

APPA6.05 SGW2828-EVK LoRaWAN Connection on The Things Network (TTN)

Mar 2023 V1.0

Introduction

The SGW2828-01A LoRa Module (SGW2828-01A) integrates the Semtech SX1276 long-range low-power transceiver and RF power amplifier with STMicroelectronics' MCU. SGW2828-01A is proven to enable connectivity over 20km line-of-sight, over 5km in dense urban areas and through at least 10 concrete walls (onsite testing conducted in Hong Kong) at 30dBm Tx power maximum, with fast frequency hopping and high sensitivity. Supporting LoRaWAN[®], the global de-facto standard for the Internet of Things, SGW2828-01A supports connection to two LoRaWAN-based networks: The Things Network (TTN) and the Helium Network. SGW2828-01A is available in the SGW2828 LoRa Module EVK (SGW2828-EVK) for immediate application deployment.

This application note describes the procedures to connect the SGW2828-EVK to TTN and provides the AT command sets to enable LoRaWAN applications via TTN. This application note includes the use of a TTN Gateway (RAK831 LPWAN Gateway Concentrator Module with Raspberry Pi Model 3B) but any connected TTN-enabled Gateway that is in the vicinity to detect the SGW2828-EVK would support the same purpose.

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1. Getting Started: Required Tools:

- a. SGW2828-EVK LoRa Evaluation Kit, including
 - +2dBm SMA antenna (915MHz)
 - Micro-USB cable
 - SGW2828-EVK PC Tool V1.4.1 (also downloadable at <u>https://sgwire-less.com/static/tools/SGW2828-PC-Tool.7z</u>)
- b. TTN Gateway Used in this application note is the RAK831 LPWAN Gateway Concentrator Module V4.3.0 with Raspberry Pi Model 3B
 - RAK831 firmware: V4.3.0
 - Raspberry Pi OS Full (32-bit): Debian 11.5 with desktop
- c. PC with Windows 10 or above
- d. The Things Network ID account for TTN Console

2. Operation Guide to join TTN:

2.1. <u>Prepare Hardware:</u>

1. Using the micro-USB cable, connect the SGW2828-EVK with the antenna to the PC (Figure 1). Toggle the power switch to ON.



Figure 1: SGW2828-EVK

2. On your PC, open up <u>Device Manager > Ports (COM & LPT)</u> to determine the COM port number to which the SGW2828-EVK is connected (Figure 2).

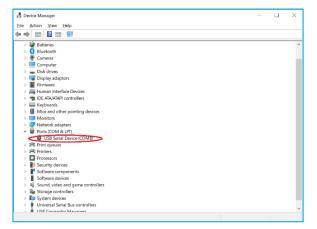


Figure 2: SGW2828-EVK PC Tool COM Port Selection

3. Open up the SGW2828-EVK PC Tool. Choose the COM port number with the connected SGW2828-EVK and click 'Connect' (Figure 3).

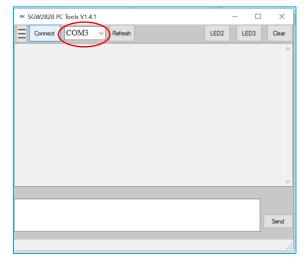


Figure 3: SGW2828-EVK PC Tool COM Port Selection and Connection

Note: The SGW2828-EVK PC Tool includes an engineering mode to enable AT commands. Access as needed at <u>Menu > Mode > Engineering Mode</u> (Figure 4).

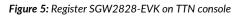
Mode	Engineering Mode	2	LED2	LED3	Clear
Configuration	Exit				
					Send

Figure 4: Toggle to Engineering Mode

2.2. Add SGW2828-EVK on TTN Console

- 1. Power up the TTN Gateway.
- 2. Login to the TTN Console. Open the application to which you wish to add the SGW2828-EVK.
- 3. Click <u>End devices > + Register end device</u> (Figure 5).

THE THINGS NETWORK	THE THINGS STACK Community Edition	Overview	Applications	🝶 Gateways 🧳	dateways and Organizations						EU1 Community No support plan ⑦
111 Drag	ino_LHT65	Applications > E	Applications > Dragino_LHT65 > End devices								
				End devices (0)					Q Search	=+ Import end devices	+ Register end device
Over	view			ID ¢		Name ©		DevEUI	JoinEUI		Last activity
👗 End o	devices										
🗐 Live o	data							No items fo	und		



- 4. Click Enter end device specifics manually and select the following (Figure 6).:
 - Frequency plan: Asia_915-928 MHz (AS923 Group 1) with only default channels. (same frequency as the Gateway for communication)
 - LoRaWAN version: LoRaWAN Specification 1.0.3.
 - Regional Parameters version: Defaults to RP001 Regional Parameters 1.0.3 revision A.
 - Provisioning Information by OTAA is obtained by entering commands in the SGW2828-EVK PC Tool Engineering Mode (Menu > Mode > Engineering Mode):
 - JoinEUI: AT+APPEUI=?
 - DevEUI: AT+DEUI=?
 - AppKey: AT+APPKEY=?
 - End Device ID: Automatically generated upon entering above information, or you can also enter your own.

Remarks: Guideline on choosing unique ID at <u>https://www.thethingsindustries.com/docs/reference/id-eui-constraints/</u>.

• Click <u>Register end device</u>.

SGW2828-EVK LoRaWAN Connection on The Things Network (TTN)

Overview	Register end device Does your end device have a QR code? Scan it to speed up onboarding.	documentation-demo-app	Asia 915-928 MHz (AS923 Group 1) with only		
🙏 End devices	Scan end device QR code	End devices	Regional Parameters version () * RP001 Regional Parameters 1.0.3 revision A		
Eive data	End device type	Live data Payload formatters	Show advanced activation. LoRaWAN class and cluster settings ~		
<> Payload formatters	Input Method Select the end device in the LoRaWAN Device Repository	大 Integrations マ	Provisioning information JainEut ©* 10 00 00 00 00 00 00 Reset		
Collaborators	Enter end device specifics manually Frequency plan © *	Or API keys ✿ General settings	76 00 00 00 00 00 00 00 maxe This end device can be registered on the network DevEUT⊙* 78 B3 05 7E 09 05 63 21 Q Generate 7/50 used		
Or API keys	Select		АррКеу⊙° 90 53 34 73 78 84 D5 01 81 26 F3 55 А0 58 51 0Е Ф Generate		
General settings	LoRaWAN version () *		End device ID © * eu-70b3d57dd0056321 This value is automatically prefilied using the DevEUI After registration		
	Regional Parameters version (*) *		View registered end device Register another end device of this type		
	To continue, please enter versions and frequency plan information	< Hide sidebar	Register end device		

Figure 6: Register SGW2828-EVK on TTN console by manually adding

Note: You can optionally set the location of the SGW2828-EVK. Click <u>Change location settings</u> and set location by putting a pin on the map widget, or entering the Latitude, Longitude and Altitude values (Figure 7).

↑15 ↓13 • Last activity 33 minutes ago ⑦	
Overview Live data Messaging Location Payload formatters	Claiming General settings
日本 reserved of the Kowidon Article Kowidon Article Kowidon Article Arti	
Click into the map to set a location	
22.33	
The north-south position in degrees, where 0 is the equator	
Longitude *	
114.19	
The east-west position in degrees, where 0 is the prime meridian (Greenwich)	
Altitude*	
0	
The altitude in meters, where 0 means sea level	

Figure 7: Set SGW2828-EVK location

2.3. AT Commands to Join Network and Send Message

 Connection to TTN Gateway: AT+JOIN=1 'Accept join-request' is shown on the TTN Console when the connection is successfully established (Figure 8).

🗯 SGW2828 PC	Tools V1.4.1 - Engineering Mode					- 🗆 X	1												
Mode Configuration	Disconnect		LED2 LI	ED3 Ci	ear	Packet:		THE THINGS NETWORK	1	Commun	ity Edition	Overview	Applications	ᡖ Gateways	🚢 Orgai	inizations			
	17:22:02:531 21s397:TX on freq 923200000 Hz at D 17:22:02:566 OK)R 2			^	Receive: 17:22:08:284 3237733135363A4D4143207278446F6E550D0A A 17:22:08:300 284555543A4AF494F4544000A								Applications	> End device	es > Dragino_LHT65 > eui-:	133637305e395f16 > Live data		
	17:22:02:948 21s817:MAC txDone 17:22:07:947 26s819:RX_1 on freq 923200000 Hz a	t DR 2				Send: 17:22:02:516:415428444F494E303100		Dragino_LHT65			eui-333637305e395f16								
	17:22:08:284 27s156:MAC x:Done 17:22:08:300 +EVT:JOINED					17.22.02.010 4104204444546303100 ·································		V		Over	rview						eul-33363730		
		Status		Status		🙏 End i	devices	S				↑ 2 ↓1	 Last activit 	ty 3 minutes ago ⊘					
					🗐 Live	data					Overview	Live data	Messaging Location	Payload formatters Claimin					
					~	×		<> Paylo	oad for	matters	~	Time Ty	/pe		Data	preview			
	AT Command AT+JOIN=1							犬 Integ	grations	s	~	↑ 17:22:05 Fo	orward join-accept	message	DevA	ddr: 26 88 A3 62 ↔ 🖺			
	Message Hex			Se	nd			🚜 Colla	aborato	ors		🔁 17:22:03 Ad	ccept join-request		DevA	ddr: 26 88 A3 62 ↔ 🖺			
												↑ 17:21:18 Fo	orward join-accept	message	DevA	ddr: 26 0B BE AA 🗘 🖺			

Figure 8: AT Command for Join Network

- 2. Send Hex data message: AT+SEND=portnumber:confirmedmode:message (Figure 9), or Send ASCII data message: AT+SNDTXT=portnumber:confirmedmode:message
 - Port Number to distinguish message type: 1-223
 - Mode to determine if system acknowledgement is required: 0: unconfirmed, 1: confirmed

For instance, when you type AT+SEND=88:1:1234, you will see both uplink and downlink acknowledgement of on the TTN Console that the message "1234" has been sent.

	Tools V1.4.1 - Engineering Mode				- c x		THE THINGS STACK			
Mode Configuration	Disconnect	LED2	LED3	Cear	Packet:	THE THINGS	THE THINGS STACK Community Edition	Overview	Applications	🛓 Gateways 🛛 A Organizations
	17:37:54:872 973e673:TX on freq 923200000 Hz at DR	84								
	17:37:54:878				Receive: 17.38.00.059					a b a construction of the construction of the data
	17:37:54:978:973e784:MAC txDone				284556543A53454E445F434F4E4649524D4544000A		ragino_LHT65			Applications > Dragino_LHT65 > End devices > Demo > Live data
	17:37:59:972 978s774:RX_1 on freq \$23200000 Hz at 1	084			Send:		ragino_ch165			
	17:38:00:043 978s860 MAC mDone				17.37.54.856 41542853454E443D38383A313A313233340D					- Domo
	17:38:00:059 +EVT:SEND_CONFIRMED									Demo
	17.36.00.003 *EV1.3EN0_CONFIRMED				Status		verview			LD: EUF-3336373038396016
					A					↑7 ↓ 5 Last activity 1 minute ago ③
						A B	nd devices			
										Overview Live data Messaging Location Payload formatters Claiming General settings
				v		🗐 U	ve data			overview Energiada Hessaging Education Payload formations Claiming General settings
								Time 1	Dune	Data preview
	AT Command AT+SEND=88:1:1234					<> P2	ayload formatters	1005	type	vera prenew
	Message			Send				↓ 16:36:36 S	Schedule data downl	ink for transmissi_ DevAddr: 26 08 CB DC ↔ 🐐 Rx1 Delay: 6
	- Hex					犬 In	tegrations Y			
								↑ 16:36:36 P	orward uplink data	message DevAddr: 26 08 CB DC 🗘 🐚 Payload: 12 34 🗘 🐐 FPort: 88 Data rate: SF7BH125 SNR: 9.2 RSSI: -57

Figure 9: AT Command for send message

2.4. AT Commands for Device EUI, Application EUI, Application Key and Network Key

The Device EUI, Application EUI, Application Key and Network Key can be changed at any time and will reset back to default after power cycled. Alternatively, the parameter can be fixed by saving it into EEPROM. Enter commands in the SGW2828-EVK PC Tool Engineering Mode:

	System Command	Command
1	Device EUI	
	Get DEUI	AT+DEUI=?
	Set DEUI	AT+DEUI=DEUI
	Device EUI in EEPROM	
	Set DEUI in EEPROM	AT+EEDEUI=DEUI
	Activate DEUI in EEPROM	AT+USE_EEDEUI=1
	 De-active DEUI in EEPROM and use default value 	AT+USE_EEDEUI=0
2	Application EUI	
	Get APPEUI	AT+APPEUI=?
	Set APPEUI	AT+APPEUI=APPEUI
	Application EUI in EEPROM	
	Set APPEUI in EEPROM	AT+EEAPPEUI=APPEUI
	Activate APPEUI in EEPROM	AT+USE_EEAPPEUI=1
	• De-active APPEUI in EEPROM and use default value	AT+USE_EEAPPEUI=0
3	Application Key	
	Get APPKEY	AT+APPKEY=?
	Set APPKEY	AT+APPKEY=APPKEY
	Remarks: Application key can only be set before network join.	
	Application Key in EEPROM	
	Set APPKEY in EEPROM	AT+EEAPPKEY=APPKEY
	Activate APPKEY in EEPROM	AT+USE_EEAPPKEY=1
	De-active APPKEY in EEPROM and use default value	AT+USE_EEAPPKEY=0
4	Network Key	
	Get NWKKEY	AT+NWKKEY=?
	Set NWKKEY	AT+NWKKEY=NWKKEY
	Remarks: Network key will be stored and no reset is needed after power reset.	

Remarks:

- The ":" symbol must be added between each pair of digits when setting the parameters.
- The SGW2828-EVK must be power cycled after writing any parameter in the EEPROM.
- OTAA LoRaWAN 1.0.x does not require NWKKEY setting, it is generated in network server and SGW2828-EVK uses the AppNonce value in join-accept message to generate the same key.

2.5. Enable SGW2828-EVK to TTN Communication without PC:

Once you have added the SGW2828-EVK on the TTN Console, provided that you are in vicinity of a TTN Gateway, you can enable TTN connection and send message without the need of a PC.

	LED 1	LED 2	LED 3
Regular Operation			
Power On	On	Flashing	Off
Connection			
Connection Success	On	On	On
Connection Fail	On	Flashing	Off
Send Message			
Sent Success	On	On	On
Sent Fail	On	On	Flashing

- 1. SGW2828-EVK's LED2 and LED3 remain off when power up.
- 2. Connection to TTN via LoRaWAN gateway:

Press SW3 once to send join network request. Both LED2 and LED3 will light up upon join success. Remarks: Please allow approximately 5 seconds for the server to acknowledge the join request. Remarks: LED 2 indicates TTN connection success; while LED 3 indicates acknowledgement success data sent. Remarks: Should the join connection be unsuccessful, please repeat Step 2.

3. Send message:

Press SW3 can send a default 8-byte message, if success message is sent, LED3 will light up again and you can see message "1234567890ABCDEF" on TTN console.

Remarks: Please allow approximately 5 seconds for the server to acknowledge the send request. Remarks: Should the sent request be unsuccessful, please repeat Step 3.

4. System reset:

Should you wish to conduct SGW2828-EVK system reset during your development process, press SW2 to conduct.

3. Other AT Commands Set

System Command	Command
General Commands	
Get or set verbose level AT+VL	Read Command AT+VL=? Execution Command AT+VL= <level> Where: • <level> = 0 - 3</level></level>
LoRaWAN Network Management Commands	
Get firmware version AT+VER	Execution Command AT+VER=?
Get or set the adaptive data rate functionality AT+ADR	Read Command AT+ADR=?
	Execution Command AT+ADR= <adr> Where:</adr>
	• <adr> = 0: off, 1: on</adr>
Get or set data rate AT+DR	Read Command AT+DR=?
	Execution Command AT+DR= <datarate></datarate>
	Where: • <datarate> = Window data rate 2 - 7</datarate>
Get or set active regions AT+BAND	Read Command AT+BAND=?
	Execution Command AT+BAND= <bandid></bandid>
	Where: • <bandid> = Active region, 0:AS923, 1:AU915, 6:KR920, 8:US915</bandid>
Get or set the LoRa class AT+CLASS	Read Command AT+CLASS=?
	Execution Command AT+CLASS= <class></class>
	Where: • <class> = LoRa class, A or C</class>

System Command	Command
LoRaWAN Network Management Commands	
Get or set duty cycle setting AT+DCS	Read Command AT+DCS=?
	Execution Command AT+DCS= <dutycycle></dutycycle>
	Where: • <dutycycle> = ETSI DutyCycle, 0: Off; 1: On</dutycycle>
Get or set the join delay on Rx window 1 AT+JN1DL	Read Command AT+ JN1DL=?
	Execution Command AT+JN1DL= <delay></delay>
	Where: • <delay> = Delay in ms</delay>
Get or set the join delay on Rx window 2 AT+JN2DL	Read Command AT+JN2DL=?
	Execution Command AT+ JN2DL= <delay></delay>
	Where: • <delay> = Delay in ms</delay>
Get or set the delay of the Rx window 1 AT+RX1DL	Read Command AT+RX1DL=?
	Execution Command AT+RX1DL= <delay></delay>
	Where: • <delay> = Delay in ms</delay>
Get or set the delay of the Rx window 2 AT+RX2DL	Read Command AT+RX2DL=?
	Execution Command AT+RX2DL= <delay></delay>
	Where: • <delay> = Delay in ms</delay>
Get or set the data rate of the Rx window 2 AT+RX2DR	Read Command AT+RX2DR=?
	Execution Command AT+RX2DR= <datarate></datarate>
	Where: • < DataRate> = Rx2 window DataRate, 2 – 7
Get or set the frequency of the Rx window 2 AT+RX2FQ	Read Command AT+RX2FQ=?
	Execution Command AT+RX2FQ= <freq></freq>
	Where: • <freq> = Freq in Hz</freq>

System Command	Command
LoRaWAN Network Management Commands	
Get or set the transmit power AT+TXP	Read Command AT+TXP=? Execution Command AT+TXP= <power> Where: • <power> = Transmit power, 0 - 7 (Valid range according to region)</power></power>
Radio Tests Commands	
Start RF tone test AT+TTONE	Execution Command AT+TTONE
Start the RF RSSI tone test AT+TRSSI	Execution Command AT+TRSSI
Get or set the config LoRa RF test AT+TCONF	Read Command AT+TCONF=?
	Execution Command AT+TCONF= <freq>:<pow>:<bw>:<sf>:4/<cr>: <lna>:<pa>:<mod>:<paylen>:<freqdev>: <lowdropt>:<bt></bt></lowdropt></freqdev></paylen></mod></pa></lna></cr></sf></bw></pow></freq>
	Where: • <freq> = Frequency in Hz • <pow> = Power in dBm • <bw> = Bandwidth in kHz • <mod> = Modulation, 0: FSK, 1: Lora, 2: BPSK • <paylen> = PayloadLen in Bytes • <freqdev> = FskDeviation in Hz • <lowdropt> = 0: Off, 1: On, 2: Auto • <bt> = BTproduct, 0: no Gaussian Filter Applied, 1: BT=0,3, 2: BT=0,5, 3: BT=0,7, 4: BT=1</bt></lowdropt></freqdev></paylen></mod></bw></pow></freq>
Sets the number of packets to be sent for PER RF Tx test. AT+TTX	Execution Command AT+TTX= <packetnb> Where: • <packetnb> = Nb of packets sent</packetnb></packetnb>
Sets the number of packets to be received for PER RF Rx test. AT+TRX	Execution Command AT+TRX= <packetnb> Where: • <packetnb> = Nb of packets expected</packetnb></packetnb>
Information Command	
Gets the battery level AT+BAT	Execution Command AT+BAT=?

Useful Links

- 1. SG Wireless SGW2828-EVK official product page: <u>https://www.sgwireless.com/product/SGW2828-EVK</u>
- 2. SG Wireless SGW2828-01A official product page: <u>https://www.sgwireless.com/product/SGW2828</u>
- 3. Semtech SX1276 official product page: <u>https://www.semtech.com/products/wireless-rf/lora-transceiv-ers/sx1276</u>
- 4. STMicroelectronics MCU STM32L072KBU6 official product page: <u>https://www.st.com/en/microcontrollers-</u> <u>microprocessors/stm32l072kb.html</u>
- 5. TTN Gateway (RAK831 LPWAN Gateway Concentrator Module with Raspberry Pi Model 3s): http://www.thethingsnetwork.org/docs/gateways/rak831/
- 6. The Things ID sign-up page: <u>https://id.thethingsnetwork.org/oidc/interaction/Uz_QyTi9f_bR9cmIQV2nl/reg-ister</u>

Revision History

Revised	Version	Description
14-Mar-2023	1.0	Initial document release

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