PRODUCT SPECIFICATION

Product Name	**EK-G76SXB** **LoRa™ Wireless Communication Module**
Version	**A**
Doc No	
Date	**Sep 6th ,2017**

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Document History

Date	Revised Contents	Revised By	Version
Sep 6th ,2017	Initial Version	Fox/Chunyi	A

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1. General Description

The EK-G76SXB integrates ARM Coretex®-M4 MCU with LoRa™ modulation that provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

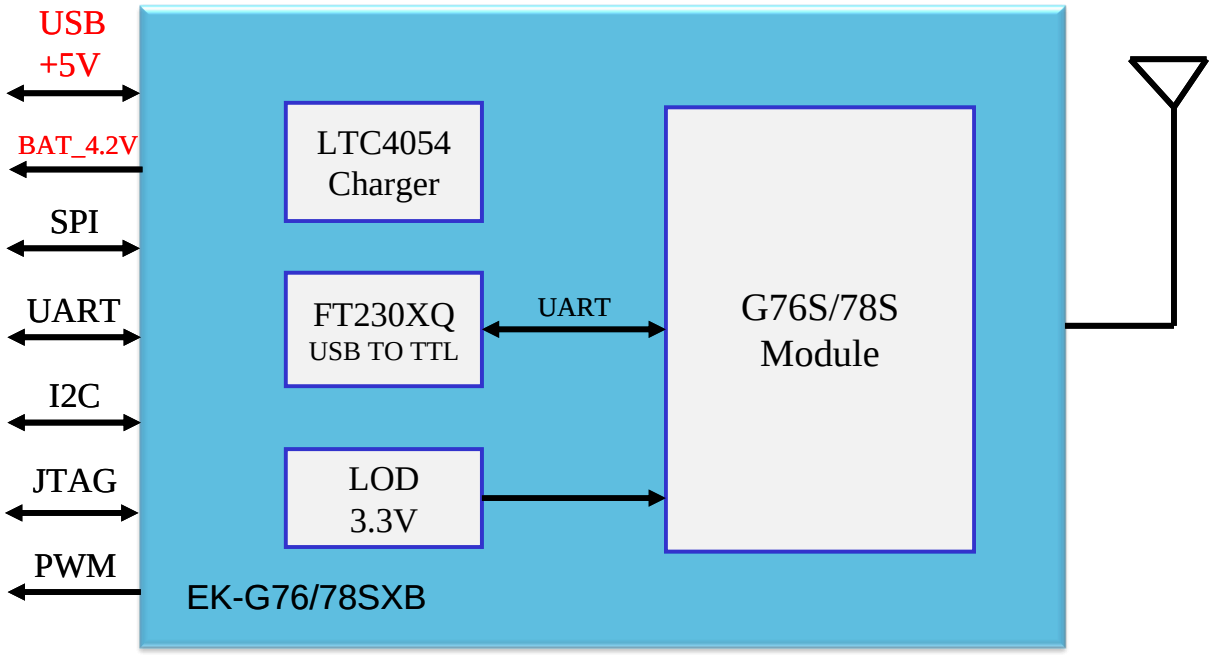
EK-G76SXB can achieve a sensitivity of over -136 dBm. The high sensitivity combined with the integrated +20 dBm power amplifier yields industry leading link budget making it optimal for any low data rate application requiring range or robustness. LoRa™ also provides significant advantages in both blocking and selectivity over conventional modulation techniques, solving the traditional design compromise between range, interference immunity and energy consumption.

Feature

- Dimension：47.94 mm x 24.38 mm
- LoRa™ Modem
- +20 dBm constant RF output vs. V supply
- Programmable bit rate up to 37500 bps
- High sensitivity: down to -136dBm
- Excellent blocking immunity
- Preamble detection
- Automatic RF Sense and CAD with ultra-fast AFC
- Payload up to 128 bytes with CRC

1-1 Block Diagram

A simplified block diagram of the EK-G76SXB module is depicted in the figure below.



1-2 Product Version

The features of EK-G76SXB is detailed in the following table

Part Number	Frequency Range	Spreading Factor	Bandwidth (K Hz)	Effective Bitrate (bps)	Est. Sensitivity (dBm)
EK-G76SXB	902-928 MHz 863-870 MHz**	6 - 12	62.5 - 500	146 - 37500	-109 to -136*

Note: * LORA setting SF=12, BW=62.5k, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1.

**Optional FW support for European band 868 MHz.

1-3 Specification

Model Name	EK-G76SXB
Product Description	LoRa Wireless Communication Module in XBee Format
Host Interface	UART / IRQs
Operation Conditions	
Temperature	■ Storage：-50℃ ~ +105℃ ■ Operating：-20℃ ~ +70℃
Humidity	■ Operating：10 ~ 95% (Non-Condensing) ■ Storage：5 ~ 95% (Non-Condensing)
Dimension	47.94 mm x 24.38 mm (+/-0.15mm), connector exclusive

2. Electrical Characteristics

2-1. Absolute Maximum Ratings

Symbol	Parameter	Min.	Typ.	Max.	Unit
VDD33	Supply Voltage	-0.3		3.9	V
V_{IN}	Input voltage on digital pins	-0.3		3.9	V
Pmr	RF Input Level			+10	dBm

2-2. Recommended Operating Range

Symbol	Parameter	Min.	Typ.	Max.	Unit
VDD33	Supply Voltage	2.4	3.3	3.6	V
ML	RF Input Level			+10	dBm

2-3. Power Consumption Characteristics (pure module measured)

Symbol	Parameter	Conditions	Typ.	Max.	Unit
IDDSL	Supply current in Sleep mode	Sleep Stop Mode		5	uA
IDDST	Supply current in Standby mode	Crystal oscillator enabled	9	10.1	mA
IDDR	Supply current in Receive mode		17.5		mA
IDDT	Supply current in Transmit mode with impedance matching	RFOP = +20 dBm RFOP = +17 dBm RFOP = +13 dBm RFOP = + 7 dBm	128 83 65 49		mA

2-4. RF Characteristics

The table below gives the electrical specifications for the transceiver operating with LoRa™ modulation.

Following conditions apply unless otherwise specified:

- Supply voltage = 3.3 V.
- Temperature = 25° C.
- Frequency bands: 915/868 MHz
- Bandwidth (BW) = 125 kHz.
- Spreading Factor (SF) = 12.
- Error Correction Code (EC) = 4/6.
- Packet Error Rate (PER)= 1%
- CRC on payload enabled.
- Output power = 13 dBm in transmission.
- Payload length = 64 bytes.
- Preamble Length = 12 symbols (programmed register PreambleLength=8)
- With matched impedances

LoRa Transmitter (Conductive)					
Item	**Condition**	**Min.**	**Typ.**	**Max.**	**Unit**
Frequency Range	Band1	863	915	928	MHz
Tx Power Level	PA_BOOST pin	17.0	18.5	20.0	dBm
LoRa Receiver (Conductive)					
Item	**Condition**	**Min.**	**Typ.**	**Max.**	**Unit**
Frequency Range	Band1	863	915	928	MHz
RFS_L62_HF (Long-Range Mode, highest LNA gain, LNA boost, 62.5 kHz bandwidth)	SF = 6		-117		dBm
	SF = 7		-113		dBm
	SF = 8		-126		dBm
	SF = 12		-136		dBm
RFS_L500_HF (Long-Range Mode, highest LNA gain, LNA boost, 500 kHz bandwidth)	SF = 6		-108		dBm
	SF = 7		-113		dBm
	SF = 8		-116		dBm
	SF = 9		-119		dBm
	SF = 10		-122		dBm
	SF = 11		-125		dBm
	SF = 12		-127		dBm

2-5. Digital Characteristics

2-5-1. DC characteristics

Input voltage levels

Symbol	Description	Conditions	Min	Typ.	Max	Unit
VIH	I/O input high level voltage	NRST	0.7xVDD33	-	-	V
		BOOT0	0.7xVDD33	-	-	V
		GPIO	0.7xVDD33	-	-	V
VIL	I/O input low level voltage	NRST	-	-	0.3xVDD33	V
		BOOT0	-	-	0.14xVDD33	V
		GPIO	-	-	0.3xVDD33	V
R_{PU}	Weak pull-up Equivalent resistor	V_{IN} = GND	30	45	60	K Ω
R_{PD}	Weak pull-down Equivalent resistor	V_{IN} =VDD33	30	45	60	K Ω

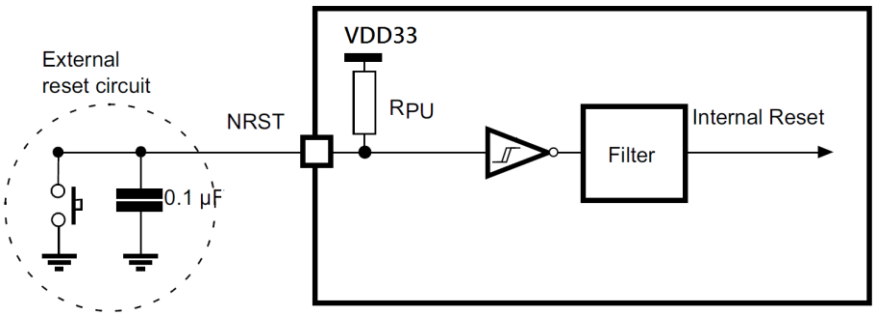
Output voltage levels

Symbol	Description	Conditions	Min	Max	Unit
V_{OL}	Output low level voltage for an I/O pin	CMOS port / IIO = +8 mA 2.7 V≦VDD33≦3.6 V	-	0.4	V
V_{OH}	Output high level voltage for an I/O pin		VDD33-0.4	-	
V_{OL}	Output low level voltage for an I/O pin	TTL port / IIO =+ 8 mA 2.7 V≦VDD33≦3.6 V	-	0.4	
V_{OH}	Output high level voltage for an I/O pin	TTL port / IIO =- 6 mA 2.7 V≦VDD33≦3.6 V	2.4	-	
V_{OL}	Output low level voltage for an I/O pin	IIO = +15 mA 2.7 V≦VDD33≦3.6 V	-	1.3	
V_{OH}	Output high level voltage for an I/O pin	IIO = -15 mA 2.7 V≦VDD33≦3.6 V	VDD33-1.3	-	
V_{OL}	Output low level voltage for an I/O pin	IIO = +4 mA 1.65 V≦VDD33≦3.6 V	-	0.45	
V_{OH}	Output high level voltage for an I/O pin	IIO = +4 mA 1.65 V≦VDD33≦3.6 V	VDD33-0.45	-	

2-5-2. NRST pin characteristics

The NRST pin input driver uses CMOS technology.
It is connected to a permanent pull-up resistor (R_{PU}).

The following figure is recommended NRST pin protection circuit against parasitic resets.



Symbol	Description	Conditions	Min	Typ.	Max	Unit
R_{PU}	Weak pull-up Equivalent resistor	V_{IN} = GND	25	40	55	K Ω
V_F	NRST Input filtered pulse				100	nS
V_{NF}	NRST Input not filtered pulse	VDD33 > 2.7 V	300			nS

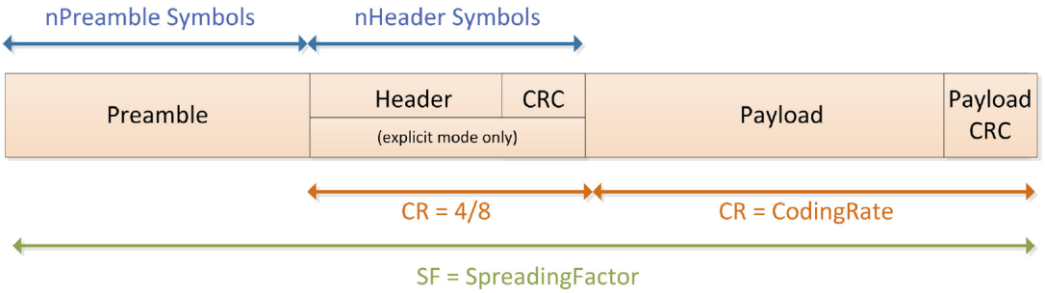
2-5-3. UART Interface Parameters

Baud Rate = 38400 bps
Data Bits = 8 bits
Stop Bits = 1 bit
Parity Check = None
Flow Control = None

3. Control Protocol

<This chapter describes the behavior of factory default firmware. For customized firmware, this chapter is not applicable.>

3-1 LoRaTM Packet Brief



The LoRa™ Packet comprises three elements:

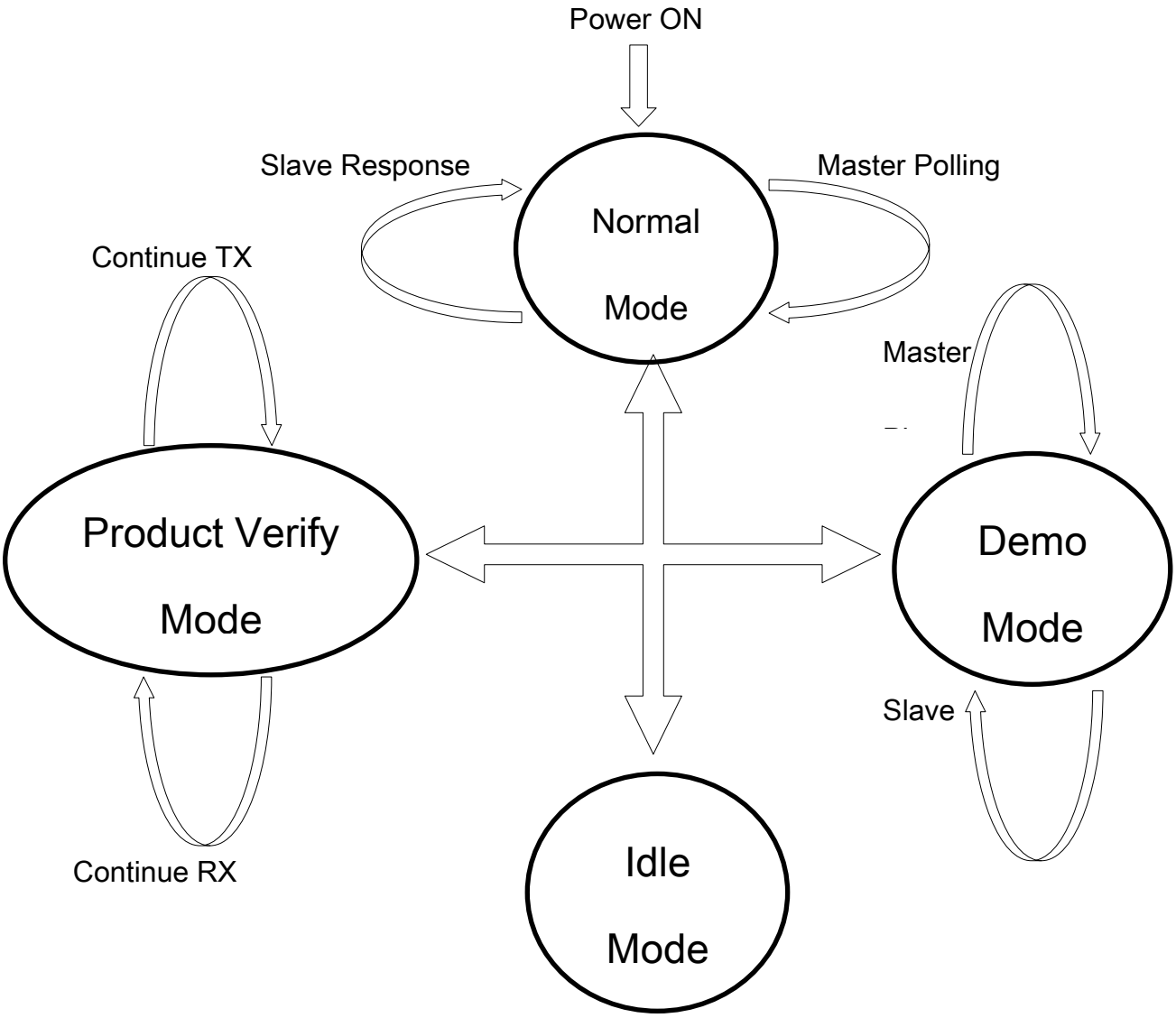
- A Preamble
  The preamble is used to synchronize receiver with the incoming data flow. The preamble length is variable from 6 to 65535 symbols. By default it is configured with 12 symbols.

- Header
  The header provides information on the payload, including length, FEC code rate, and the presence of CRC for payload.

- The data payload
  The maximum length of payload is 128 bytes.

In order to meet regulation in different regions / countries, the FHSS (Frequency Hopping Spread Spectrum) maybe needs to be implemented also. That needs to control the transmission time on air within specific time. The transmission time could be calculated by LoRa Calculator, which is downloaded on Semtech Web Site.

3-2 State Chart



3-3 Command / Response Format

Command:

Command (ASCII String)	Parameter (ASCII String)	End Of Line
N Bytes	0 ~ N Bytes	0x0D (CR)

Ex.

LoraPower	17	↵
UartEchoOn		↵

Response for Command syntax error or Execute result:

Response (ASCII String)	End Of Line

Ex.

UNKNOW	(CR)(LF)
OK	(CR)(LF)
ERROR	(CR)(LF)

Response for Query Result:

Response Item 1 (space) *Response Item 2 ……. (space) Response Item N* (ASCII String)	End Of Line

Ex.

TxPacketTimeout=2183	(CR)(LF)
RFFrequency=915000000 BW=6 SF=12 ErrorCoding=1	(CR)(LF)

3-4 Command Set

Predefined Modulation

LoraGetOperationMode	
Parameter(s)	N/A
Response on Success	LoraOperationMode=in???dBm
Description	Report current modulation / sensitivity mode. There are several pre-defined sensitivity mode like below: *in121dBm* *in126dBm* *in129dBm* *in132dBm* *in135dBm* *in137dBm* *in140dBm* It reports inOtherMode while not using pre-defined mode.

LoraSF7BW250RS120 **LoraSF7BW125RS123** **LoraSF8BW500RS120** **LoraSF8BW250RS123** **LoraSF8BW125RS126** **LoraSF9BW500RS123** **LoraSF9BW250RS126** **LoraSF9BW125RS129** **LoraSF10BW500RS126** **LoraSF10BW250RS129** **LoraSF10BW125RS132** **LoraSF11BW250RS132** **LoraSF11BW125RS135** **LoraSF12BW250RS134** **LoraSF12BW125RS137**	
Parameter(s)	N/A
Response on Success	OK
Description	Use pre-defined modulation / sensitivity mode. SF=Spreading Factor, BW=Bandwidth(kHz), RS=Receiver sensitivity

Miscellaneous

LoraSystemMode	
Parameter	inNormal => For user normal application inTD => Demo Ping/Pong test inPV => Reserved for production test inIdle => Reserved for RD use.
Response on Success	OK
Description	Setup system operation mode.

LoraMode	
Parameter	MASTER or SLAVE. Ex. LoraMode MASTER
Response on Success	OK
Description	Configure the role of LoRa device.

LoraReset	
Parameter(s)	N/A
Response on Success	OK
Description	Software reset LoRa front end functions.

LoraStartWork	
Parameter	ENABLE or DISABLE Ex. LoraStartWork ENABLE
Response on Success	OK
Description	Configure the module to enable/disable LoRa functions.

Terminal Echo Control

UartEchoOn	
Parameter(s)	N/A
Response on Success	OK
Description	Echo UART received data. It is useful for manual control by console.

UartEchoOff	
Parameter(s)	N/A
Response on Success	OK
Description	Turn off UART echo. This is default setting to avoid mix messages while console output.

Product Verify Test

LoraPV_TXresult	
Parameter(s)	N/A
Response on Success	LoraPV_TXresult=xxx
Description	Stop RF transmission. Report the quantity of transmitted packets.

LoraPV_TXstart		
Parameter(s)	0	Keep transmission with default payload.
	2	Parameter 1 = quantity of packets Parameter 2 = payload string in ASCII coding Ex. LoraPV_TXstart 1200 werty It means transmit string “werty” 1200 times.
Response on Success		OK
Description		Start RF transmission.

LoraPV_RXresult	
Parameter(s)	N/A
Response on Success	LoraPV_RXresult=xxx
Description	Stop RF receive. Report the quantity of correctly received packets.

RF Frequency

LoraGetRFFrequency	
Parameter(s)	N/A
Response on Success	RFFrequency=915000000
Description	Report current RF carrier frequency in Hz.

LoraFreq	
Parameter	Carrier frequency in Hz. Ex. LoraFreq 915000000
Response on Success	OK
Description	Configure RF carrier frequency in Hz. For SX1276, Range is 137 kHz ~ 1020 kHz ~~For SX1278, Range is 137 kHz ~ 525 kHz~~

RF Output Power

LoraGetRFPower	
Parameter(s)	N/A
Response on Success	RFPower=20
Description	Report output power setup for transmission in dBm.

LoraPower	
Parameter	RF output power level in dBm. Ex. LoraPower 17
Response on Success	OK
Description	Configure RF output power level. It must be within 5 to 20.

LoRa Modulation

LoraGetPreambleLength	
Parameter(s)	N/A
Response on Success	PreambleLength=8
Description	Report the preamble length of LoRa packet while transmission in symbol.

LoraPreambleLength	
Parameter	Preamble length in symbol. Ex. LoraPreambleLength 12
Response on Success	OK
Description	Configure LoRa packet preamble length. It must be within 6 to 65535.

LoraGetImplicitHeader	
Parameter(s)	N/A
Response on Success	HeaderStatus=Explicit
Description	Report the LoRa packet contains header (Explicit) or not (Implicit).

LoraImplicitHeader	
Parameter	ENABLE or DISABLE. Ex. LoraImplicitHeader ENABLE
Response on Success	OK
Description	Configure LoRa packet contains header (Enable) or not (Disable).

LoraGetPara	
Parameter(s)	N/A
Response on Success	RFFrequency=915000000 BW=6 SF=12 ErrorCoding=1 RFPower=20 FreqHopOn=false HeaderStatus=Explicit CRC=ON PreambleLength=8 PayloadLength=9 TxPacketTimeout=2183 RxPacketTimeout=2183
Description	Report complete RF parameters.

LoraGetSF	
Parameter(s)	N/A
Response on Success	SF=6
Description	Report the LoRa modulation spreading factor (6 to 12).

LoraSF	
Parameter	Spreading factor (6 to 12). Ex. LoraSF 8
Response on Success	OK
Description	Configure LoRa modulation spreading factor.

LoraGetBW	
Parameter(s)	N/A
Response on Success	BW=1
Description	Report the LoRa modulation bandwidth factor. 0 => 7.8 kHz, 1 => 10.4 kHz, 2 => 15.6 kHz 3 => 20.8 kHz, 4 => 31.2 kHz, 5 => 41.6 kHz 6 => 62.5 kHz, 7 => 125 kHz, 8 => 250 kHz, 9 => 500 kHz

LoraBW	
Parameter	Bandwidth factor. Ex. LoraBW 6
Response on Success	OK
Description	Configure LoRa modulation bandwidth factor. Refer to **LoraGetBW** for more details.

LoraGetCRC	
Parameter(s)	N/A
Response on Success	CRC=ON
Description	Report the payload CRC check is enabled (ON) or not (OFF).

LoraCRC	
Parameter	ENABLE or DISABLE. Ex. LoraCRC ENABLE
Response on Success	OK
Description	Configure LoRa packet contains payload CRC (Enable) or not (Disable).

LoraGetErrorCoding	
Parameter(s)	N/A
Response on Success	ErrorCoding=1
Description	Report the LoRa packet FEC coding rate factor. 1 => 1.25, 2 => 1.5, 3 => 1.75, 4 => 2.0

LoraErrorCoding	
Parameter	FEC coding rate factor. Ex. LoraErrorCoding 1
Response on Success	OK
Description	Configure LoRa packet FEC coding rate factor. Refer to **LoraGetErrorCoding** for more details.

Payload Control

LoraGetPayloadLength	
Parameter(s)	N/A
Response on Success	PayloadLength=9
Description	Report the payload length of LoRa packet while transmission in byte.

LoraPayloadLength	
Parameter	Payload length in byte. Ex. LoraPayloadLength 64
Response on Success	OK
Description	Configure LoRa packet payload length in byte. It must be within 1 to 128.

LoraGetRxPacketTimeout	
Parameter(s)	N/A
Response on Success	RxPacketTimeout=2183
Description	Report current timeout interval for receive in mS.

LoraGetTxPacketTimeout	
Parameter(s)	N/A
Response on Success	TxPacketTimeout=2183
Description	Report current timeout interval for transmission in mS.

Receiver Sensitivity

LoraGetRxGain	
Parameter(s)	N/A
Response on Success	RxGain=1
Description	Report the latest received LoRa packet gain in dBm.

LoraGetSNR	
Parameter(s)	N/A
Response on Success	SNR=0
Description	Report the latest received LoRa packet SNR value in dB.

LoraGetRSSI	
Parameter(s)	N/A
Response on Success	RSSI=-45
Description	Report the latest received LoRa packet RSSI value in dBm.

Frequency Hopping

LoraGetFreqHopOn	
Parameter(s)	N/A
Response on Success	FreqHopOn=true20
Description	Report the frequency hopping is enabled (true) or not (false). The value (20) after the string “true” is the hopping interval. The frequency hopping option is reserved for feature use.

LoraFreqHopOn	
Parameter	Frequency hopping interval. Ex. LoraFreqHopOn 10
Response on Success	OK
Description	Configure frequency hopping interval. Interval = 0 means disable frequency hopping.

3-5 Control Flow Example

Product Verify:

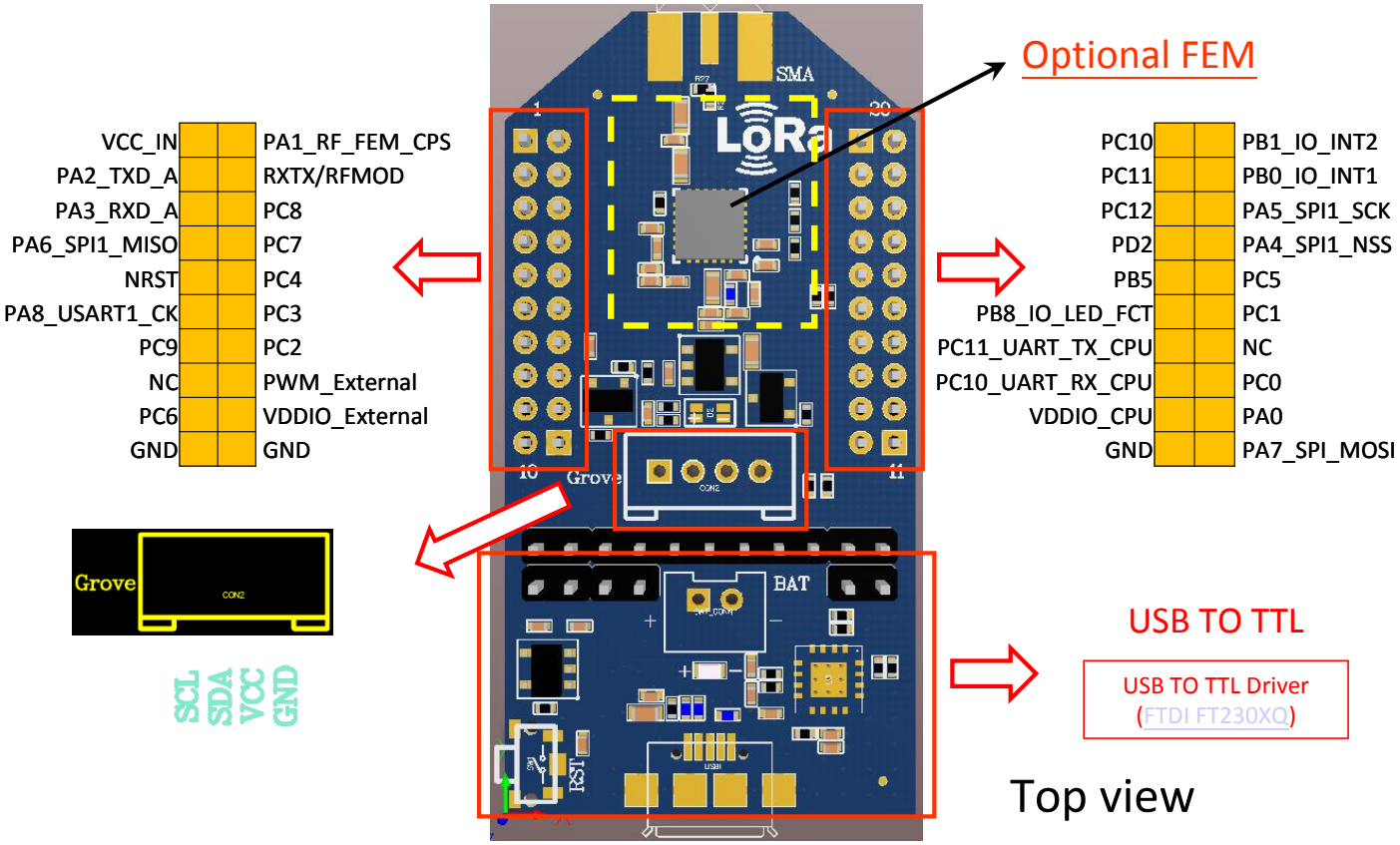
Step	TX Side	RX Side
1	LoraSystemMode inPV	
2	LoraStartWork ENABLE	
3		LoraPV_RXstart
4	LoraPV_TXstart	
5	LoraPV_TXresult	
6		LoraPV_RXresult
7	Check the difference on quantity of transmitted/received packets	

Ping Pong Demo:

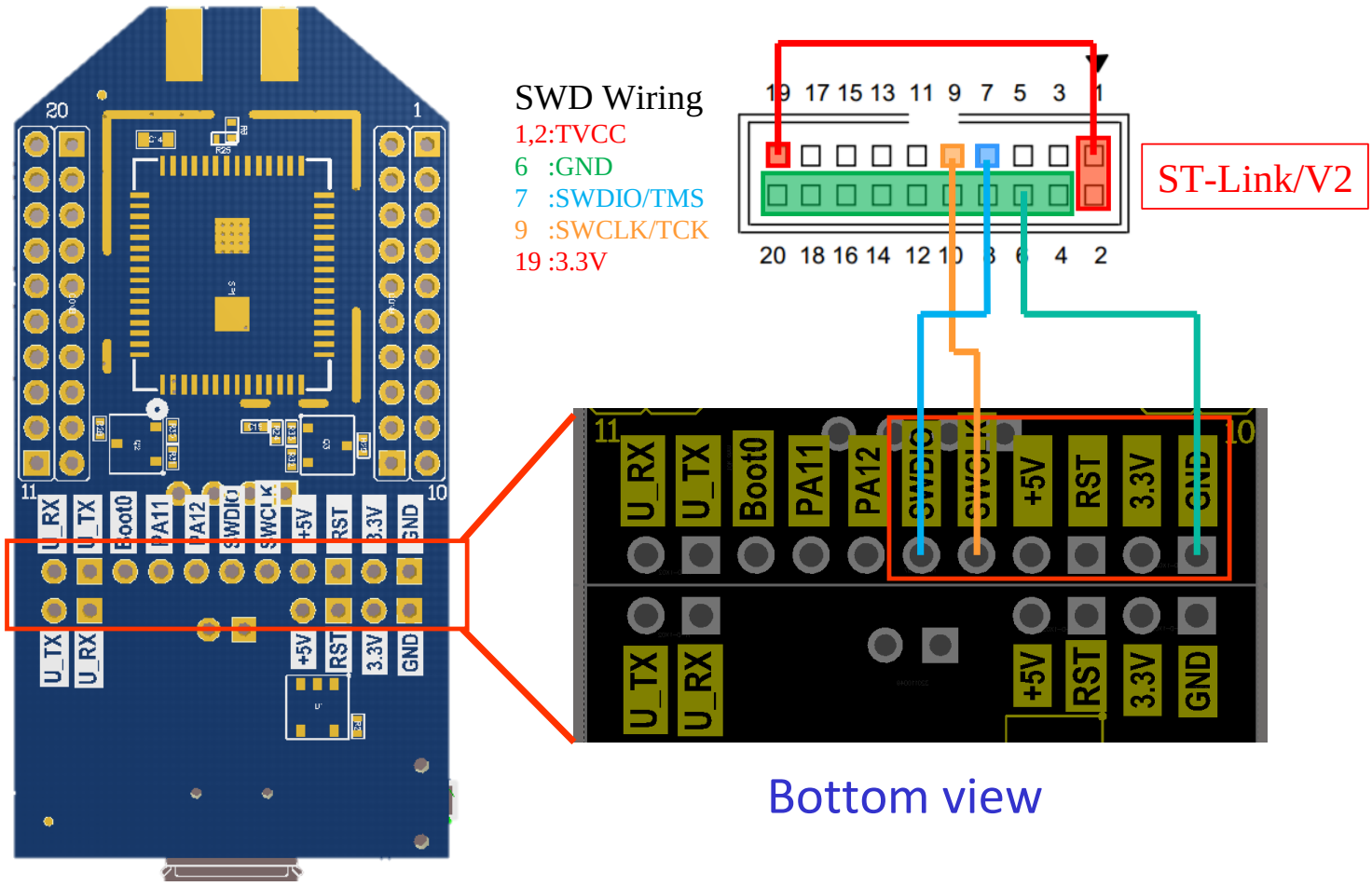
Step	Master Side	Slave Side
1	LoraMode MASTER	LoraMode SLAVE
2	LoraSystemMode inTD	
3	LoraStartWork ENABLE	
4	Check the message display on console.	

4. Pin Definition

TOP View of Product:

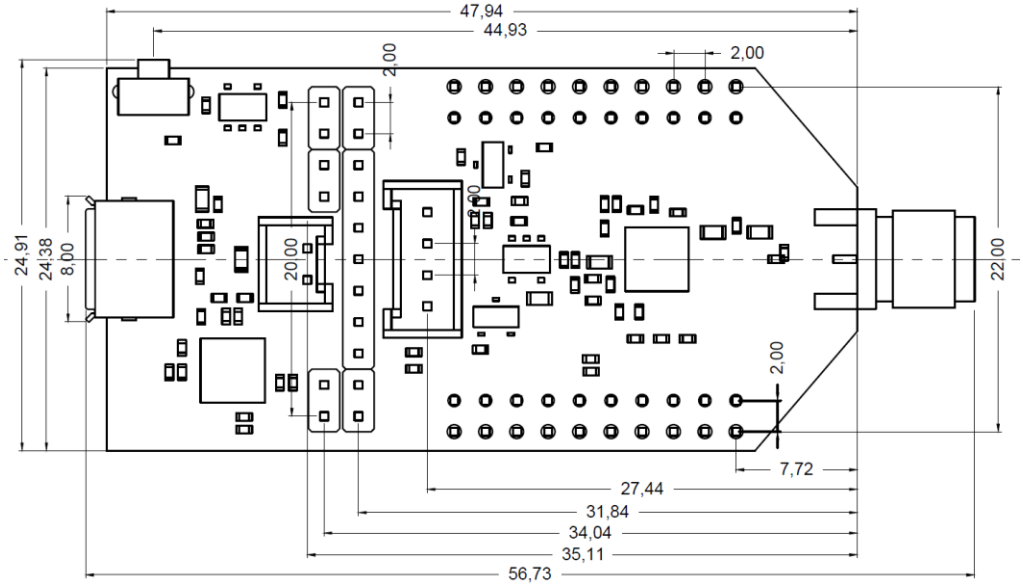
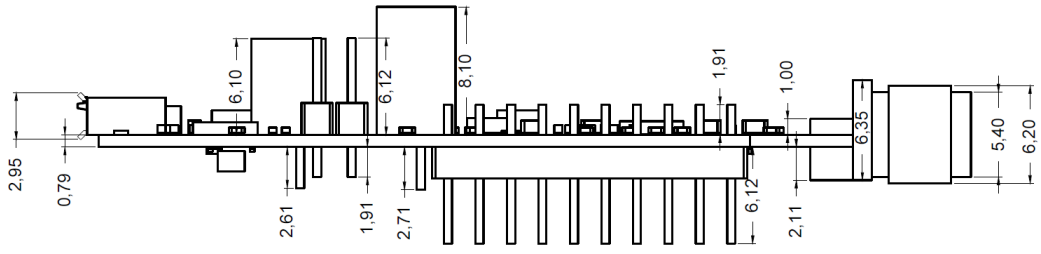


Bottom View of Product:



5. Mechanical Drawings

TOP View of Product:



Side View of Product: