

UM2085 User manual

Ultra-low-power STM32 and LoRa[®] Nucleo pack with NUCLEO-L073RZ board and I-NUCLEO-SX1272D RF expansion board

Introduction

The ultra-low-power STM32 and LoRa[®] Nucleo pack (P-NUCLEO-LRWAN1) is a kit based on a NUCLEO-L073RZ board, an I-NUCLEO-SX1272D LoRa[®] RF expansion board from Semtech corporation and a sub-gigahertz sma antenna. The expansion board includes the low-power transceiver SX1272 which features the long-range modem LoRa[®]. This modem provides high-performance LoRa[®] modulation as well as OOK / FSK modulation. It is optimized for use in the 868MHz and 915MHz bands and its maximum output power is 14dBm. The P-NUCLEO-LRWAN1 Nucleo pack is compatible with the I-CUBE-LRWAN1 software expansion, a certified middleware stack (V1.0), compliant with the LoRaWAN[™] specifications V1.0.1. It provides support for bidirectional end-devices in Class-A and Class-C protocols and for end-devices activation either through over-the-air activation (OTAA) or activation by personalization (ABP).

After introducing briefly end-to-end operations, this document describes the main components of the P-NUCLEO-LRWAN1 Nucleo pack and how to configure them to join and participate to a LoRa[®] network.



Figure 1. P-NUCLEO-LRWAN1 Nucleo pack

1. Picture is not contractual.



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1 LoRa overview

The *Figure 2* shows an overview of the LoRa end-to-end link. Motes are also called nodes or end-devices. The end-devices collect data provided by environmental sensors like temperature, humidity and pressure, then send the sensor data to the gateway through an RF LoRa link. The gateway acts as a packet forwarder to the network and application server, where sensor data are retrieved and post-processed.





A gateway in a final environment acts as a packet forwarder, meaning that it forwards the application payload to the network/application server using 3G/Ethernet backhaul. However, for development purpose, the gateway can be programmed to embed an Application server and managed locally (see the dashed arrow in *Figure 2*).



2 System description

This section describes the hardware components needed to build the end node and prepare the gateway for an end-to-end communication.

The hardware components are:

- NUCLEO-L073RZ board (see Section 2.1: NUCLEO-L073RZ board)
- I-NUCLEO-SX1272D expansion board (see Section 2.2: I-NUCLEO-SX1272D expansion board)
- Gateway (see Section 2.3: Gateway)

2.1 NUCLEO-L073RZ board

Information about the STM32 Nucleo board is available on www.st.com.

The NUCLEO-L073RZ board embeds an STM32L073RZ MCU, a 32-bit microcontroller based on Cortex[®]-M0+ with 192-Kbyte Flash memory, 20-Kbyte SRAM: these characteristics, together with its peripheral set, enable the LoRa middleware stack (I-CUBE-LRWAN) to run. Moreover, the NUCLEO-L073RZ board embeds the ST morpho extension pin headers for full access to all STM32 I/Os and an on-board ST-LINK/V2-1 debugger/programmer with SWD connector able also to manage the serial communication with the STM32L073RZ.

User can power up the NUCLEO-L073RZ board by connecting it to a PC through a USB cable. However, the ideal setup for the end-device is to be battery operated. Attach a battery holder for 3 x Alkaline AAA (or AA) batteries at the back of the NUCLEO-L073RZ board and connect/solder the +/- terminals to the power pins on the ST morpho connector as shown in *Figure 3*. Set the jumper JP5 to E5V so that the board takes the power from the battery. Now the resistor R32 can be removed to reduce the current consumption of the board. Put a jumper on JP1 to allow the ST-LINK debugger to release the reset pin of the target STM32, when the ST-LINK USB is not connected and enumerated on the PC. This allows the STM32 to execute the firmware with the NUCLEO-L073RZ board connected to the PC through the USB.



Figure 3. NUCLEO-L073RZ board: top view (right) and with batteries (left)





2.2 I-NUCLEO-SX1272D expansion board

I-NUCLEO-SX1272D is the STMicroelectronics code name of the ARM[®] mbed[™] shield SX1272MB2DAS. It embeds a LoRa RF transceiver SX1272 chip and all associated RF matching and filtering components enabling one-single, 50ohm antenna port. I-NUCLEO-SX1272D embeds its 32MHz crystal as well. The I-NUCLEO-SX1272D is fully controlled by SPI and interrupt lines.

Optionally Grove compatible sensors can be plugged on the expansion boards. The *Figure 4* below shows a picture of the board together with the I/O lines.





2.3 Gateway

2.3.1 Semtech IoT starter kit

This kit is designed to offer a self-contained Plug and Play local loop for all IoT object designers, allowing them to verify that their design is able to connect to a public IoT network, following the LoRaWAN specifications. No connection to an Ethernet network is required, and this simplifies the setup of the starter kit. A simple cross-over Ethernet cable is used to access the kit. It is composed of:

- RaspberryPi B+ with its LoRa IoT shield unit and pre-installed microSD[™] card
- SX1301-based concentrator reference design
- Active GPS antenna
- Power adapter (mini USB)

See Figure 5: Semtech IoT starter kit gateway.



The Semtech gateway is configured as a local server, meaning that the gateway is performing the network/application server, the web server as well as the gateway functions. No packets are sent to the internet.





The gateway is powered up using the mini USB connector, the RaspberryPi requires about two seconds to boot. The kit is ready once arrows are upward on the LCD display, as shown below in *Figure 6*:



Figure 6. IP address on LCD display

Two ways are available to get connected to the starter kit:

- Connection to an Ethernet network composed of a router and a DHCP server (the IP address on the LCD screen is then directly entered in the web browser).
- Connection using an Ethernet cable connected between the development PC and the starter kit. In this case the IPv4 address of the development PC must be set to 192.168.1.101, following the steps shown in the *Figure* 7:



Network Work network	Access type: No Internet access Connection	
Connection General Connectivity: IPv4 Connectivity: IPv6 Connectivity: Media State: Duration: Speed: Details Activity Sent	Local Area Connection Properties Internet Protocol Version 4 (TCP/ Networking Authentication Sharing Connect using: You can get IP settings assigned this capability. Otherwise, you n for the appropriate IP settings. Intel(R) Ethemet Connection 1218-LM Obtain an IP address autor This connection uses the following items: Client for Microsoft Networks QoS Packet Scheduler Internet Protocol Version 6 (TCP/IPv4 Internet Protocol Version 4 (TCP/IPv4 Link-Layer Topology Discovery Mappe Link-Layer Topology Discovery Respo Obtain DNS server address	IPv4) Properties ? d automatically if your network supports used to ask your network administrator matically 192.168.1.101 255.255.255.0 . s automatically
Bytes: 6,09	Install Uninstall Description Transmission Control Protocol/Internet Protor wide area network protocol that provides corr across diverse interconnected networks. OK Cancel	· · ·

Figure 7. Ipv4 address setting sequence in Control Panel/Network and Sharing Center

2.3.2 Other gateways

Kerlink and Multitech provide gateways performing the same function as the starter kit. They also forward the data to a cloud network server and application server through an internal 3G path.

2.4 Installation of the PC tools

Follow the steps below to install the PC tools:

- 1. Install the preferred Integrated Development Environment (IDE). Three toolchains are supported: IAR[™] EWARM, Keil[®] MDK-ARM[™] and AC6 SW4STM32
- 2. Install a web browser
- 3. Install the ST-LINK/V2-1 driver
- Establish the connection with the NUCLEO-L073RZ board by connecting the USB port of the NUCLEO-L073RZ to the USB port of the PC. Allow the PC to enumerate and install the ST-LINK USB drivers
- 5. Install a terminal software like Tera Term

Connect the NUCLEO-L073RZ board to the PC and open the Tera term. Select the ST-LINK virtual COM port and configure the Tera Term as shown in *Figure 8*:



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Tera Term: New con	nnection	Tera Term Terminal setup		Tera Term: Serial port setup	
© tcp/ip	Hustry Service: Telnet TCP gorth: 22 SSH SSH yercion: SSH2 - Other Protogot: UNSPEC -	Terminal size 00 X 24 V Term size = win size Auto window resize Terminal ID: VT100 •	Newline Receive: AUTO V Transmit: CR Cascel Help Local echo	Port: Baud rate: Data: Pgrity:	COM7 • OK 9216011 • Cancel none • Hala
© Sgrial	Port (COM/2 SIMicroelectronics SILink Viri • COM/2 SIMicroelectronics SILink Virtual COM OK Cancel Help	Anowerback: Kaniji (receive) UIF8 - Zbit katakana logale: japanoso	CodePage: 932	Stop: Elow control: Transmit delay 0 msec/gt	none • nar 0 msec/line

Figure 8. Terminal setup

2.5 Firmware setup for the end-device

Follow the steps below to set up the firmware for the end-device:

- 1. Download the latest LoRa firmware package from the www.st.com/i-cube-lrwan webpage and unzip the package to a desired location.
- In the following figures, Keil IDE is used. Open the Keil project for the "Class A" sample application in \Projects\Multi\Applications\LoRa\classA\MDK-ARM\ STM32L073RZ-Nucleo.
- 3. Configure the project by selecting the expansion board sx1272mb2das in the dropdown list showed below in *Figure 9*.



Figure 9. Project configuration

 Define a specific frequency band in the Keil Project Options preprocessor setting. The following bands are supported: USE_BAND_780, USE_BAND_868 and USE_BAND_915.



Figure 10. Setting the frequency band

evice Targ	t Output Listing User C	/C++ Asm Linker [Debug Utilities	
Preproces	or Symbole			
riepioces	i Symbols			

2.6 Firmware configuration

Follow the steps below to configure the firmware:

1. Select the activation mode by modifying the definitions in the comissioning.h file as showed in *Table 1*

Table 1. Selection of the activation mode

Defines	Comments
#define OVER_THE_AIR_ACTIVATION	 When set to 1 the application uses the Over-the- Air activation procedure When set to 0 the application uses the Personalization activation procedure

2. Commission the device (see Table 2)

	•
Defines	Comments
#define LORAWAN_APPLICATION_EUI	128-bit application EUI
#define LORAWAN_APPLICATION_KEY	128-bit application key
#define STATIC_DEVICE_EUI	 When set to 1 DevEui is LORAWAN_DEVICE_EUI When set to 0 DevEui is automatically generated using 96-bit STM32 unique ID
#define LORAWAN_DEVICE_EUI	Used when DevEUI auto generation is not enabled.

Table 2. Over-the-air activation parameters

Example:

#define OVER_THE_AIR_ACTIVATION 1
#define STATIC_DEVICE_EUI 0
#define LORAWAN_APPLICATION_EUI { 0x01, 0x02, 0xA6, 0xAB, 0xF7, 0x15, 0x88, 0x09, 0xCF, 0x4F, 0x3C }

- 3. Save the modified files and compile the code
- 4. Program the STM32 by clicking the download button from the toolbar

The following text (*Figure 11*) appears on the terminal after the device starts:



```
Figure 11. Tera-Term output
```

File	Edit	Setup	Control	Window	Help										
DTAA DevE IppE IppK JERS :×Do	ui= ui= ey= ION: ne	37-36 01-01 2B 7E 4201	-39-32 -01-01 15 16 0108	-6F-33-81 -01-01-0 28 AE D	0-07 1-01 2 A6 A)	8 F7	15	88	09	CF	4F	3C			
×Do	ne ED														

Table 3. Activation by personalization parameters

Defines	Comments
#define STATIC_DEVICE_EUI	 When set to 1 DevEui is LORAWAN_DEVICE_EUI When set to 0 DevEui is automatically generated using 96-bit STM32 unique ID
#define LORAWAN_DEVICE_EUI	Used when DevEUI auto generation is not enabled.
#define LORAWAN_DEVICE_ADDRESS	Used when DevAdd auto generation is not enabled.
#define LORAWAN_NWKSKEY	Used when Activation by Personalization is selected.
#define LORAWAN_APPSKEY	Used when Activation by Personalization is selected.

Example:

#define OVE	R_THE_AIR_ACTI	VATION			()			
#define STA	TIC_DEVICE_ADD	RESS			()			
<pre>#define LOR 0x00, 0xC8</pre>	AWAN_APPLICATI }	ON_EUI	{	0xBE,	0x7A,	0x00,	0x00,	0x00,	0x00,
#define LOR	AWAN_NWKSKEY	{ 0x2B,	0x7E,	0x15,	0x16,	0x28,	0xAE,	0xD2,	0xA6,
		0xAB,	0xF7,	0x15,	0x88,	0x09,	0xCF,	0x4F,	0x3C }
#define LOR	AWAN_APPSKEY	{ 0x2B,	0x7E,	0x15,	0x16,	0x28,	0xAE,	0xD2,	0xA6,
		0xAB,	0xF7,	0x15,	0x88,	0x09,	0xCF,	0x4F,	0x3C }

The following text (*Figure 12*) appears on the terminal after the device is reloaded and started up using the above parameters:



📒 COM33 - Tera Term VT	
File Edit Setup Control Window Help	
ABP DevEui= 37-36-39-32-6F-33-80-07 DevAdd= 00247912 NwkSKey= 2B 7E 15 16 28 AE D2 A6 AB F7 AppSKey= 2B 7E 15 16 28 AE D2 A6 AB F7 VERSION: 42010108	7 15 88 09 CF 4F 3C 7 15 88 09 CF 4F 3C 7 15 88 09 CF 4F 3C

5. The Adaptive Data Rate (ADR) feature is enabled in the end-device main.c file (ON by default). When ADR is enabled, the end-device should be static (i.e. not moving)

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#define LORAWAN_ADR_ON

Note: If an error is encountered during programming, set the debugger to use "Connect under reset" in project options>Debug>ST-LINK Debugger Settings>Debug>Connect & Reset Options.



3 System setup

3.1 Activation parameters for a LoRa end-device

The parameters of the end-device sensor DevEUI, DevAddr, AppEUI, AppKey, AppSKey, and NwkSKey are only shown once after reset. Press the reset button on the NUCLEO-L073RZ board to display them on the terminal (for example the software terminal Tera Term). Take note of them since they are needed when enrolling the end-device to the server.

3.2 Enrolling the end-device to the gateway of the IoT starter kit internal server

To enroll the end-device follow the steps below:

- 1. Launch a web browser session and enter the gateway IP address into the address bar of the web browser.
- 2. The following page appears (*Figure 13*):

Leadii	ng Analog & Mixed Signal Products						
Home	LoRa TM — Semtech or	n the Internet of Things					
Motes	me removing pages demonstrate the capabilities and range of Democritis conditionings, they are populated by network of condi- motes and gateways tied to this machine.						
Gateways Network Activity	Sections)						
Network Map	Applications	List of applications on the network. Manage and create new ones					
y mantenanoe	Motes	List of all LoRaMotes available on the network					
	Gateways	List of all LoRa gateways available on the network					
	Network Activity	The most recent packets received across the network					
	Network Map	An interactive demonstration of the LoRa network					
	Maintenance	Maintenance of Starter Kit hardware					
	Server version: R2.1.1 - Build date 20	15-11-06 07:53:06 GMT					
	©2015 Semtech Corporation	\ CA Transparency in Supply Chains Act \ Privacy Policy \ Terms of Use					

Figure 13. IoT starter kit internal server page

3. Create a LoRa application. Click on "Applications" and add a new application. The AppEUI flashed in the end-device must be recorded in the gateway, as shown below in *Figure 14*.



ſ

Leading	y Analog & Mixed Signal Proc	nucis				
	LoR:	a				
5	EMTECH S	77		_		
lome \\ Applications						
	Applications					
▶ Home	Applications					
 Home Applications 	Applications					
Home Applications Motes	Applications Below is a list of LoRa a	applications on the	network. Use the fields a	t the top to	o set up a new one o	on the server.
 Home Applications Motes Gateways 	Applications Below is a list of LoRa a	applications on the Owner	network. Use the fields a	it the top to	o set up a new one o	on the server.
 Home Applications Motes Gateways Network Activity 	Applications Below is a list of LoRa a Name •	applications on the Owner	network. Use the fields a EUI (AppEUI)	it the top to	o set up a new one o	on the server.
Home Applications Motes Gateways Network Activity Network Map	Applications Below is a list of LoRa a Name +	applications on the	network. Use the fields a EUI (AppEUI)	It the top to	o set up a new one o	on the server.
Home Applications Motes Gateways Network Activity Network Map Maintenance	Applications Below is a list of LoRa a Name * New: defaultApp	applications on the Owner Unknown]	network. Use the fields a EUI [AppEUI] 00-00-00-00-00-00-00-00	Add	o set up a new one o Configured Motes	on the server.
 Home Applications Motes Gateways Network Activity Network Map Maintenance 	Applications Below is a list of LoRa a Name * New: defaultApp LoRa	Owner [Unknown] ST	network. Use the fields a EUI (AppEUI) 00-00-00-00-00-00-00-00 01-01-01-01-01-01-01	Add Delete	o set up a new one o Configured Motes	on the server.

Figure 14. Adding LoRa application

4. Add the end-device according to the selected activation mode (see *Figure 15* and *Figure 16*).

Figure 15. Adding OTAA devices

Leading	Analog & Mixed Signal Products		
5			
ome \\ Applications \\ LoR	a \\ Motes		
Home	LoRa Motes		Print
Applications			
Motes	personalisation.	for this application. A new one may be commissioned using over-the-air protocol or	
Gateways	o		
No. of the second	Over-the-Air Motes		
Network Activity	Makes and south the state second	k by negotiating with the server using an application key. Enter this key below to prepa	re the server.
Network Activity	motes ordinarily join the network	in the second seco	
Network Activity Network Map Maintenance	Motes ordinarily join the network		
Network Activity Network Map Maintenance	Mote (DevEUI)	Application Key (Apotey)	
Network Activity Network Map Maintenance	Motes orginarily join the network (DevEU)	Application Key [AppKey]	Add



٦

Figure 16.	Adding	ABP	devices
------------	--------	-----	---------

	ading Analog & Mixed Signal Product	s				
	SEMTECH LORa			1.127		
Home \\ Applications \\ LoR	a \\ Motes				Text Size	-
▶ Home	Eona motoo				Print	
▶ Applications	Delaw and the metric and forward	Constitution of Constitution		the constant of a second second		
Motes	Below are the motes configured	for this applicatio	n. A new one may be commissioned using ove	r-the-air protocol or personalisation.		
Gateways	Over-the-Air Motes					
Network Activity			Ab the contraction of the Barbler law water	ali in the last the second state and a		
Network Map	Motes orginarily join the network	t by negotiating w	with the server using an application key. Enter	this key below to prepare the server.		
▶ M aintenance	Mote	Application Key				
	(Devicin)	(vppney)				
	N ew.					~
	Personalised Motes					
	Personalised Motes					
	Personalised Motes Personalised motes are configur communicate on the network. Er	ed with the <u>netwo</u> iter these same d	ork address, application session key and netw letails below to prepare the server.	ork session key already present, so they are	ready to	
	Personalised Motes Personalised motes are configur communicate on the network. Er Mote (DevEUI)	ed with the <u>netwi</u> nter these same d Network Address (DevAddr)	ork address, application session key and <u>netw</u> letails below to prepare the server. Application Session Key (AppSkey)	ork session key already present, so they are Network Session Key Network Session Key	ready to	
	Personalised Motes Personalised motes are configur communicate on the network. Er Mote (Dev30) New	ed with the <u>netwa</u> nter these same d Network Address (DevAddr)	ork address, application session key and netw letais below to prepare the server. Application Session Key [PopSics]	ork session key already present, so they are Network Session Key (Mwk Sky)	ready to	[

5. Reset the end-device by pressing the reset button on the NUCLEO-L073RZ board. The following text appears on the terminal (*Figure 17*).

Figure 17. Joined end-device

File Edit Setup	Control Wind	ow Help				
ОТАА DevEui= 37-36- АррЕui= 01-01- АррКеу= 2В 7Е	-39-32-6F-33 -01-01-01-01 15 16 28 AB	-80-07 -01-01 D2 A6 AB	F7 15 88	09 CF 4F	3C	Î
UERSION: 42010 txDone rxDone JOINED	91 08					

3.3 Visualization of the IoT starter kit packet

Click on "Network Activity" to view the frames transmitted by the end-device (see *Figure 18*).





letwork Activity LoRa S ×		1000,000		And Providence									1
C 192.168.1.100/	/activity/page.6/												
Leading	Analog & Mixed S	ignal Products											
	5	LoRa											
5	SEMTECH	S	-	_	_	-	-	_	-				i
													Ī
Home \\ Network Activity													
	Networl	k Activity									Text	Size 😑	
Home	Below are sta	tistics from from as transmitted	by LoBaMo	too perce	the netwo	de					🔒 Pr	int	
Applications	You can alter	natively view the most recent fr	Dy LORAMC	ooch mot	o che networ	к.							
Motes	rou can diter	nacively view the most recent in				_				()			
Network Activity			First	Previous	345	67	8 9	Next	Last	(67)			
Network Map	Time	Mote (DevEUI)	Sequence #	Freq (MHz)	Modulation	ı BW (Hz)_	SF	Coding Rate	ADR	Gateway	Chan	RSSI (dBm)	
Maintenance	2015-12-08 15:58:00	37-36-39-32-6F-33-80-07	15	868.3	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-67	1
	2015-12-08 15:57:52	37-36-39-32-6F-33-80-07 🧾	14	868.1	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F	0	-69	
	2015-12-08 15:57:45	37-36-39-32-6F-33-80-07 🥅	13	868.3	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F 🌉	1	-67	
	2015-12-08 15:57:38	37-36-39-32-6F-33-80-07 🥅	12	868.1	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F 🕎	0	-67	
	2015-12-08 15:57:32	37-36-39-32-6F-33-80-07 🧾	11	868.3	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-67	
	2015-12-08 15:57:25	37-36-39-32-6F-33-80-07 🥅	10	868.3	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-67	
	2015-12-08 15:57:18	37-36-39-32-6F-33-80-07 🏢	9	868.3	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F 🌉	1	-69	
	2015-12-08 15:57:11	37-36-39-32-6F-33-80-07 🥅	8	868.5	LoRa	125	SF7	4/5	on	FF-FE-B8-27-EB-57-66-3F 🌉	2	-67	
	2015-12-08 15:54:44	37-36-39-32-6F-33-80-07 🥅	7	868.1	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	0	-65	
	2015-12-08 15:52:16	37-36-39-32-6F-33-80-07 🥅	6	868.1	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	0	-66	
	2015-12-08 15:49:47	37-36-39-32-6F-33-80-07 🧾	5	868.3	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-64	
	2015-12-08 15:47:19	37-36-39-32-6F-33-80-07 🥅	4	868.3	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-67	
	2015-12-08 15:44:50	37-36-39-32-6F-33-80-07 🥅	3	868.1	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	0	-68	
	2015-12-08 15:42:22	37-36-39-32-6F-33-80-07 🥅	2	868.3	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F	1	-68	
	2015-12-08	37-36-39-32-6F-33-80-07 🥅	1	868.1	LoRa	125	SF12	4/5	on	FF-FE-B8-27-EB-57-66-3F 🌉	0	-68	

Figure 18. Network activity

3.4 Visualization of the IoT starter kit device data

LED status is changed by clicking on the "Activate" button. A "LED ON" message is printed on the terminal (see *Figure 19*):



Figure 19.	Device data visualization
LoRaMote 37-36-39-32-6F-33-80-0	
Network address: 00:24:79:12 Application: LoRa (01-01-01-01-01-01-01) Owner: ST	COM33 - Tera Term VT File Edit Setup Control Window Help
View transmission performance View application data from this mote	rxTimeOut txDone rxTimeOut vyTimeOut
Environment	rxDone rxDone LED_OFF
[Last update at 2015-12-08 15:42:22]	rxTimeOut rxTimeOut
Battery: 100%	t×Done r×TimeOut r×TimeOut
Temperature: 0 °C Pressure: 0 hPa Altitude: 0 m	txDone rxDone LED ON txDone rxTimeOut rxTimeOut

Click on "View application data from this end-device" to view the data payload (see *Figure 20*):

		iigu				r	~ <u> </u>		~									
2	2015-12-08 16:49:48	473	00	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:42	472	00	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:35	471	00	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:28	470	00	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00
2	2015-12-08 16:49:21	469	00	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:15	468	00	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:08	467	01	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:49:01	466	01	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:48:53	465	01	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:48:47	464	01	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:48:40	463	01	00	00	00	00	00	00	fe	3e	09	0d	05	03	ab	00	00
2	2015-12-08 16:48:33	462	01	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00
2	2015-12-08 16:48:27	461	01	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00
2	2015-12-08 16:48:20	460	01	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00
2	2015-12-08 16:48:13	459	01	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00
2	2015-12-08 16:48:07	458	01	00	00	00	00	00	00	fe	3e	09	Ød	05	03	ab	00	00

Figure 20. Data payload





3.5 IoT starter kit shutdown

To prevent a possible corruption of the microSD card files, shutdown the gateway properly before powering off: click on "Maintenance" and click on "Shutdown" (see *Figure 22*).

Figure 22. Shutting down the g	ateway
Maintenance	
This page allows you to control the Semtech LoRa S shut down or restart the device along with the asso gateway functions. Shut down Restart	STK hardware. Use it to ociated server and



4 Extension of the system

The application presented in *Section 3: System setup* can be enhanced using the X-NUCLEO-IKS01A1 board (see *Figure 23*) in combination with the P-NUCLEO_LRWAN1 pack. The X-NUCLEO-IKS01A1 board hosts four sensors:

- The humidity and temperature sensor (hts221)
- The pressure sensor (lps25H)
- The 3D accelerometer (LSM6DS0)
- The 3D magnetometer (LIS3MDL)

More information are available on the www.st.com website.

Only hts221 and lps25H sensors are used in this extension. The sensors are accessed by an I^2C interface and the unused interrupts are routed to the STM32.



Figure 23. X-NUCLEO-IKS01A1 board

4.1 Hardware modification

To fit both expansion boards, do the following modifications on the X-NUCLEO-IKS01A1 board:

- Disconnect the I²C lines of the accelerometer and magnetometer (remove sb1, sb2, sb5 and sb6)
- Disconnect the interrupt lines of the accelerometer and magnetometer (remove sb21, sb22 and sb27)
- Remove supply to accelerometer and magnetometer by removing jumpers JP1 and JP2

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On SX1272MB2DAS cut DIO3 (J1 Pin 6 must be cut, refer to *Figure 25: I-NUCLEO-SX1272D expansion board*).

4.2 Firmware modification

When X-NUCLEO-IKS01A1 expansion board is plugged between the NUCLEO-L073RZ board and the SX1272MB2DAS LoRa expansion board, SENSOR_ENABLED must be defined in \Projects\Multi\Applications\LoRa\classA\inc\hw_conf.h.

4.3 IoT starter kit device data visualization

The following *Figure 24* shows the sensor data, sent from the end-device to the LoRa network.

Environm	ent
[Last update	at 2015-12-08 18:05:10]
Location : Battery : Device LED :	43°37′7″N, 7°3′5″E, 0m 100% Off Activate Deactivate
Temperature Pressure: Altitude:	: 26.48 °C 1004.4 hPa 65.2 m
Conditions	During the Last 24 Hours
Sensor data graph	04:54:54 1 04:54:54 1
LED status	lſ

Figure 24. End-device data visualization



5 Ordering information

To order the ultra-low-power STM32 and LoRa Nucleo pack, refer to Table 4.

Table 4. Ordering information

Order code	Board
P-NUCLEO-LRWAN1	NUCLEO-L073RZ, I-NUCLEO-SX1272D and sub-gigahertz antenna



5

6

Electrical schematic



UM2085

23/25

Electrical schematic

7 Acronyms

Table 5. Acronyms

Acronym	Description
LoRa	Long Range

8 Revision history

Date	Revision	Changes
12-Sep-2016	1	Initial version.



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