

SX1276 Development Kit

USER GUIDE





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1 Preamble

This document describes how to use the SX1276 Evaluation kit. This document describes especially the SX1276 Eiger platform and the SX1276SKA User Interface. We strongly recommend for the user to read thoroughly the datasheet of the SX1276 prior to start working on the device. Most of this document assumes a general knowledge on the SX1276 and modern RF communications.

2 Introduction

The SX1276 is a single-chip integrated circuit ideally suited for today's high performance ISM band RF applications. Added to the renowned, high-performance and low-cost, FSK / OOK RF transceiver modem, the SX1276 is also equipped with the LoRa proprietary transceiver modem. This advanced feature set, including a state of the art packet engine, greatly simplifies system design whilst the high level of integration reduces the external BOM to a handful of passive decoupling and matching components. It is intended for use as high-performance, long range, half-duplex bi-directional RF links, and where stable and constant RF performances are required over the full operating range of the device down to 1.8V.

The SX1276 is intended for applications over a wide frequency range and it is covering all available sub-1GHz frequency bands (168MHz, 434MHz, 470MHz, 868MHz and 902MHz). Coupled with a link budget in excess of 135 dB in FSK in excess of 155 dB in LoRa, the SX1276 really offers the possibility of two modems in one single package. The SX1276 complies with both ETSI and FCC regulatory requirements and is available in a 5x5 mm QFN 28 lead free package.

The SX1276 Evaluation kit, based around the Eiger platform, allows the user to test every aspect of the radio, both from the system and RF point of view.

On one hand, the Eiger platform is a touch screen portable device which has been design to enable quick and easy testing of the PER performances of the SX1276. On the other hand, the SX1276SKA is a PC based evaluation tool which allows in depth testing of the radio.

This document is therefore divided in two parts: the first part present the SX1276 Eiger module and how to perform PER test in LoRa and FSK; the second part of this document present the SX1276 SKA and how it can be used to test every single aspect of the radio.



3 Getting Started

3.1 Evaluation Kit Contents

The SX1276DVK1 Development Kit consists of:

- 2 x SX1276RF1 modules
- 2 x Eiger platforms
- 2 x dipole antennas for LF frequency band
- 2 x dipole antennas for HF frequency band
- 2 x Mini-USB cables
- 2 x Touch Screen Styluses
- Disclaimer Note



Figure 1: SX1276 Development Kit



3.2 Ordering information

Each of part of the SX1276 Evaluation kit can be ordered as a single entity or in a whole package. When ordering, please refer to the following parts numbers:

SX1276DVK1IAS	SX1276 Development Kit - 169/868MHz version with TCXO
SX1276DVK1JAS	SX1276 Development Kit - 433/868MHz version with XTAL
SX1276DVK1KAS	SX1276 Development Kit - 490/915MHz version with XTAL
SX1276RF1IAS	SX1276 Evaluation Module - 169/868MHz version with TCXO + Antennas
SX1276RF1JAS	SX1276 Evaluation Module - 433/868MHz version with XTAL + Antennas
SX1276RF1KAS	SX1276 Evaluation Module - 490/915MHz version with XTAL + Antennas

For more information on each of the options available, please, contact your local Semtech representative. The SX1276SKA evaluation software, the firmware, drivers and all SX1276 related materials are available on the Semtech website: http://www.semtech.com/wireless-rf/rf-transceivers/

3.3 Updating the firmware

Updating the Eiger platform firmware is straight forward given that the user follows some simple steps. The first step is to install the Eiger platform drivers on the PC used to update the firmware. These drivers, called RLink USB drivers are located in the folder RLinkDrv given with every version of the firmware. To install the driver, simply launch the file RLinkUSBInstall.exe.

Once the RLink drivers are installed, the firmware upgrade is done through the update.bat file which will upload the correct version of the firmware depending on several options related to the Eiger platform or module being used. When launching the application, the following window opens:





This window invites the user to select the STM32 daughter board fitted on the Eiger platform. The pictures below should help the user to recognize which daughter board is which. Added to this, the STM32F407 daughter board is equipped with a small camera clearly visible at the back of the module. To finish, the STM32F429 is easily identifiable thanks to the size of its MCU.



STM32F103 Module



STM32F407 Module



STM32F429 Module



If the Eiger platform is not powered up, is wrongly connected or if the RLink drivers are not installed, the following message will be displayed on the screen:

C\WINDOWS\system32\cmd.exe
1. STM32F103 2. STM32F407 3. STM32F429 Please select platform [1,2,3]: 3
!!! WARNING: This will program the bootloader into the OPEN4 platform.!!!!!!Current application will be erased.!!!
Press Ctrl-C to abort. Press any key to continue
CatHex: hex file concatenator. Copyright <c> KEOLABS S.A.S. 1987-2012. All rights reserved. Raisonance is a KEO LABS brand.</c>
Cortex_pgm: software for programming Cortex microcontrollers using a RLink. Copyright <c> KEOLABS S.A.S. 1987-2013. All rights reserved. Raisonance is a KEO LABS brand.</c>
(0) Selecting target: STM32F429ZI (0) Configuring RLink Driver OK
Connecting to RLink ??? Error 304: Unable to open USB com with RLink. Please check RLink connection and driver installation.
ERROR ERROR
OPEN4 programmation failed. Please check that the "Debug" USB connector is plugged and that the OPEN4 is powered up. (press the OPEN4 button if you are unsure)
Press any key to continue

In this situation, the user need to make sure the device is correctly powered and turned on. Please, refer to section 4.1 of this document for more information.



This is what the full upgrader should look like at the end of the software update.

- 0 -X C:\WINDOWS\system32\cmd.exe STM32F103 STM32F407 STM32F429 1.2. 3. STM32F429 Please select platform [1,2,3]: 3 !!! WARNING: This will program the bootloader into the OPEN4 platform.
!!! Current application will be erased. ::: Press Ctrl-C to abort. Press any key to continue . . . CatHex: hex file concatenator. Copyright (c) KEOLABS S.A.S. 1987-2012. All rights reserved. Raisonance is a KEO LABS brand. Cortex_pgm: software for programming Cortex microcontrollers using a RLink. Copyright (c) KEOLABS S.A.S. 1987-2013. All rights reserved. Raisonance is a KEO LABS brand. (0) Selecting target: STM32F429ZI... (0) Configuring RLink Driver... OK Connecting to RLink... OK Connecting to target... OK Silicon Revision Id: 0x10036419. Option bytes: RDP=0xAA, USER=0xEF, WRP=0xFFFF3FFF Measured Target Voltage : 2.9V. ок (2) Erasing Option Bytes and Flash... OK (20) Programming file sx12xxEiger.hex to Flash... OK (27) Starting program execution... OK (28) Closing com with RLink... OK Press any key to continue . . . _

Once the software has been upgraded, it is recommended to reset all the internal settings on the Eiger platform. For more information on how to achieve this, please, refer to section 5.2.1.1 of this document.





4 Eiger Platform Presentation

4.1 Platform Description

The Eiger platform is intended to enable a quick and easy range test of the sx1276 module. Here most of the modem parameters are pre-configured and the user only needs to set some RF parameters.





4.2 SX1276 Module Hardware

The SX1276DVK is a USB based evaluation software designed to allow simple and easy evaluation of the suitability of the SX1276 for a given application. There are three evaluation module developed around the SX1276 and each module is targeted to specific RF Bands.

4.2.1 SX1276RF1IAS

The SX1276RF1IAS is targeted to the 169MHz and 868MHz frequency bands.



Figure 3: SX1276RF1IAS Module Schematic



4.2.2 SX1276RF1JAS

The SX1276RF1JAS is targeted to the 433MHz and 868MHz frequency bands.



Figure 4: SX1276RF1JAS Module Schematic



4.2.3 SX1276RF1KAS

The SX1276RF1KAS is targeted to the 490MHz and 915MHz frequency bands.



Figure 5: SX1276RF1KAS Module Schematic



4.2.4 Module Antenna

The SX1276RF1 modules are fitted with 2 RF antenna SMA connectors. Each antenna connection has been specifically designed to offer the best RF matching to a specific frequency band.



Figure 6: LF and HF Antenna Connection

Five antennas types could be delivered with kits. The antennas can be identified through their color dedicated or shape, to a specific frequency band (LF=169, 433 or 490MHz, HF=868 and 915 MHz). Antenna types and part numbers are subject to be changed.

Do not connect both antenna types at the same time on the module.



Figure 7: Frequency Band Targeted Antenna



5 Eiger platform for PER Testing

5.1 Menu Description

The Eiger menu is organized around the touch screen which allows the user to set on the fly a limited number of parameters. We will here describe each menu window so that the user can quickly start doing PER testing.

The idea behind the PER demo is to set one of the Eiger platform as a transmitter and the other one as a receiver. Then both platforms can me moved away one from the other, in an urban or in an open field environment, to easily capture the PER between the transmitter and the receiver.

The PER demo operates in FSK or in LoRa modes so that the advantages and drawbacks of each modulation can been seen easily.

5.2 Using the Eiger platform

When booting up, the Eiger application will detect the hardware module connected to configure the RF parameters dedicated to each modules. Each hardware module is fitted with an EEPROM which is programmed at manufacturing. However, if for any reasons, the EEPROM cannot be read or has not be programmed, the following window is shown.

In case of doubt, the exact part number of the hardware module connected is written on the right side of the module.







When the module is successfully detected, the home screen is the first window displayed on the control touch screen.



5.2.1 System Window





In case of miss-operation or to simply reset the Eiger module into a known state, it is possible the reset the touch screen parameters or to reset the device parameters to their default parameters.



Once a box is ticked, "clicking" on the Apply button will reset the selected parameters. The ticked box will then go un-ticked.

5.2.1.2 Battery





5.2.1.3 Bootloader



5.2.1.4 About





5.2.2 PER Demo Window

When entering the PER Demo Windows, the EEPROM on the module type is read so that the module connected can be used. If the EEPROM is faulty, not present or damaged, the following windows is displayed.



If the module is detected correctly, the PER demo is accessed and the following window is displayed.



The PER Demo menu is the core of the Eiger platform testing. The menu is divided in three main areas, Tx, Rx and Settings. The PER Settings menu allows the user to set several parameters of the Radio for Tx and Rx.



A text in green indicates that the value can be changed. For example, on the first window of the PER Setting screen, you will see:





5.2.2.1 PER Settings Menu running in FSK mode

For a given modulation, there is only a limited set of parameters that can be set by the user. Most of the parameters are set automatically in the software to keep the interface user friendly.





5.2.2.2 PER Packet Settings Menu running in FSK mode



In FSK mode, the payload is built in the following way:

Preamble (8 Bytes)	SyncWord (0x69-0x81-0x7E-0x96)	Payload length (1 Byte)	Payload (Platform ID, 32-bit packet cnt, 'P', 'E', 'R', FCS, 'Padding [xx Bytes]')	CRC (2 Bytes)
-----------------------	-----------------------------------	-------------------------------	---	------------------

The preamble length, the SyncWord and the basic payload structure cannot be changed by the user. However, the payload length is adjustable and the 'Padding' field will increase or decrease depending of the payload size. The CRC can also be enabled or disabled from the packet settings menu. All in all the smallest packet will be 22 bytes long and the longest packet will be 78 bytes long in total.



5.2.2.3 PER Settings Menu running in LoRa mode





5.2.2.4 PER Packet Settings Menu running in LoRa mode



In LoRa mode, the payload is built in the following way:

Preamble	Header	Payload	CRC
(8 Symb.)	(8 Symb.)	(Platform ID, 32-bit packet cnt, 'P', 'E', 'R', FCS, 'Padding [xx Bytes]')	(2 Bytes)

The preamble length, the Header and the basic payload structure cannot be changed by the user. However, the payload length is adjustable and the 'Padding' field will increase or decrease depending of the payload size. The CRC can also be enabled or disabled from the packet settings menu.



5.2.2.5 PER TX Mode

Once the RF parameters are set, putting the Eiger module in TX mode will initiate the packet transmission. The TX window displays the RF parameters and the number of packet sent since the beginning of the test.

PER Tx window in Lora mode:

5 00:04:37 2.0.1 PER - LoRa	- Tx Mode	TX Modulation para	meters
Power	14 dian		
RF Frequency	915.00 MNz		
Spreading Factor	SF12		
Error Coding	4/6	Number of packet se	ent
Bandwidth	125.0 kHz		
Payload Size	9 bytes		
Packet #	12		
		Reset the counter	
Home	Reset Back		

PER Tx window in FSK mode:

5 00:05:00 2.0.1	- Tx Mode
Power RF Frequency Bitrate Payload Size Packet #	14 dBn 915.00 MHz 9.6 kbps 9 bytes 46
Home	Reset Back



5.2.2.6 PER RX Mode

PER Rx window in Lora mode:



In LoRa mode, when sub-noise reception is occurring (SNR < 0), the displayed RSSI value is extrapolated using the SNR indicator. When the SNR > 0, the actual SNR is not computed and the value is clamped.



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PER Rx window in FSK mode:





5.2.3 PER Rx Bar-graph

In Rx mode, a bar-graph indicates the distribution of the error over time. This is especially useful to detect the cause of the error, whether a burst of noise in the frequency band or if the device in in the limit of reception range. The examples below highlight what each case looks like:

 Here, the device is at the limit of the reception range
 Blue: the reception is good and we are receiving every packet sent

 FER
 6.35 %
 Geodetic content of the reception content of the recepting content of the recepting content of the rec

As we can see in the picture below, the device lost many packets in a short amount of time.





6 SX1276SKA Software Description

The SX1276SKA is organized on a PC software GUI communicating through USB with the Eiger platforms. In this situation, the Eiger platforms are only used as a gateway to communicate with the SX1276.

6.1 SX1276SKA Quick start Guide

It is recommended that this user guide is read in conjunction with the SX1276 datasheet.

- 1. Plug the Eiger Platform USB ports to the computer (one USB is used to power the platform while the other USB is used for communication).
- 2. Run the SX1276 User Interface software: Start > All Programs > SX1276SKA > SX1276SKA
- 3. The SX1276SKA should connect automatically to the User Interface Software. If not, click on the USB connect button, located in the top left hand corner of the window toolbar.
- 4. Once connected the SX1276SKA shows the default configuration of the SX1276 register settings upon power-up. If the EVK is not connected, the GUI screen is grayed out and an error message is displayed in the bottom left hand corner of the status bar.



Figure 8: Connect both USB ports to use the SX1276SKA



The SX1276SKA has been developed to test all the capabilities and features of the FSK and LoRa modems present in the device. However, both modems have different control commands and must be operated independently.

SX1276 Starler Kit A	
File Action Tools Help	
🚰 🛃 🐢 Modem LoRa FSK Reset 🔄 👌 Reg Monitor: ON OFF 💿	
→ Opens Registers window	Irq flags
> Refresh all registers value	 RxReady TxReady
Set Radio in LoRa or FSK	PIILock
Connect or disconnect to the module	Rssi
Save Radio configuration	Timeout
	Preamble
└──→ Load Radio Configuration	SyncAddressMatch
	FifoFull
	Eifel avel
	EifoCverrun
	Brades/Cast
	PacketSent
SX1276SKA Version	
Eiger Module Firmware Version	LowEat
\rightarrow SX1276 Chinset Version	
	Operating mode
currently loaded	 Sleep Standby Synth. Tx Transmitter
	🗇 Synth. Rx 🔘 Receiver
Version: 1.0.Beta5 Firmware Version: 2.0.B1 Chip version: 1.1 Config File: -	Connection status: 🧉

Figure 9: SX1276 window organization

While this approach has limitation on testing the system capability of the device, it allows the user to thoroughly evaluate the device from the radio point of view

This chapter is presenting the various windows and field that controls the radio operations. While some controls can be obvious, some others may need the user to refer to the datasheet to get a full description of the commands.

A load radio configuration is implemented and allows the opening of SX1276SKA configuration files (.cfg). This is implemented through a standard Windows file dialog box and may also be accessed through the short cut buttons of the Window Toolbar.

In the same way, it is possible to save the SX1276SKA configuration files (.cfg). This is implemented through a standard Windows file dialog box. The default file name is the last configuration file saved.



For reference purposes, it is possible to display the register map of the device. This can help the user to refer to the datasheet register when testing the device.

Register	Addr	Value	Register	Addr	Value	Register	Addr	Value	Register	Addr	Value
RegFifo	0x00	0x00	RegRxTineout1	0x20	0x00	RegDioMapping1	0x40	Ox00	RegTest60	0x60	0x00
RegOpMode	0x01	0x01	RegRxTineout2	0x21	0x00	RegDioMapping2	0x41	0x00	RegAgeRef	0x61	Ox1C
RegBitrateMsb	0x02	Ox1A	RegRxTineout3	0x22	0x20	RegVersion	0x42	0x11	RegAgcThresh1	0x62	0x0E
RegBitrateLsb	0x03	0x09	RegRxDeay	0x23	0x00	RegTest43	0x43	0x00	RegAgeThresh2	0x63	0x5B
RegFdevMsb	0x04	0x00	RegOsc	0x24	0x05	RegPliHop	0x44	0x20	RegAgcThresh3	0x64	0xCC
RegFdevLsb	0x05	0x52	RegPreanbleMsb	0x25	0x00	RegTest45	0x45	0x00	RegTest65	0x65	0x0E
RegFrfMsb	0x06	OxE4	RegPreanbleLsb	0x26	0x03	RegTest46	0x46	0x00	RegTest66	0x66	Ox41
RegFrfMid	0x07	0xC0	RegSyncConfig	0x27	0x93	RegTest47	0x47	0x00	RegTest67	0x67	0x50
RegFrfLsb	0x08	0x00	RegSync/alue1	0x28	0x55	RegTest48	0x48	0x00	RegTest68	0x68	0x00
RegPaConfig	0x09	0x0F	RegSync/alue2	0x29	0x55	RegTest49	0x49	0x00	RegTest69	0x69	0x00
RegPaRamp	0x0A	0x19	RegSync/alue3	0x2A	0x55	RegTest4A	0x4A	Ox00	RegTest6A	0x6A	0x00
RegOcp	0x0B	0x2B	RegSync/alue4	0x2B	0x55	RegTaxo	0x4B	Ox09	RegTest68	0x6B	0x00
RegLna	0x0C	0x20	RegSync/alue5	0x2C	0x55	RegTest4C	0x4C	0x00	RegTest6C	0x6C	0xA0
RegRxConfig	0x0D	0x00	RegSync/alue6	0x2D	0x55	RegPaDac	0x4D	0x84	RegTest6D	0x6D	0x00
RegRssiConfig	0x0E	0x02	RegSync/alue7	0x2E	0x55	RegTest4E	0x4E	0x00	RegTest6E	0x6E	0x0F
RegRessiCollision	0x0F	0x0A	RegSync/alue8	0x2F	0x55	RegTest4F	0x4F	0x00	RegTest6F	0x6F	0x0B
RegRosiThresh	0x10	OxFF	RegPackstConfig1	0x30	0x90	RegTest50	0x50	0x00	RegPll	0x70	0xD0
RegRssiValue	0x11	0x00	RegPackstConfig2	0x31	0x00	RegTest51	0x51	0x00	RegTest71	0x71	0x00
RegRxBw	0x12	0x15	RegPayleadLength	0x32	0x01	RegTest52	0x52	0x00	RegTest72	0x72	0x14
RegAfcBw	0x13	0x0B	RegNodeAdrs	0x33	0x00	RegTest53	0x53	0x00	RegTest73	0x73	0x00
RegOokPeak	0x14	0x28	RegBroalcastAdrs	0x34	0x00	RegTest54	0x54	0x00	RegTest74	0x74	0x00
RegOokFix	0x15	0x0C	RegFifoTuresh	0x35	0x0F	RegTest55	0x55	0x00	RegTest75	0x75	0x00
RegOokAvg	0x16	0x12	RegSeqConfig1	0x36	0x00	RegTest56	0x56	0x00	RegTest76	0x76	0x00
RegRes17	0x17	0x47	RegSeqConfig2	0x37	0x00	RegTest57	0x57	0x00	RegTest77	0x77	0x00
RegRes18	0x18	0x32	RegTimeResol	0x38	0x00	RegTest58	0x58	0x00	RegTest78	0x78	0x00
RegRes 19	0x19	0x3E	RegTime1Coef	0x39	OxF5	RegTest59	0x59	0x00	RegTest79	0x79	0x00
RegAfcFei	0x1A	0x00	RegTime2Coef	0x3A	0x20	RegTest5A	0x5A	0x00	RegTest7A	0x7A	0x00
RegAfcMsb	0x1B	0x00	RegImag:Cal	0x3B	0x82	RegFormerTemp	0x5B	0x00	RegTest7B	0x7B	0x00
RegAfcLsb	0x1C	0x00	RegTemp	0x3C	OxF6	RegTest5C	0x5C	0x07	RegTest7C	0x7C	0x00
RegFeiMsb	0x1D	0x00	RegLowBat	0x3D	0x02	RegBitrateFrac	0x5D	0x00	RegTest7D	0x7D	0x00
RegFeiLsb	0x1E	0x00	RegirqFlags1	0x3E	0x80	RegTest5E	0x5E	0x00	RegTest7E	0x7E	0x00
RegPreambleDetect	0x1F	0x40	RegirgFlags2	0x3F	0x40	RegTest5F	0x5F	0x00	RegTest/F	0x7F	0x00

Figure 10: Register table

For advance user only, it is also possible to read or write the register directly by pressing the <CTRL>+<ALT>+<T> keys of the PC keyboard simultaneously.

Registers			
	Address	Data	
	0x01	0x81	
	Write	Read	

This window allows the user to write to and read from the contents of individual configuration register addresses. Note that address and data are entered in hexadecimal format.



6.2 LoRa Mode

6.2.1 LoRa Menu

By default, when the application is launched, the SX1276SKA is configured in LoRa.

File Action Help Impodement Lots FSX Reset Impodement Refresh all registers value Impodement PayloadCreferor ValidHeader Direct access to sub menu Opens Registers window Indicates the Modem IRQ and Modem status Moden status Indicates the Modem IRQ and Modem operating Mode Signal detected Operating mode Signal detected Operating mode Signal detected Operating mode Signal detected Operating mode Indicates the Modem operating Mode Signal detected Operating mode	SX1276 Starter Kit A	
Refresh all registers value Direct access to sub menu Opens Registers window Indicates the Modem IRQ and Modem status Indicates the Modem operating Mode	File Action Help	
Operating mode Sleep Sleep Standby Synth. Rx Synth. Tx Rx Rx Rx Rx CAD	Refresh all registers value Direct access to sub menu Opens Registers window Indicates the Modem IRQ and Modem status	Ing flags PayloadCrcError ValidHeader TxDone CadDone CadDone FhssChangeChannel CadDetected Moden status Modem clear Header info valid Rx on going Signal synchronized Signal detected
Version 10 Patris L Einmung Version 20 P1 L Chinematics 11 L Config Film	Indicates the Modern operating Mode	Operating mode Steep Standby Synth. Rx Synth. Tx Rx Tx continuous Rx Single CAD



6.2.2 LoRa Common Window

General RF frequency:	915000'000	1 xx	D Frequency: D input selection:	32000'000	🗘 Hz	Irq flags RxTimeout RxDone PayloadCrcError
Tx settings		PA0 -> "ransmits on PA1 -> "ransmits on	pin RFO pin PA_BOOST			 ValidHeader 5 Tx0one CadDone FhssChangeChannel CadDetected
PA ramp:	40	🔹 µs 💦 PL	L bandwidth:	300'000	Hz	Modem status
Maximum output power:	10.8	🚖 dBm 🖉 Ov	erload current protection:	ON OFF		Midem clear
Output power:	10.8	dBm Ov	erload currenttrimming:	100	mA	Header info valid
+20 dBm on pin PA_BOOST	: ON OFF					Rx on going
Rx settings		AGC auto: 3	I ON OFF			Signal synchronized Signal detected
		LNA boost:	ON OFF			6
DIO mapping			4			Sleep Standby
DIO5	0104	DIO3	4 DI02	DIO1	DIO0	Synth. Rx Synth. 1x Rx Tx continuou
ModeReady -	CadDetected 👻	CadDone 💌	RhssChangeChannel -	RxTimeout ·	RxDone -	C Rx Single CAD

Figure 11: SX1276SKA Boot-up windows

- 1: Set the default basic parameters for the Radio.
- 2: Set the parameters related to the transmission of the data such as output power.
- 3: Set the parameters related to the reception of the data such as AGC or LNA boost settings.
- 4: Set the mapping for the device IO pins. The Status of the IO is then displayed over time in the section 5 of the window.
- 5: This section indicates the modem and DIOs status
- 6: Set the operating mode of the device.



6.2.3 LoRa Parameters Window

File Action	Help dem: LoR	a FSK	Reset 🖻	Reg Monito	or: ON	OFF						
Settings Spreading factor: Coding rate: Bandwidh: Rx timecut: Low datarate optimize	SF7 4/5 125 1.047552	© 0=F	v kHz	Preamole leng Implicit header Payloid length Payloid CRC:	h: 12 © 01 11 © 01	N @ OFF	symbols	IRQ ma Rx time Rx don Payloa Valid h Tx don CAD do FHSS o	ssk eout: d CRC error: e: e: one: change channel: etected:	 ON ON ON ON ON ON ON ON ON 	 OFF OFF OFF OFF OFF OFF OFF OFF 	Ing flags RxTimeout RxDone PayloadCrCError ValidHeader TXDone CadDone FhssChangeChannel CadDetected Modem status
Rx header info —	2	Receive header	d valid count	PLL timeout	Rx payloi	ad CRC	Rx payload coding rate	Number of receiv	f bytes ved			 Modem clear Header info valid Rx on going Signal synchronized Signal detected
dukel Status	Current	hopping annel	Received v packet co	ralid Rx data addre	ouffer ess	Received pac SNR [dB]	ket Received RSSI	packet dBm]	Current RSSI value [dBm]			Operating mode
Mc33age	HE 76 88 7	XADECIM	AL EF 2		. \$Vgt	ASCII		Start Start Rx packets	Log		Tx 💿 Rx	Sleep Standby Synth. Rx Synth. Tx Rx Rx Tx continuou Rx Single CAD

Figure 12: LoRa Radio parameters window

- 1: Set the Radio settings for the LoRa modulation
- 2: Details status of the reception
- 3: Set the payload to be transmitted control the emission or reception of the radio
- 4: Enable or disable the IRQ related to the LoRa modulation



6.3 FSK Mode

6.3.1 FSK Menu

The FSK menu is organized around several windows allowing the user to set the radio step by step. The detail of each window is described from section 5.2.1.1 onward.

Some information are however global to the FSK radio operation and are thus displayed on every window as shown on figure 9.



Figure 13: FSK window structure

In FSK mode, it is possible to perform a quantitative spectrum analysis but reading the RSSI value across a range of Frequency. It is also possible to have a qualitative measurement of the RSSI as it is detected by the chipsets. This tool is especially useful when a more expensive spectrum analyzer is not at hand reach.

When Monitor is set to ON, the GUI will constantly scan the status of the FSK IRQ register and displays the status on the right hand side of the GUI. Setting Monitor to OFF disables this features.



6.3.2 Common window

Modem: Loka FX Reset 🔄 🥘 Reg Monitor: UN OFF 🐨	
Common Transmitter Receiver RQ & Map Packet Handler Sequencer Temperature	
General RF frequency: 915'000'000 ⊕ Hz Fast hopping: ● ON ● OFF Bitrate: ● 7799 ⊕ bps Bitrate: ● 0 ⊕ Hz Bitrate: ● 5005 ⊕ Hz Fdev: +/- 5005 ⊕ Hz Modulation ● FSK OOK Modulation shapng: ● OFF ● Gaussian filter, BT = 1.0 ● Gaussian filter, BT = 1.0 ● Gaussian filter, BT = 1.0	Irq flags ModeReady RxReady TxReady Fillock Rssi Timeout Preamble SyncAddressMatch FiloFull FiloEmpty FifoLevel ElfoDuerrun
© Gaussian filter, BT = 0.3 Oscillators XO Frequency: XO input selection: RC oscillator calibration: Battery management Low battery threshold trim: 1.835 ▼ V	 PacketSent PayloadReady CrcOk LowBat Operating mode Sleep Standby Synth. Tx Transmitt Synth. Bx Receiver

Figure 14: FSK Common window

The Common window allows the user to set the common Tx/Rx parameters for the modulation. Parameters such as the modulation type (FSK or OOK), Frequency, Bitrate, frequency deviation or the oscillator details can be entered in this window.

When Frequency Hopping is used, the control bit "Fast Hoping" need to be set so that the internal PLL can optimize to jump from one frequency to the next in the smallest amount of time.

It is also in this window that the Gaussian Filter parameter is set for the transmission. A general description would be:

- 1: Set the general parameters for the modulation
- 2: Set the modulation Type and the Gaussian filter parameter (Tx Only)
- 3: Set the oscillators parameters



6.3.3 Transmitter window

mmon Transmitter Receiver	IRQ & Map Packet Handler Sequencer	Temperature on pin RFO on pin PA_EOOST	1	Ing flags ModeReady RxReady TxReady FILLock Rssi Turead
	PA ramp:	40	Ψμs	Imeout Preamble SuppAddress Match
	Output power Maximum output piwer: 2 Output power:	10.8		 FifoFull FifoEmpty FifoLevel
	+20 dBm on pin PA_BOOST: Overload current protection 3	ON ● 0	DFF	 FifoOverrun PacketSent PayloadReady Coolk
	Trimming:	100	mA 😒	LowBat
	PLL bandwidth 4	300'000	🗇 Hz	Operating mode Steep Standby
				Synth. Tx Transmitte

Figure 15: FSK Transmitter window

As indicated through its name, the transmitter window groups the configuration parameters related to the transmission:

- 1: This field allows the user to select the radio output pin. Depending of the SX1276 module version, it may or may not be possible to select the RFO pin as output.
- 2: Set the output power of the radio. The maximum output power is 20dBm.
- 3: Overload current protection
- 4: PLL Bandwidth



6.3.4 Receiver window

Moden	n: LoRa F	SK Reset	🗟 👌 Reg Moni	tor: ON OFF					
ammon Transmitter Bandwidth Rx filter bandwidth AFC filter bandwidth: AGC AGC 2000 2	10'417 50'000 Sta	HQ & Map P Hz Hz Hz	AFC AFC AFC aub: 5 AFC aub: 5 AFC aub lear: AFC: Cli FEI: Re	ON OF ON OF ON OF ad 0	F F Hz Hz	Demodulator 8 Bit synchronizer: OOK Threshold type: Peak threshold step:	ON OF Peak 0.5	F dB	Ing flags ModeReady RxReady TxReady PIILock Rssi
Reference Level: Threshold step 1: Threshold step 2: Threshold step 3:	28 14 5 11	dB	RSSI Offset: 6 Smoothing: Threshdd:	0 8 -127.5	ti dB ti dBm dBm	Fixed threshold: Peak threshold decr.: Avg threshold cutoff: Avg offset:	12 1x per chip 382 0	dB ♥ ♥ dB	 Timeout Preamble SyncAddressMatch FifoFull FifoEmpty
Threshold step 4: Threshold step 5: Preamble detectorn Detection: Size: 3 Error tolerance:	12 12 ON 3 0	dB dB dB dB OFF byte chip	Restart Rx on collin Collision threshold Rx Rest Rx trigger:	sion: ON OF 10 art Rx Restart PL	F 7	Timeout RSSI: 9 Preamble: Signal sync: Inter packet Rx delay:	0.000 0.000 106.688 0.000	AV ms AV ms AV ms AV ms	 FifoLevel FifoOverrun PacketSent PayloadReady CrcOk LowBat
Lna settings 4 LNA boost: ⑦ ON	Refer -1 OFF	rence 03 Gain I I I I I I I I I I I I I I I I I I I	Threshold 1 Thre- -89 G2	eshold 2 Thres -84 -7 G3	hold 3 ¹³ G4	Threshold 4 1 -6' G5 ©	Fhreshold 5 -49 ->1 G6	Pin [dBm]	Operating mode Seep Standby Synth. Tx Transmitte Synth. Rx Receiver

Figure 16: FSK Receiver window

This window allows the user to set the parameters for the packet reception:

- 1: Set the reception bandwidth filter and set the AFC reception bandwidth filter Please, note that the AFC bandwidth filter is disregarded if AFC Auto is set to OFF
- 2: Enable or disable the AGC and set the step threshold (I am not sure what it does actually)
- 3: Enable or disable the preamble detector and set the preamble detector parameters. Please, note that the preamble detector must be enabled if the reception is triggered on preamble detection.
- 4: Enable or disable the LNA boost
- 5: Enable or disable the AFC and read the FEI
- 6: Control the RSSI detection. If the reception is triggered on the RSSI detection, these parameters allow controlling the level of RSSI triggering the reception and smoothing the peak detector to avoid false detection in case of random peak in the frequency band.
- 7: These parameters control the events that trig a reception and the behavior of the receiver in case of collision
- 8: Enable or Disable the bit synchronizer and configure the OOK demodulator
- 9: Set internal timing between events



6.3.5 IRQ and Map window

mmon Transmitter Receiver IRQ & Map Packet Ha	ndler Sequencer 1	Temperature	irq flags ModeReady RxReady
Devic Bit Sy Data r Opera	e status nchronizer: node: 1 ting mode:	ON Continuous Standby	 TxReady PIILock Rssi Transit
- DIO se Pream	attings able IFQ: 2	ON OFF	 Preamble SyncAddressMatch
DIO m DIO5: DIO4:	appinj	CkOut •	 FifoFull FifoEmpty FifoLevel FifoOverrun
DIO3: DIO2: DIO1: DIO1:	3		 PacketSent PayloadReady CrcOk LowBat
Clock Frequ	out ency: 4	1000000 • Hz	Operating mode Sleep Standby Synth. Tx Transmitt
			Synth. Rx Receiver

Figure 17: FSK IRQ and Map window

The IRQ and Mapping window is used to set and control the IRQs in the device:

- 1: Indicates the current status of the device
- 2: Enable or disable the preamble detection IRQ (when starting on RSSI detection)
- 3: Configures the IRQ and how they are mapped with the DIOs of the device.
- 4: Disable or Enable and set the clock out of the device



6.3.6 Packet Handler window

mmon Transmitter Rec Data mode: Preamble size: Auto restart Rx mode: Preamble polarity: Sync word: FIFO fill condition:	ERQ & Map Pax Continuous 3 2 ON, wait for PL 0 0xAA ON 0 0 ON 0 0	L to lock 0x55 FF ss Alvay	Sequencer Temp bytes	Address based filter Node address: Broadcast address: DC-free: CRC calculation: CRC auto clear:	Image:	ing flags ModeReady RxReady TxReady PIILock Rssi Timeout
Sync word size: Sync word value: Packet format: Payload length:	4	Fixed 0x01	bytes bytes	CRC polynom: Tx start condition: FIFO Threshold: IO Home: IO Home Power fram Beacon:	 IBM ● CCITT FibLevel ● FifoNotEmpty 15 ○ ON ● OFF ○ ON ● OFF ○ ON ● OFF ○ ON ● OFF 	 Preamble SyncAddressMatch FifoFull FifoEmpty FifoLevel FifoOverrun PacketSent
acket 2					Device status	 PayloadReady CrcOk
Preamble 55-55-55	55-55-55	Length	Node Address	Message 0	CRC Bit Synchronizer: ON 13-63 Data mode: Continuous	LowBat
Message 3	HEXADECIMAL			ASCII	Operating mode: Standby Control 4 Start Log Fill FIFO	Operating mode Sleep Standby Synth. Tx Transmitt

Figure 18: FSK Packet Handler window

The packet handler is the main interface windows to control the transmission or reception of packets once the radio has been setup. Whether in transmission or reception, this window allow the user to defined the packet to be transmitted or to be received

- 1: This field allows the user to define the packet structure.
- 2: Once the packet structure has been defined, this view allows the user that all each field of the packet structure is set correctly.
- 3: Enter the payload to be transmitted or display the payload received.
- 4: Control the packet handler transmission or reception.



6.3.7 Sequencer window

ommon Transmitter Receiver RQ & Map Packet Handler Sequencer Temperature	
Sequencer: Start Stop Idle mode: Standby • Transition from start: To LowPowerSeledic • Low power selection: Sequencer OFF • Transition from idle: To Tx • Transition from receive: Unused • Transition from receive: Unused • Transition from packet receive: To Sequencer OFF • Transition from packet receive: To Sequencer OFF • Timer 1 resolution Timer 1 coefficient OFF • ps X 245 * = OFF Timer 2 resolution Timer 2 coefficient OFF • ps X 32 * = OFF	μg flage ModeReady ® RxReady TxReady © TitReady TitReady © PillLock Rssi © Timeout Preamble SyncAddressMatch FrifoFull © FrifoEult FrifoEupty © FifoEvel FrifoEvel © FifoEvel FrifoCverrun © PacketSent PayloadReady μs Operating mode © Seep © Standby © Synth, Tx Transmitt

Figure 19: FSK Sequencer window

The sequencer window allows the user to setup the internal state machine of the device and control how the device will react following an event. For more information on the FSK internal state machine, please, refer to the datasheet.



6.3.8 Temperature window

Common Transmitter Rec	aiver IRQ & Map Packet Handler Sequencer Temperature	120 10	ing flags ModeReady RxReady TuReady
Q calibration Auto: Calibration: Calibration status: Temperature delta (Actual - Former): Temperature Monitor: Measuring: Threshold: Change higher than thresh		120 - - 130 120 - - 70 120 - - 70 120 - - 60 120 - - 60 120 - - 60 120 - - 60 120 - - 60 120 - - 60 100 - - 60 100 - - 20 100 - - 20 20 - - 10 40 - - 10 20 - - 10 10 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 - - - 20 -	 PIILock Rssi Timeout Preamble SyncAddressMatch FifoFull FifoEmpty FifoEvel FifoOverrun PacketSent PayloadReady CrcOk LowBat
			Operating mode Sleep Standby Synth. Tx Transmitte Synth. Rx Receiver

Figure 20: FSK Temperature window

The SX1276 is fitted with an internal temperature sensor. Note that user is prompted to calibrate the SX1276 temperature sensor by clicking on the Calibrate button to access the temperature calibration dialog box. If auto calibration is set, a new calibration will be performed at every temperature change that exceeds the threshold. Threshold value could be set to 5, 10, 15 and 20°C.



7 How to...

7.1 ... perform a simple transmission / reception in LoRa

Performing a simple Transmission – Reception in LoRa is fairly straight forward. First, the user needs to set the RF transmission parameters:

SX1276 Starter Kit A						LC2011	Cat the frequency
File Action Help							Set the frequency
Midem: LoR	a FSK Reset 🛛	Reg Monitor 0	N OFF I III				
ommon LoRa							
General						ing flags	
	Terrer and the second		XD Frequency:	32'000'000	0 Hz	Refineout	
RF frequency:	915'000'000	Hz Hz	XO input selection		la.	PavloadCroError	
						ValidHeader	
Tx settings						@ TxDone	
		PAD -> Transmits of	in pin RFO			CadDone	
		C PA1 -> Transmits of	n pin PA_BOOST			FhschargeCharnel	
PA ramp:	40	* µs	PLL bandwidth	300'000	the Ha	CadDetected	
Maximum output sower	10.8	din alim	Overload current instection	ON OOF		Noden status	
Dutred prover	10.8	A den	Duerload current rimmion	100	the mat	Modern clear	
-70 dBm via til 6000ST-	0.01 0.00		orrenous content titlening.	1	101 mm	Bran anion	
*20 dam on pin HA_BOOST	O ON CON					Signal synchronized	
Rx settings						Signal detected	
		AGC auto	ON OFF				
		LNA boost	O ON @ OFF			Openting mode	
						C Seen @ Standby	
DID mapping						🔿 Synth Rx 🔿 Synth. Tx	
DIO5	DI04	DIO3	DIO:	DIO1	DIOD	Fx Tx continuous	
ModeReady • Ce	adDetected •	CedDone	ResChangeChannel ·	PxTmeout •	RxDone •	O Fx Single O CAD	

Second, the user needs to set the LoRa modulation parameters:

SX1276 Starter	Kit A									
File Action	Help	Recet 108	I Ben Masila							Set the Spreading Factor
Common LoRa			and I wanted							
Settings	6530			12	[A]	RQ mask Rx timeout	© ON	· OFF	ing flags Ø RxTimeout	
Coding rate:	4/5		mplicit header		OFF	Rx done:	O ON	OFF	RxDone RxDone	Set the Coding Rate
Bandwidth:	250	* 2147	Payload length	32	1 bytes	Payload CRC error	O ON	· OFF	ValidHeader	~ `
Rx timeout Low datarate	0.409600	÷.	Payload CRC:	0 ON 🔹	DEE	Valid header Tx done:	© ON	OFF OFF	TxDone CadDone	
optimize:	O ON COP					CAD done FHSS change channe		OFF OFF	PhssOhangeOhannel GedDetected	Set the Bandwidth
Pu handar info						CAD detected.	O ON	OFF	Moden status	
PA Reader Into	Receive	ed valid r count	P.L timeout	Rx payload CRC	fix peyload coding rate	Number of bytes received			Header info valid Px on going	Optimize transmission
Packet status				0		0			Signal synchronized Signal detected	for Low Datarate OFF
	Current hopping channel	Received vi packet cou	ald Fix detat	uffer Receive ss SNP	d paciet Received [de] RSSI (r	packet Current RSS Bml value (dBn)			Operating mode	(mandatory for SF11 and
Message	0	0	0	1.1.1	0 +155	0 -155.0 Packet Control			🔿 Skep 🔹 Standby	SF12 with BW=125KHz)
	HEXADECIN	UAL.		ASC		Start Log	0	× • R×	Synth. Fix Synth. Tx Ri Tx continuous Ri Single C40	
Version: 1.0.Beta1	Firmware Version	n •	Chip ve	sion: -	Config File -		_	_	Connection status	Set the Payload
								_		
	Clic	k "St	tart" to	o start	Transm	nitting			Set the De	vice in Transmitter Mode

It is important to notice that the device mode of operation is standby between packets, this is why the Operating mode is left in "Standby".



On the Reception side, the principle is exactly the same. We first need to set the basic radio parameters:

SX1276 Starter Kit A							Set the frequency
File Action Help							
🖌 🕼 Modem: Loi	Ra FSK Reset	Reg Monitor: Of	I OFF I				
Common LoRa							
General RF frequency:	915'000'000	(t) Hz	© Frequency © input selector:	320000000 © TCXD 🔮 Cr/s	tel Hz	ht fage RxTimeout RxDone PayloadCrcEmor WildHander	
Tx settings		 PA0 -> Transmits o PA1 -> Transmits o 	n pin RFO n pin PA_BOOST			TsDore CadDore PhsChargeCharnel CadDore CadDore	
PA ramp:	40	* µa 1	LL bendwidth	300'000	+ Hz	Nodem status	
Maximum outputpower.	10.8	1 dBm (verload current protection.	. ON OFF		Modern clear	
Output power:	10.8	🗄 d8m (Verload curret trimming:	100	2 mA	Header info valid	
+20 dBm on pin PA_BOOST	O ON . OFF					Rx on going	
Pix settings		AGC auto: INA boost	 ON OFF OV OFF 			Signal synchronized Signal detected Coerating mode States States	
DIO mapping						O Synth. Rx O Synth. Tx	
DI05	DI04	DIO3	002	0101	DIOO	🔿 Rx 🛛 🔿 Tx continuous	
ModeReady . C	CadDetected •	CadDone •	ResOrangOrannel •	RxTimeout •	RxDone •	🔿 Rx Single 💮 CAD	

Then we need to set the device in reception after setting the Lora modulation parameters.

SX1276 Starter8	Kit A								Contration - X -	
File Action I	Help									Set the Spreading Factor
🖌 🖌 Me	dem: LoRa	FSK Reset	Reg Monit	IOT ON OFF	0					~
Common LoRa										
Settings						IRQ mask			ing flags	
Spreading factor:	SF10	•	Preamble leng	ph 12	aymb	ols Rx timeout	O ON @	OFF	RxTimeout	
Coding rate:	4/5	*	Implicit heade	. OON .	OFF	Rx done.	O ON #	OFF	PavloadCrcError	Set the Coding Rate
Bendwidth:	250	* 144	Peuloed lengt	32	1 bytes	Payload CRC error	© ON .	OFF	ValidHeader	
Rx timeout	0.409600	101 +	Payload CRC	O ON .	OFF	Valid header	O ON .	OFF	TxDone	
Low datarate		0.000				Tx done:	O ON 🔮	OFF	CadDone	Sot the Randwidth
optimize	O ON 1	e care				CAD Socie	O ON .	OFF	FhssChargeCharnel	Set the bandwidth
						FHSS change chan	vel O ON	OFF	G CadDetected	
						CAD detected	O ON	OFF	Noden status	
Rx header info —						Harrison and the second		_	Modern clear	
		Received valid	PLL timeout	Rx payload CRC	Rx payload	Number of byses			 Header info valid By or exists 	Enable the payload CRC
	-	neader cours			cooing rate	received	_		Fix on going Sinnal sunchronized	abaak
Packet status		1.04			1				Signal detected	CHECK
	Current h	opping Received	valid Rx data	buffer Receiv	ed sacket Receiv	ed packet Current RS	9			
	chan	nel packet o	oovit add	ess SN	R (6) RS	Si (dBim) value (dBi	7		Operating mode	
	0	0			0	155.0 -155.0			O Dura B Duratio	
Message	HEY	ADECIMA		45/		Packet Control			C Seeb By C Seeb Se	Optimize transmission for
Carlier 10 Patri	1 Emm	Venier	L Chieve			Ra pacieta	<u>09</u> 0 Tx:		Rx Tx continuous Rx Single CAD	Low datarate OFF (mandatory for SF11 and SF12)
erander a di detad	1 roman	e recover.	1 Crip vi	Cranons +	1 compignie -				1 commercion statute	
							_			
	liok "	Stort" to	o otort	Doooiu	lina		6	Sot t	ha Davias in D	acciver

At this stage, the transmission – reception should be complete and the user should see the LEDs blinking on the Eiger platforms.



7.2 ... perform a simple transmission / reception in FSK

First, you need to set the RF parameters for the transmission:

SK1276 Stater KR A	Set the frequency. 915,000,000 Hz
För Action Texh Holp G 🙀 de Modern Lofa FSK Reset 👔 🕼 Reg Montan Off Off 🖗	
Image:	Wing Native Wing Set the bitrate: 19,200 bps Plan Set the bitrate: 19,200 bps Plan Set the bitrate: 50,000 Hz Plane Set the Frequency deviation: 50,000 Hz Plane Set the Frequency deviation: 50,000 Hz Plane Set the Frequency deviation: 50,000 Hz
Britey nanopent Los betrey deactor ① DN @ OFF Los betrey threatoid trin [120] • V	 ○ Seen # Example ○ Spech Ts. ○ Transmitter ○ Sech Ts. ○ Transmitter

In the transmitter, receiver and IRQ windows, all the parameters can be left at their default values and then we simply need to set our packet structure.

						- Set the preamble Size. S			
FSK Reset [] ()	Reg Molton Of	N OFF @				- <u> </u>			
IRG&Mep Packet Har	rder Sequercer Ter	granture.							
Packet .	•	Add uns haved hits	ring: Off Node N	ode or Broadcast	in tage				
3 (0)	0,946	Node address:	0 0x00		a Referety	Set the preamble polarity: 0x55			
CFF.	-	Brunktast address II - 0x00 @ TxReady		@ Txfleady					
■ 0x4A © 0x55		DC-bae	CIFF C Marchester	() Whitening	@ PiLock	·			
. ON COFF		CRC calculation	. ON O OFF		@ Fast				
· Sync address ()	Abores	CRC auto clear	CN OFF		@ Tirest	Set the Sync Word size: 1			
4 (0)	bytes	CRC polynom	0-18H @ CC/TT		B Preatie				
35-55-55-55		Tx start condition	O Filderel @ Fildlad	mails.	SyncAdbeesHetch				
· Variable O Fired	đ	FIFO Threahold	15 8	99.54	@ FAST-JI				
1 0 0-01	by bea	IO Hone	O ON . OFF		- Thicky	Set the Sync Word: 0x60- 0x81-			
		IO Home Power for	He		B FACARA	Set the Sync Word. 0x03- 0x01			
		Execut.	O ON @ OFF						
					a factoriation				
Senc. He	with Nodelaldreen	Messar	CRC Extension	0.1	@ CreDk	Sot the packet length: variable			
6-55-55-55	00	1	33-63 Cat mode	Packet	@ Loufet	Set the packet length. Valiable			
			Oprating mode	Standby	Operating made				
XADECIMAL		ASCII	The lot	Can the second	O Seep # Sanday				
			*	Na Pareo	O Sett. Ta . O Treamber				
					O Synth Ro. O Receiver	Set the payload: 0xA1-0xA2			
	BGL13mg Protein Face Face GPE © All © All © All © All </td <td>Bit Little Product fixed on Search of the s</td> <td>Bit Ling Packet Franche Bagaron Terperature Radiu • Adfress Intel Vio Adfress Intel Vio Bit • Adfress Intel Vio Mole Adfress GPE • • Adfress Intel Vio © OLI OLF OCK cellulation Books Address © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI Julation For address For address For address © OLI Julation For address For address For address § Dubl Julation Holesholdwass Messager For address § Station GO Octower Address Address § Station GO Messager For address For address § Station</td> <td>BGL3big Packet Needs Searce Searce</td> <td>Balance Terrente Balance Terrente Balance Terrente Colf Control Terrente Balance Terrente Colf Control Terrente Colf Control Terrente</td> <td>Note Transfer Base of Seventies Version Seventies Version Seventies Version Seventies Version Seventies OF O</td>	Bit Little Product fixed on Search of the s	Bit Ling Packet Franche Bagaron Terperature Radiu • Adfress Intel Vio Adfress Intel Vio Bit • Adfress Intel Vio Mole Adfress GPE • • Adfress Intel Vio © OLI OLF OCK cellulation Books Address © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI OLF OCK cellulation For address OCK cellulation © OLI Julation For address For address For address © OLI Julation For address For address For address § Dubl Julation Holesholdwass Messager For address § Station GO Octower Address Address § Station GO Messager For address For address § Station	BGL3big Packet Needs Searce Searce	Balance Terrente Balance Terrente Balance Terrente Colf Control Terrente Balance Terrente Colf Control Terrente Colf Control Terrente	Note Transfer Base of Seventies Version Seventies Version Seventies Version Seventies Version Seventies OF O			



At this stage the radio is fully configured on the transmitter side. We can now set the device in Transmitter mode so that packets are ready to be sent from the device.

SX1276 Starter Gr A		Cardina and Cardina an
File Action Tools Help G G 49 Modem LoRa FSK Reset () () Reg Moniton () ()	7.0	
Connon Transitier Receiver IRQ & Map Packet Harder Sequencer Temperatur		
Data mode: Packet ■ Adds Preventile size: 0 0 10% Note Also nation R mode 00% 0.05% 0.04% Note Spin notif @ DAL 0.05% 0.04%	bits based Niming B OFF Node Node or Enveloped bits bits B OFF Solid Solid doctal address: B OFF Solid Solid doctal address: B OFF Solid Solid Catious and Solid B OFF O Marchealar Solid Catious and Solid B OFF Solid Solid Solid Catious and Solid B OFF Solid Solid Solid Catious and Solid Solid B OFF Solid	Modilady Modilady Modilady Modilady Trimacy Transit Transit Modilady Modilady Trimacy Transit Modilady Modil
Packat Preamble Sync Length Node Address N 51.51.51.51 55.51.51.55 70	Device status Message CRC Di Synchronizer: ON 31/31 Distancia	Set the Device in Transmitter Mode
Henage HOADECIMA. AS	Correl Correl Standy Fill (FO)	A small control window appears allowing the user to set the number packets to be sent. Setting the valu to '0' will make the device transmitting

To start sending packets, simply click on the "Start" button.

1 00 5555555 ● Vanable ○ Fixed 1 00 0x01	bytes	Cric polynom Tx start condition FIFO Threshold IO Home IO Home Power 1 Beecon;	1 0 10 10 10 10 10 10 10 10 10 10 10 10 10	D FACE-rel @ FACEAUER 5 00 @ OFF 5 0N @ OFF 5 0N @ OFF	atr	SynckobressMetch Frid-Full Frid-Full Frid-Full Frid-Full Frid-Full Frid-Full PackatSet	Press "Start" to start sending packets
Sync Leng 55-55-55 00 HEXADECIMA	th Kode Addres	ASCII	CRC 33-63	Device status Bit Synchronicer Data mode Operating mode Carend Start	ON Packat Standby Patrico	Protection Protocheck Protocheck Copecting mote Same & Samday Samith Tar - Feasandar	Press "Stop" to stop sending packets
	Sync address ○ Ja 4 00 5055555 4 00 50555 4 00 1 00 00 1 00 00 00 1 00 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00 00 1 00	Sync address Joneys 4 Jon Joneys 4 Joneys Automatical Synchronic Synchroni Synchroit Synchronic Synchronic Synchyreteeeee Synchronic Synchy	Sync datess Jikeys CRC axtr clear: 4 Sci Svis Svis 55:55:55:55 Sci Trait clear: Trait clear: 57:90 Sci Svis Svis Svis 57:90 Sci Svis Svis Svis Svis 57:90 Sci Svis Svis Svis Svis 55:95:95:50 O0 Sci Maxaget Maxaget HXADECIMAL ASCII Sci Sci Sci	Sync address Jakeys CRC subt citer: 4 30 byes CRC pdynem: 5555555 Tix start condoor File File 1 30 Budit Here Budit 555555 Budit Here Budit Budit 555555 00 Start CRC 555555 00 Start CRC HXADECIMAL ASCII F	Sync Address Always CPC sats clear 0.N OF7 4 B bytes CPC patron: ISM 0.CCTT 5555555 To test condition: ISM 0.CCTT Follower Folo	Syne abbres Jakeys CRC subsidier ID N OFF 4 Bit bytes CRC polynom: IBM & OCFT 55:55:55 Tit satit condition Friduers' sime Friduers' sime 3 Bot Date Press diff Bit COTF 55:55:55:5 Date Date Date OH OFF 55:55:55:5 Dot Date Date Date Date Date HXADECIMAL ASCH Tit Statilized Facilized Facilized	

The device is now sending packet. You can also see the Yellow LED flashing on the Eiger modules to indicate that the device is currently transmitting.



We must now configure the receiver side. Open a new window of the SX1276SKA and configure the radio as done for the transmitter side. The process is identical:

File Action Tool Help		Set the frequency: 915.000.000 Hz
² → W. Modern: Lofic PER, Faunt:] → 10,1 kegs linkste (Dirich Off) Converse: Transmitter / Income: PEG Alkelle Faunce: W1500000 B) HIT Fit Fragmen; W1500000 B) HIT Faunce: W1500000 B) HIT Fit Fragmen; W1500000 B) HIT Faunce: W1500000 B) HIT Faunce: W1500000 B) HIT Faunce: W1500000 B) HIT Faunce: W1500000 B) HIT Faunce: B) HIT Faunce: W15000000 B) HIT Faunce: B) HIT Faunce: W15000000 B) HIT B) B) HIT Hobilation staging O OFF O Condition: D DO OF B) HIT Ondition staging D Paunce: D DO OF B) HIT B) Ondition: D DO OF D DO OF HIT B) HIT B) D Paunce D DO OF	tellar Biodinary Biolinary Bio	Set the bitrate: 19,200 bps Set the Frequency deviation: 50,000 Hz

In the receiver, it is necessary to set some parameters to configure the receiver.





To finish, the user must simply set the packet handler parameters as in Tx:

🗱 1311276 Starter Kit A					Set the preamble size: 5
File Action Tools H	felp				
🥶 🖬 💠 Modem: Lof	fa FSK Reset (3 3) Reg Monton O	N OFF I			O at the same and black a clarify a OuEE
Coreon Traveniter Peoel	er IRG & Map Packet Handler Sequencer Te	ueatre.			Set the preamble polarity: 0x55
Data mode:	Packat .	Address based Maring	● OF	N Taga	
Preorible side:	3 il) bytes	Node address:	0 (1) 0x00	B Rufeesty	
Auto restart Rx mode	CHE .	broadcast address	(ii) (ii) (iii)	@ Tuffeady	O at the Orma Mand almost 4
Pleanble polarity:	⊕ 0x44. © 0x55	DC-free	· OF · Marchester · Vhitering	Pitack	Set the Sync word size: 4
Sync word	CON COFF	CRC calculation:	* ON COM	@ Pasi	· · · · · · · · · · · · · · · · · · ·
FIFO MI condition	· Sync address · Abusys	CRC also deter	BON O OFF	@ Timetal	
Sync word size	4 0 bytes	CRC polynom:	C IBH COTT	Grand March	
Sync: word value:	55-55-55-58	Tx start condition:	O FALevel · FAUNCEDraty	Set the Sync Word: 0x69-0x81	
Pachat format	Variable © Fixed	FIFO Threshold	12 10	Philosty	
Pb/kod leight	1 9 001 bytes	ID Home	D ON COFF	· FALevel	
		K) Hone Pover frame	O ON . OFF	FAQuena	
		Beacon	O ON @ OFF	@ Packetbert	Set the packet length: variable
Packet			Duice statue	Payloadflasty	i
Preamble	Sync Langth Node Addres	n Maxanga CRC	BiOynotronizer: ON	@ CeOk	
55-55-55	55-55-55 00	33-6	Drs mode Packet	. Toward	
Nessaja			Cresi	Operating mode	Press "Start" to start receiving packets
-	HEXADECIMAL	ASCH	Start Log Fulfield	O Steep # Standy	51
			forest the second second second second	O Synth Tix O Transmitter	· · · · · · · · · · · · · · · · · · ·
				O Synth. Ro: O Receiver	Set the Device in Receiver Mede
					Set the Device in Receiver would
- Venior 15 Retail 1 Freme		. I. Confin File .		1 Constantian datase 4	/
The sector of th		1 congrise		1	
				$\langle \rangle$	
/					
/	L				
The rea					
	aived pavles d	in diamly	aved here	A 1 1 2	
The rec	ceived payload	is displa	ayed here	Number of pa	acket received



7.3 ... perform Continuous transmission and Reception in LoRa

It is possible to set the SX1276 in Continuous Tx mode to perform a spectral evaluation of the LoRa modulation. In this mode, the SX1276 will be going through the FiFo and send whatever data are present in the RAM.

mmon LoRa Settings ipreading factor Coding rate: landwidth: Its timeout cow detarate ptimize:	5F7 • Presentile length: 12 ⊚ symbols 4/5 • Implicit header: ○ ○ N ● OF 125 • HHz Payload length: ○ ⊙ bytes 0102400 ⊙ s Peyload CRC: ○ ○ ○ bytes © ON ● OFF ● ○ ○ N ● ○						bols Rx Rx Pay Xal Tx CA FR	IRD mask Rx timeout: O N O FF Rx done: O N O FF Payload CRC pror: O N O FF Valid header: O N O FF Tx done: O N O FF CAD done: O N O FF FKSS change channel: O N O FF CAD done: O N O FF			Ite fags PR-Done Project/CEFror Valid-Header CasCone Physical Creation CasColescied Nodem status Modem provides	
header info		Received vi	alid p	PLL timeout	Rx payload CRC	Rx payload coding rate	Numb	er of bytes cerved	0.00		 Modern clear Header info valid Rx on poing 	
		0	-	9	9		1	0			Signal synchronized	
cket status	[c	hinder D			Real Provide	durch at Direct		C	-1:		Signal detected	
	correra	nnel i	packet cour	nt addre	In SN	R [IB] R	ssi (dBm)	value (dBm)			Operating mode	Set the device in
		0	0	0		0	-155.0	-195.0			0.0m 0.0mb	
esage	HE	KADECIMAL			ASC		Packet Sk	control et Log	0	Tx 🗇 Rx	Synth, Rx Synth, Tx Rx Rx Rx Rx Single CAD	

It is also possible to set the device in Continuous Rx mode. In this mode, the device is continuously receiving the packet sent from the transmitter.

ammon LoRe Settings Spreading factor Coding rate: Bandwidth: Rx timeout Low delarate sptimize:	SF7 4/5 125 6 102400 © ON	• OFF	• kHz	Preamble leny Implicit heade Payload lengt Payload CRC	at 12 r ⊖ ON ● 0 t 52 : ⊖ ON ● 0	If symbol D/F If bytes D/F	IRQ Rx1 Rx1 Payl Valie Tx 6 CAD FHS	mask irreout tone: load CRC error: d header: lone: l done IS change channel	© ON © ON © ON © ON © ON © ON	OFF OFF OFF OFF OFF OFF OFF OFF	in flags RuTimenut RuTimenut PayloseCroEnter ValieNeader TaCone CadDone FiscoCaspoChannel CadDetected	
t header info		Receive	d valid	PLL timeout	Rx payload CRC	Rx payload	CAE	detected	© ON	OFF	Rodem status Modem clear Header info valid	
		header ()		٥	cooing rate	rec	0			Fix on going Signal synchronized Signal synchronized	
cket status —	Current cha	hopping nnel	Received packet o	d velid Pox deta covint add	ess Receiver	(e) Feceive RSS	l packet (dBm)	Current RSSI value (dBm)]		Operating mode	
		0	0			-15	5.0	-155.0	1			
essage	HE	ADECIM	WL.		ASCI	*	Packet (Sta	rt Log	0	Ta @ Pa	O Synth Rx O Synth Tx Bx O Tx continuous Rx Single O CRD	າ node



7.4 ... Log the Transmitted or Received packets

The SX1276SKA has a logging facility which allows the user to get the exact time stamps at which a packet has been sent or received and with all the information related to this packet.

Settings								IRQ	mask		_	in flage
Spreading factor	SF7	i i i i i i i i i i i i i i i i i i i	•	Preamble l	noth 12		10 sumb	Ret	imeout	O ON	OFF	RxTimeout
Coding rate:	4/5	Institut tender			Ider O ON OF Rx done					0 ON	· OFF	OFF BrDone
Bandwidth	125		• 144+	Paulostile	-		i han	Pay	load CRC error:	© ON	· OFF	ValidHeader
Retiment	0 102400	1		Pauload CS					d header:	O ON	· OFF	TxDone
Low datarate				r ay sold on o	- 0			Txd	Tx done:		· OFF	CadDone
optimize:	ON	OFF						CAD	done:	O ON	. OFF	FhssChangeChannel
								FHS	S change channe	E O ON	· OFF	CadDetected
								CAD	detected	O ON	. OFF	Nodem status
Rx header info -												Modem clear
		Received	i valid count	PLL timeout	Rx pa	foad CRC	Rx payload coding rate	Numbe	r of bytes reived			 Rx on going
		0				0			0			Signal synchronized
Packet status -	_				-			-				Signal detected
	Curren	t hopping annel	Received packet of	vaid Rx d out a	stabuffer (dress	Received SNR 1	picket Receiv RSS	ed packet	CurrentRSS value (#Bm)			Overating mode
	T	0	0		0	0		55.0	-155.0	-		
Message	1.1.1					1.000	1.1.2	Packet	Control	_		() Sleep 🔮 Standby
-	HE	DADECIM	u.			ASCII	101	Sta	rt Log	01	x 🛛 Rx	O Synth Rx O Synth. Tx
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lession: 1.0 RetaS	1 Firms	vare Version		1 Obie	version		'onfor File -					L Connection status: @
ernore annoess	1	THE TERMON		1 . c	TO JACK	-	to any the				_	1 connection hards

Depending if you are in FSK mode or in LoRa mode, a different pop-up window will appear:



In FSK mode, the packet logger allows to the user to only log a limited amount of packet (indicated by the value "Max Samples"). Then, when the packets are being transmitted or received, the number of desired packets will be logged in the file selected.



In LoRa mode, the packet logger is enabled or disabled. Once enabled, all transmitted or received packets will be logged in the selected file until the packet logger is disabled.

When enabling the packet logger, it is possible to start a complete new log in a new file or to append an existing file.



7.5 ... perform a CW or PN9 Tx test on the SX1276

The SX1276 does not have a dedicated CW or PN9 Tx test mode implemented. However, it is possible to perform this test manually by setting the device in Tx continuous mode, and feed PN9/15 data stream to the DATA pin (DIO2/DATA), from a signal generator.

7.6 ... check the frequency accuracy of the SX1276 module

There is a very simple way to get the frequency error of the sx1276 modules. The core idea is to set the device in FSK and to set the frequency deviation to 0. In this case, the device will only emit a signal at the center frequency. The difference between the measured value and the set value gives you the frequency error.



8 Troubleshooting

Each Eiger platform, radio module or software kit has been thoroughly tested before to be released for customer evaluation. The section below highlights some of the common issues faced by users and how it can be fixed.

8.1 The Eiger platform indicates very high PER even in short range

There are several reasons which can have a dramatic influence over the performance of the platform. One of the common reasons is that the frequency selected is in the GSM or in another already used frequency band. If the frequency you have selected is already used by another RF system, the communication will obviously be affected. We therefore recommend to the user to check the RF band usage in his location before to start any PER testing.

8.2 The communication range in Lora is very poor

There are two aspects which can limit the LoRa performances: the emission power and the antenna. Please, make sure that we are using enough power to reach the distance you want to achieve. The Eiger platform can output up to 20dBm signals. The other aspect is the antenna, please, make sure the antenna you are using is designed to operate at the frequency region you are transmitting in.

8.3 The SX1276SKA do not detect the device through the USB

This issue is usually caused by a wrong connection of the USB The step below should fix the issue.

- 1- Make sure the Eiger Platform is powered down (Battery switch set to 0) and is not connected to the PC through the USB.
- 2- Reconnect the side USB to the PC, the red LED on the left side should light up
- 3- Connect the bottom USB to the PC.
- 4- Power the device up (Battery switch set to 1)
- 5- Press the five-way central push button until the screen light up.
- 6- Launch the SX1276SKA on the PC

8.4 The Eiger platform does not seem to work anymore

The battery is probably empty and you should connect the device through the side USB to a computer for a few hours, time for the battery to charge.

8.5 The Eiger platform touch screen is not accurate

This is probably due to a miss-calibration of the touch screen. In this situation, the user should reset the touch screen calibration and perform an accurate calibration using the stylus provided.



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