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SX1230-12SKA

User's Guide: Advanced Mode

Table of Contents

Table of Figures

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:

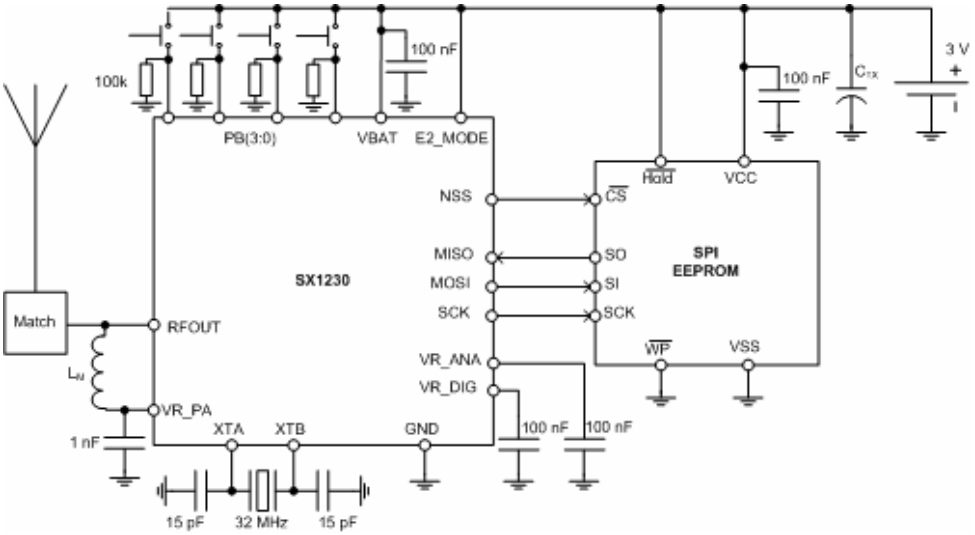


Figure 1. SX1230 Stand Alone Operation with Companion E²PROM

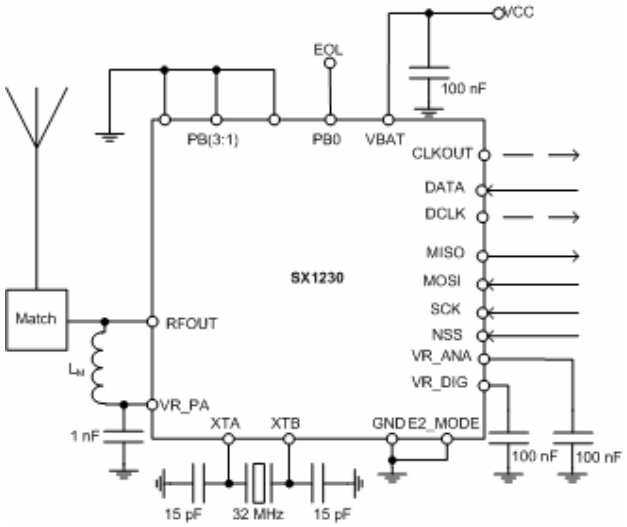


Figure 2. SX1230 Connections for Microcontroller Based Operation

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 SX1230-12SKA Evaluation kit is composed of:

- SX1230SKA board
- SX1212SKA board
- SMA Connectorised Antenna for 434 MHz
- SX1230-12SKA 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: SX1230-12SKA Contents (CR2032 Cell not Shown)

2.2 Installation

The software for the SX1212SKA and SX1230SKA must each be installed individually. The installation process for each is identical.

SX1212SKA Advanced Mode Software Installation

1- Put the CDROM in your computer and browse the contents of the CD.
2- Open the "sx1212starterkitsetupweb.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 SX1212SKA board to the PC via the USB interface.
5- Launch "SX1212SKA" from the Start menu.
6- Click on "Connect" button in toolbar or in File menu.
7- SX1212SKA 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 SX1212SKA 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

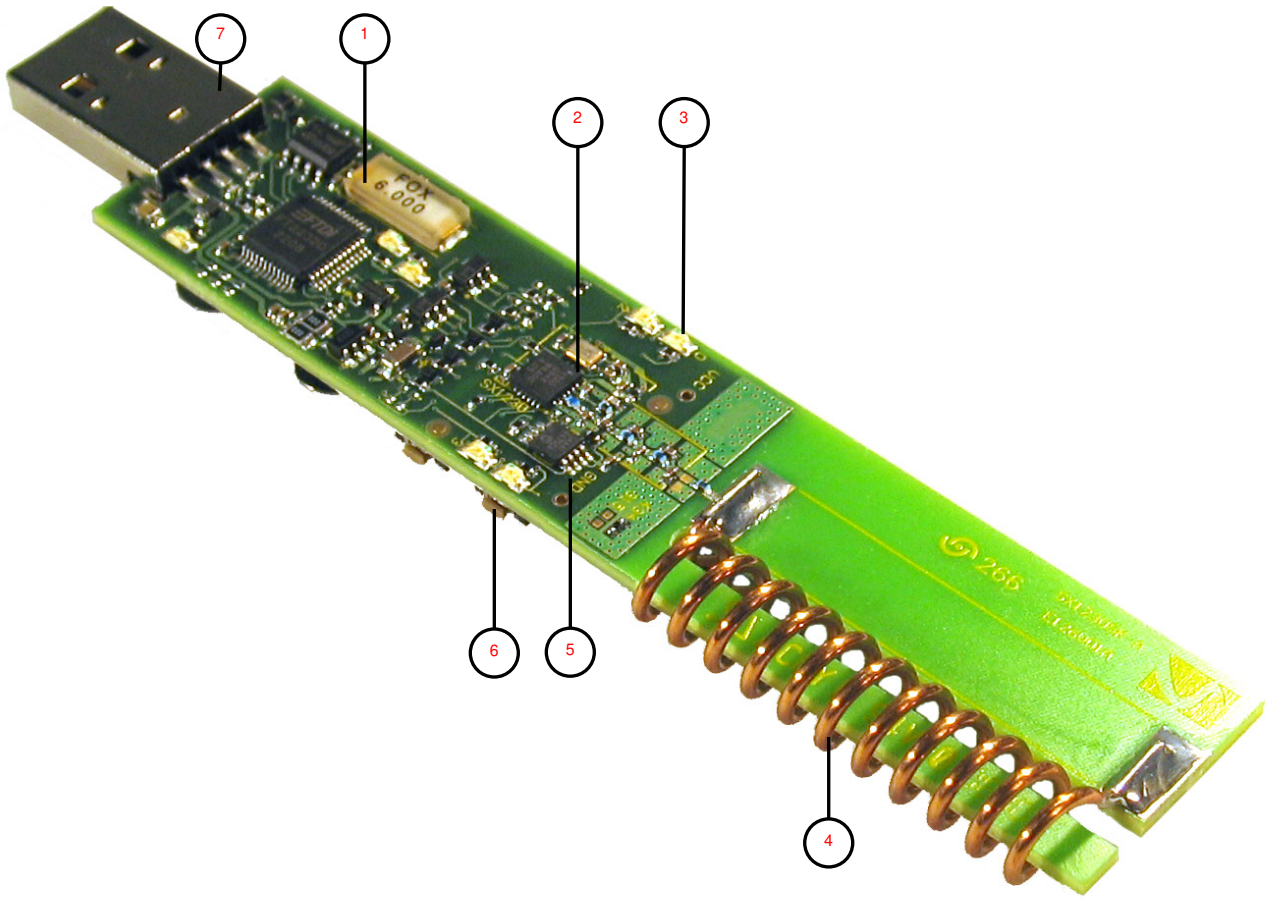


Figure 4: SX1230SKA, 868 and 915 MHz Band, Board Picture

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 434 MHz band the RF link between SX1230SKA and SX1212SKA is established through a PCB mounted helical antenna (4) to give a realistic impression of the range and other performances attainable in a miniaturised application.

3.2 SX1212SKA Overview

The SX1212SKA features the SX1212 reference design (1) and is also interfaced via an FTDI bridge (6) to the USB type 'A' interface (2) 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). Connection to the separate antenna is made through an SMA connector (3) which can also be useful for laboratory based testing.

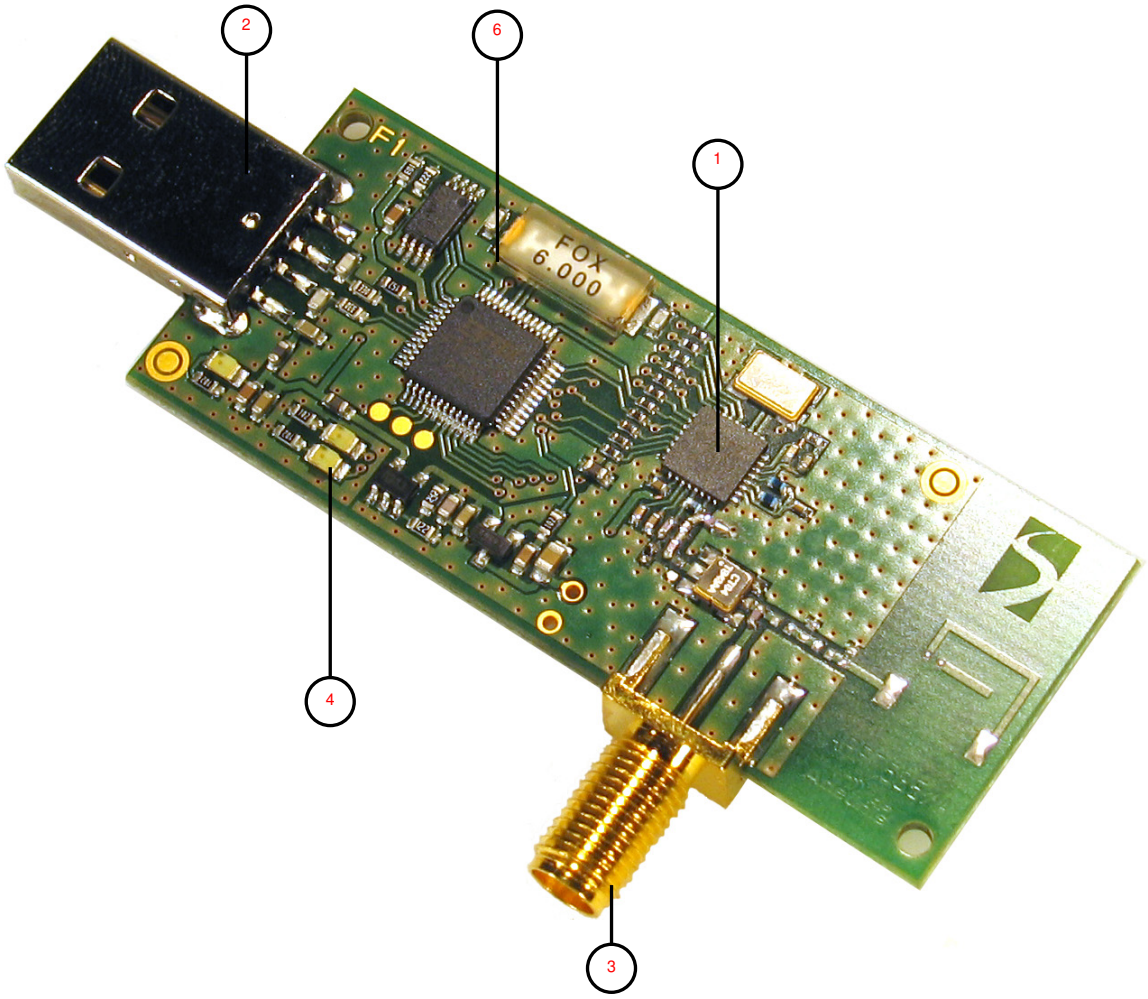


Figure 5: SX1212SKA Board Picture

4 Quick Start Guide: MCU Mode

With both SX1230SKA and SX1212SKA software installed, follow the sequence below to establish communication between the SX1230 as transmitter and the SX1212 as receiver.

4.1 SX1212SKA Quick Start

1. Plug the SX1212SKA into the USB port of the computer.

2. Run the SX1212 User Interface software Start > All Programs > SX1212SKA > SX1212SKA

3. The SX1212SKA 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 SX1212SKA shows the default configuration of the SX1212 register settings upon power-up.

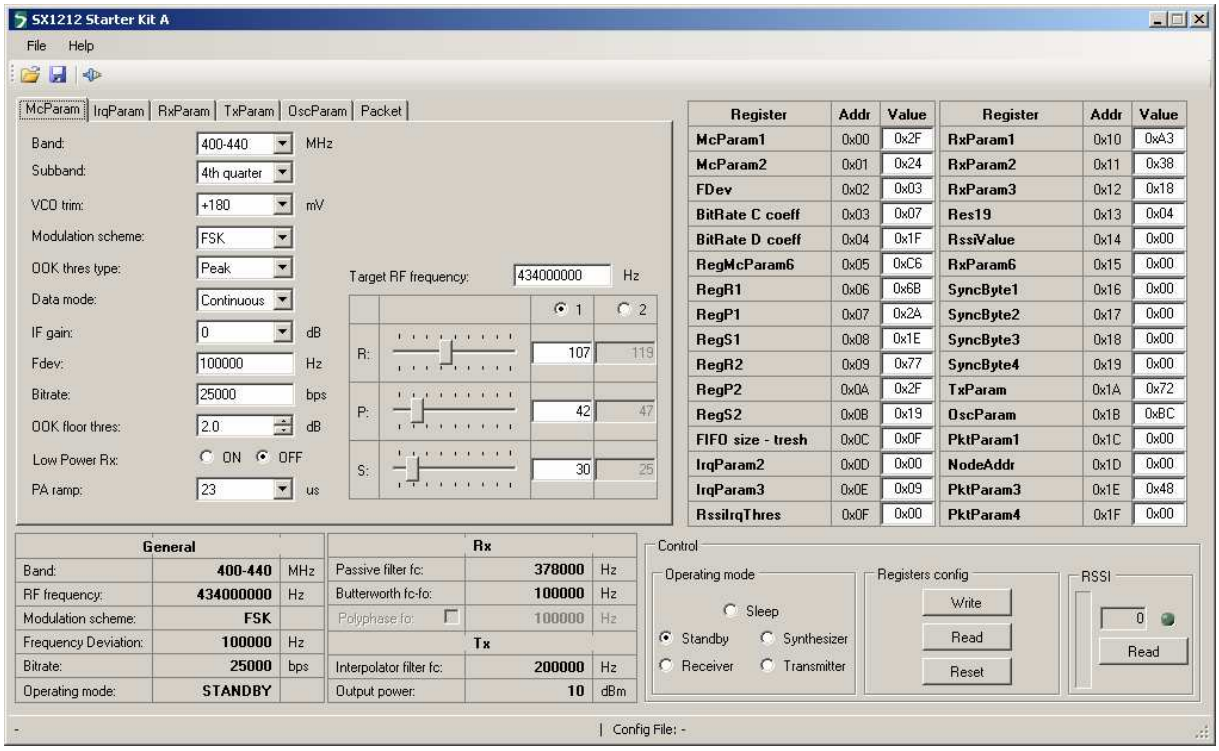


Figure 6. SX1212 User Interface, Default Settings

5. Once connected the SX1212SKA shows the default configuration of the SX1212 register settings upon power-up (as shown in *Figure 6*).

6. The settings for communication between SX1212SKA 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 "434_SX1212_pingpong.cfg" file from the "SX1212 Demo Files" folder on the CD-ROM.

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.

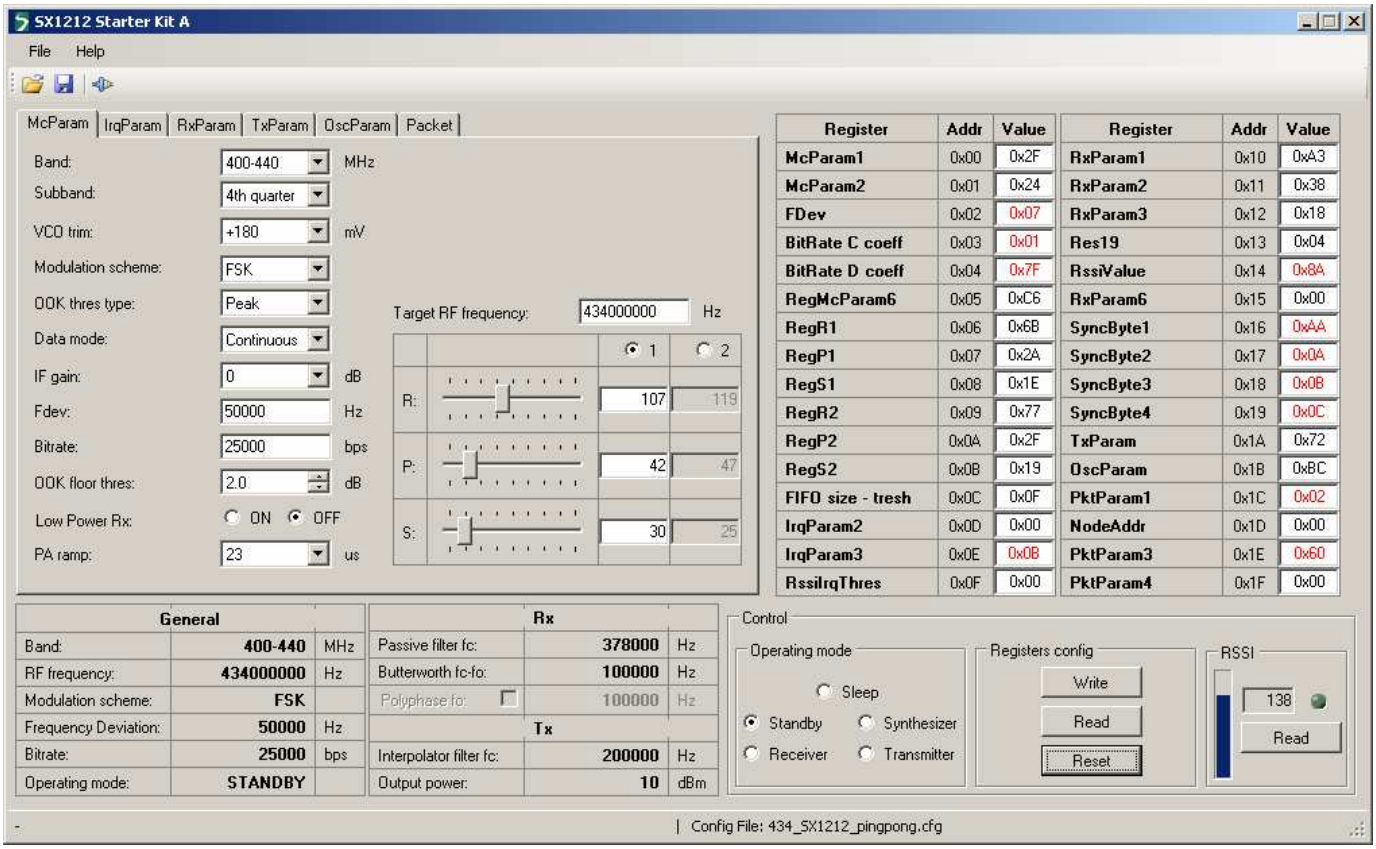


Figure 7. The New SX1212 Configuration: Ready to be Written

9. By clicking on the write button in the 'Registers config' section, the new register values are written to the SX1212 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 SX1212SKA enters packet receive mode and is now listening for valid packets. At this juncture the SX1230SKA transmitter must be configured.

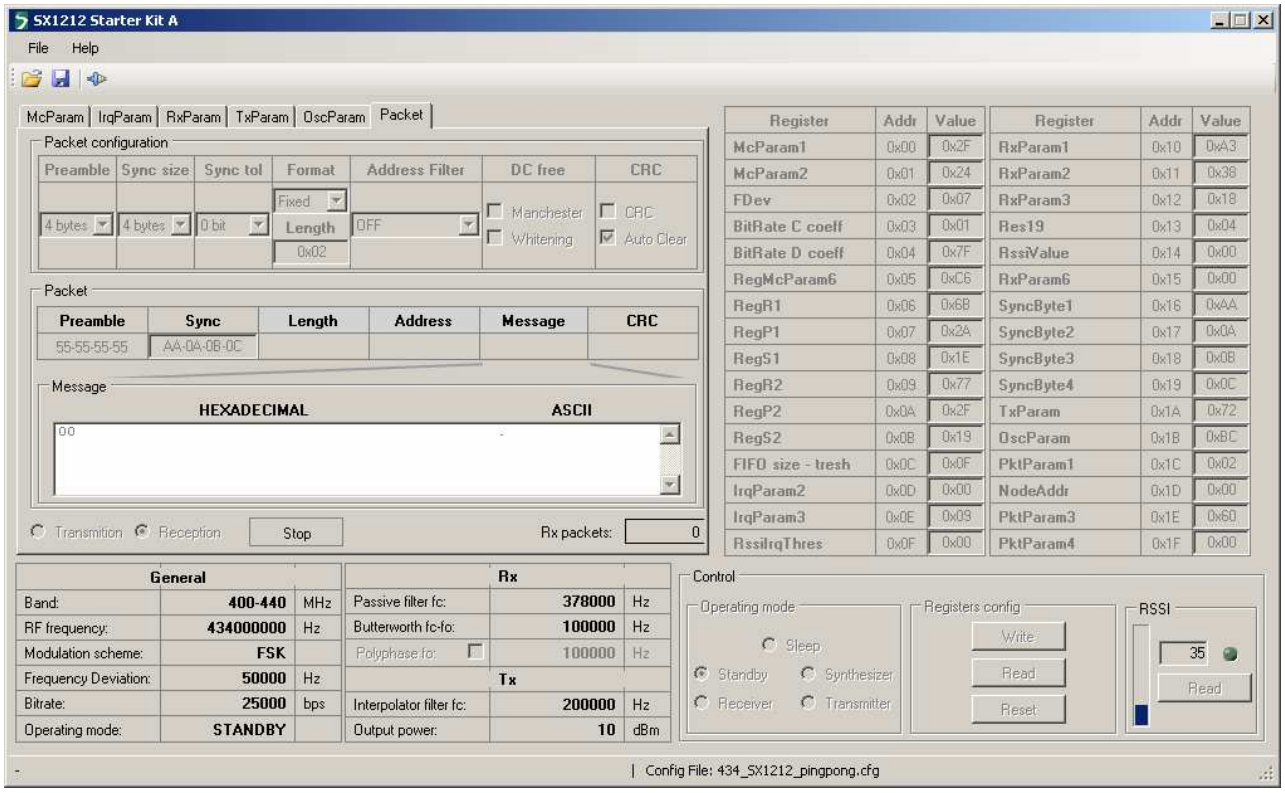


Figure 8. The SX1212SKA User Interface whilst in Packet Receiver Mode

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*).

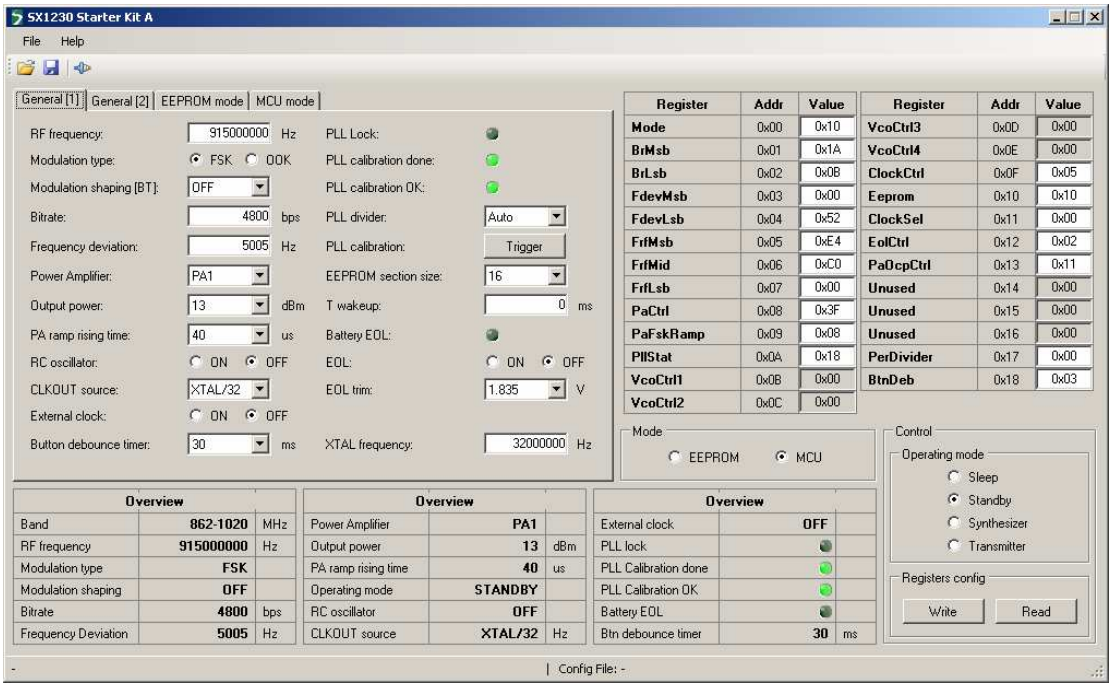
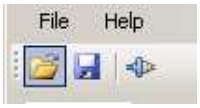


Figure 9. SX1230 User Interface, Default Settings

5. The settings for communication between SX1212SKA 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 "434_SX1230_pingpong.cfg" file from the "SX1230 Demo Files" folder on the CD-ROM.

7. The display will then appear as shown in Figure 10. These are the link parameters which match those which will be programmed to the SX1212SKA.

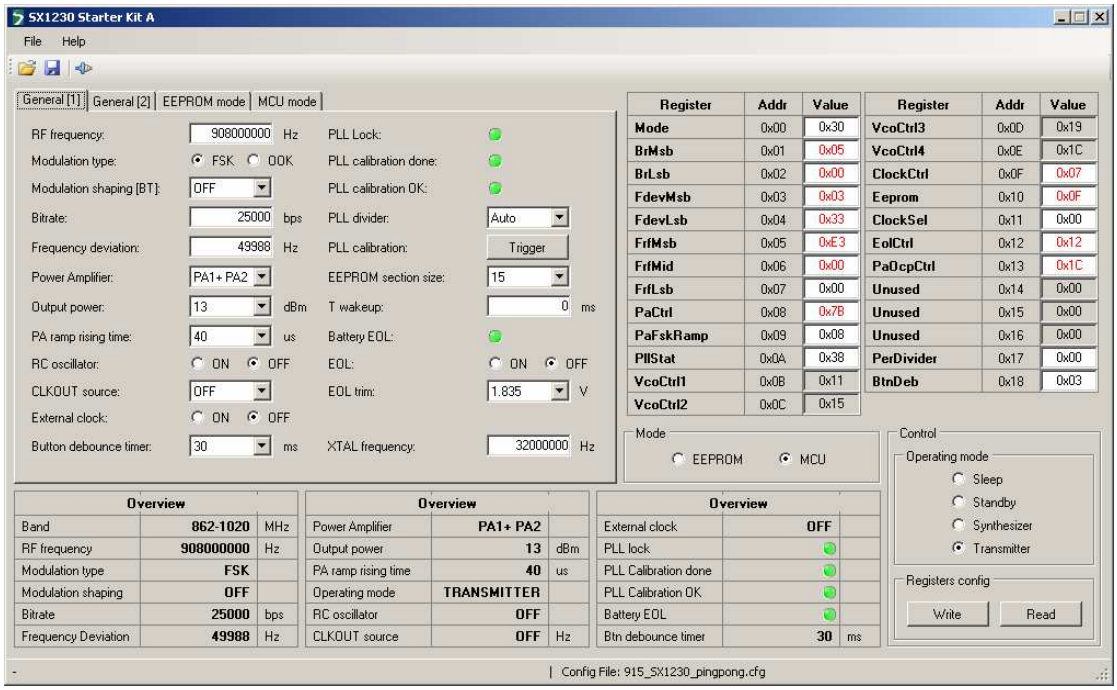
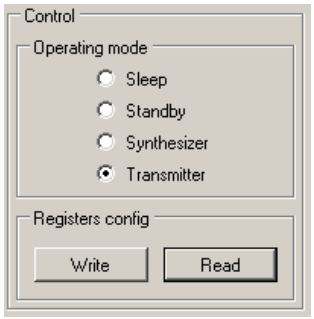


Figure 10. The New SX1230 Configuration: Ready to be Written

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 SX1212SKA 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.

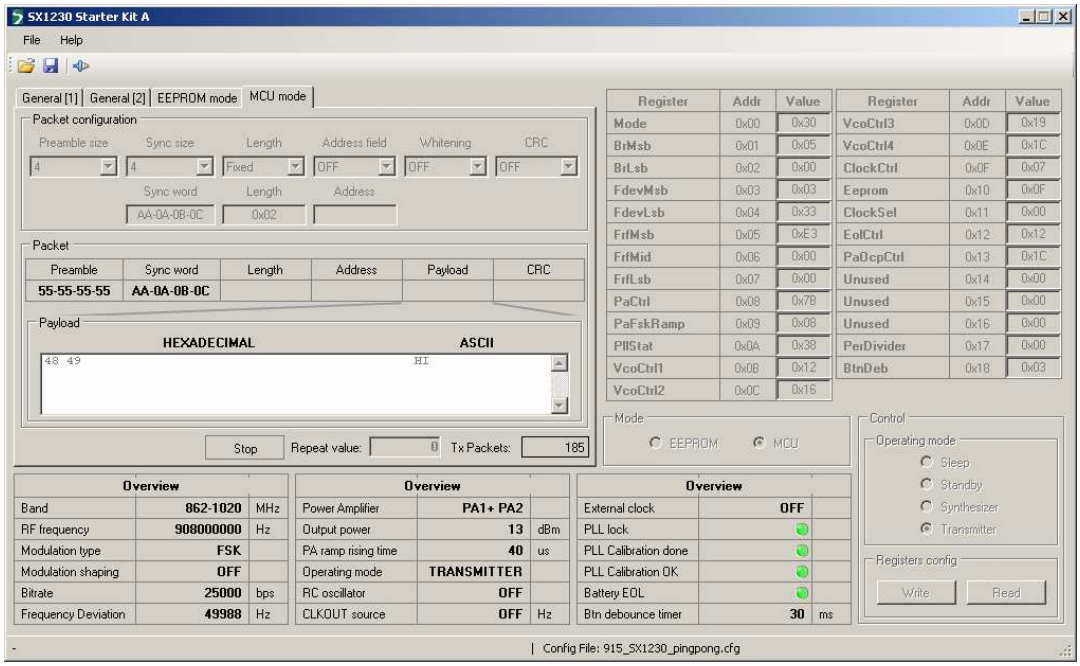


Figure 11. SX1230 During MCU Mode Packet Transmission

4.3 Link Test

With both devices configured as described in the preceding two sections, reception of valid packets by the SX1212 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 SX1212SKA user interface on one machine and the SX1230SKA 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 SX1212SKA Configuration

Initiation of the SX1212SKA for operation in Stand Alone Mode is identical to that described in Section 4.1. Please configure the SX1212SKA 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.

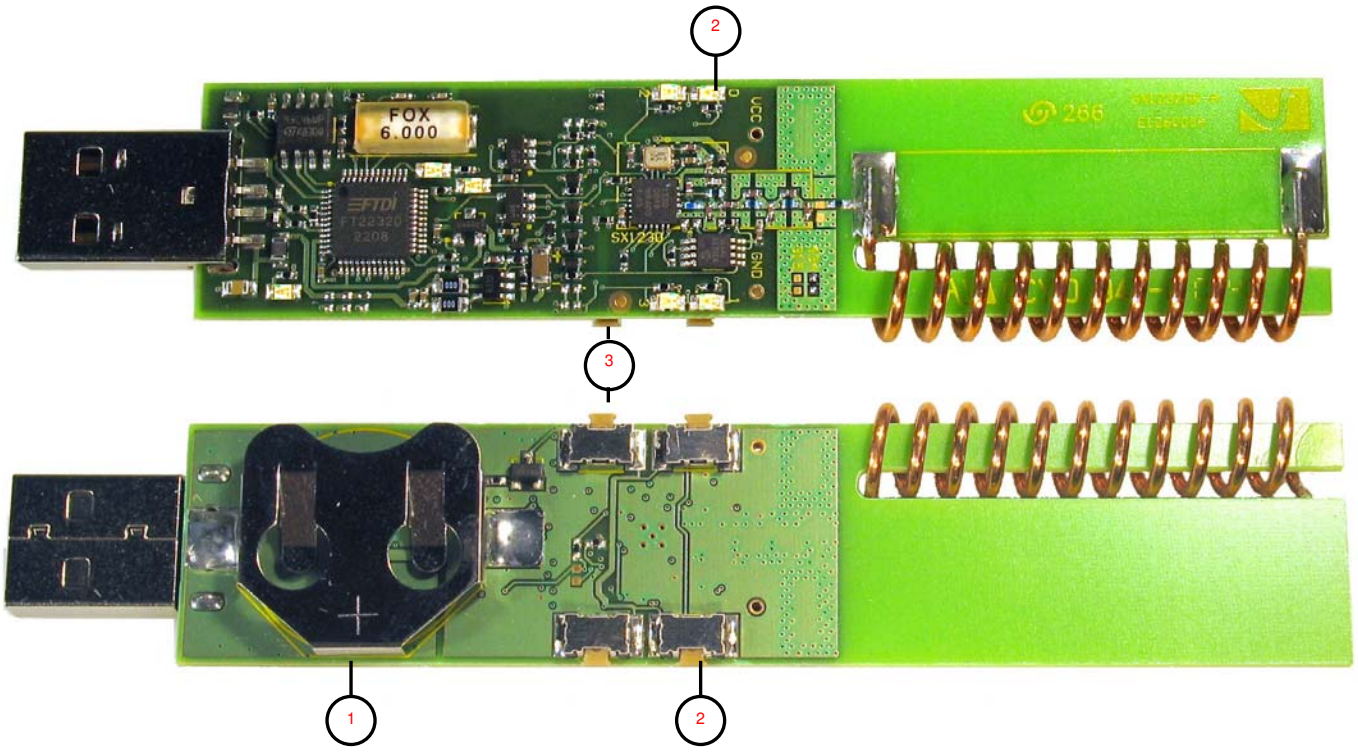


Figure 12. Hardware for E²PROM (Stand Alone) Operation

3. The SX1230SKA is not ready to be used in conjunction with the SX1212SKA 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 SX1212SKA 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.

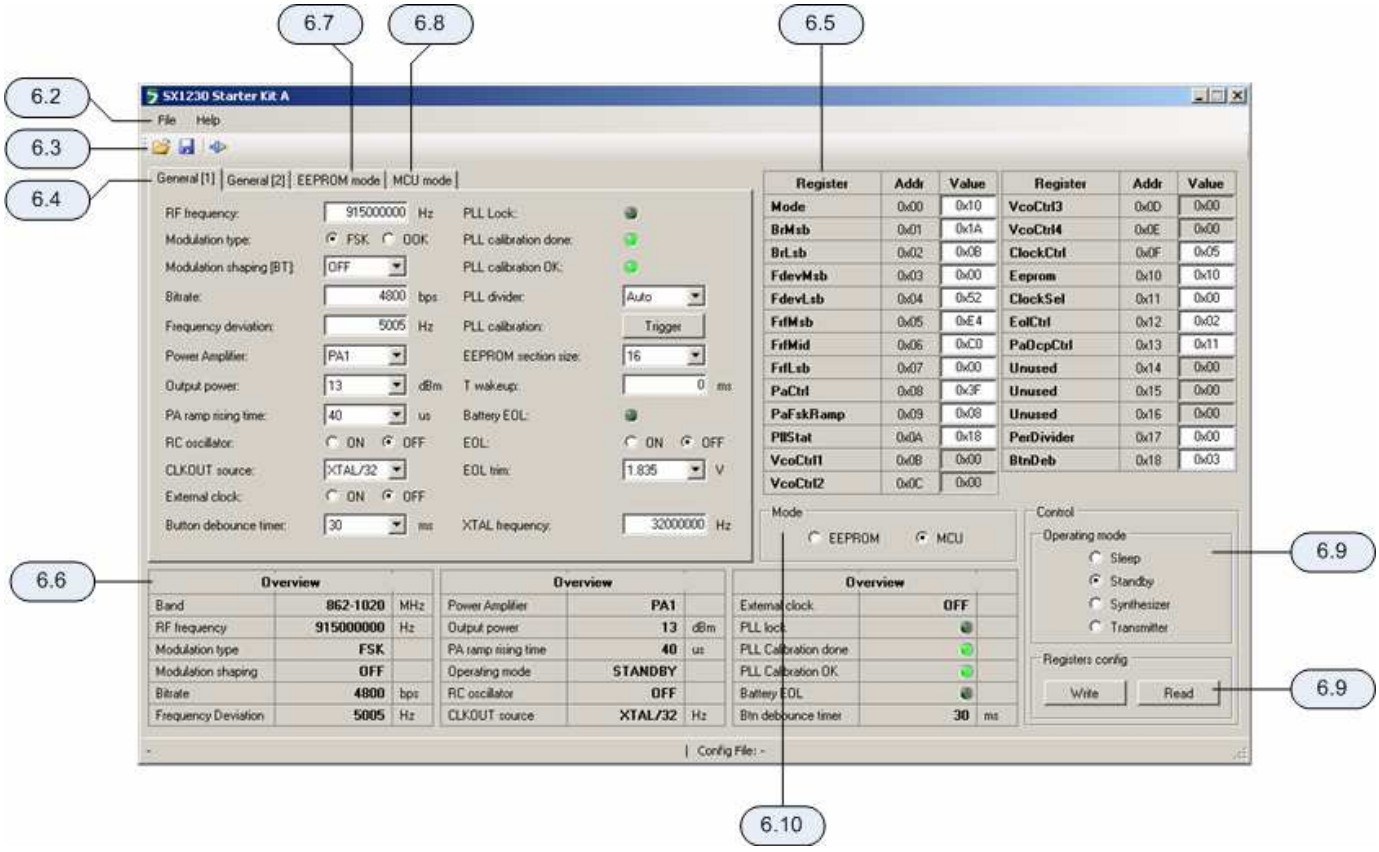
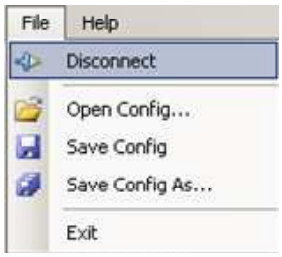


Figure 13: SX1230SKA GUI Overview and References to the User Guide Description of this Chapter.

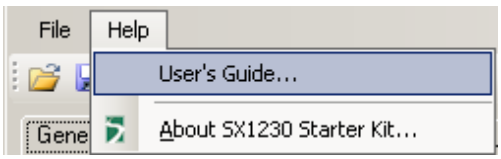
6.2 File Menu



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.

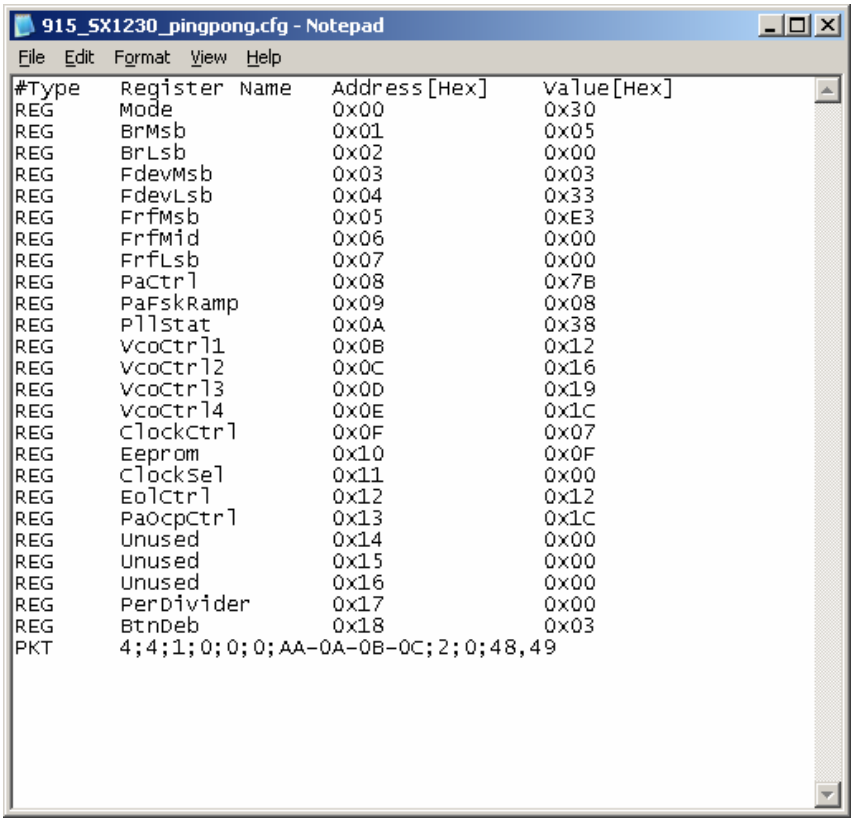


Figure 14. Example Text Editor Output of the SX1230 Configuration File

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.

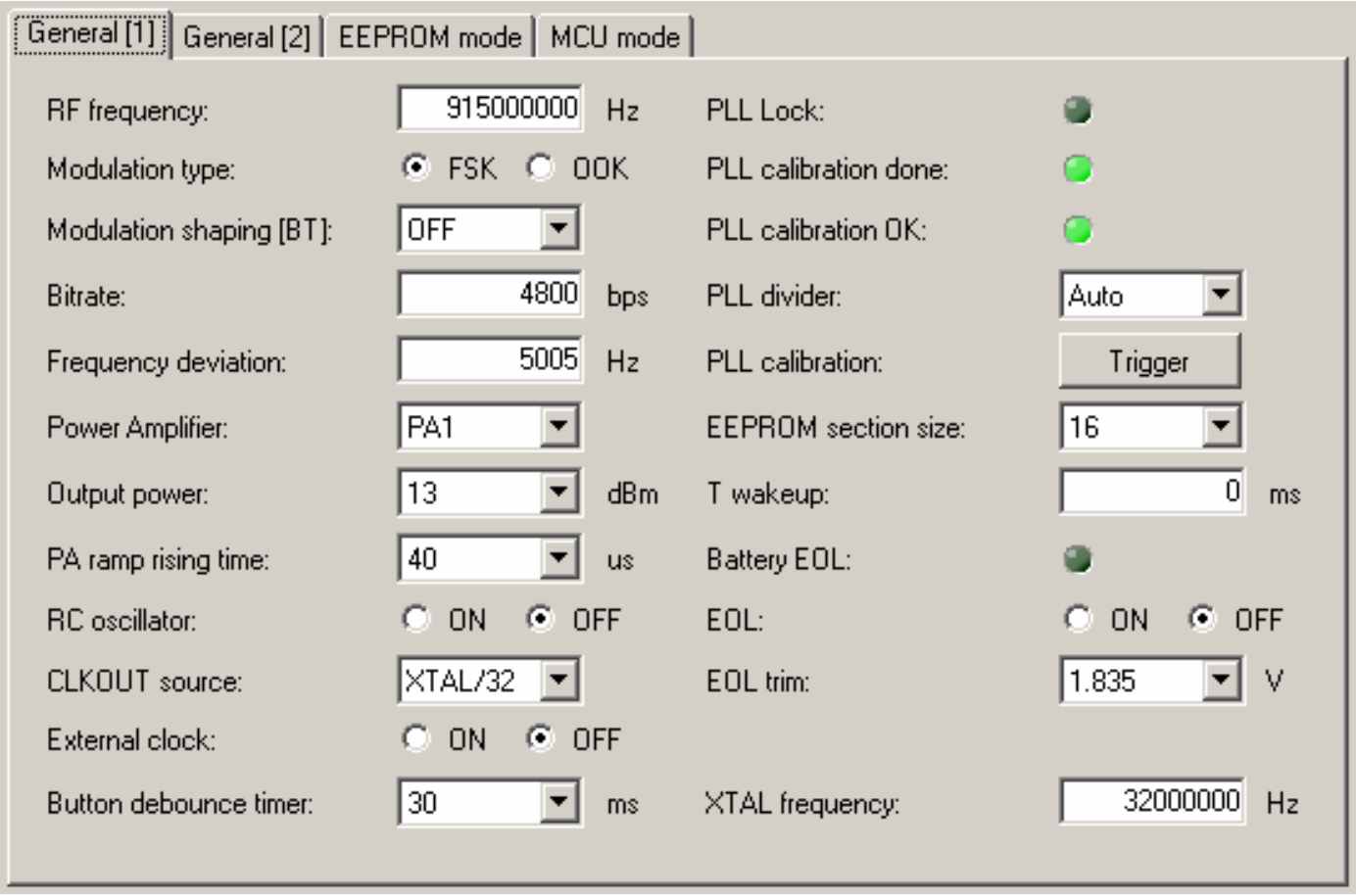


Figure 15. The General Configuration Tab Features the most Commonly Used Configuration Parameters

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 290 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.

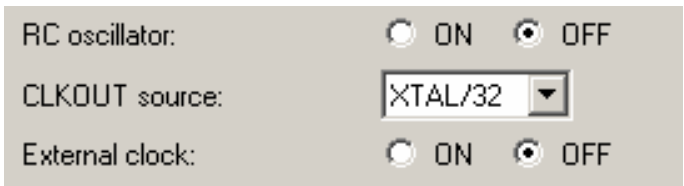
Output Power

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

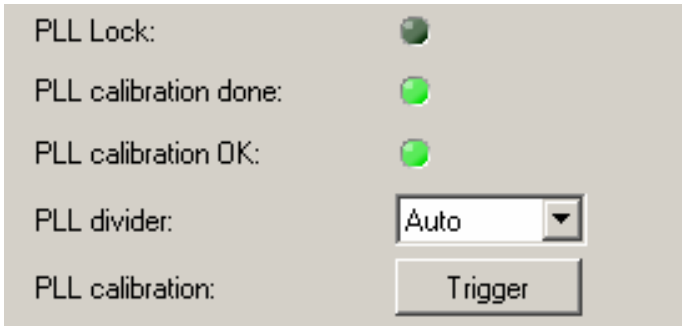


Although not directly accessible from the SX1230SKA, for completeness, the source of the clock output signal can be selected and its frequency altered in accordance with the range of programmable divider values. For more information please consult the SX1230 datasheet.

Push Button Debouncer

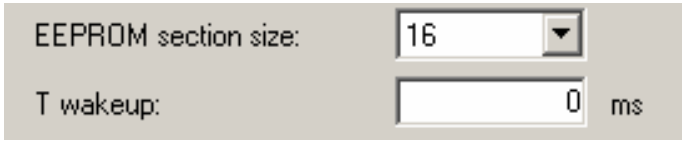
The four general purpose digital inputs – here connected to the four push buttons – has a variable debounce timer. Several common values are accessible from a drop down menu.

PLL Lock Detection Parameters



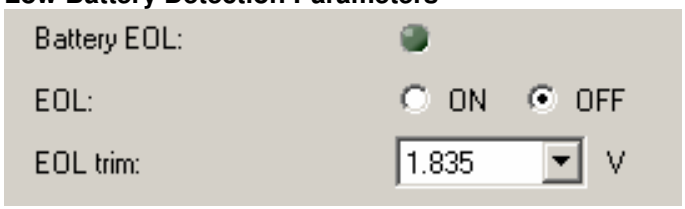
Three LED type indicators display the status of the SX1230 following the last register read cycle of the SX1230. Various options exist for changing the PLL divider ratio and triggering PLL calibration. Please consult the SX1230 datasheet for a more detailed description.

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]

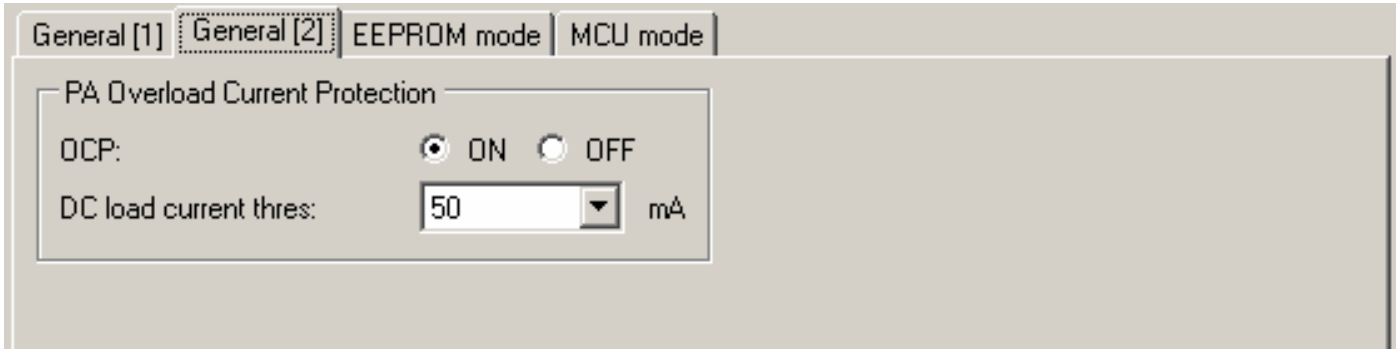


Figure 16. Second Page of the General Configuration Parameters

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:

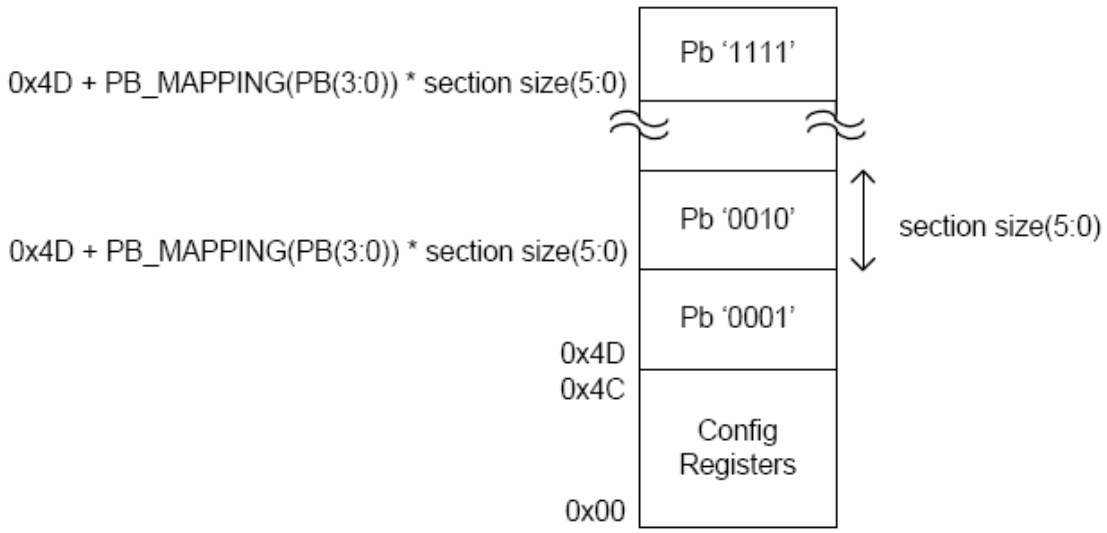


Figure 19. E²PROM Memory Mapping

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.

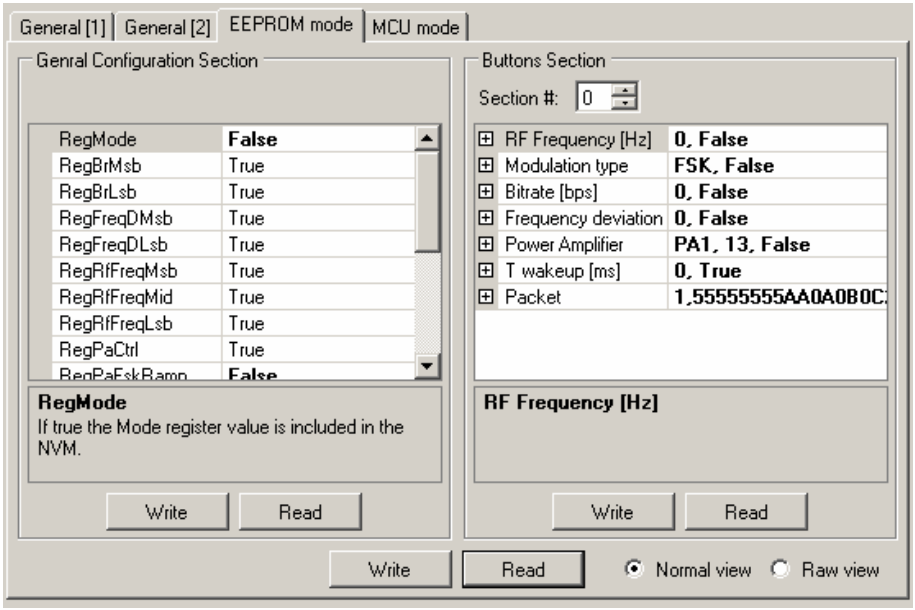


Figure 20. The E²PROM Mode Tab 'Normal View'

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).

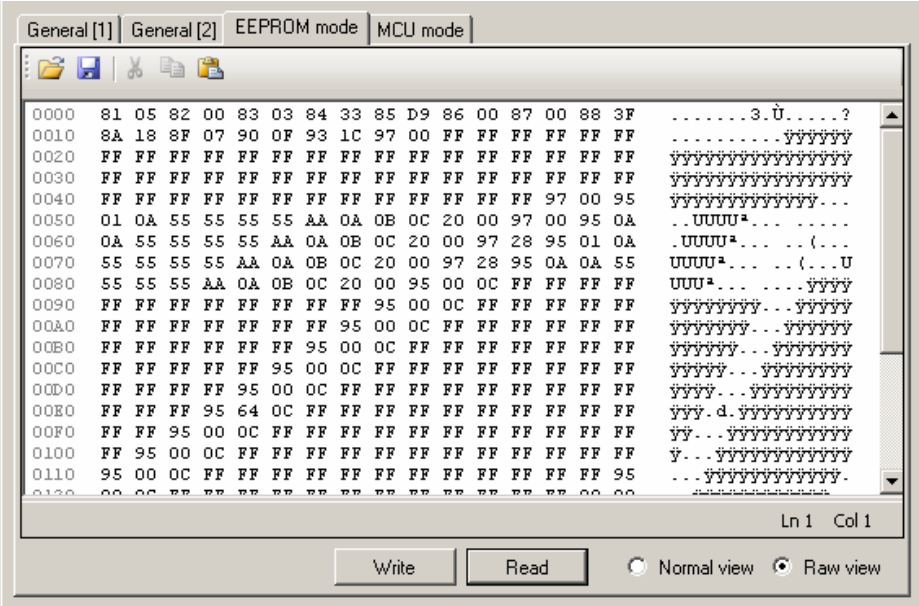


Figure 21. E²PROM Raw View

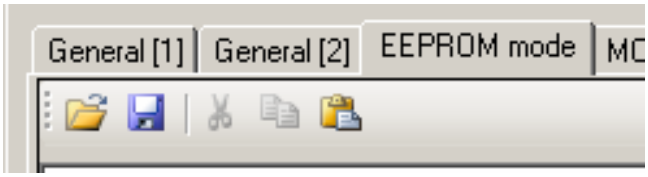


Figure 22. E²PROM Raw View Short-cut Buttons

6.8 MCU Mode Tab

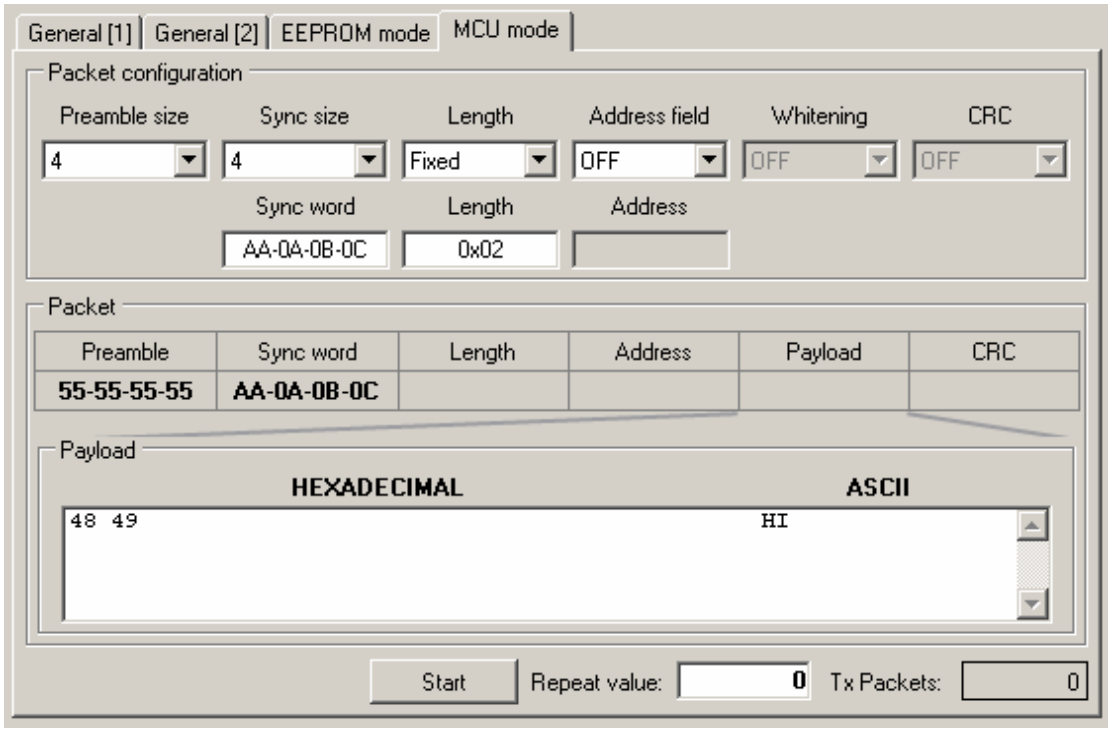


Figure 23. MCU Mode Tab Display

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 SX1212 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.