D20-NB/D20S-NB/D22-NB/D23-NB -- NB-IoT Temperature Sensor User Manual

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1. Introduction

1.1 What is D2x-NB NB-IoT Temperature Sensor

The Dragino D2x-NB is a **NB-IoT Temperature Sensor** for Internet of Things solution. D2x-NB has 1 ~ 3 temperature probes. D2x-NB will convert the Temperature readir

The temperature sensor used in D2x-NB can **measure -55°C ~ 125°C with accuracy ±0.5°C (max ±2.0 °C)**.

D2x-NB supports **temperature alarm feature**, user can set temperature alarm for instant notice. D2x-NB supports Datalog feature, it can save the data when there is no N

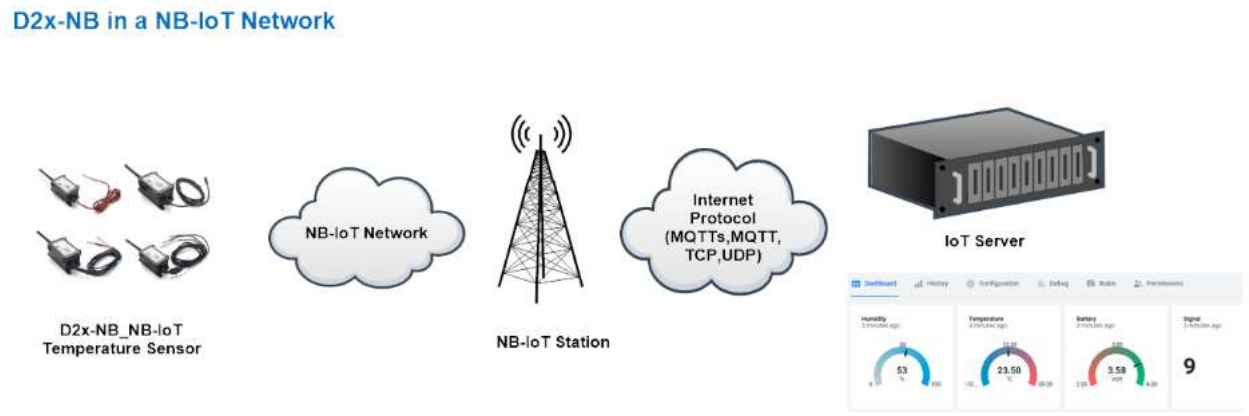
D2x-NB has max 3 probes which measure maximum 3 temperature points.

D2x-NB supports different uplink methods including **MQTT, MQTTs, UDP & TCP** for different application requirement, and support uplinks to various IoT Servers.

D2x-NB **supports BLE configure and OTA update** which make user easy to use.

D2x-NB is powered by **8500mAh Li-SOCI2 battery**, it is designed for long-term use up to several years.

D2x-NB has optional built-in SIM card and default IoT server connection version. Which makes it works with simple configuration.



1.2 Features

- NB-IoT Bands: B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B28/B66/B70/B85 @H-FDD
- Ultra-low power consumption
- 1 ~ 3 External Temperature Probes
- Measure range -55°C ~ 125°C
- Temperature alarm
- Multiply Sampling and one uplink
- Support Bluetooth v5.1 remote configure and update firmware
- Uplink on periodically
- Downlink to change configure
- 8500mAh Battery for long term use
- Nano SIM card slot for NB-IoT SIM

1.3 Specification

Common DC Characteristics:

- Supply Voltage: 2.5v ~ 3.6v
- Operating Temperature: -40 ~ 85°C

Temperature Sensor:

- Dallas DS18B20
- Range: -55 to + 125°C
- Accuracy ±0.5°C (max ±2.0 °C)

NB-IoT Spec:

NB-IoT Module: BC660K-GL

Support Bands:

- B1 @H-FDD: 2100MHz
- B2 @H-FDD: 1900MHz

- B3 @H-FDD: 1800MHz
- B4 @H-FDD: 2100MHz
- B5 @H-FDD: 860MHz
- B8 @H-FDD: 900MHz
- B12 @H-FDD: 720MHz
- B13 @H-FDD: 740MHz
- B17 @H-FDD: 730MHz
- B18 @H-FDD: 870MHz
- B19 @H-FDD: 870MHz
- B20 @H-FDD: 790MHz
- B25 @H-FDD: 1900MHz
- B28 @H-FDD: 750MHz
- B66 @H-FDD: 2000MHz
- B70 @H-FDD: 2000MHz
- B85 @H-FDD: 700MHz

Battery:

- Li/SOCI2 un-chargeable battery
- Capacity: 8500mAh
- Self Discharge: <1% / Year @ 25°C
- Max continuously current: 130mA
- Max boost current: 2A, 1 second

Power Consumption

- STOP Mode: 10uA @ 3.3v
- Max transmit power: 350mA@3.3v

1.4 Applications

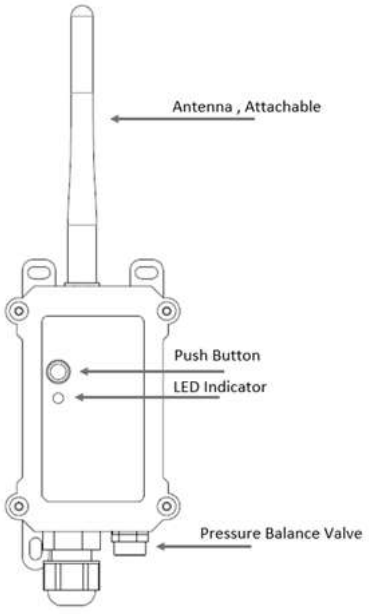
- Smart Buildings & Home Automation
- Logistics and Supply Chain Management
- Smart Metering
- Smart Agriculture
- Smart Cities
- Smart Factory

1.5 Sleep mode and working mode

Deep Sleep Mode: Sensor doesn't have any NB-IoT activate. This mode is used for storage and shipping to save battery life.

Working Mode: In this mode, Sensor will work as NB-IoT Sensor to Join NB-IoT network and send out sensor data to server. Between each sampling/tx/rx periodically, se
as Deep Sleep mode.

1.6 Button & LEDs



Behavior on ACT	Function	Action

Pressing ACT between 1s < time < 3s	Send an uplink	If sensor has already attached to NB-IoT network, sensor will send an uplink packet, **blue led** will blink once. Meanwhile, BLE module will be active and user can connect via BLE to configure device.
Pressing ACT for more than 3s	Active Device	**Green led** will fast blink 5 times, device will enter **OTA mode** for 3 seconds. And then start to attach NB-IoT network. **Green led** will solidly turn on for 5 seconds after joined in network. Once sensor is active, BLE module will be active and user can connect via BLE to configure device, no matter if device attach NB-IoT network or not.
Fast press ACT 5 times.	Deactivate Device	**Red led** will solid on for 5 seconds. Means device is in Deep Sleep Mode.

Note: When the device is executing a program, the buttons may become invalid. It is best to press the buttons after the device has completed the program exe

1.7 BLE connection

D2x-NB support BLE remote configure and firmware update.

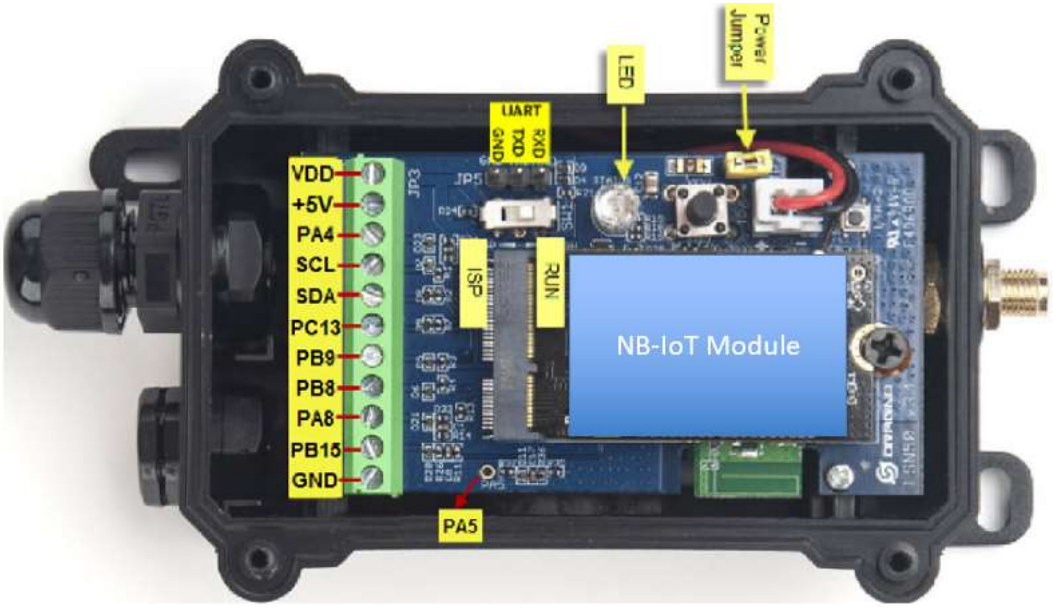
BLE can be used to configure the parameter of sensor or see the console output from sensor. BLE will be only activate on below case:

- Press button to send an uplink
- Press button to active device.
- Device Power on or reset.

If there is no activity connection on BLE in 60 seconds, sensor will shut down BLE module to enter low power mode.

1.8 Pin Definitions , Switch & SIM Direction

D2x-NB use the mother board from D2x-NB which as below.



1.8.1 Jumper JP2

Power on Device when put this jumper.

1.8.2 BOOT MODE / SW1

1) ISP: upgrade mode, device won't have any signal in this mode. but ready for upgrade firmware. LED won't work. Firmware won't run.

2) Flash: work mode, device starts to work and send out console output for further debug

1.8.3 Reset Button

Press to reboot the device.

1.8.4 SIM Card Direction

See this link. How to insert SIM Card (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%

1.9 Hardware Variant

Model	Photo	Probe Info
D20-NB		1 x DS28B20 Probe Cable Length : 2 meters
D20S-NB		1 x DS28B20 Probe (Suitable for bury in soil) Material: TPE, Cable Length: 2meters
D22-NB		2 x DS28B20 Probes Cable lengths total 1.5meters per probe Cable Drawing: See This Link (https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSN50v2-D20/Cable_Drawing/&file=CAB0-35IC-K21G-210811.pdf)
D23-NB		3 x DS28B20 Probes Cable lengths total 1.5meters per probe Cable Drawing: See This Link (https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSN50v2-D20/Cable_Drawing/&file=CAB0-35IC-K31G-210811.pdf)

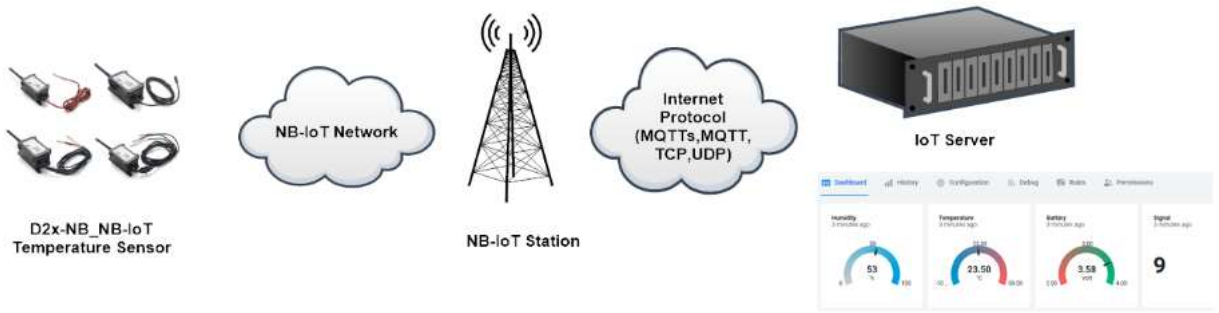
2. Use D2x-NB to communicate with IoT Server

2.1 Send data to IoT server via NB-IoT network

The D2x-NB is equipped with a NB-IoT module, the pre-loaded firmware in D2x-NB will get environment data from sensors and send the value to local NB-IoT network via protocol defined by D2x-NB.

Below shows the network structure:

D2x-NB in a NB-IoT Network



There are two version: **-GE** and **-1D** version of D2x-NB.

GE Version: This version doesn't include SIM card or point to any IoT server. User needs to use AT Commands to configure below two steps to set D2x-NB send data to I

- Install NB-IoT SIM card and configure APN. See instruction of Attach Network (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connec IoT%20models/#H2.AttachNetwork) .
- Set up sensor to point to IoT Server. See instruction of Configure to Connect Different Servers (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%2 IoT%20models/#H3.Configuretoconnecttodifferentservers) .

Below shows result of different server as a glance.

Servers	Dash Board	Comments
Node-Red (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.5A0Node-RedA028viaA0MQTT29)		
DataCake (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.4Datacake)		
Tago.IO (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.7A0Tago.ioA028viaA0MQTT29)		
General UDP (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.1GeneralA0UDPA0Connection)	Raw Payload. Need Developer to design Dash Board	
General MQTT (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.2GeneralA0MQTTA0Connection)	Raw Payload. Need Developer to design Dash Board	
ThingSpeak (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.3A0ThingSpeakA028viaA0MQTT29)		
ThingsBoard (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%20models/#H3.6A0ThingsBoard.CloudA028viaA0MQTT29)		

1D Version: This version has 1NCE SIM card pre-installed and configure to send value to DataCake. User Just need to select the sensor type in DataCake and Activate D Instruction (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20-NB%20%26%20-NS%20NB-IoT%2

2.2 Payload Types

To meet different server requirement, D2x-NB supports different payload type.

Includes:

- General JSON format payload. (Type=5)

- HEX format Payload. (Type=0)
- ThingSpeak Format. (Type=1)
- ThingsBoard Format. (Type=3)

User can specify the payload type when choose the connection protocol. Example:

AT+PRO=2,0 // Use UDP Connection & hex Payload

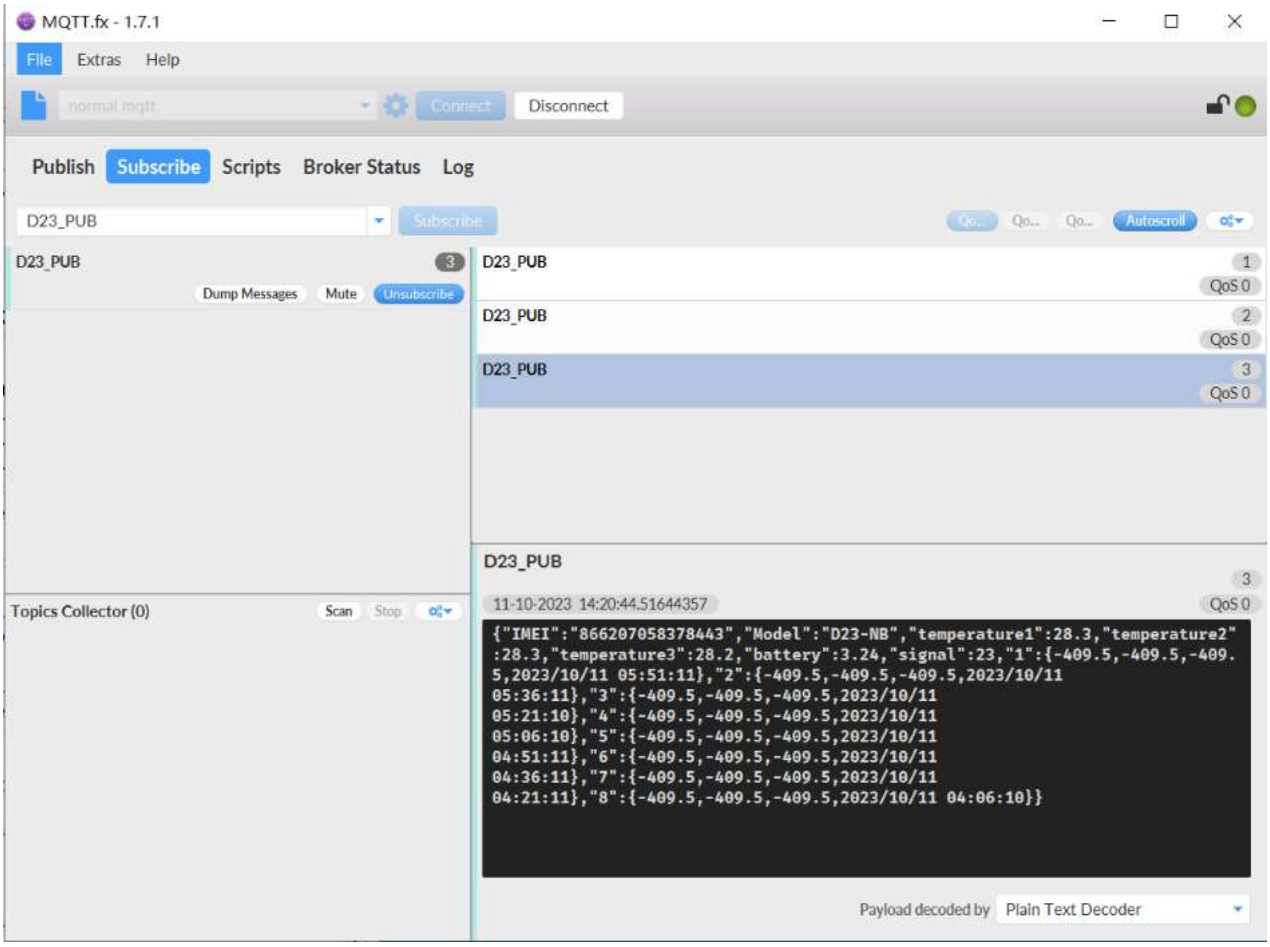
AT+PRO=2,5 // Use UDP Connection & Json Payload

AT+PRO=3,5 // Use MQTT Connection & Json Payload

2.2.1 General Json Format(Type=5)

This is the General Json Format. As below:

{"IMEI":"866207058378443","Model":"D23-NB","temperature1":28.3,"temperature2":28.3,"temperature3":28.2,"battery":3.24,"signal":23,"1":{-409.5,-409.5,-409.
{-409.5,-409.5,-409.5,2023/10/11 05:21:10},"4":{-409.5,-409.5,-409.5,2023/10/11 05:06:10},"5":{-409.5,-409.5,-409.5,2023/10/11 04:51:11},"6":{-409.5,-409.5,-409.5,2(
{-409.5,-409.5,-409.5,2023/10/11 04:06:10}}



Notice, from above payload:

- Temperature , Battery & Signal are the value at uplink time.
- Json entry 1 ~ 8 are the last 1 ~ 8 sampling data as specify by **AT+NOUD=8** Command. Each entry includes (from left to right): Temperature, Sampling time.

2.2.2 HEX format Payload(Type=0)

This is the HEX Format. As below:

f866207058378443036 40cc6180100000000113011401136526 40edf001f001f001652637cff001f001f0016526344bf001f001f001652630c6f001f001f00165262d42f001f00

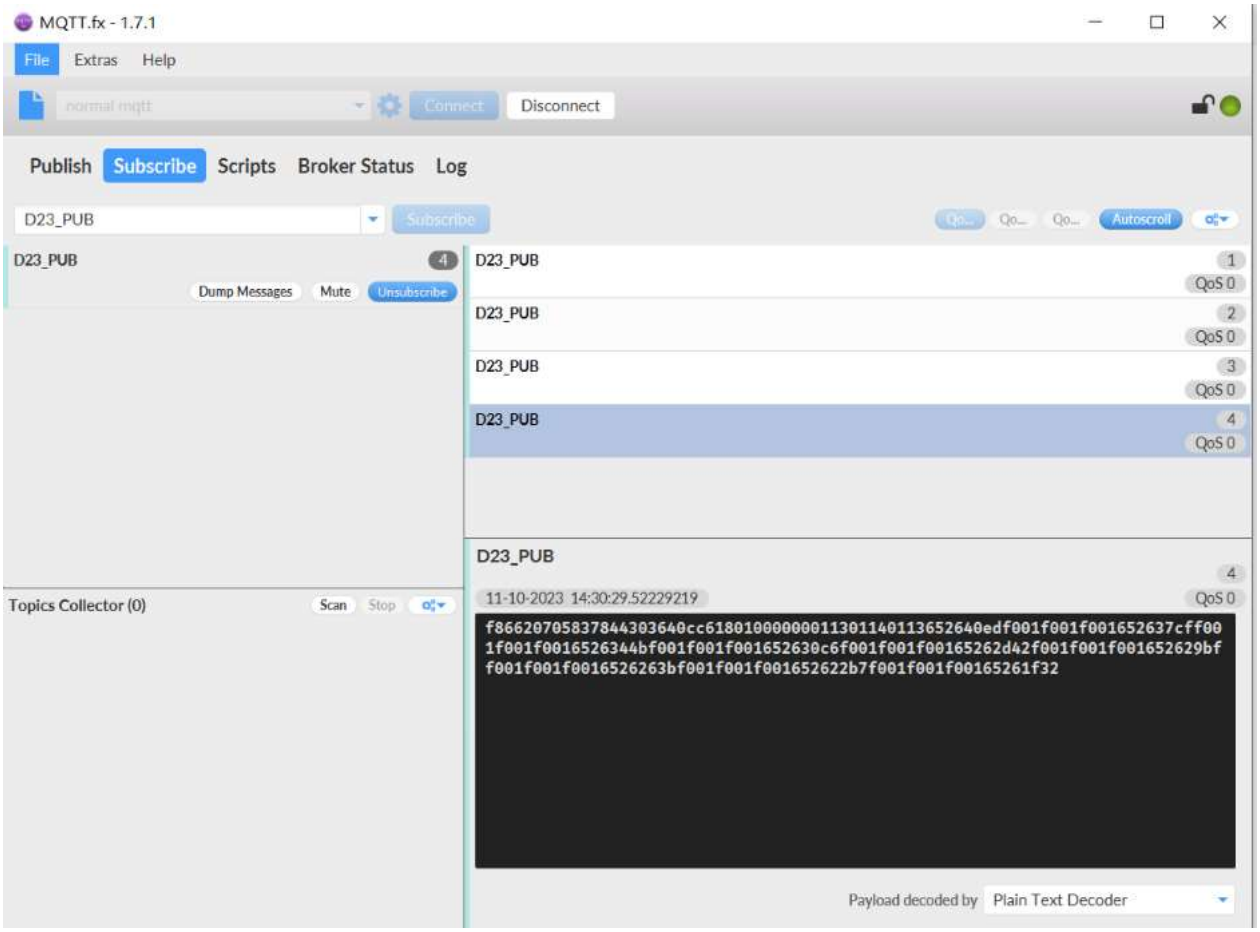
3 x DS18B20 (CFGMOD=4)

f866207058378443	0364	0cc6	18	01	0000	00	0113	0114	0113	652640ed
f+IMEI	Version	BAT	Singal	Mod	ADC	Interrupt	Temp1	Temp2	Temp3	Timestamp
8 Bytes						19Bytes				

0000	00f5	0000	0000	64f05de4	0000f001f001f00164f0594d	0000f001f001f00164f05899	0000f001f001f00164f057e5
adc1	ds18b20	ds18b20(2)	ds18b20(3)	timestamp (last 1s	last 2nd data	last 3rd data	last 4th data
12 Bytes					12 Bytes	12 Bytes	12 Bytes

0001000000000000064f056ea	0000000000000000064f05636	0001000000000000064f05582	0000000000000000064f054ce
last 5th data	last 6th data	last 7th data	last 8th data
12 Bytes	12 Bytes	12 Bytes	12 Bytes

If we use the MQTT client to subscribe to this MQTT topic, we can see the following information when the NB sensor uplink data.



Version:

These bytes include the hardware and software version.

Higher byte: Specify Sensor Model: 0x03 for D2x-NB

Lower byte: Specify the software version: 0x64=100, means firmware version 100

BAT (Battery Info):

Ex1: 0x0CC6 = 3270mV

Signal Strength:

NB-IoT Network signal Strength.

Ex1: 0x18 = 24

0 -113dBm or less

1 -111dBm

2...30 -109dBm... -53dBm

31 -51dBm or greater

99 Not known or not detectable

Temperature:

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000: Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

TimeStamp:

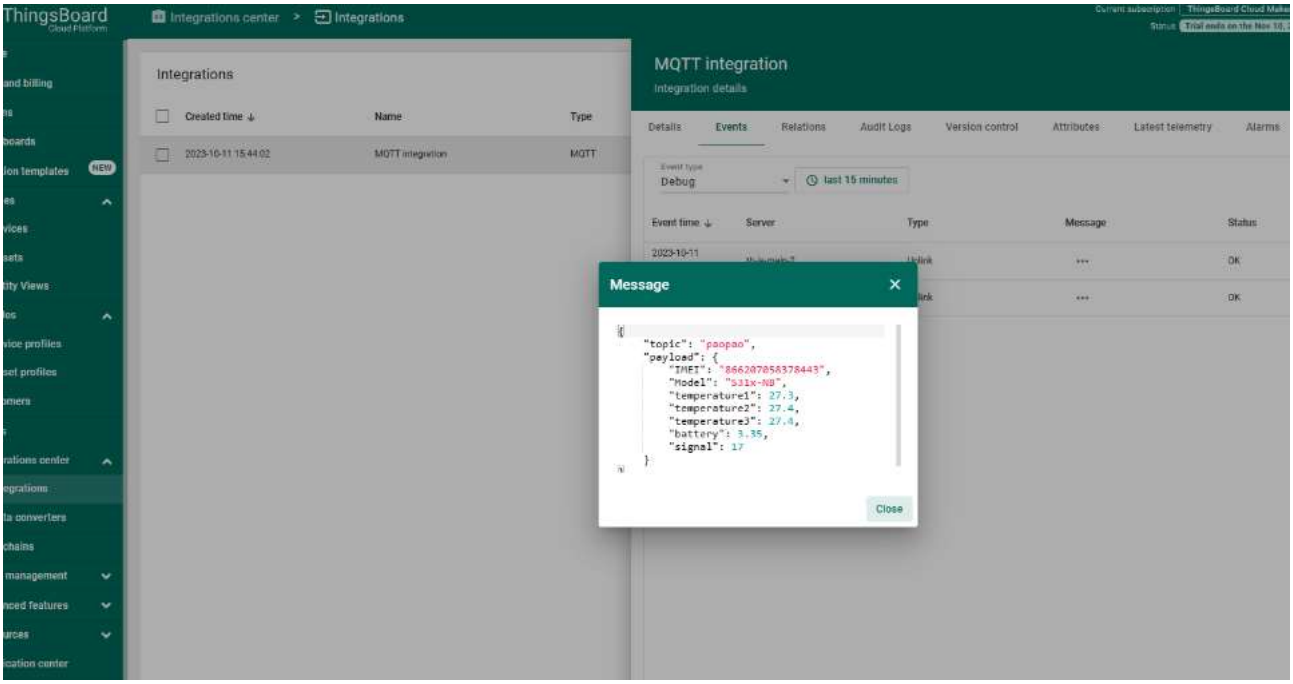
Unit TimeStamp Example: 64d49439(H) = 1691653177(D)

Put the decimal value into this link(https://www.epochconverter.com) (https://www.epochconverter.com)) to get the time.

2.2.3 ThingsBoard Payload(Type=3)

Type3 payload special design for ThingsBoard, it will also configure other default server to ThingsBoard.

{"IMEI": "866207058378443","Model": "S31x-NB","temperature1": 27.3,"temperature2": 27.4,"temperature3": 27.4,"battery": 3.35,"signal": 17}



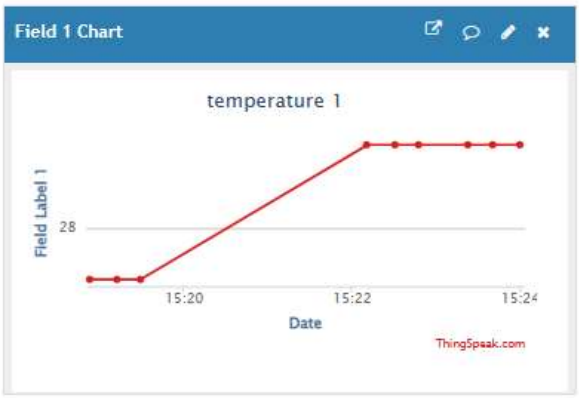
2.2.4 ThingSpeak Payload(Type=1)

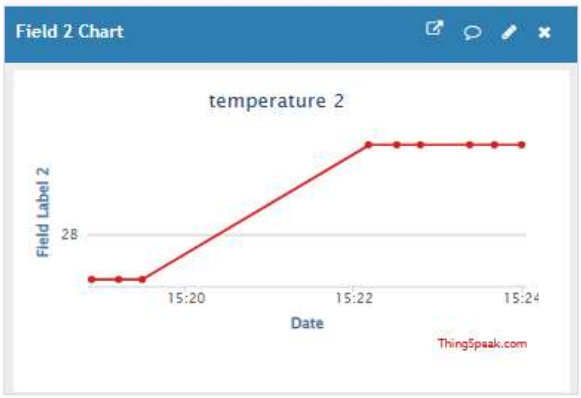
This payload meets ThingSpeak platform requirement. It includes only four fields. Form 1~5 are:

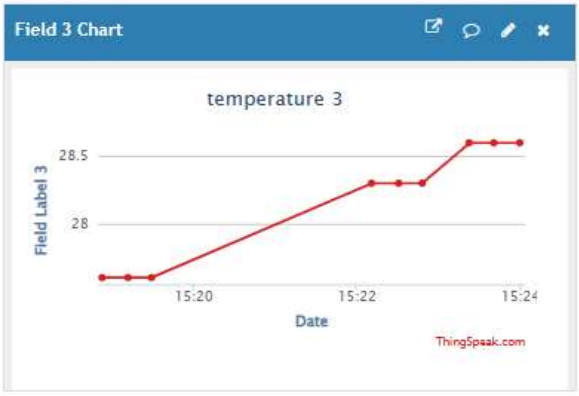
Temperature1, Temperature 2, Temperature 3,Battery & Signal. This payload type only valid for ThingsSpeak Platform

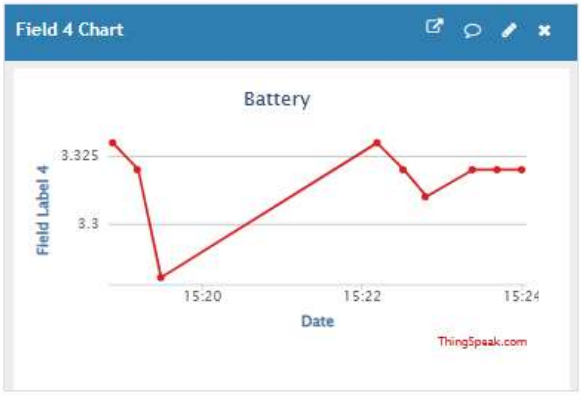
As below:

field1=temp1 value&field2=temp2 value&field3=temp3 value&field4=Battery value&field5=Signal value









2.3 Uplink Payload

D2x-NB will uplink payload via NB-IoT with below payload format:

Uplink payload includes in total 27 bytes.

Size(bytes)	**8**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**4**
Value	f+IMEI	Ver	BAT	Signal Strength	Mod	ADC	Interrupt	Temp1 **(PC13)**	Temp2 **(PB9)**	Temp3 **(PB8)**	Timestamp

If the cache upload mechanism is turned on, you will receive the payload shown in the figure below.

Frame header	**Frame data(1)**	**Frame data(2)**	**F…**	**Frame data(X)**

Decode corresponding probe color

D20:

Red <--> C1

D22:

White <--> C1 , Red <--> C2

D23:

White <-->C1 , Red <--> C2 , Black <--> C3

Temperature RED or Temperature White

This point to the Red probe in D20-NB or the probe of D22-NB/D23-NB White

Example:

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000：Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

Temperature White

This point to the Red probe in D22-NB/D23-NB.

If it is D20-NB, the value is 0x7FFF, which is 327.67.

Example:

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000：Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

Temperature Black

This point to the BLACK probe in D23-NB

If it is D20-NB/D22-NB, the value is 0x7FFF, which is 327.67.

Example:

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000：Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

2.4 Test Uplink and Change Update Interval

By default, Sensor will send uplinks **every 2 hours** & AT+NOUD=8

User can use below commands to change the **uplink interval**.

AT+TDC=600 // Set Update Interval to 600s

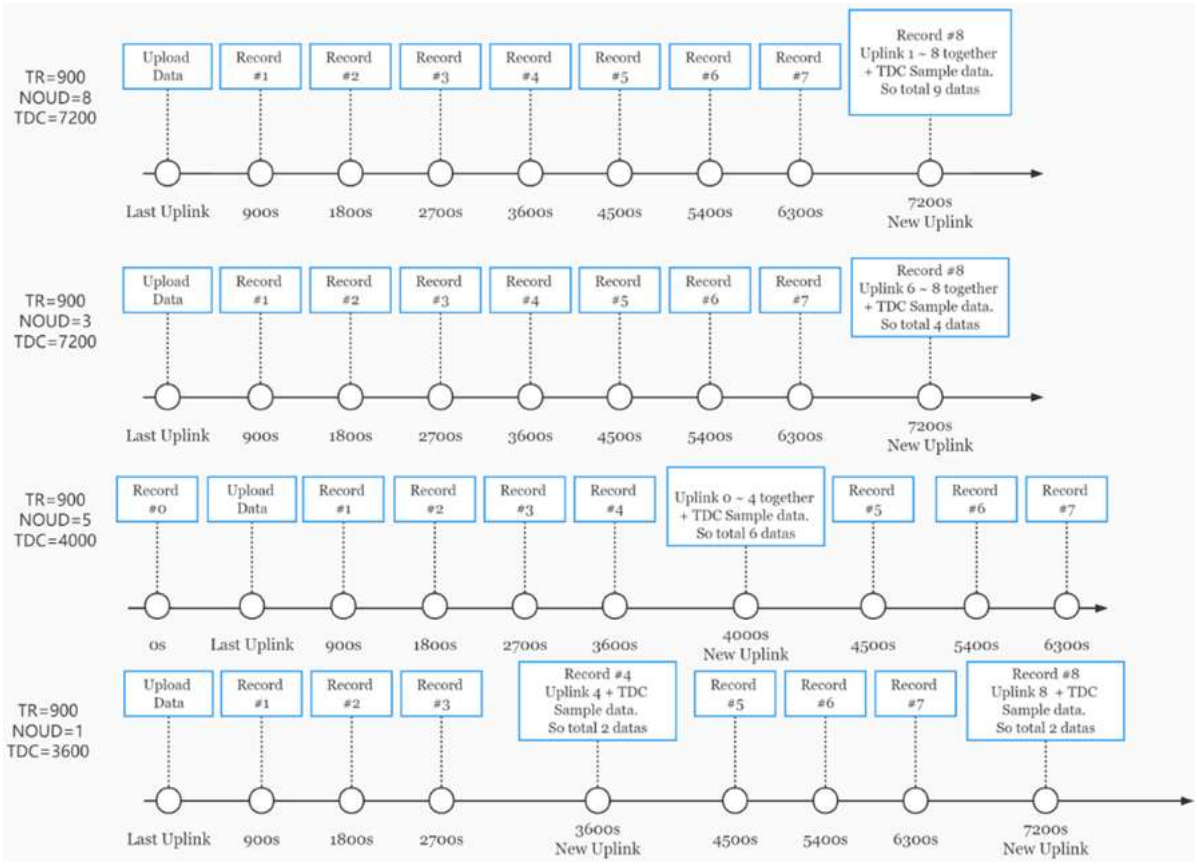
User can also push the button for more than 1 seconds to activate an uplink.

2.5 Multi-Samplings and One uplink

To save battery life, D2x-NB will sample temperature & humidity data every 15 minutes and send one uplink every 2 hours. So each uplink it will include 8 stored data + 1

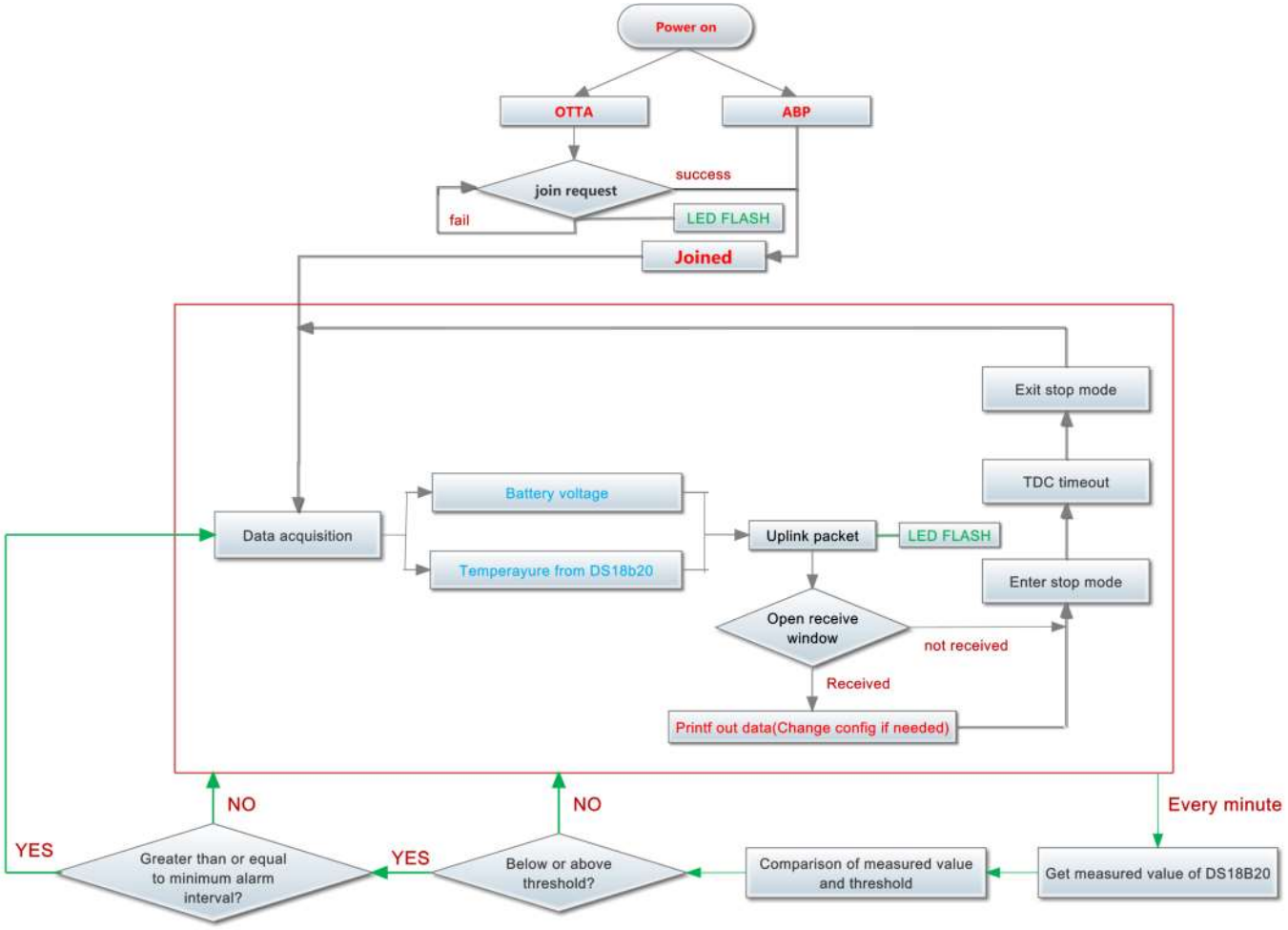
- **AT+TR=900** // The unit is seconds, and the default is to record data once every 900 seconds (15 minutes, the minimum can be set to 180 seconds)
- **AT+NOUD=8** // The device uploads 8 sets of recorded data by default. Up to 32 sets of record data can be uploaded.

The diagram below explains the relationship between TR, NOUD, and TDC more clearly:



2.6 Temperature Alarm Feature

D2x-NB work flow with Alarm feature.



Set Alarm Thredhold

Set for Separate Probes:

AT+TEMPALARM1 index=min,max

Index:

- 1: Temperature_Red
- 2: Temperature_White
- 3: Temperature_Black

min,max:

- When min=0, and max≠0, Alarm trigger when higher than max
- When min≠0, and max=0, Alarm trigger when lower than min
- When min≠0 and max≠0, Alarm trigger when higher than max or lower than min

Example:

AT+TEMPALARM1=-10,30 // Alarm when < -10 or higher than 30.

2.7 Trggier an uplink by external interrupt

D2x-NB has an external trigger interrupt function. Users can use the PB15 pin to trigger the upload of data packets.

AT command:

- **AT+INTMOD** // Set the trigger interrupt mode
- **AT+INTMOD=0** // Disable Interrupt
- **AT+INTMOD=1** // Trigger by rising and falling edge
- **AT+INTMOD=2** // Trigger by falling edge
- **AT+INTMOD=3** // Trigger by rising edge

3. Configure D2x-NB

3.1 Configure Methods

D2x-NB supports below configure method:

- AT Command via Bluetooth Connection (**Recommended**): BLE Configure Instruction (http://wiki.dragino.com/xwiki/bin/view/Main/BLE%20Bluetooth%20Remote%2
- AT Command via UART Connection : See UART Connection (http://wiki.dragino.com/xwiki/bin/view/Main/UART%20Access%20for%20LoRa%20ST%20v4%20bas

3.2 AT Commands Set

AT+<CMD>? : Help on <CMD>

AT+<CMD> : Run <CMD>

AT+<CMD>=<value> : Set the value

AT+<CMD>=? : Get the value

General Commands

AT : Attention

AT? : Short Help

ATZ : MCU Reset

AT+TDC : Get or set the application data transmission interval in s

AT+CFG : Print all configurations

AT+CFGMOD : Working mode selection

AT+DEUI : Get or set the Device ID

AT+FDR : Reset Parameters to Factory Default

AT+INTMOD : Get or Set the trigger

AT+CFM : Get or Set confirmation mode (0: Off 1: On)

AT+5VT : Get or Set extend the time of 5V power

AT+PRO : Get or Set usage agreement (1:COAP,2:UDP,3:MQTT,4:TCP)

AT+APN : Get or set the APN

AT+EXT : Get or Set Count value

AT+TR : Get or set SHT record time

AT+RXDL : Get or Set the receiving time

AT+DNSCFG : Get or Set DNS Server

AT+CSQTIME : Get or Set the time to join the network

AT+DNSTIMER : Get or Set the NDS timer

AT+LDATA : Get the last upload data

AT+GETSENSORVALUE : Returns the current sensor measurement

AT+NOUD : Get or Set the number of SHT data to be uploaded

AT+CDP : Read or Clear cached data

ATAT+TEMPALARM1 :Get or Set alarm of temp1

ATAT+TEMPALARM2 :Get or Set alarm of temp2

ATAT+TEMPALARM3 :Get or Set alarm of temp3

AT+TLSMOD : Get or Set the TLS mode

AT+SERVADDR : Server Address

UDP Management

AT+CFM : Upload confirmation mode (only valid for UDP)

MQTT Management

AT+CLIENT : Get or Set MQTT client

AT+UNAME : Get or Set MQTT Username

AT+PWD : Get or Set MQTT password

AT+PUBTOPIC : Get or Set MQTT publish topic

AT+SUBTOPIC : Get or Set MQTT subscription topic

Information

AT+FDR : Factory Data Reset

AT+PWORD : Serial Access Password

AT+LDATA : Get the last upload data

AT+CDP : Read or Clear cached data

4. Battery & Power Consumption

D2x-NB use ER26500 + SPC1520 battery pack. See below link for detail information about the battery info and how to replace.

Battery Info & Power Consumption Analyze (http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20calculate%20the%20battery%20life%20of%20Dragino%20sens

5. Firmware update

User can change device firmware to::

- Update with new features.
- Fix bugs.

Firmware and changelog can be downloaded from : **Firmware download link (https://www.dropbox.com/sh/rl01j9r0ecspjml/AAACvqfplgTfL_E_Nv-PImMVa?dl=0)**

Methods to Update Firmware:

- (Recommended way) OTA firmware update via BLE: **Instruction** (http://wiki.dragino.com/xwiki/bin/view/Main/BLE_Firmware_Update_NB_Sensors_BC660K-GL/)
- Update through UART TTL interface : **Instruction (http://8.211.40.43/xwiki/bin/view/Main/Firmware%20Upgrade%20Instruction%20for%20STM32%20base%2**

6. FAQ

6.1 How can I access t BC660K-GL AT Commands?

User can access to BC660K-GL directly and send AT Commands.

See BC660K-GL AT Command set (https://www.dropbox.com/sh/5f6ssda5fum8rvs/AABT68l8ZzWOvZ5eg2qwOoFda?dl=0)

7. Order Info

Part Number: **D20-NB-XX / D20S-NB (designed for used in Soil or Road)/D22-NB-XX / D23-NB-XX**

XX:

- **GE**: General version (Exclude SIM card)
- **1D**: with 1NCE* 10 years 500MB SIM card and Pre-configure to DataCake server

1NCE SIM Card NB-IoT network coverage: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, Germany, Great Britain, Greece, Hungary, Ireland, It Slovenia, Spain, Sweden, Switzerland, Taiwan, USA, US Virgin Islands

8. Packing Info

Package Includes:

- D2x-NB NB-IoT Temperature Sensor x 1
- External antenna x 1

Dimension and weight:

- Device Size: cm
- Device Weight: g
- Package Size / pcs : cm
- Weight / pcs : g

9. Support

- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different timezones we cannot offer live support. However, your questions will be answer
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to