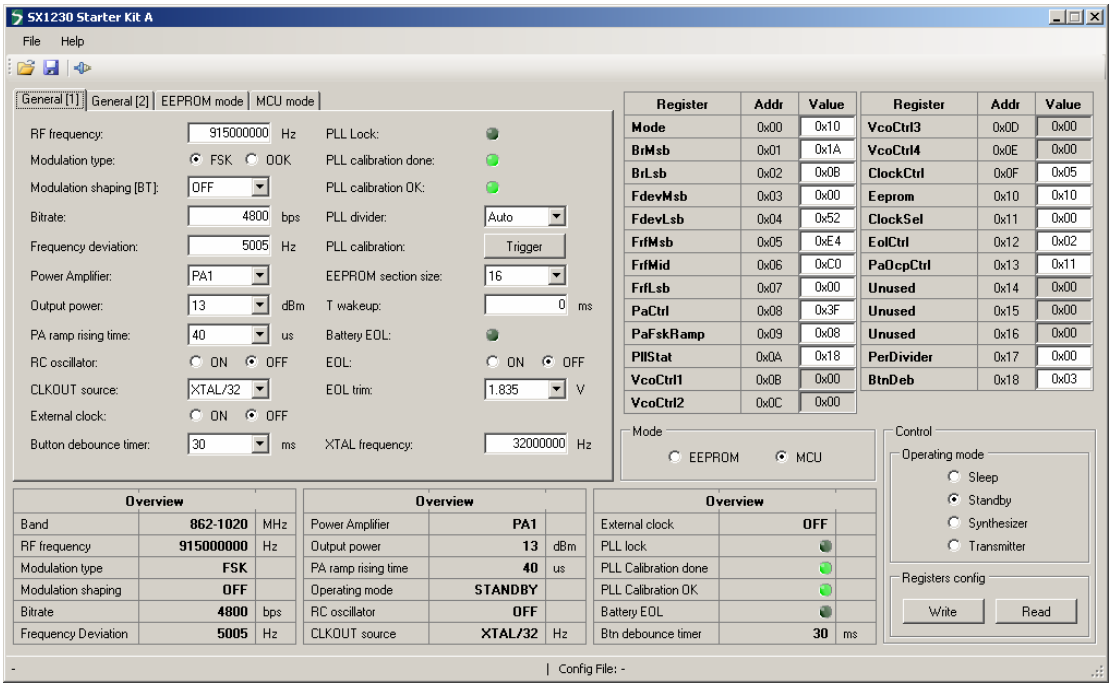


Figure 9. SX1230 User Interface, Default Settings

5. The settings for communication between SX1211SKA and SX1230SKA are located on the installation CD-ROM provided with the kit. Use the File > Open from the menu bar, or the open short-cut button to load a configuration file.

6. Load the "XXX_SX1230_pingpong.cfg" file from the "SX1230 Demo Files" folder on the CD-ROM. Where XXX corresponds to the frequency band of the SX1230SKA (either 868 or 915 MHz).

7. The display will then appear as shown in Figure 10*Figure 7*. These are the link parameters which match those which will be programmed to the SX1211SKA.

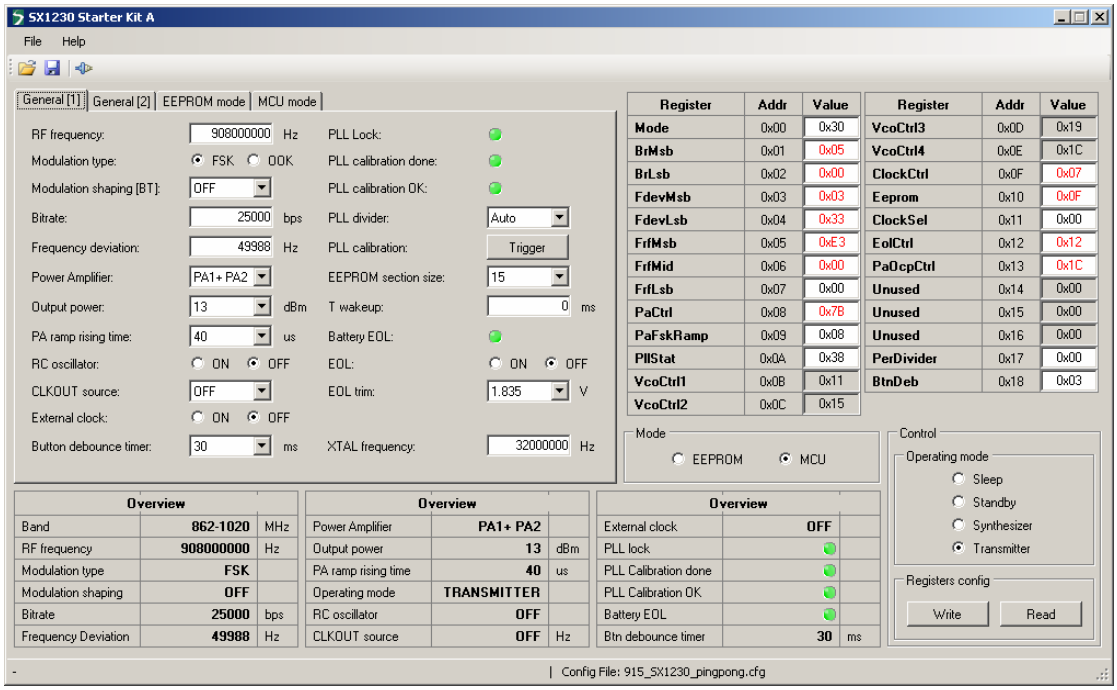
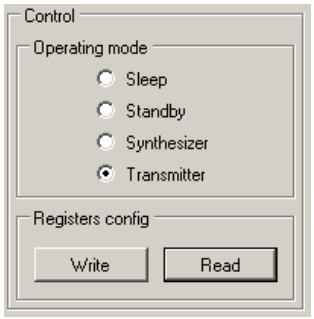


Figure 10. The New SX1230 Configuration: Ready to be Written

8. By clicking on the write button in the 'Registers config' section, the new register values are written to the SX1230 registers. If successful, the red values in the hexadecimal register summary table will turn black. As a double check, the register read button may be pressed – the values presented on the user interface should remain unchanged.



9. Once successfully configured, the SX1230 must be placed in packet transmission mode. This is done by selecting the 'MCU mode' tab – note that a pre-configured frame format identical to that for the SX1211SKA is already entered into the display. It suffices simply to click on the 'Start' button to begin continuous transmission of this frame. For clarity a screenshot illustrating the display during transmission is shown in Figure 11.

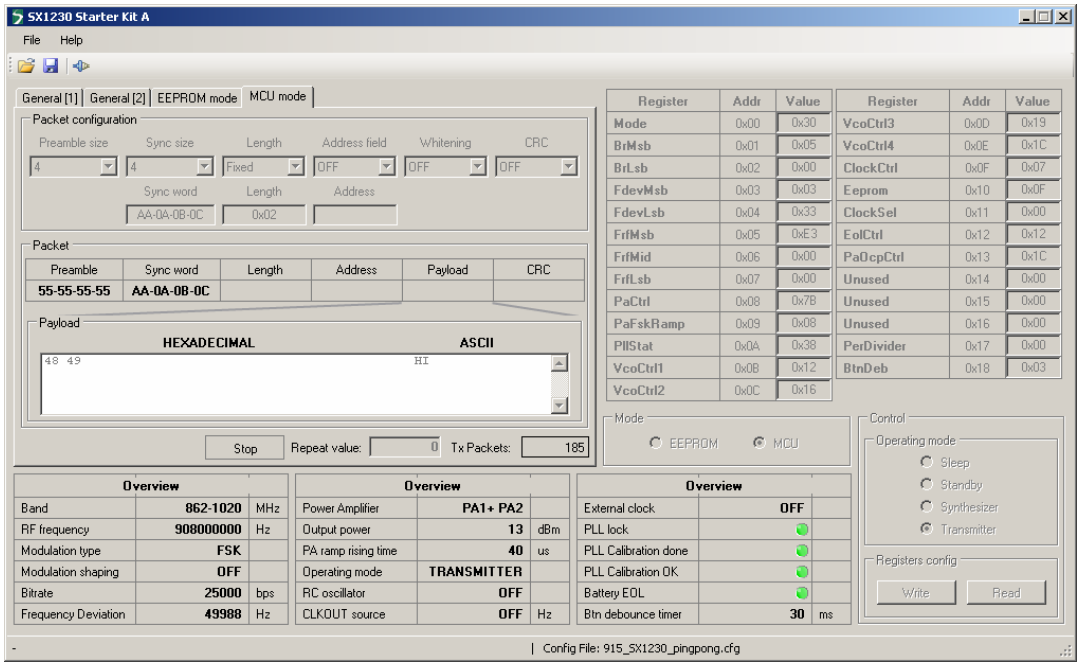


Figure 11. SX1230 During MCU Mode Packet Transmission

4.3 Link Test

With both devices configured as described in the preceding two sections, reception of valid packets by the SX1211 should be visible. Note that during link testing be sure that the USB kits are separated by several cm. Note also, that it is possible to install the SX1211SKA user interface on one machine and the SX1230 SKA user interface on another allowing range test evaluation with full control over the link parameters.

Where a pair of computers is not available, the SX1230SKA can be configured in stand alone mode. Please see the next section for a quick start guide on operation of the SX1230SKA in this mode.

5 Quick Start Guide: Stand Alone Mode

5.1 SX1211SKA Configuration

Initiation of the SX1211SKA for operation in Stand Alone Mode is identical to that described in Section 4.1. Please configure the SX1211SKA as described therein and refer to the following section for configuration of the SX1230.

5.2 SX1230SKA Configuration

There are a few simple steps to follow to configure the SX1230SKA for stand alone mode operation. Figure 12 shows both top and bottom views of the SX1230SKA hardware. The SX1230SKA companion EEPROM comes pre-programmed with a band specific configuration file already loaded.

1. Insert the CR2032 button cell into the cell holder (1), taking care to respect the polarity. Note that there is some quiescent current drain caused by the USB interface, so to maximise battery life ensure this is removed when not in use.

2. Three of the four push buttons (labeled 0 to 3 on the PCB silkscreen) are connected to the general purpose digital inputs of the SX1230. The button labeled 3 is configured as a reset button. Push this button following connection of the cell. There should now be no LEDs illuminated on the SX1230SKA.

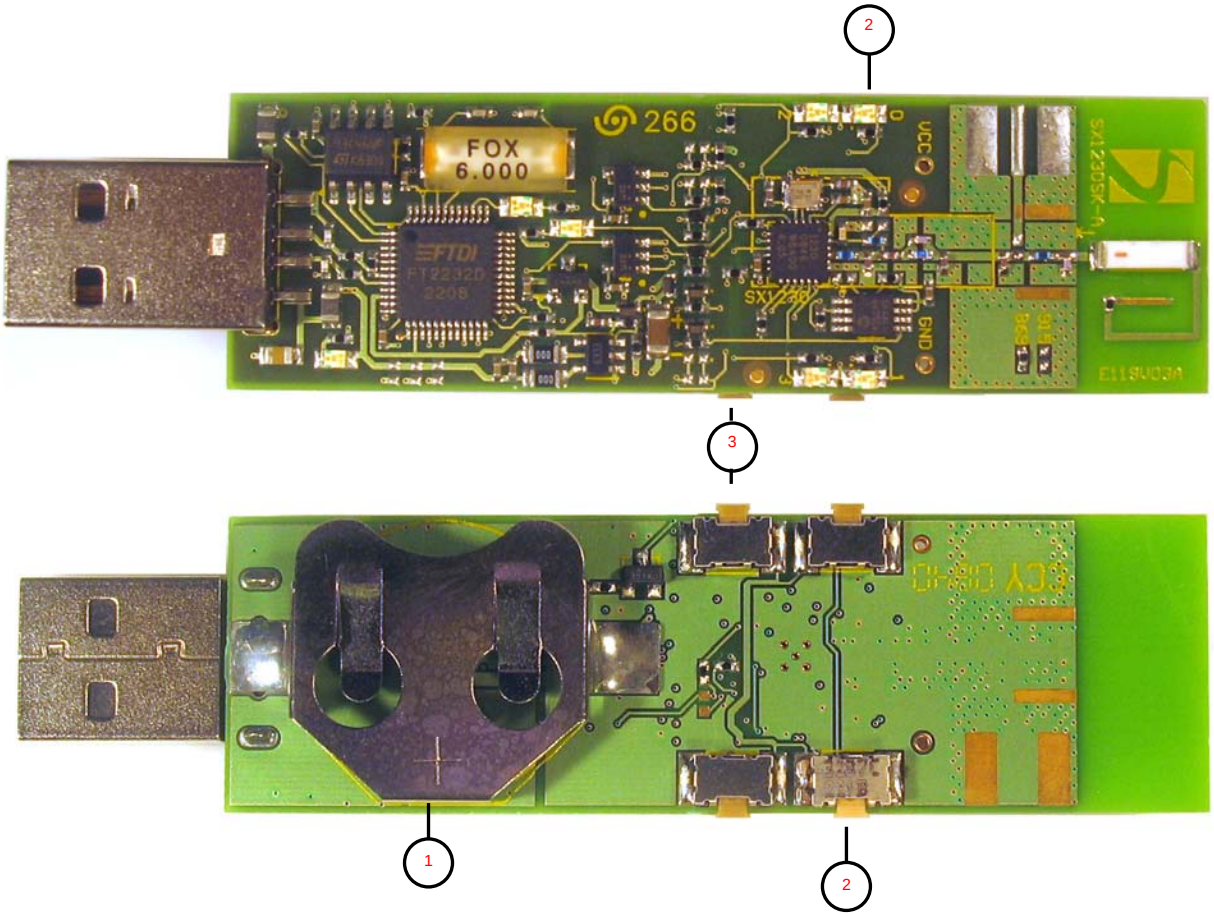


Figure 12. Hardware for E^{2}PROM (Stand Alone) Operation

3. The SX1230SKA is not ready to be used in conjunction with the SX1211SKA in frame reception mode, as described in Section 4.1.

5.3 Link Test

Each push button has the same payload mapped to it. Push button 0 transmits this single, standard format frame, once. Push button 1 has a demonstration of packet repetition. Here the packet is programmed to be resent five times. Note that the SX1211SKA may not receive all five frames successfully. This is due to the time required to empty the FIFO, whereas SX1230 will transmit all five frames in quick succession. Finally, push button 2 gives a demonstration of periodic mode. Here the frame is configured to repeat several times a second whilst the push button is held down.

To modify the E^2PROM contents please see Section 6.7. Note also that the original quick start configuration is included on the CD. Please also refer to Section 6.7 on how to load a non-volatile memory configuration file and program the E^2PROM.

Otherwise, guidance for performing link testing is the same as that already given in Section 4.3.

6 SX1230SKA Software Description

6.1 Overview

Figure 13 shows the SX1230SKA graphical user interface (GUI). Each of the numbers surrounding the display corresponds to the Chapter within this section gives the description of that feature.

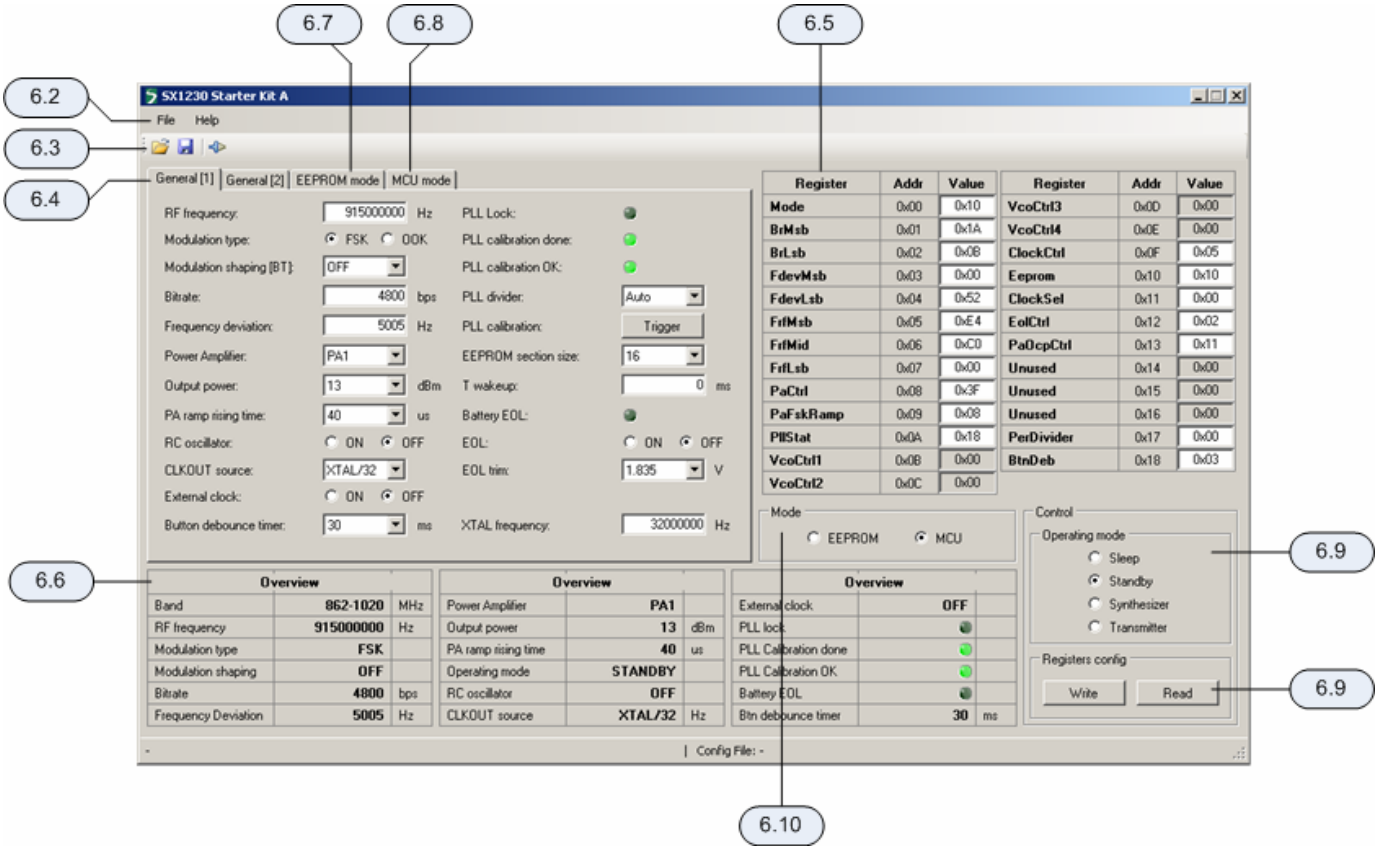
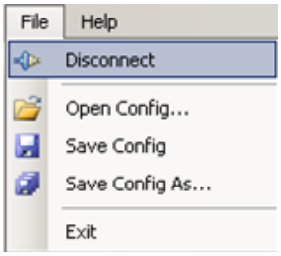


Figure 13: SX1230SKA GUI Overview and References to the User Guide Description of this Chapter.

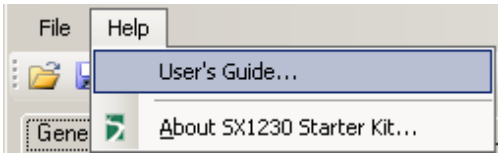
6.2 File Menu



File menu contains some general purpose functions. The first feature in the list provides the possibility of connecting or disconnecting to the USB kit. Care must be taken to ensure that the USB port is closed before unplugging the USB kit. This functionality may also be accessed through the short cut buttons (see Section 6.3).

The possibility of opening configuration files and saving the present configuration is also provided. This is done through a standard Windows file dialog box.

The Help menu contains two menu items. The first item provides a link to this user guide in PDF format. The second, 'About SX1230 Starter kit…', gives information in the revision of the software installed.



6.3 Shortcut Buttons

The shortcut buttons provide identical functionality to those listed under the file menu

The configuration 'file open' shortcut button. This opens a windows file dialog box to allow access to previously saved SX1230 register configuration files.

The 'save' configuration file shortcut button immediately saves and overwrites the existing configuration file.

The 'connect / disconnect' button allows the user to manage manually connection and disconnection of the kit. Note that any time the SX1230SKA is to be removed from the system; the kit must first be disconnected.

The saved configuration files are designed to be a useful tool for embedded software development. The file can be opened in any text editor to display the programmed register name, address and hexadecimal value programmed to that address.

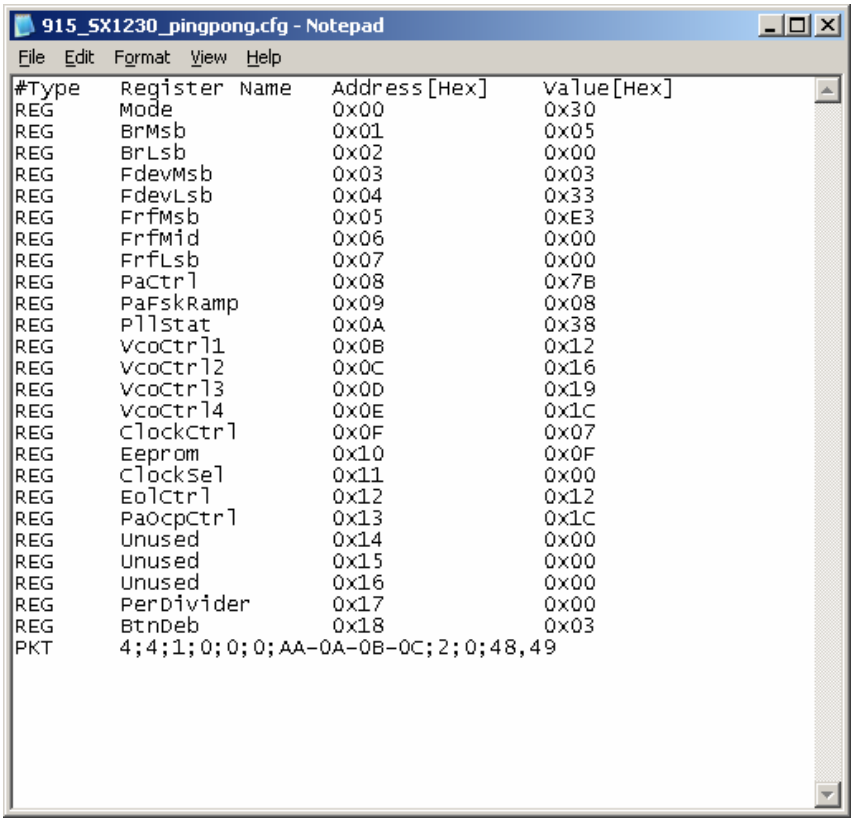


Figure 14. Example Text Editor Output of the SX1230 Configuration File

6.4 General Configuration Tabs

For clarity and ease of use the general configuration settings have been split between two tabs.

6.4.1 General [1]

The most commonly used configuration parameters are located on the General [1] tab. Each field is directly editable by the user and is refreshed every time a register read or write is performed.

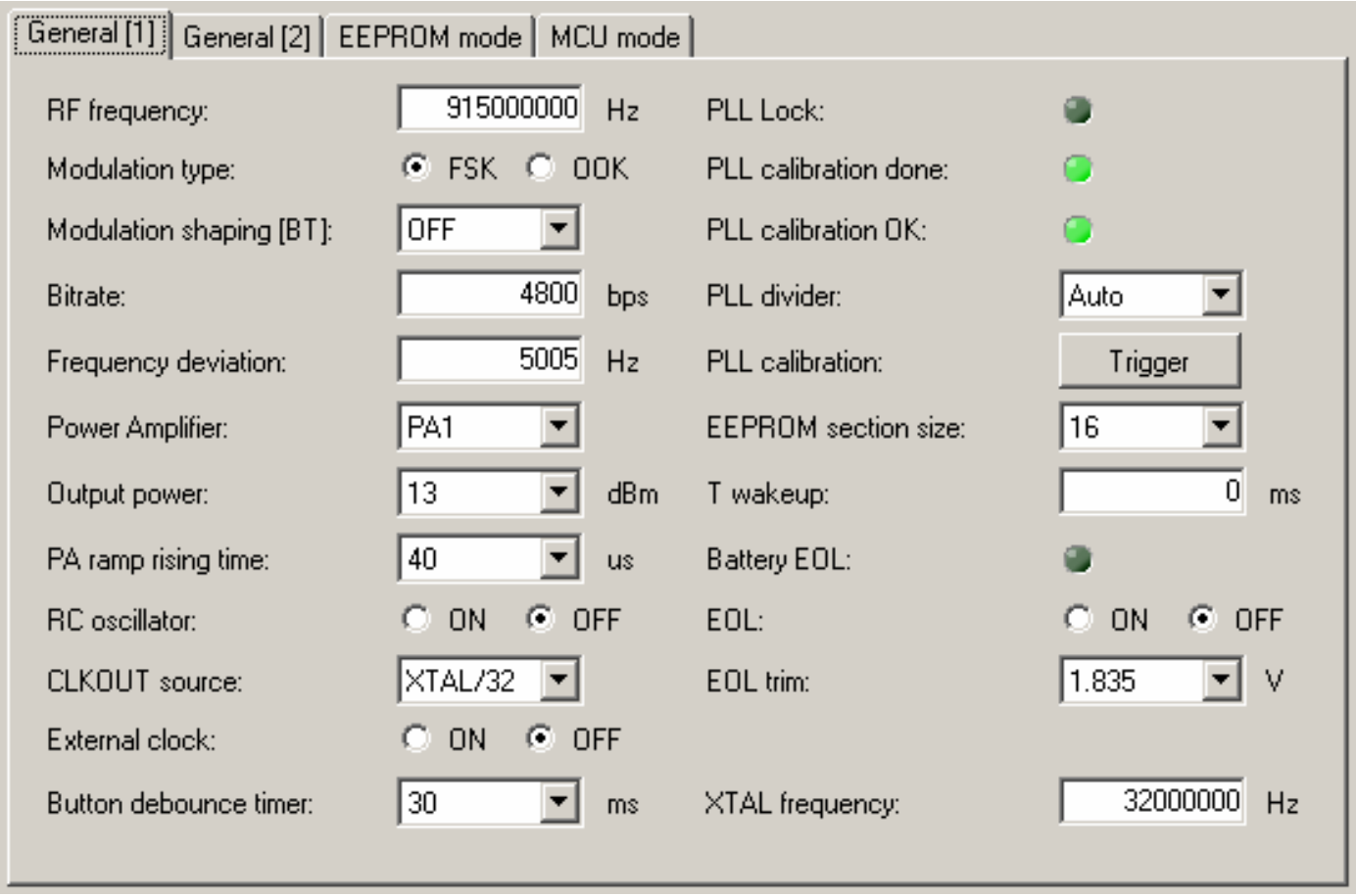


Figure 15. The General Configuration Tab Features the most Commonly Used Configuration Parameters

Where the data entry field allows direct keyboard entry, the following background highlight conventions are used to aid the user in their choice of programmed value:

An orange background highlight indicates that the precise value entered into the data entry field is not directly addressable by the SX1230. Instead the closest (rounded) value will be used.

Conversely a red background highlight indicates where the maximum or minimum value for that register parameter has been exceeded.

Each data entry field and user control of the General [1] tab is described below.

RF Frequency

The RF frequency field accepts a numerical text input from the keyboard. Values in any one of the three frequency bands from 862 to 1020 MHz are permitted. Please note that the entry units are Hz.

Modulation Type

The SX1230 is capable of both FSK and OOK modulation, they are selectable through the user interface by clicking with the mouse on the appropriate radio button.

Modulation Shaping

The Tx bit-stream may be pre-filtered before modulation. Varying strengths of filtering are accessible. The filter type also depends upon the type of modulation used. Filter coefficients are selectable from a drop-down menu.

Bitrate

The bit rate of the transmitted signal (in bps) can be directly edited in this data entry field.

Frequency Deviation

Text entry field for the frequency deviation when using FSK modulation.

Power Amplifier

Selection of single (low power) or dual (high power) operation. Note that PAs 1 and 2 must be enabled for +17 dBm operation.

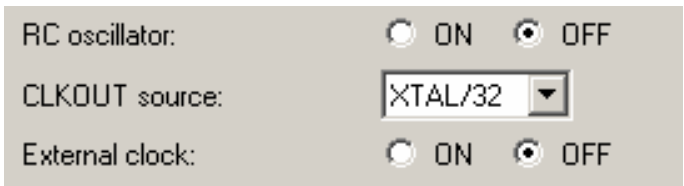
Output Power

The output power is selectable from a drop down list in the programmable 1 dB increments.

PA Ramping

The PA ramp rise time is selectable from the list of programmable values.

Oscillator

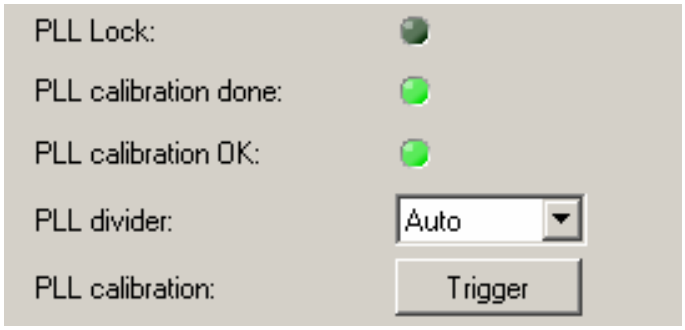


Although not directly accessible from the SX1230SKA, for completeness, the source of the clock output signal can be selected and its frequency altered in accordance with the range of programmable divider values. For more information please consult the SX1230 datasheet.

Push Button Debouncer

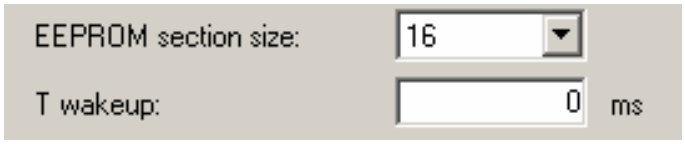
The four general purpose digital inputs – here connected to the four push buttons – has a variable debounce timer. Several common values are accessible from a drop down menu.

PLL Lock Detection Parameters



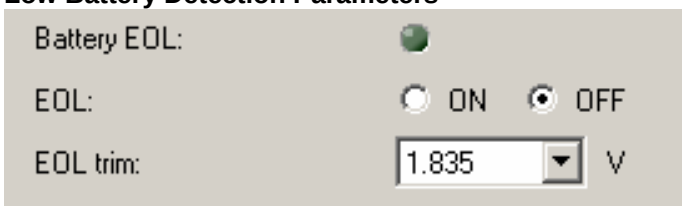
Three LED type indicators display the status of the SX1230 following the last register read cycle of the SX1230. Various options exist for changing the PLL divider ratio and triggering PLL calibration. Please consult the SX1230 datasheet for a more detailed description.

E^2PROM Mode Parameters



These two register settings are used to determine the size of each section in the E^2PROM memory and the wake-up time if periodic mode is enabled respectively. Please see Section 6.7, in conjunction with the SX1230 datasheet, for a description of how to use these E^2PROM parameters.

Low Battery Detection Parameters



The battery end of life (EOL) indicator is set if the EOL is enabled (here controlled by a radio button input) and the supply voltage passes the corresponding threshold – EOL trim.

Crystal Frequency

Most of the programmable communication setting parameters are a function of the crystal frequency used. This field allows other crystal frequencies to be tried, however, the SX1230SKA comes fitted with a 32 MHz crystal. The value should hence not be changed.

6.4.2 General [2]

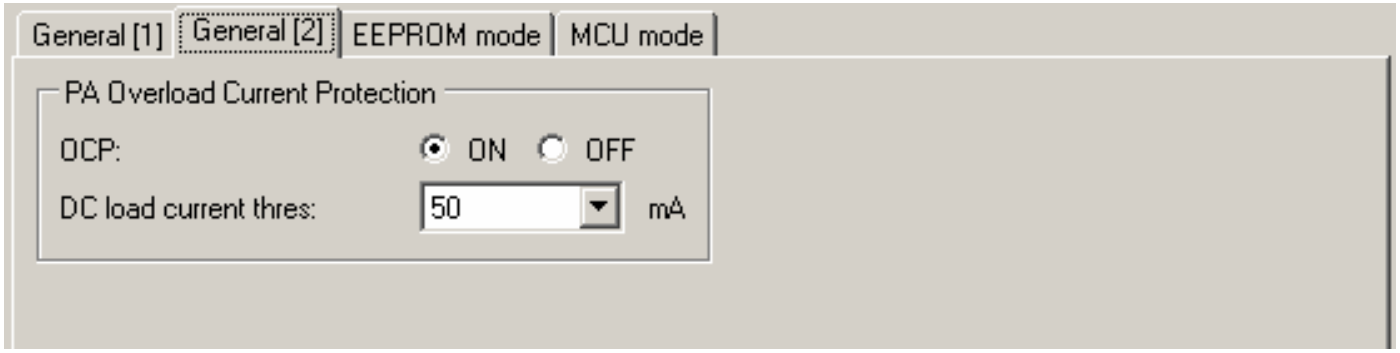


Figure 16. Second Page of the General Configuration Parameters

The second page of general configuration settings (see *Figure 16*) contains the user inputs for enabling of the power amplifier over current protection (OCP) and setting the current limit from a drop down menu. The current limit must be increased to 100 mA or higher for operation of the SX1230 at the maximum output power of +17 dBm.

6.5 Register Hexadecimal Display

Figure 17 shows the register summary of the SX1230. In addition to manual user entry in the fields described in the previous section, direct hexadecimal entries may be made into the register display. Note that values yet to be written to the SX1230 registers appear in red. Note, also, that for full control flexibility, incorrect (red) values entered in the hexadecimal section *will still be written* in the event of a register 'write'. So care must be exercised when editing the hexadecimal values.

Register	Addr	Value	Register	Addr	Value
Mode	0x00	0x10	VcoCtrl3	0x0D	0x19
BrMsb	0x01	0x1A	VcoCtrl4	0x0E	0x1C
BrLsb	0x02	0x0B	ClockCtrl	0x0F	0x05
FdevMsb	0x03	0x01	Eeprom	0x10	0x10
FdevLsb	0x04	0x52	ClockSel	0x11	0x00
FrfMsb	0x05	0xE4	EolCtrl	0x12	0x12
FrfMid	0x06	0xC0	PaOcpCtrl	0x13	0x1B
FrfLsb	0x07	0x00	Unused	0x14	0x00
PaCtrl	0x08	0x3F	Unused	0x15	0x00
PaFskRamp	0x09	0x08	Unused	0x16	0x00
PllStat	0x0A	0x10	PerDivider	0x17	0x00
VcoCtrl1	0x0B	0x12	BtnDeb	0x18	0x03
VcoCtrl2	0x0C	0x16			

Figure 17. Register Hexadecimal Display

Note that values changed in this portion of the display cause the values in the tabbed configuration section to be changed dynamically.

6.6 Overview Panel

A summary of the values presently entered into the user interface software is shown in the overview display at the bottom of the screen. This covers all of the SX1230 register values, including those not displayed on the tab presently selected, and indicates the true value which will be written to the SX1230 configuration registers.

Overview		
Band	862-1020	MHz
RF frequency	915000000	Hz
Modulation type	FSK	
Modulation shaping	OFF	
Bitrate	4800	bps
Frequency Deviation	5005	Hz

Overview		
Power Amplifier	PA1	
Output power	13	dBm
PA ramp rising time	40	us
Operating mode	STANDBY	
RC oscillator	OFF	
CLKOUT source	XTAL/32	Hz

Overview		
External clock	OFF	
PLL lock		
PLL Calibration done		
PLL Calibration OK		
Battery EOL		
Btn debounce timer	30	ms

Figure 18. The Configuration Overview Display

6.7 E²PROM Mode Tab

The E²PROM mode tab is used to configure the contents of the E²PROM for stand alone mode operation of the SX1230SKA. In this mode the SX1230 acts as SPI master and can download both configuration and payload information from an SPI E²PROM. The E²PROM memory map is shown below:

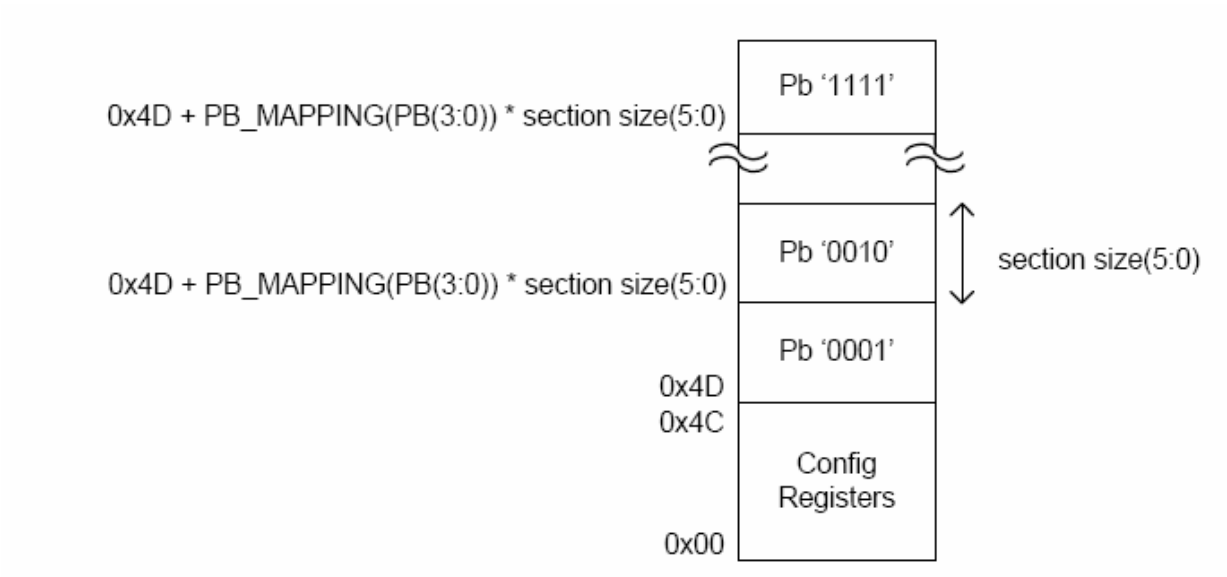


Figure 19. E²PROM Memory Mapping

The bottom 0x4C locations in the E²PROM are reserved general configuration information – configuration which is the same for every button press. The subsequent sections are then mapped to the remaining 15 possible combinations of the 4 digital inputs (for mapping details please see the SX1230 datasheet). These may contain either i) solely payload or ii) a combination of supplementary configuration information and payload.

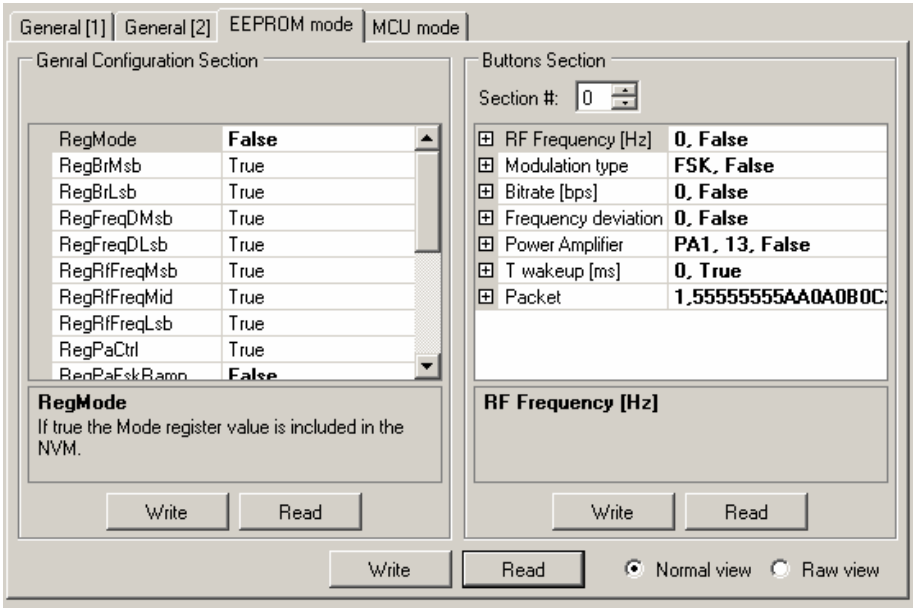


Figure 20. The E²PROM Mode Tab 'Normal View'

The E²PROM mode display is broken down into two types, selectable by the radio button control in the bottom right hand corner of the display. The default is 'Normal view' which shows the E²PROM contents in human readable format (see Figure 20). The left hand 'General Configuration Section' dictates which registers are to be written to the general configuration section – True indicating that the value will be written, False that it will not. The values written to the configuration section are taken from the General setting tabs of Sections 6.4.1and 6.4.2. The general configuration settings may be read or written independently of the rest of the E²PROM contents by clicking the Read or Write button within the section.

The rightmost frame contains the contents of each of the input specific sections. The contents of a particular section are displayed individually. The section may be changed by entering the desired section in the 'Section #:' input. Several useful common parameters and the payload itself are listed within the 'Buttons' section. Each can be edited directly. The input specific section of the E²PROM memory can be written or read independently of the rest of the E²PROM contents by clicking on the write or read button within the Buttons Section.

At the bottom of the display are the controls for global read or write of the E²PROM contents. These cause the whole E²PROM to be read or written, respectively.

The radio button control in the bottom right hand corner allows selection between Normal and Raw views of the E²PROM contents.

An alternative perspective of the E²PROM contents is available in 'Raw view', illustrated in Figure 21. Here we see the E²PROM contents in hexadecimal (centre column) and ASCII (right column) versus the E²PROM address in hexadecimal (left column) in tabular format. Note also the addition of several short-cut buttons. These allow the user to save or recall E²PROM (.NVM – non volatile memory) files to or from disc storage. Copy, cut and paste functionality is also provided.

Once programmed the SX1230 may be disconnected from the USB port, unplugged and used in stand-alone mode. The SX1230SKA comes pre-programmed with an example E²PROM contents (see the quick start Section for more details).

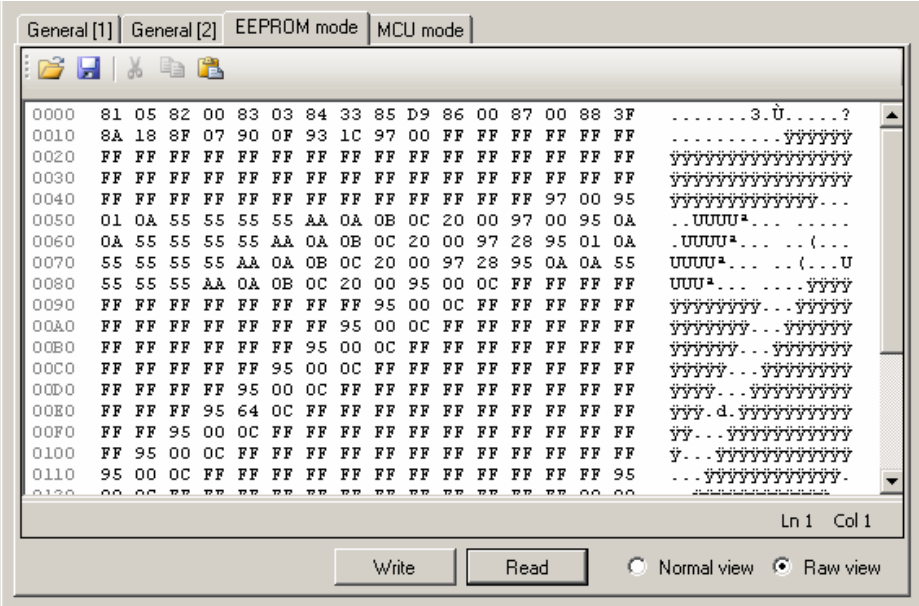


Figure 21. E²PROM Raw View

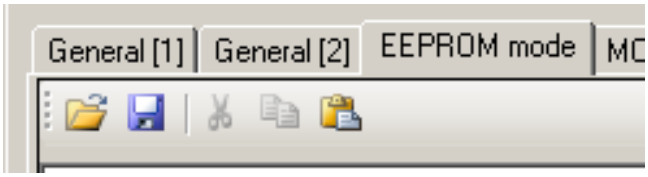


Figure 22. E²PROM Raw View Short-cut Buttons

6.8 MCU Mode Tab

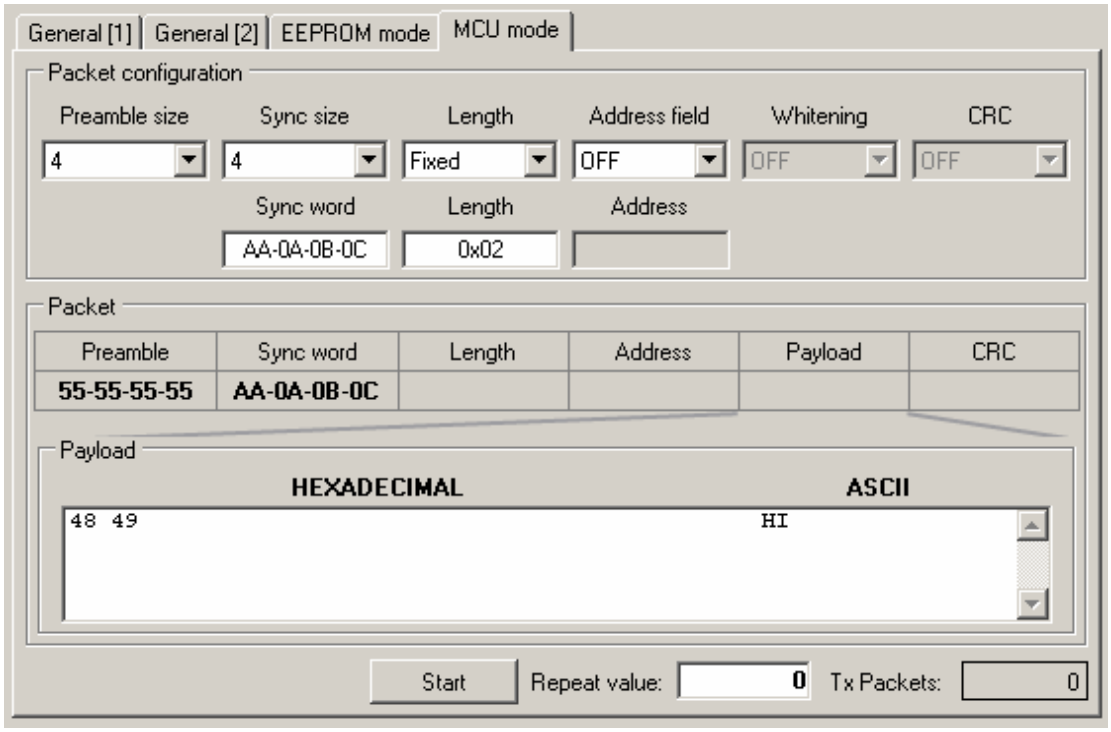


Figure 23. MCU Mode Tab Display

The MCU mode tab allows the user to define a custom packet for transmission by the SX1230SKA. The packet configuration section (top) allows the user enable and set the length of a pulse train preamble (sent at the data rate). A custom syncronisation word of up to 4 bytes may also be added. Fixed or variable length packets may also be stipulated (see the SX1211 datasheet for more information), as may an optional 1 byte address.

With these options entered the constructed packet is shown in the 'Packet' frame. The packet payload may also be edited in either ASCII or hexadecimal. Packet transmission starts when the 'Start' button is pressed. Either infinite transmission (repeat value = 0) or a finite number of packets may be transmitted by editing the repeat value.

6.9 The Mode Control Box

Figure 24. The Control Box

The control box gives access to the operating modes of the SX1230. By selecting one of the radio buttons, the SX1230 is immediately transferred into that mode without the need to read or write to the registers. The control for reading and writing to the registers is also within the control frame. The Read button will read the contents of the SX1230 configuration registers and display them in the hexadecimal, overview and tabbed configuration areas.

Similarly, a register write can be performed by clicking the write button. Here the contents of the hexadecimal display are written directly to the SX1230 configuration registers.

Note that the E^2PROM contents cannot be manipulated from this section instead see Section 6.7.

6.10 MCU / E^2PROM Mode Selection

In the frame labeled 'Mode' either MCU or Stand Alone (E^2PROM) operation can be selected. This allows the stand alone mode to be entered whilst connected to the USB port. Note that transition to and from E^2PROM mode generates a hardware reset (transition cannot be made dynamically) and so the register contents of the SX1230 will be lost upon transition.

7 SX1211SXA Software Description

7.1 Overview

Figure 25 shows the SX1211SKA graphical user interface. Each of the numbers surrounding the display corresponds to the Chapter within this section which corresponds to the description of that GUI feature.

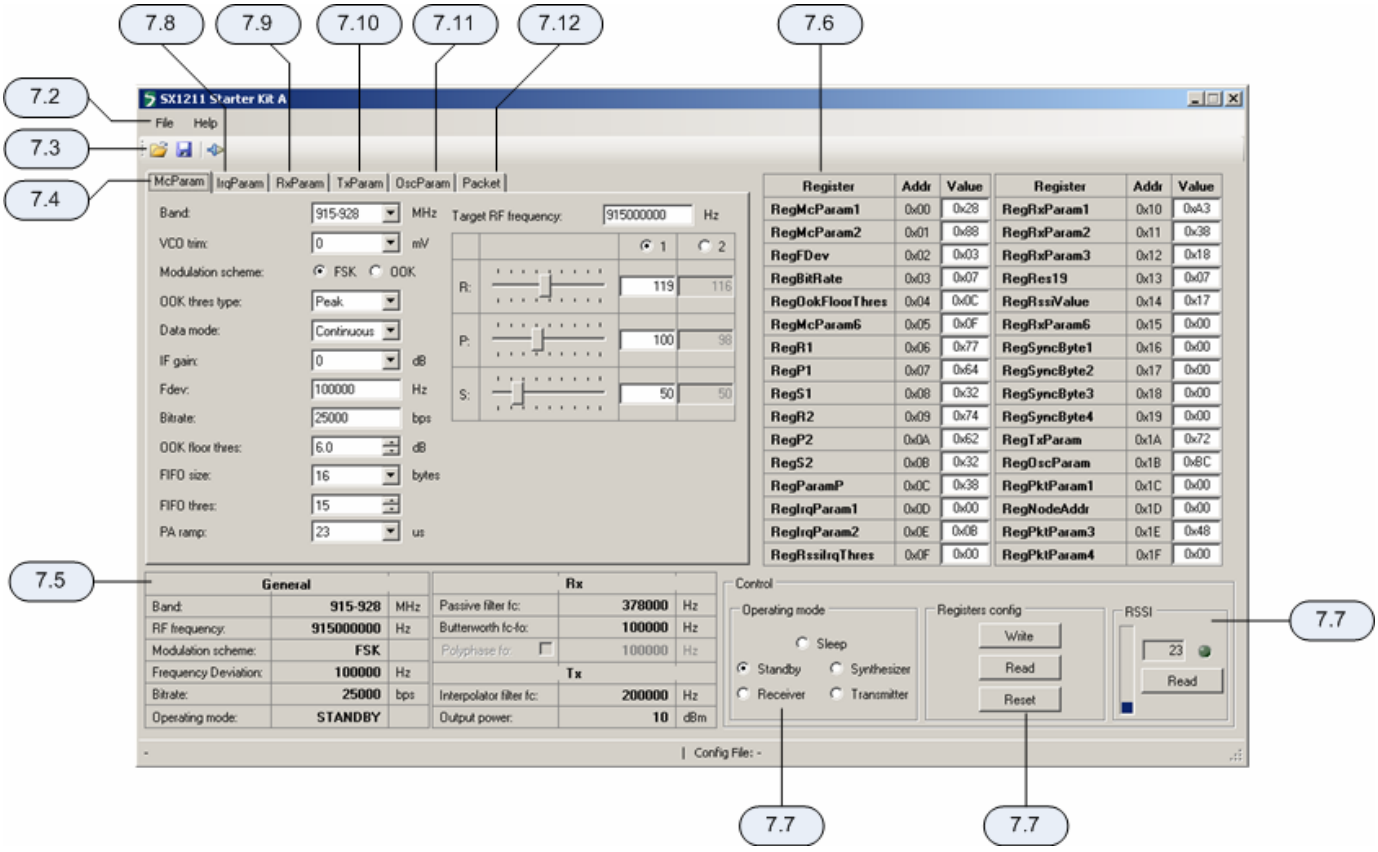
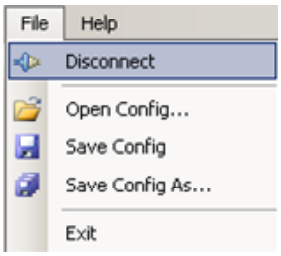


Figure 25. SX1211SKA GUI Overview and References to the User Guide Description of this Chapter

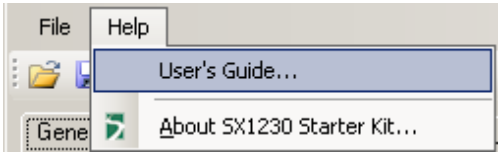
7.2 File Menu



File menu contains some general purpose functions. Some of them can also be accessed on the toolbar by clicking directly on the icon. The first feature in the list provides the possibility of connecting or disconnecting to the USB kit. Care must be taken to ensure that the USB port is closed before removing the USB kit. This functionality may also be accessed through the short cut buttons (see Section 7.3).

The possibility of opening configuration files and saving the present configuration is also provided. This is done through a standard Windows file dialog box.

The Help menu contains two menu items. The first item provides a link to this user guide in PDF format. The second, About SX1230 Starter kit…, gives information in the revision of the software installed.



7.3 Shortcut Buttons

The shortcut buttons provide identical functionality to those listed under the file menu

The configuration file open shortcut button. This opens a windows file dialog box to allow access to previously saved SX1211 register configuration files.

The save configuration file shortcut button immediately saves and overwrites the existing configuration file.

The connect / disconnect button allows the user to manage manually connection and disconnection of the kit. Note that any time the SX1211SKA is to be removed from the system; the kit must first be disconnected.

The saved configuration files are designed to be a useful tool for embedded software development. The file can be opened in any text editor to display the programmed register name, address and hexadecimal value programmed to that address.

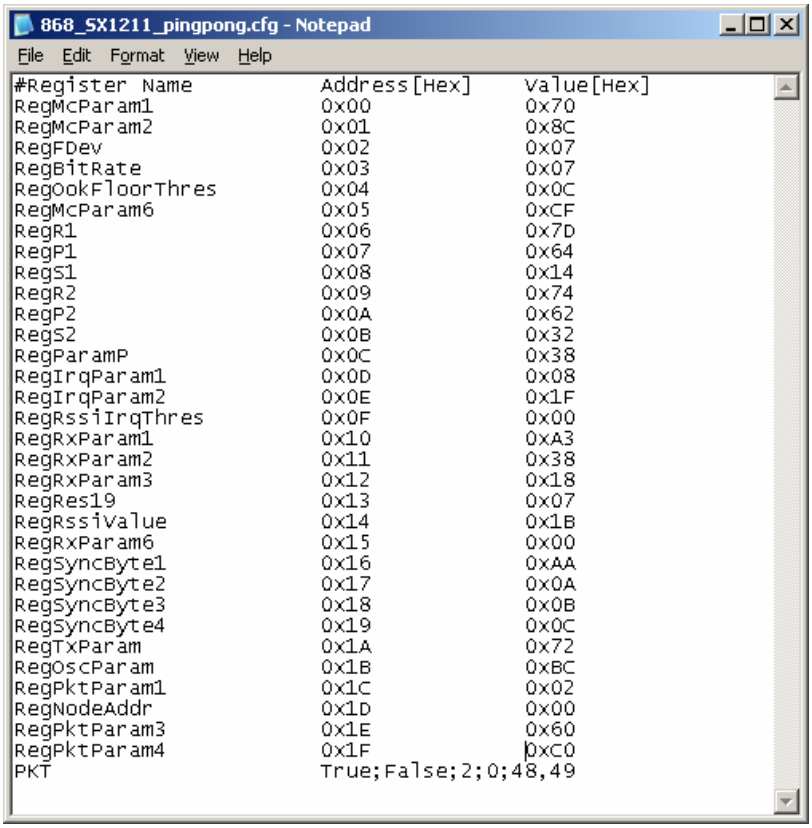


Figure 26. Example Text Editor Output of the SX1211 Configuration File

7.4 McParam Tab

Band Selection

One of the three operating bands for the SX1211 may be selected here. The SX1211SKA hardware is band specific and so the corresponding band should be selected.

VCO Voltage Trim

In some designs the VCO voltage requires trimming. The SX1211SKA reference design does not require this function, but is included here for completeness.

Modulation Selection

The SX1211 is capable of both FSK and OOK modulation, they are selectable through the user interface by clicking with the mouse on the appropriate radio button.

OOK Receiver Detection Type

Several modes of OOK detection are possible, please see the SX1211 datasheet for mode information on configuring the OOK receiver.

Data Mode

Three data modes are available for the SX1211, typically packet mode is selected automatically, requiring no user selection, upon launching the Packet Test (see Section 7.12).

Gain of the IF Stage

The gain of the intermediate frequency amplifier chain can be adjusted manually.

Frequency Deviation

Text entry field for the frequency deviation when using FSK modulation.

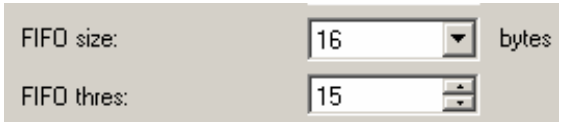
Bit Rate

The bit rate of the transmitted signal (in bps) can be directly edited in this data entry field.

Floor Threshold for OOK Detection

Margin to the OOK demodulation threshold – see SX1211 datasheet for more details.

FIFO Settings

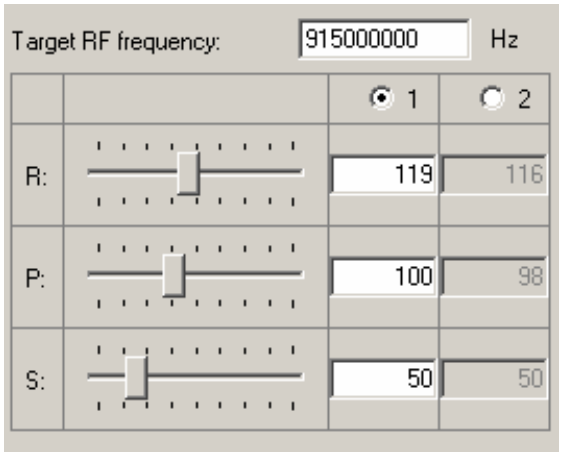


Both the working size of the FIFO and the number of bytes it must store before generating a hardware interrupt are user defined. Again this functionality is largely automated in the packet test mode (Section 7.12).

PA Ramping

The PA ramp rise time is selectable from the list of programmable values.

Frequency of Operation



The frequency of operation of the SX1211 is a set by three frequency divider ratios. (See the illustration below). Based upon the frequency of the crystal oscillator and the values of these divider ratios the local oscillator frequency may be determined.

To simplify this process, the SX1211SKA user interface sees this process completely automated. By entering the desired operating frequency in the text field at the top of the display, the resultant R, P and S divider ratios are calculated (see the SX1211 datasheet for information on their calculation).

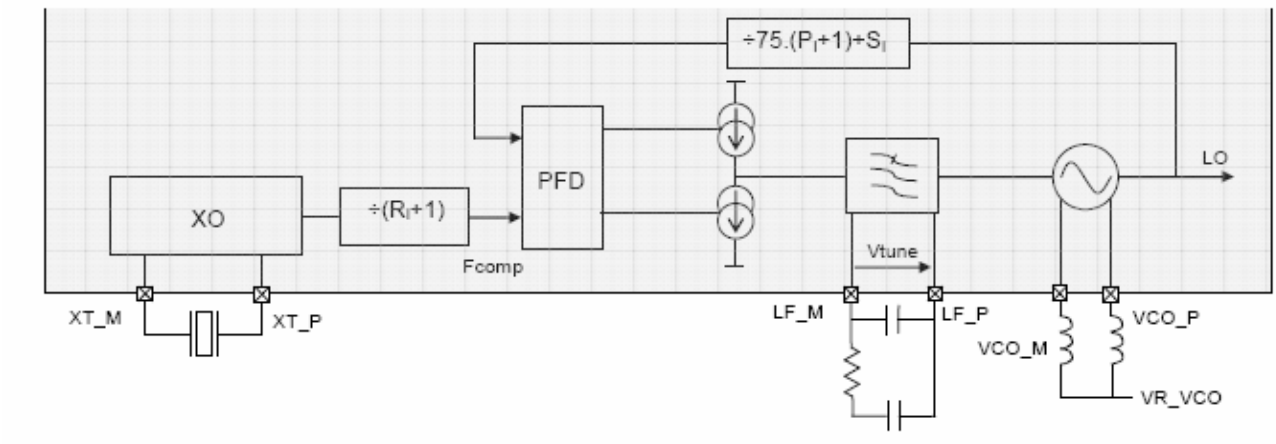


Figure 27. SX1211 Local Oscillator Generation

7.5 Overview Panel

A summary of the values presently entered into the user interface software is shown in the overview display at the bottom of the screen. This is sub-divided into three sections pertaining to: general configuration, transmitter settings and receiver parameters.

General		
Band:	915-928	MHz
RF frequency:	915000000	Hz
Modulation scheme:	FSK	
Frequency Deviation:	100000	Hz
Bitrate:	25000	bps
Operating mode:	STANDBY	

Rx		
Passive filter fc:	378000	Hz
Butterworth fc-fo:	100000	Hz
Polyphase fo: ☐	100000	Hz
Tx		
Interpolator filter fc:	200000	Hz
Output power:	10	dBm

Figure 28. The Overview Panel

7.6 Register Hexadecimal Display

Figure 29 shows the register summary of the SX1211. In addition to manual user entry in the fields described in the previous section, direct hexadecimal entries may be made into the register display. Note that values yet to be written to the SX1211 registers appear in red. Note, also, that for full control flexibility, incorrect (red) values entered in the hexadecimal section *will still be written* in the event of a register 'write'. So care must be exercised when editing the hexadecimal values.

Register	Addr	Value	Register	Addr	Value
RegMcParam1	0x00	0x28	RegRxParam1	0x10	0xA3
RegMcParam2	0x01	0x88	RegRxParam2	0x11	0x38
RegFDev	0x02	0x03	RegRxParam3	0x12	0x18
RegBitRate	0x03	0x07	RegRes19	0x13	0x07
RegOokFloorThres	0x04	0x0C	RegRssiValue	0x14	0x00
RegMcParam6	0x05	0x0F	RegRxParam6	0x15	0x00
RegR1	0x06	0x8F	RegSyncByte1	0x16	0x00
RegP1	0x07	0x79	RegSyncByte2	0x17	0x00
RegS1	0x08	0x14	RegSyncByte3	0x18	0x00
RegR2	0x09	0x74	RegSyncByte4	0x19	0x00
RegP2	0x0A	0x62	RegTxParam	0x1A	0x72
RegS2	0x0B	0x32	RegOscParam	0x1B	0xBC
RegParamP	0x0C	0x38	RegPktParam1	0x1C	0x00
RegIrqParam1	0x0D	0x00	RegNodeAddr	0x1D	0x00
RegIrqParam2	0x0E	0x09	RegPktParam3	0x1E	0x48
RegRssiIrqThres	0x0F	0x00	RegPktParam4	0x1F	0x00

Figure 29. The Hexadecimal Register Display Summary

7.7 The Mode Control Box

The mode control box is sub-divided into three sections. The first 'Operating mode' allows the user to change the operating mode of the SX1211 by clicking on the radio button corresponding to the desired mode. Note that the transition between modes is instantaneous. The centre section, 'Registers config' allows the register settings entered elsewhere in the user interface to be written to the configuration registers of the SX1211 by clicking the write button. The read operation will read the configuration registers and refresh the user interface display with the values read from the SX1211.

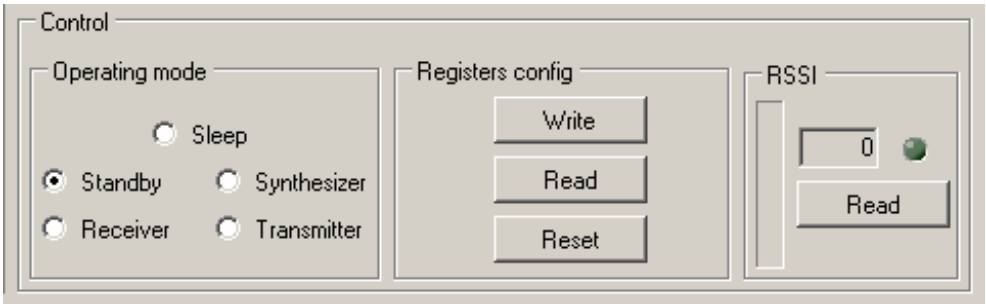


Figure 30. The Mode Control Box also Incorporates RSSI

The third, rightmost, section of the mode control box allows an instantaneous RSSI (received signal strength indicator) measurement. Please note that this feature is only accessible when the SX1211 is in the receiver operating mode.

7.8 The IrqParam Tab

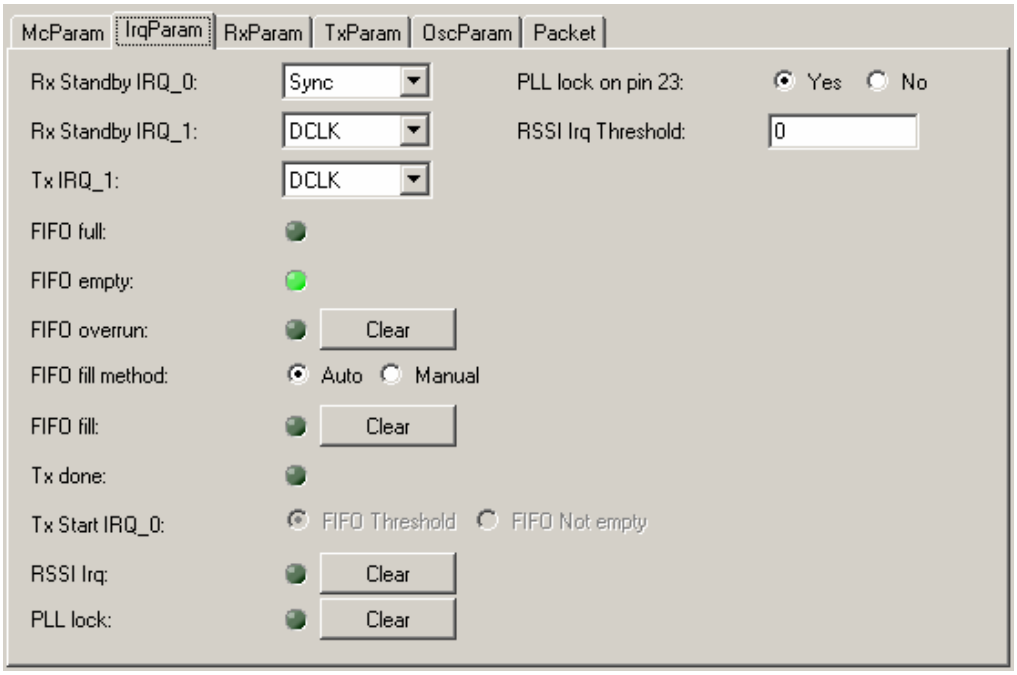


Figure 31. The Interrupt Mapping Display

For total register coverage by the user interface, the interrupt mapping for the SX1211 can be controlled through the configuration of the IrqParam display. Note, however, that the hardware interrupt feature is not used directly by the GUI. For further information please see the corresponding register descriptions in the SX1211 datasheet and the PCB layout and schematics of Section 9.

7.9 The RxParam Tab

The receiver parameter field provides full access to all of the software configurable settings of the SX1211. For reference, a simplified block schematic of the SX1211 receiver is shown in figure Figure 32. The settings configurable in the receiver parameter tab correspond to the programmable baseband receiver functions.

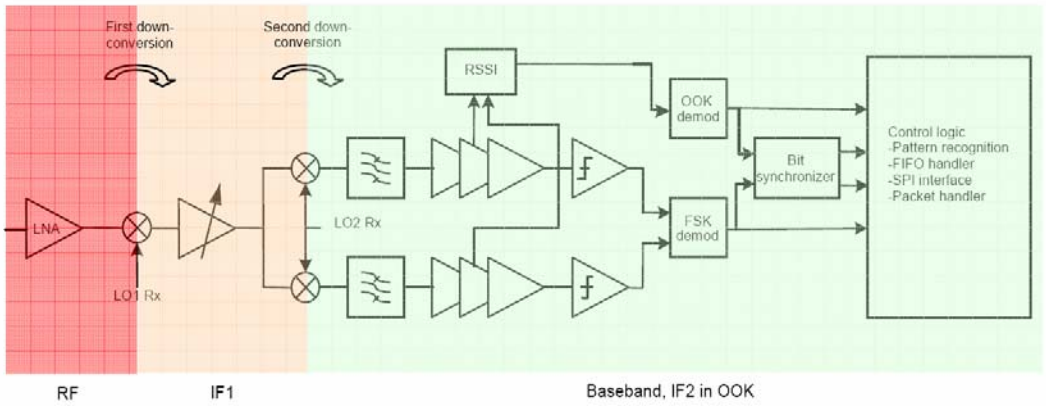


Figure 32. SX1211 Receiver Block Diagram, the Colours Correspond to the Frequency of Operation.

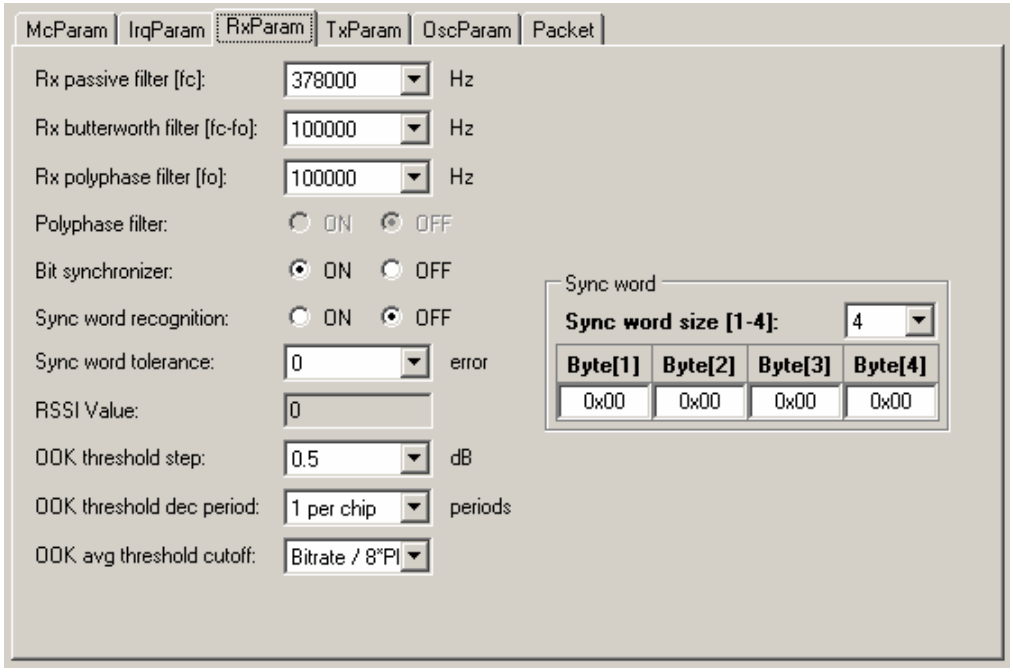


Figure 33. Receiver Parameter Display

For a complete description of the functionality of the receiver section please consult the SX121 datasheet. However, the principle fields of interest for general use are:

Rx Filters:
The first three text entry fields of the receiver parameters correspond to the baseband filtering section. Note that the Butterworth filter is the narrowest of the three filters and determines the receiver channel bandwidth.

Bit Synchroniser:
This block performs timing recovery and synchronises the decision on whether a given bit is logical high or low based upon the received bit stream. This block yields a substantial improvement in receiver sensitivity performance and it is hence recommended that it be left enabled.

Sync Word:
The synchronisation word is applicable to operation in buffered and packet modes. For packet mode operation the sync word is set using the packet editor – this may be found in the 'Packet' Tab (Section 7.12). Link testing by the SX1211SKA is done in packet mode only – sync word provision is made here for completeness.

OOK Settings:
OOK demodulation is based upon measurements from the RSSI block and there are a rich variety of settings for how the OOK signal is detected and processed. These techniques and the corresponding settings are given a detailed treatment in the SX1211 datasheet.

7.10 The TxParam Tab

The transmitter configuration of the SX1211 is shown in Figure 34. This shows that the modulating signal is generated by direct digital synthesis (DDS), unconverted through the superheterodyne mixer stages and then amplified by a power amplifier chain.

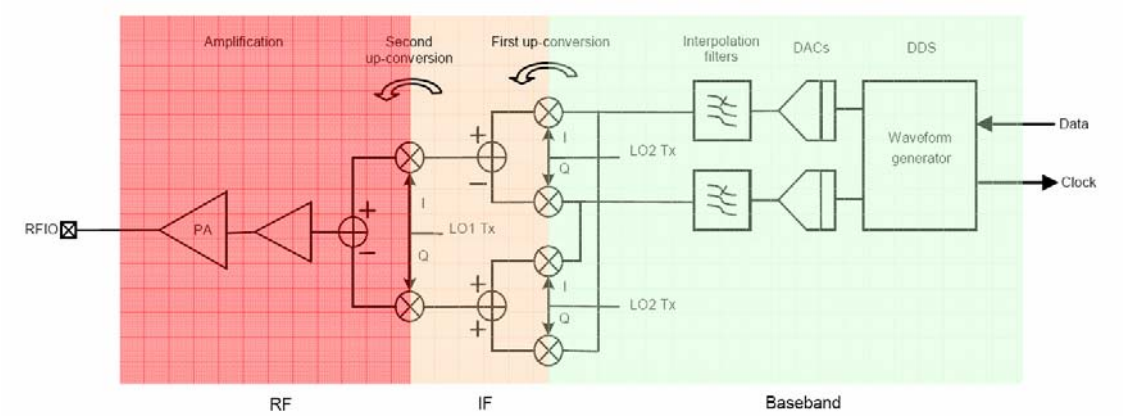


Figure 34. SX1211 Simplified Transmitter Block Schematic Diagram

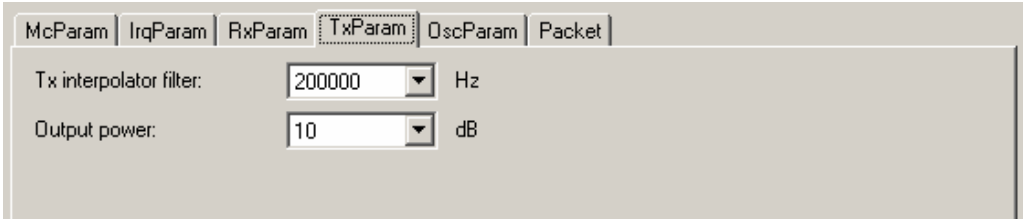


Figure 35. The Transmitter Parameter Tab Display

The two parameters which are configurable for transmit operation of the SX121 are:

Output Power:
The output power of the SX1211 can be programmed in 3 dB steps. Valid programmable powers are selected from a drop-down list of valid values.

Interpolation Filter Setting:
The DDS output requires filtering to remove the spurii common in the generation of signals through this technique; this is performed by the interpolation filters. The cut-off frequency of the interpolation filters can be selected from the drop down menu of valid values. The technique for calculating the cut-off frequency may be found in the SX1211 datasheet.

7.11 The OscParam Tab

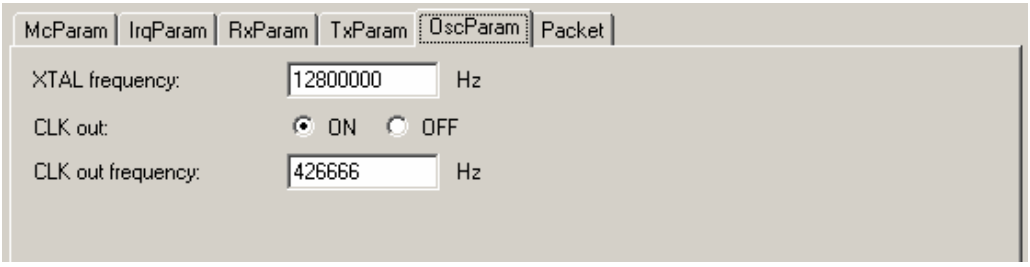


Figure 36. The Oscillator Parameter Display

The oscillator parameter display gives access to the clock output functionality. This can be enabled or disabled and the frequency changed by entering a value in the 'CLK out frequency' text field. Note also that there is provision to change the frequency of the crystal. Changing of the crystal frequency has a knock on effect on all parameters that are a function of the reference frequency, for example bit rate, filter settings, RF output frequency. The SX1211SKA is fitted with the 12.8 MHz crystal recommended in the SX1211 reference design. For this reason the crystal value should, typically, be left unchanged.

7.12 The Packet Test Tab

The 'Packet' tab is the principle interface for conducting transmission or reception testing. The display, as shown in Figure 35 is divided into three horizontal portions. The top portion of the display is given to the packet editor. Here the configuration of the packet, either to be transmitted or received by the SX1211SKA is constructed.

The packet layout contains all of the features described in the SX1211 datasheet. This includes:

Preamble
This input allows the user enable and set the length of a pulse train preamble (sent at the data rate).

Sync word size
A custom syncronisation word of up to 4 bytes may also be added.

Sync tol
The number of errors which may be accommodated in the sync word (bits), before the packet is rejected.

Format / Length / Address
Fixed or variable length packets may also be stipulated (see the SX1211 datasheet for more information), as may an optional 1 byte address.

Digital Coding
Optional channel coding including CRC, data whitening and Manchester coding are also available.

With these options entered the constructed packet is shown in the 'Packet' frame. Where the SX1211SKA is to be used in transmit mode, the packet payload may also be edited in either ASCII or hexadecimal. Packet transmission

is enabled by selecting the 'Transmission' radio button. This starts when the 'Start' button is pressed. Either infinite transmission (repeat value = 0) or a finite number of packets may be transmitted by editing the repeat value.

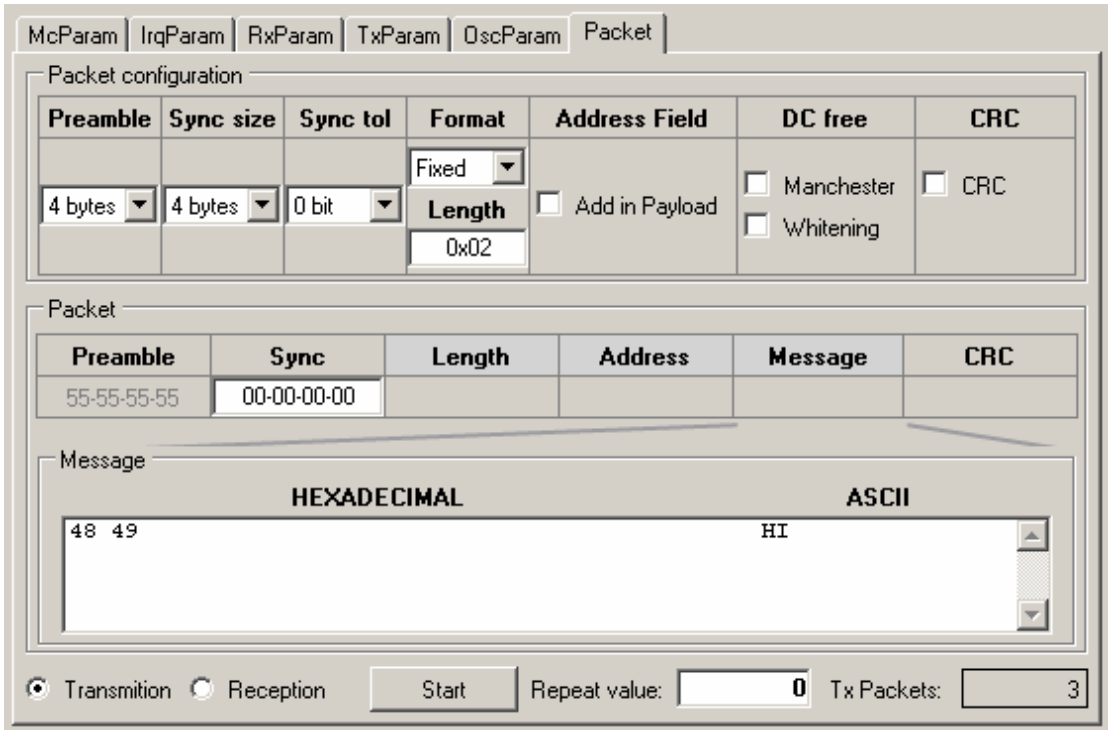


Figure 37. The Packet Receiver / Transmitter Test Display

For receive mode, the normal mode of operation in conjunction with the SX1230SKA, the reception the 'Reception' radio button is selected and the start button pressed. From this moment the SX1211 is placed in receive mode and listens continuously for a packet corresponding to the format entered in the packet editor. Upon successful reception, the payload received is shown in the 'Message Box' and the number of received packets is incremented. For indication of the signal strength received by the SX1211SKA, the RSSI display (see Section 7.7) is activated and continuously refreshed.

By way of example, Figure 38 shows the entire user interface display whilst receiving a valid packet payload.

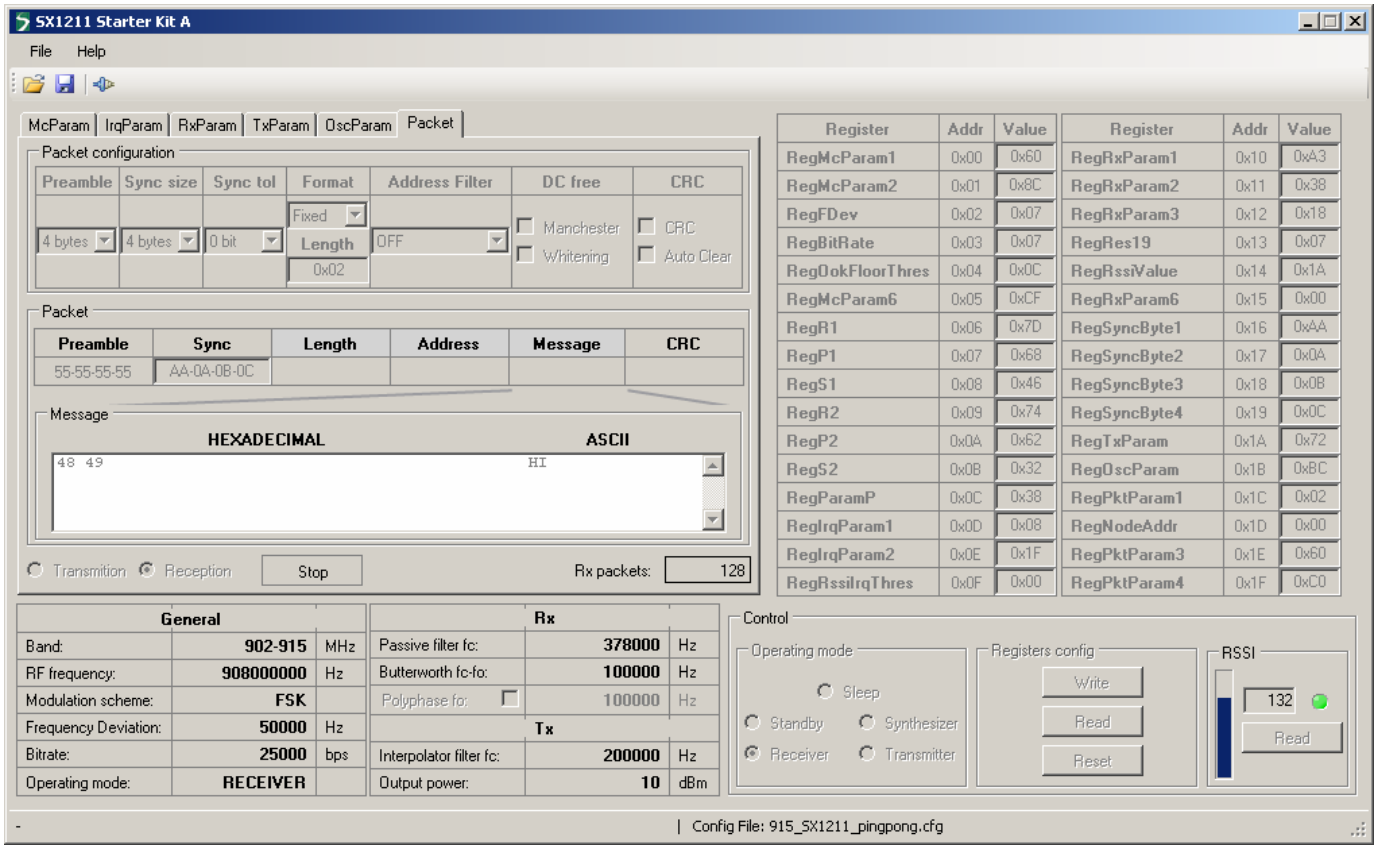
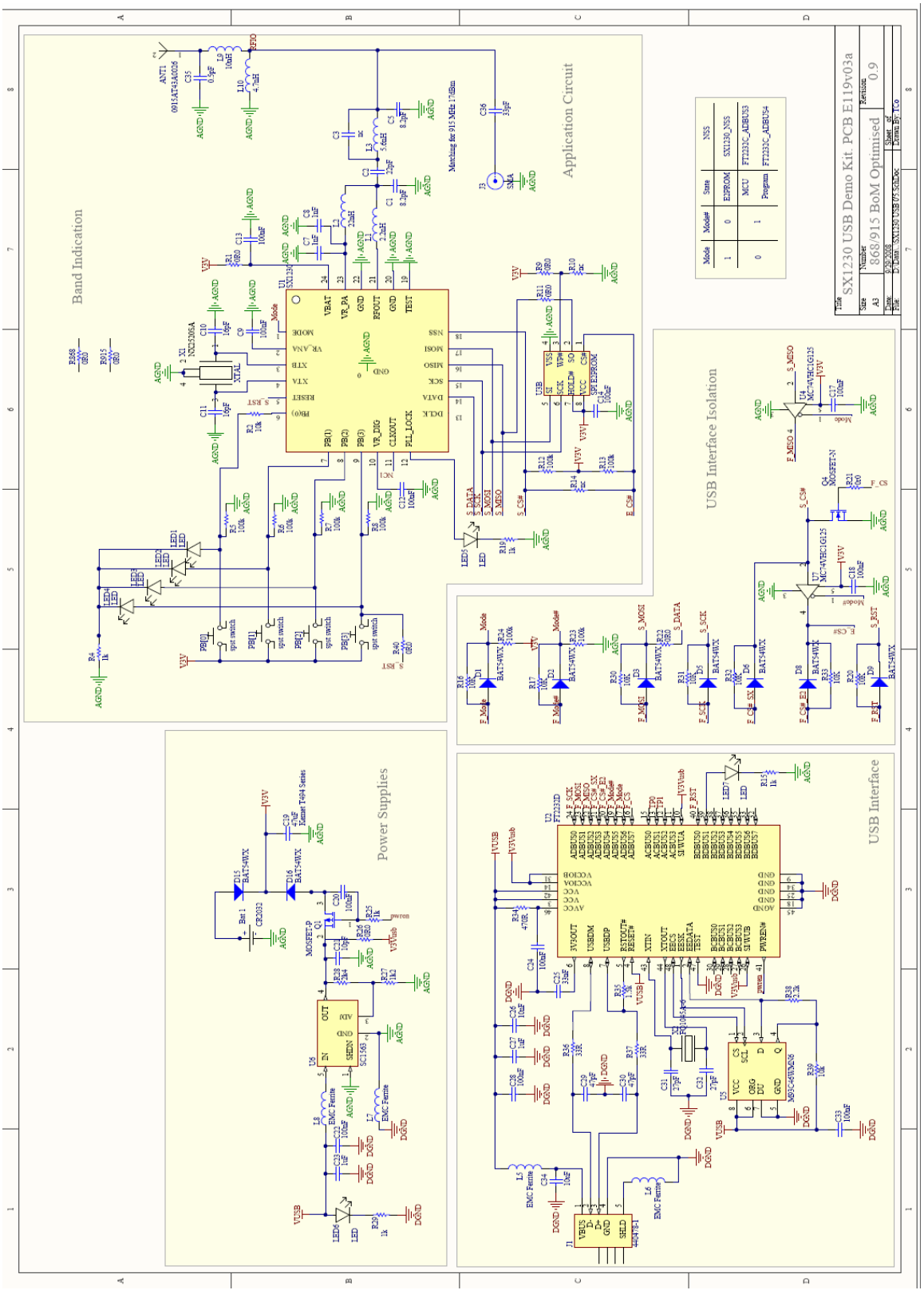
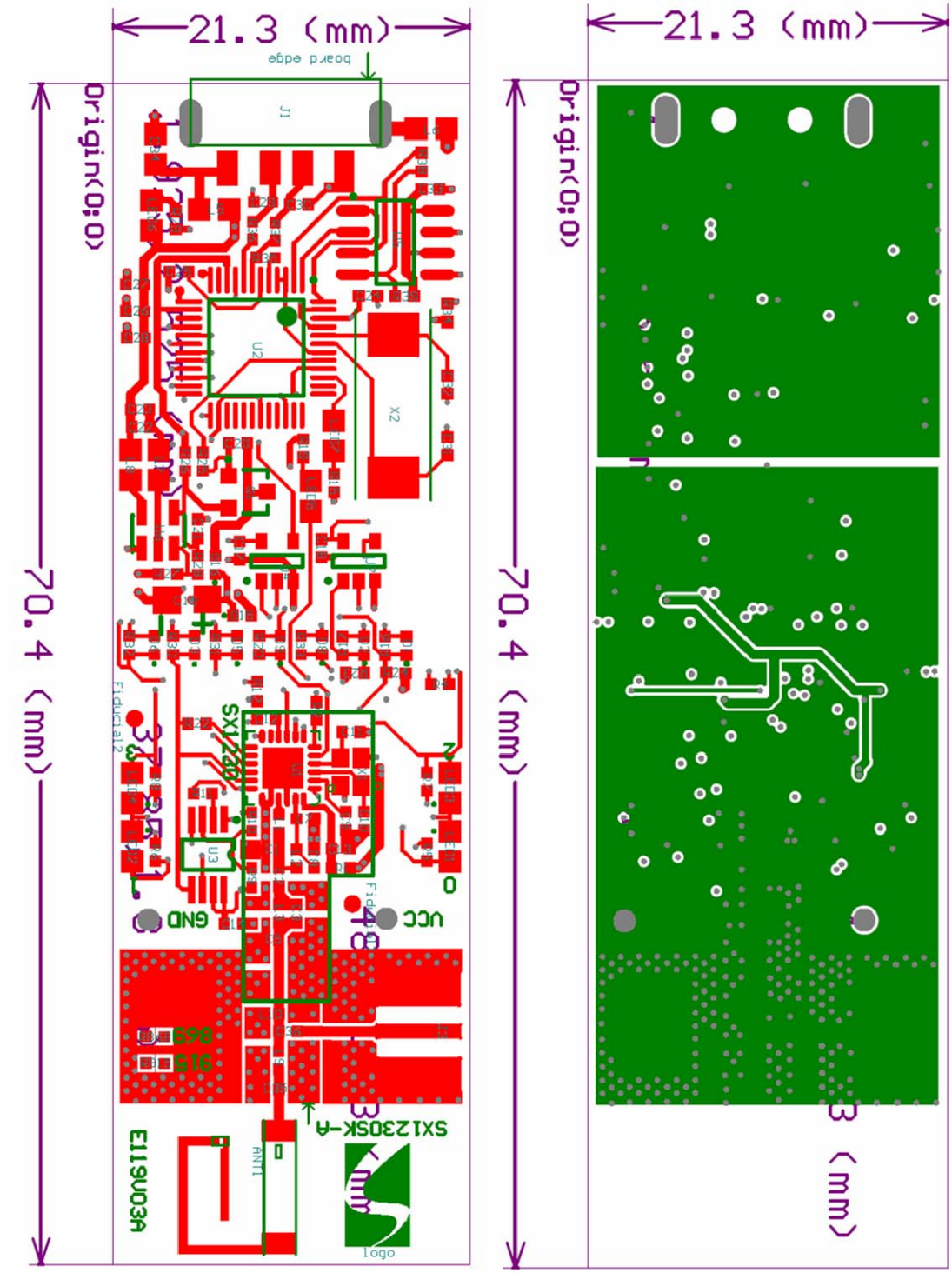
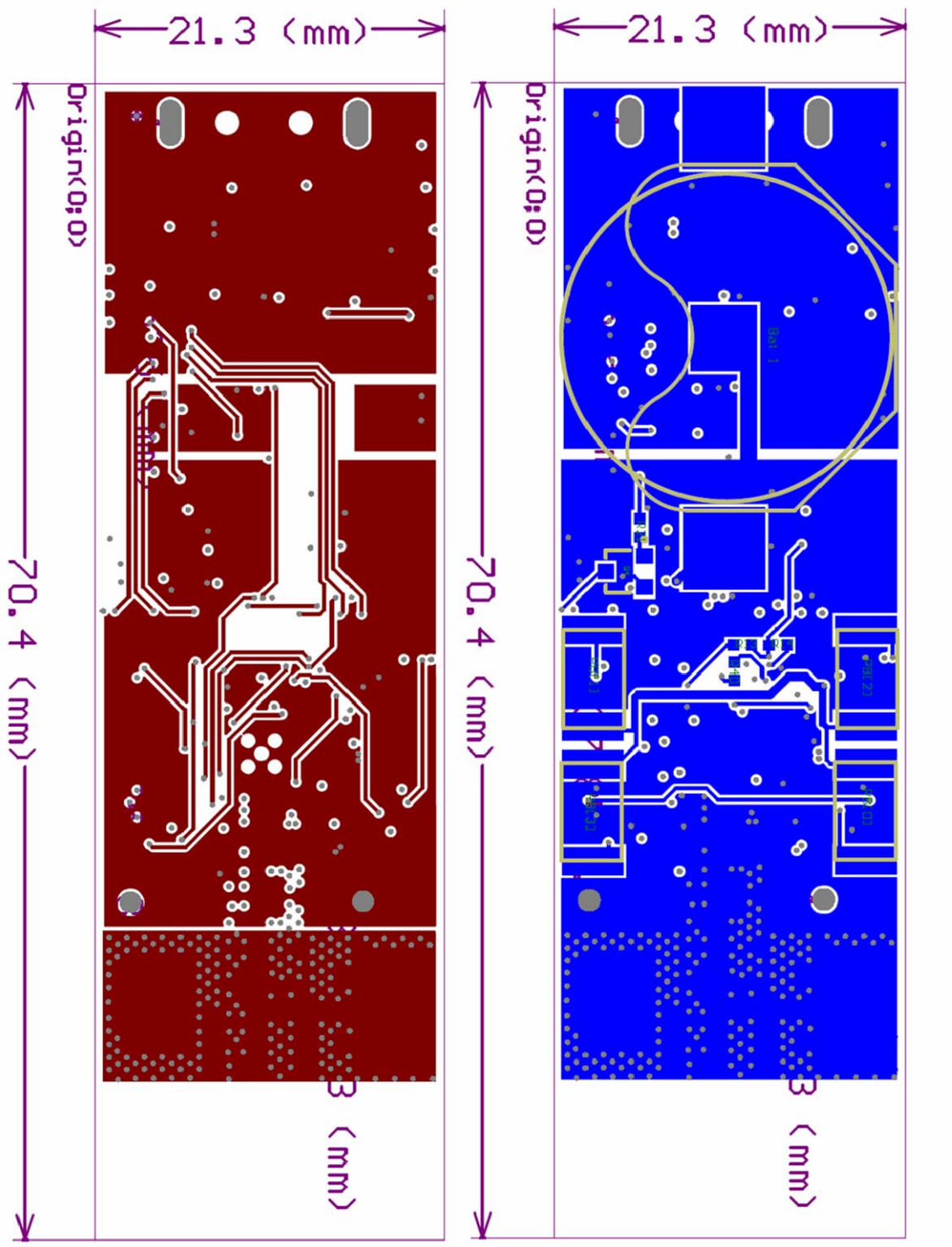


Figure 38. Software Display: Successful Packet Mode Reception

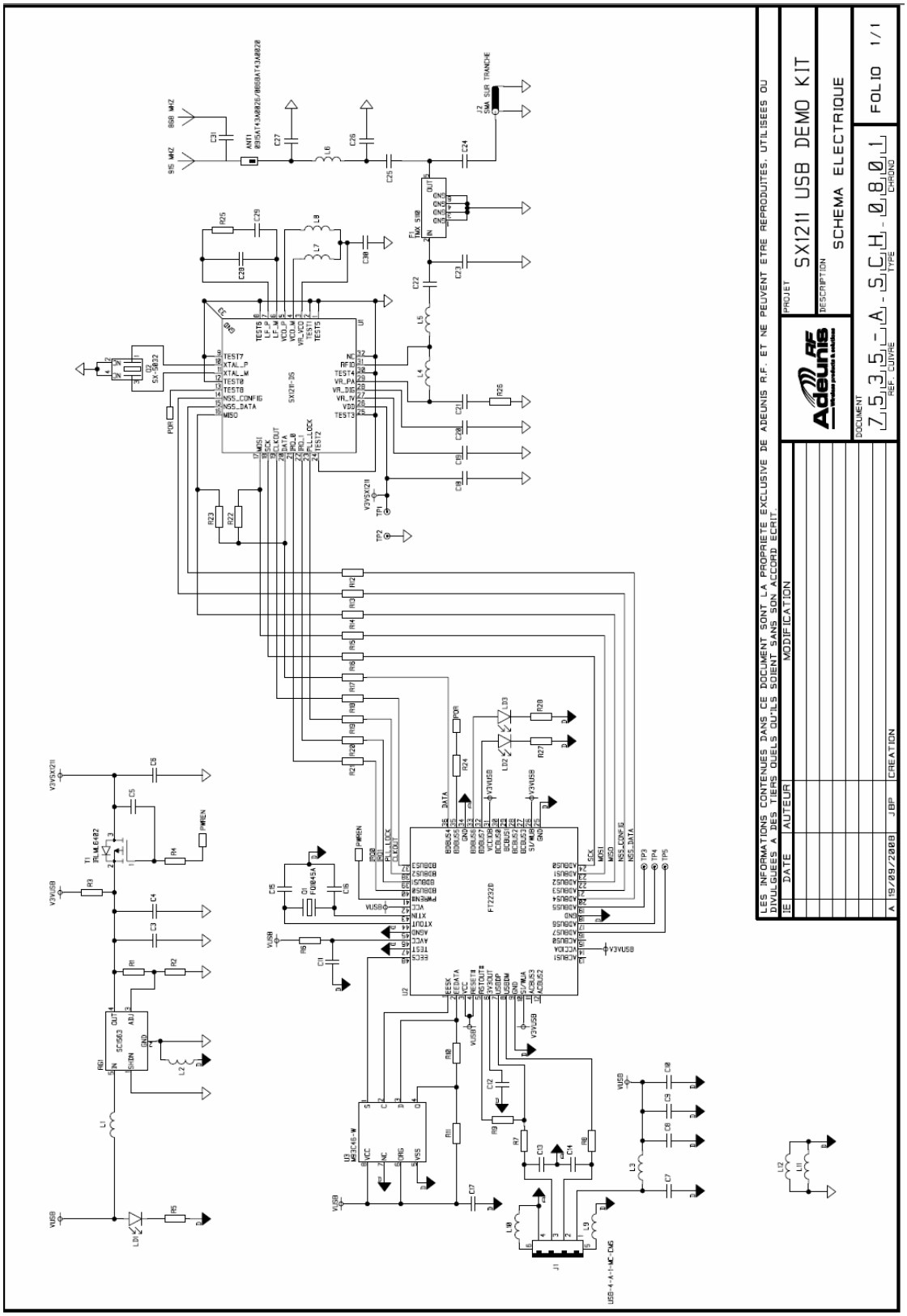
8 Schematics and 4-Layer PCB Layout: SX1230SKA

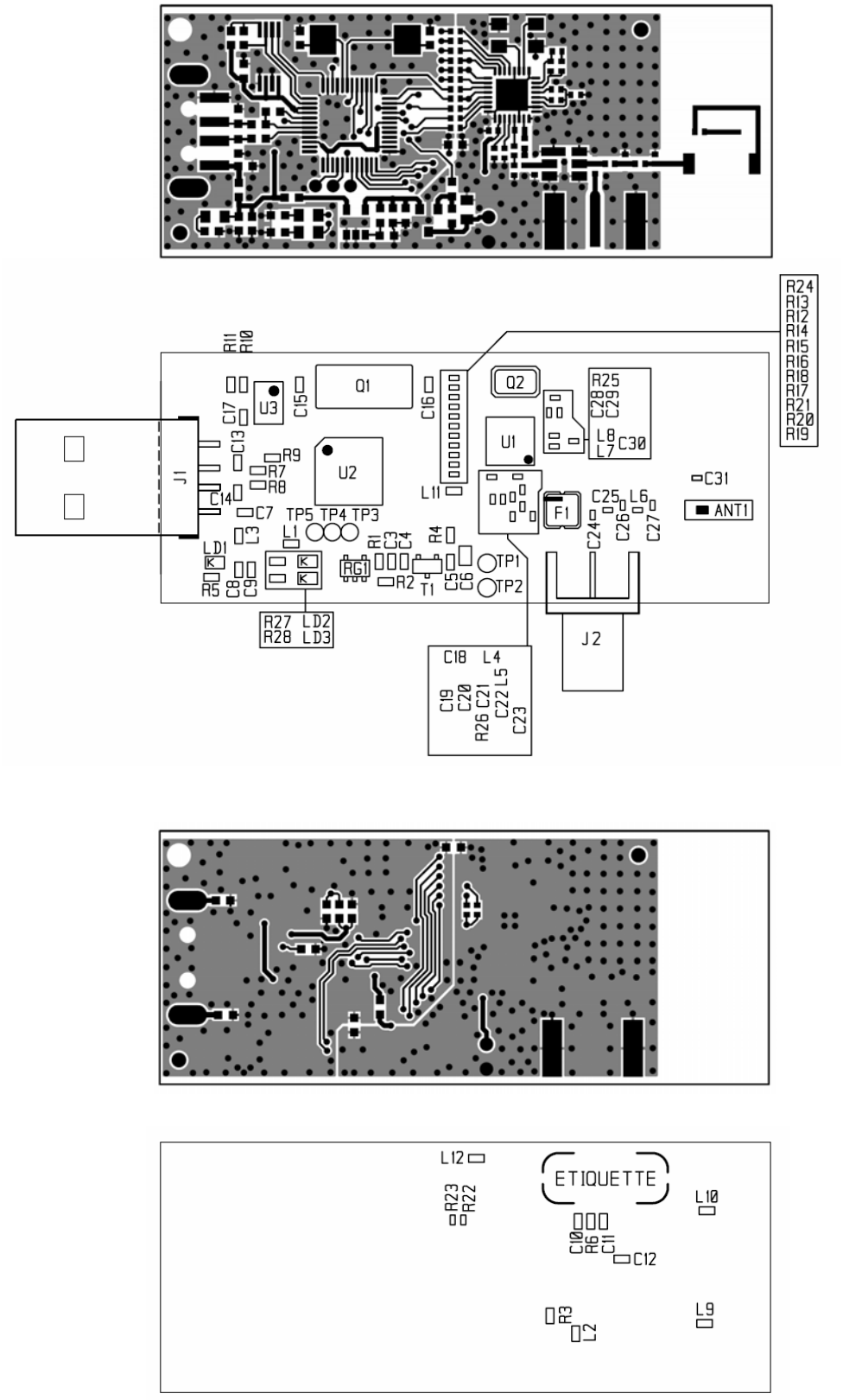



21.3 (mm)
board edge
Origin(0;0)
70.4 (mm)
J1
U2
X2
U3
SX1230
Fiducial2
GND
VCC
SX1230SK-A
E119V03A
ANT1
logo
21.3 (mm)
Origin(0;0)
70.4 (mm)
3 (mm)


21.3 (mm)
Origin(0;0)
70.4 (mm)
3 (mm)
21.3 (mm)
Origin(0;0)
70.4 (mm)
3 (mm)

9 Schematics and 2-Layer PCB Layout: SX1211SKA




R24
R13
R12
R14
R15
R16
R18
R17
R21
R20
R19
R11
R10
U3
C15
C17
C13
Q1
C16
Q2
R25
C28
C29
L8
L7
C30
U1
J1
R9
R7
R8
U2
C14
C7
TP5 TP4 TP3
L11
C31
ANT1
F1
C25
L6
C24
C26
C27
L3
L1
R1
C3
C4
R4
D1
A5
C8
C9
RG1
R2
T1
C5
C6
TP1
TP2
R27 LD2
R28 LD3
J2
C18 L4
C19
C20
C21
R26
C22 L5
C23
L12
R23
R22
ETIQUETTE
L10
C10
R6
C11
C12
R3
L2
L9

10 References

- [1] SX1230 Datasheet
- [2] SX1211 Datasheet

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