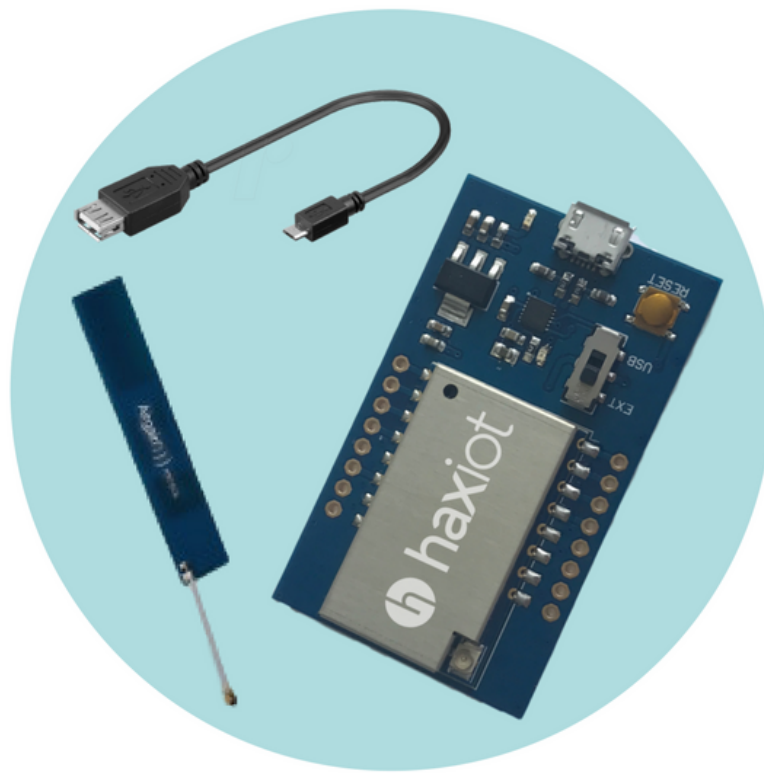


HXC900

HXC Client User Guide



Version 1.09



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1 Introduction

The Haxiot HXC Client module supports the LoRa radio technology and the LoRaWAN protocol stack. This enables long-range, low-power devices to be remotely administered. The technology allows devices to connect with gateways up to 15km. The module requires a gateway and a Network Server in LoRaWAN mode.

The HXC client module provides easy integration to devices with the HXC API. Service Providers, Enterprises, and application providers can use the HXC Zero Touch API to activate customer devices Haxiot cloud services.

There are two variations of HXC Client Module, 400MHz (Model: HXC400) and 900MHz (Model: HXC900). Both variants share a common footprint and software API for global coverage in a range of LoRaWAN channel bands.

Module features

- LoRaWAN and LoRa modes
- UART interface
- AES128-bit encryption
- Class A and Class C
- Industry standard AT command set
- Embedded API for device integration
- OTAA and ABP authentication
- Public or private networks
- Standard or custom regional channel plans
- Global roaming ready LoRaWAN address
- Zero-Touch Provisioning API for factory activation
- Vibration resistant to industrial devices
- Wide range of supply voltages 2.2 - 3.6V
- Ultra-low power sleep mode (10uA)
- FCC (USA) and IC (CANADA) certified (HXC900)



2 Physical Characteristics

2.1 Absolute Maximum Ratings

Description	Symbol	Min	Typ.	Max	Units
Supply voltage	V _{CC}	0.5	3.3	3.9	V
Control voltages	V _{TX} , V _{RX}	-0.2		-	V
RF Input Power				+10	dBm
RF output power				+20	dBm
Temperature		-40		+85	°C
Shock	3x fall of 100cm				

2.2 Operating Range

Description	Symbol	Min	Max	Units
Supply voltage	V _{CC}	2.5	3.6	V
Control voltages	V _{TX} , V _{RX}	-0.2	-	V
RF Input Power	u.FL		+10	dBm
RF Output Power	u.FL		+20	dBm
Temperature		-40	+85	°C

2.3 Power Consumption

Description	Symbol	Min	Typ	Max	Units
Transmit	Tx	-	126	-	mA
Receive	Rx		17	-	mA
Idle	Idle		4		mA
Sleep	Sleep		12		uA

Power consumption is based on ambient temperature of 25°C and 3.3V supply voltage.

2.4 Physical Dimension

Description	Symbol	Min	Typ	Max	Units
Length	L	-	30.5	-	mm
Width	W		15.0	-	mm
Height	H		4		mm



3 Radio Performance

The HXC Client utilizes a +20dB LoRa radio chipset from Semtech for transmit and receive. The external radio connection for the antenna uses a Hirose u.FL micro coaxial cable connector with 50ohm impedance matching. The radio has been optimized for transmission and reception across the 902-928Mhz ISM frequency band.

3.1 Antenna Selection

The HXC client modules require external, dipole antennas. Haxiot recommends Airgain flexible F910D 863-930Mhz antenna with peak gain of 2.2dB.

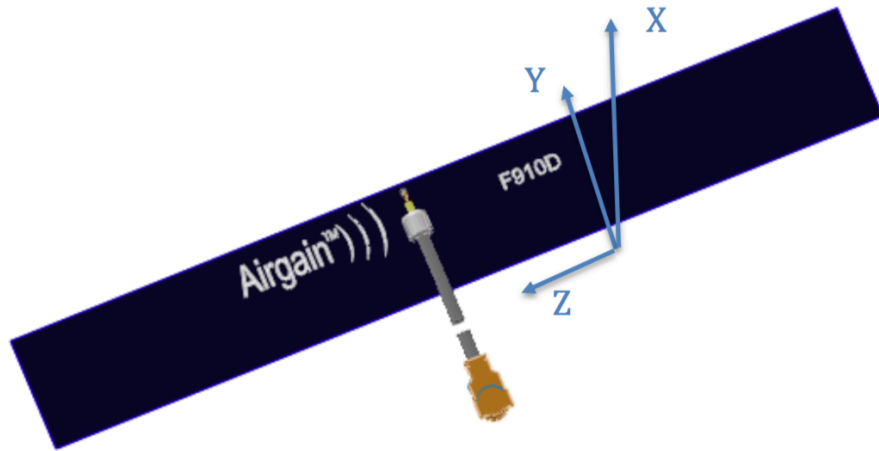


Figure 1: Airgain F910D measurement axes

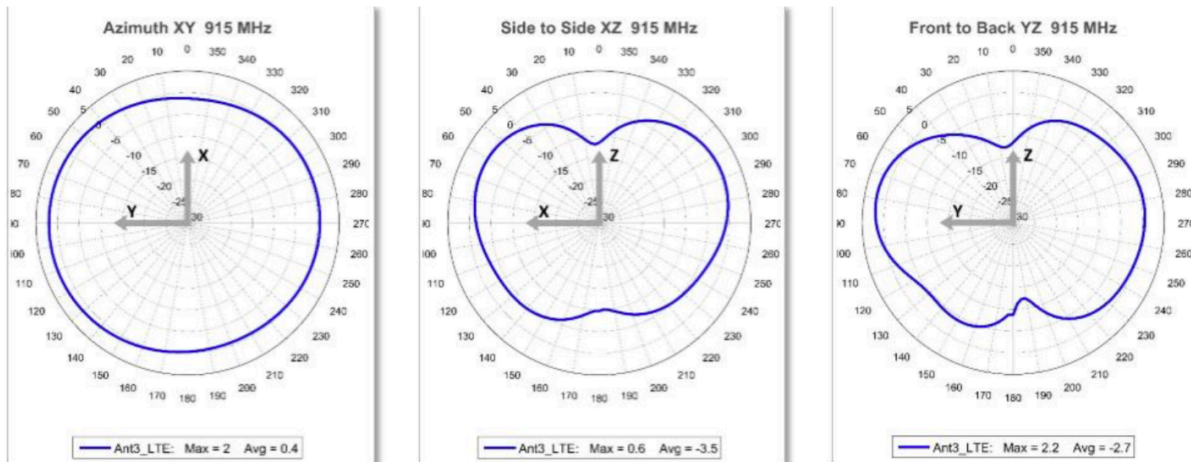


Figure 2: F910D radiation patterns at 915Mhz



4 Operating Modes

This section provides an overview of the operating modes and regional parameters for the HXC series module.

4.1 LoRaWAN Class A

The HXC series module supports Class A and Class C modes of operation. In Class A operating mode, the HXC module can transmit anytime but will only receive during the Receive Window 1 and Receive Window 2. When not sending, receiving or processing AT commands, the module will be in low-power sleep mode. Receiving an AT command will wake up the module.

4.2 LoRaWAN Class C

In Class C mode, the HXC module is in Rx mode if not sending data in Tx mode. The device will receive packets on Receive Window 1 only after transmission of a packet at the RX1 Delay Window timeslot. At all other times, the module will be in Rx mode using the Receive Window 2 frequency and data rate.

4.3 LoRa Modem

The modem can be in LoRaWAN mode (default) or LoRa mode. In the LoRa modem mode, the HXC module supports single packet sending or continuous receiving of LoRa packets without the LoRaWAN protocol. This mode allows for sending/receiving of 3rd party protocols over LoRa modulation that do not use the LoRaWAN standard.

4.4 Test Mode

This mode supports a continuous-transmit command for testing purposes only. When the Continuous Transmit command is executed the HXC module will continuously transmit an un-modulated RF signal. This mode is ideal for testing and tuning antennas for devices being fitted for enclosures.



4.5 LoRaWAN Regional Parameters

4.5.1 HXC400 Parameters

The tables below show all the necessary parameters for HXC400.

4.5.1.1 Default Parameters Table

Parameters	Default	Modifiable
Device EUI	Globally Unique EUI-64	Yes
Device Address	0	Yes
Application EUI	0	Yes
Application Key	0	Yes
Application Session Key	0	Yes
Network Session Key	0	Yes
Maximum Datarate	DR5	No
Minimum Datarate	DR0	No
Default Datarate	DR0	Yes
Maximum Transmit Power	TX0	No
Minimum Transmit Power	TX5	No
Default Transmit Power	TX0	Yes
Maximum Receive Window	3 seconds	No
Receive Window 1 Delay	1 second	Yes
Receive Window 2 Delay	2 seconds	Yes
Join Rx Window 1 Delay	5 seconds	Yes
Join Rx Window 2 Delay	6 seconds	Yes
Rx Window 2 Frequency	471.3MHz	Yes
Rx Window 2 Datarate	DR3	Yes
Default Channel Configurations	CH0: Freq=471.5MHz; DRmax=5; DRmin=0; CH1: Freq=471.7MHz; DRmax=5; DRmin=0; CH2: Freq=471.5MHz; DRmax=5; DRmin=0;	Yes
Maximum Possible Number of Channels	16	No
Join Channels	CH 0,1,2	No

4.5.1.2 Data Rate Table

Datarate	Spreading Factor	Bandwidth
DR0	SF12	125KHz
DR1	SF11	
DR2	SF10	
DR3	SF9	
DR4	SF8	
DR5	SF7	



4.5.1.3 Power Table

Tx Power	Configuration (dB)
Tx0	20
Tx1	14
Tx2	11
Tx3	8
Tx4	5
Tx5	2

4.5.2 HXC900 Parameters

The tables below show all the necessary parameters for HXC900.

4.5.2.1 Default Parameters Table

Paramaters	Default	Modifiable
Device EUI	Globally Unique EUI-64	Yes
Device Address	0	Yes
Application EUI	0	Yes
Application Key	0	Yes
Application Session Key	0	Yes
Network Session Key	0	Yes
Tx Minimum Datarate	DR0	No
Tx Maximum Datarate	DR4	No
Rx Minimum Datarate	DR8	No
Rx Maximum Datarate	DR13	No
Default Tx Datarate	DR0	Yes
Maximum Transmit Power	TX5	No
Minimum Transmit Power	TX10	No
Default Transmit Power	TX5	Yes
Maximum Receive Window	3 seconds	No
Receive Window 1 Delay	1 second	Yes
Receive Window 2 Delay	2 seconds	Yes
Join Rx Window 1 Delay	5 seconds	Yes
Join Rx Window 2 Delay	6 seconds	Yes
Rx Window 2 Frequency	923.3MHz	Yes
Rx Window 2 Datarate	DR8	Yes
Default Channel Configurations	<ChNo>, <FreqHz>, <DRmax>, <DRmin> 0,902300000,3,0 1,902500000,3,0 2,902700000,3,0 3,902900000,3,0 4,903100000,3,0 5,903300000,3,0 6,903500000,3,0 7,903700000,3,0	Yes



Maximum Possible Number of Channels	72	No
-------------------------------------	----	----

4.5.2.2 Data Rate Table

Tx / Rx	Datarate	Spreading Factor	Bandwidth
Tx	DR0	SF10	125KHz
	DR1	SF9	
	DR2	SF10	
	DR3	SF9	
	DR4	SF8	
Rx	DR8	SF12	500KHz
	DR9	SF11	
	DR10	SF10	
	DR11	SF9	
	DR12	SF8	
	DR13	SF7	

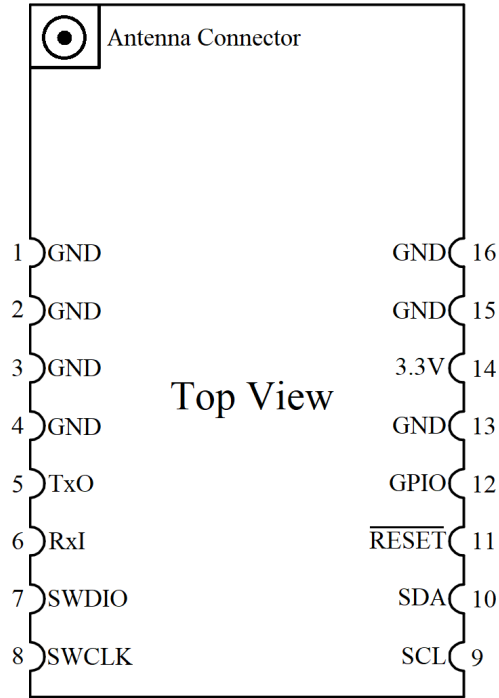
4.5.2.3 Power Table

Tx Power	Configuration (dB)
Tx5	20
Tx6	18
Tx7	16
Tx8	14
Tx9	12
Tx10	10



5 Pin Definitions

5.1 Pin Layout



5.2 Pin Descriptions

Pin No.	Pin Name	Function
1	GND	Power Ground
2	GND	Power Ground
3	GND	Power Ground
4	GND	Power Ground
5	TxO	HXC Tx-Out Pin
6	RxI	HXC Rx-In Pin
7	SWDIO	SWD Data Pin
8	SWCLK	SWD CLK pin
9	SCL	I2C CLK pin
10	SDA	I2C Data Pin
11	RESET	Active low reset pin of HXC
12	GPIO	HXC GPIO for future use
13	GND	Power Ground
14	3.3V	Power VCC
15	GND	Power Ground
16	GND	Power Ground

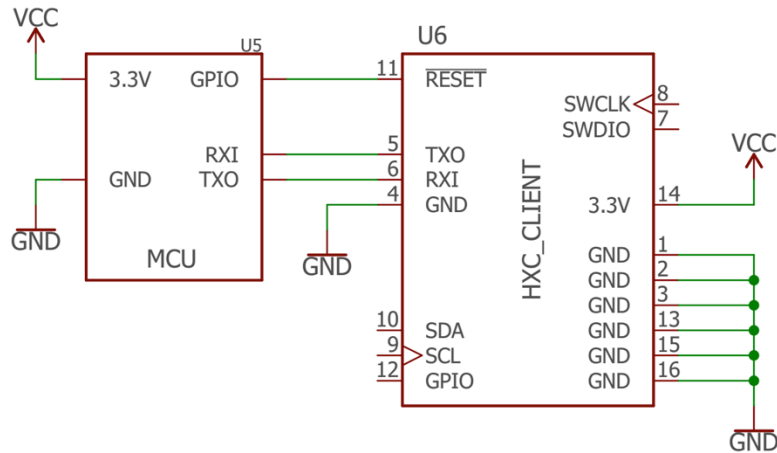
Note: The pins are 3.3V tolerant and not 5V tolerant.



6 Connection Diagram

The figures below show some possible ways a user can interface an HXC client module.

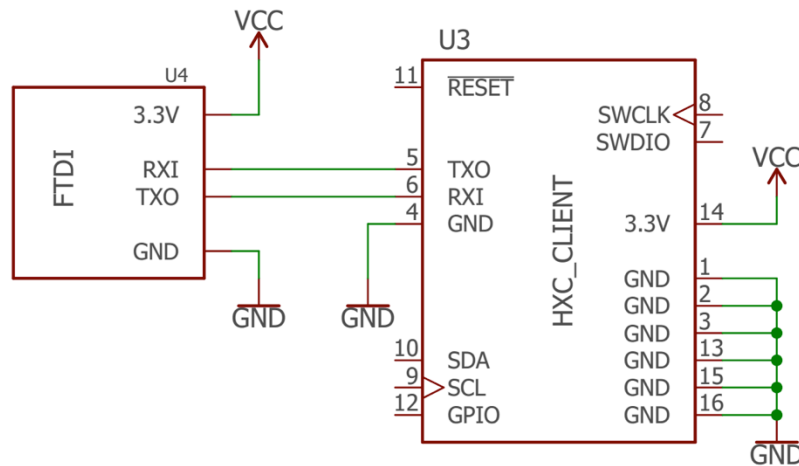
6.1 Interfacing with a Microcontroller



This is the minimal connection needed to interface with an MCU. Users will need to connect Rx and Tx of MCU with the TXO and RXI of the HXC Client, respectively. A GPIO pin to /RESET pin connection is needed to reset the HXC client module. An example with basic APIs can be found here (under development).

Note: The /RESET pin (Pin 11) is pulled-up to 3.3V (Pin 14) by 47Kohm. TxO (Pin 5) and RxI (Pin 6) are internally pulled up to 3.3V by the ARM processor.

6.2 Interfacing with a USB-to-Serial Module

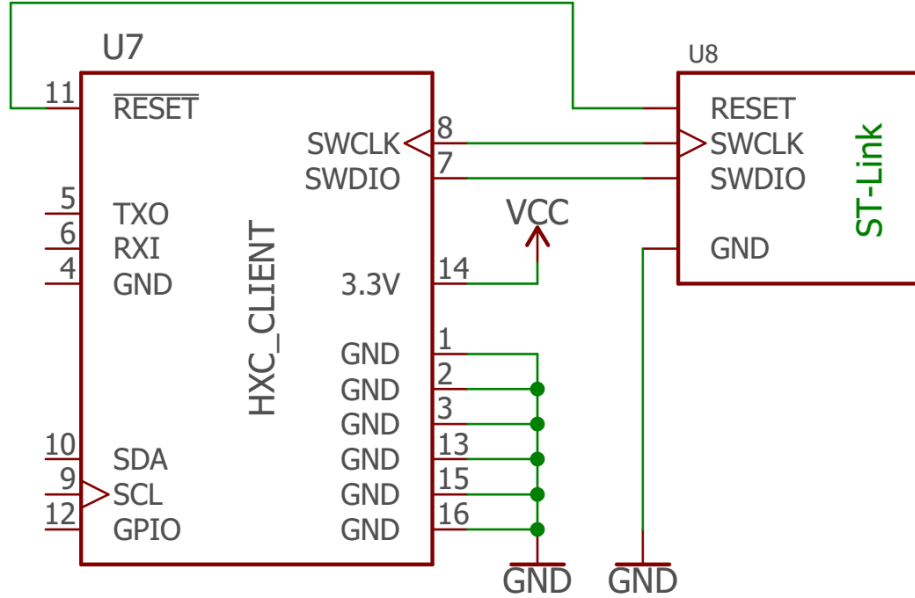


This is the minimal connection to interface with a USB-to-Serial chip (e.g. FTDI FT232RL). Our **HXC Client USB Board** includes an FTDI IC and comes with a USB connector that you can directly connect to your PC/Laptop. By default, /RESET pin is pulled-up to 3.3V (Pin 14). An example of terminal setup configuration can be found in [Appendix I](#).



6.3 ST-Link Connection

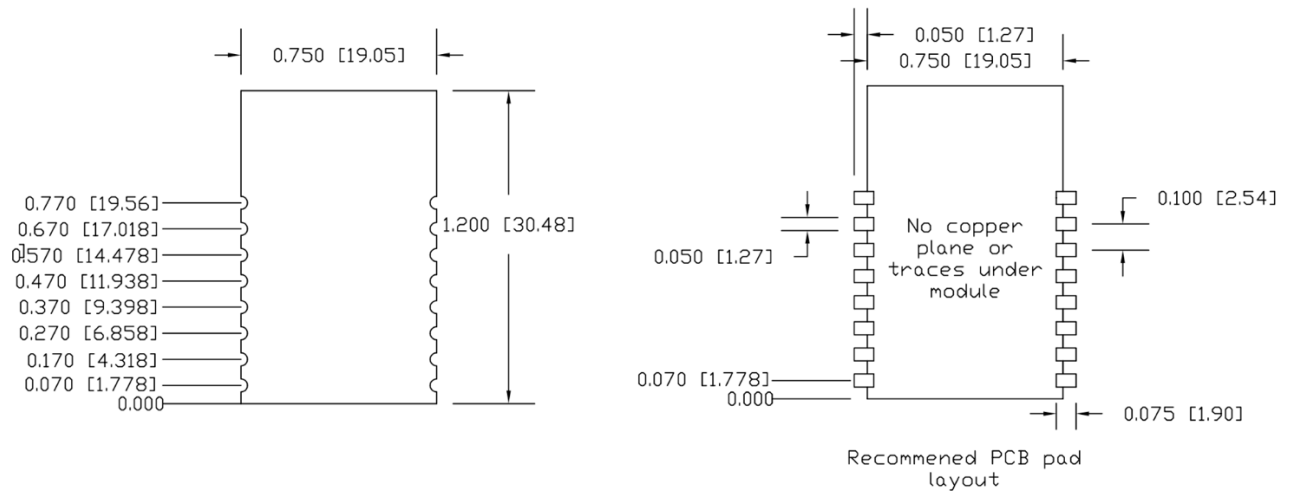
If the user needs to update the HXC Client Module firmware, an ST-Link programmer will be necessary. In future, a bootloader feature will be added so that users can update firmware over USB.



Note: ST-Link doesn't have a power source. Users will have to make sure that HXC Client is powered by 3.3v.



7 Package Information



Measurement in inches [millimeters]

Note: No copper plane, traces or oscillator under the module.



8 AT Command Reference

8.1 Overview

The AT command set is a standard developed by “Hayes” to manage modems. The HXC series modules can be managed using a simple set of ASCII AT commands over a serial UART interface. The HXC device is a slave device and must be connected to a UART master device.

8.2 Module Interface

The HXC contains a low-speed UART that can be connected to a host system such as an MCU, a serial port or a serial-to-USB interface. The default configuration parameters for the serial interface are:

```
Baud rate: 9600
Data: 8 bits
Parity: none
Stop: 1 bit
Flow control: none
```

[Appendix I](#) describes how to setup a terminal emulator with these configurations. These settings are non-modifiable.

8.3 Conventions

- Commands are case sensitive.
- All commands have a response.
- Command length can never exceed 256 characters or bytes.
- All AT commands must end with “\r\n” i.e. <CR><LF> where <CR> is carriage return and <LF> is newline/linefeed.
- Note that each line preceded by ‘>>>’ in the examples below is the one provided by the client module to host.

8.4 Introductory Message

After a power-on-reset, the module will respond with the Hardware Module number along with the firmware version and ‘RDY’. A software reset will also print these messages. The example below shows the introductory message of an HXC400 module.

```
>>>HXC400 AT Interface
>>>FW Ver: 1.15
>>>RDY
```

8.5 Command Syntax

All AT commands start with the standard prefix “AT” and then “+xxx” with ‘+xxx’ denoting the specific command. For example:



AT+VER<CR><LF>

Here “+VER” is the command. The response (<value> or <status>) of the commands will be in the format like: “Return value<CR><LF>” and/or “Status<CR><LF>”. For example, the response of “AT+VER” will be:

```
>>>1.15<CR><LF>
>>>OK<CR><LF>
```

There are four command behaviors:

- **Help Command: AT+XXX?**

This provides a short help of the given command, for example:

```
AT+DEVEUI?<CR><LF>
>>>Get or set device EUI<CR><LF>
>>>OK<CR><LF>
```

- **Run Command: AT+XXX**

This is used to run a command, such as:

```
AT+VER<CR><LF>
>>>1.15<CR><LF>
>>>OK<CR><LF>
```

- **Get Command: AT+XXX=?**

This is used to get the value of a given command, for example, **AT+NJS=?**

```
AT+NJS=?<CR><LF>
>>>NOT JOINED<CR><LF>
>>>OK<CR><LF>
```

- **Set Command: AT+XXX=<value>**

This command is used to input a value, for example:

```
AT+NJM=OTAA<CR><LF>
>>>OK<CR><LF>
```

Note: Not all HXC commands have all four behaviors. The details of a specific AT command can be found in section [9.7 AT Commands](#).



8.6 Status and Error List

Every command returns a `Status` string with a `<CR>` and `<LF>` after the `Status` string. The possible statuses for the HXC Client module are:

- **OK:** Command ran correctly without error.
- **AT_ERROR:** Generic error.
- **AT_PARAM_ERROR:** Parameter related issues.
- **AT_BUSY_ERROR:** LoRa® network is busy, so the command could not be completed.
- **AT_PARAM_OVERFLOW:** The command length is too long.
- **AT_NO_NETWORK_JOINED:** LoRaWAN network has not been joined yet.
- **AT_INVALID_MODE:** The HXC client is in wrong mode (LoRa/LoRaWAN).
- **AT_RX_ERROR:** Error detection during the reception of the command over UART.

This status and error code list applies to all AT commands. Users can refer to this list to know what is happening inside HXC client when they receive errors. More details of statuses and error codes are described below. Note that each line preceded by '`>>>`' in the examples, is the one provided by the client module to host.

8.6.1 AT_ERROR

There are several reasons users can receive 'AT_ERROR' responses:

- If a command does not end with '`<CR><LF>`'. For example:

```
AT+VER<LF>
>>>AT_ERROR<CR><LF>
```

- If a command does not start with 'AT'. For example:

```
+VER<CR><LF>
>>>AT_ERROR<CR><LF>
```

- If the user tries to use a command behavior that is not available (Refer to section [9.7](#) for possible AT command behaviors). For example, User cannot set/change the version of HXC Module.

```
AT+VER=1.0.0<CR><LF>
>>>AT_ERROR<CR><LF>
```

8.6.2 AT_PARAM_ERROR

Users can receive this error for AT command argument/parameter related cases. Such as:

- If the number of parameters is invalid. For example, Rx2 window setup command requires two parameters: frequency and data rate.

```
AT+RX2WND=471200000<CR><LF>
>>>AT_PARAM_ERROR<CR><LF>
```

- If the content of the parameter is invalid. For example, Network Join Mode can be either 'ABP' or 'OTAA'.



```
AT+NJM=OTHER<CR><LF>
>>>AT_PARAM_ERROR<CR><LF>
```

- If the command format is not right. For example, The command format of sending a packet over LoRaWAN is: (instead of ':' if you use ',')

```
AT+SEND=<ACK>,<PORT>:<DATA><CR><LF>
AT+SEND=1,100,Hello Mars!<CR><LF>
>>>AT_PARAM_ERROR<CR><LF>
```

8.6.3 AT_BUSY_ERROR

Users can receive this error for following reasons:

- If the user initiates a transmission during an ongoing or scheduled transmission. For example, executing 'AT+SEND', right after another 'AT+SEND' command before receiving transmission done confirmation message ('txDone').

```
AT+SEND=1,100:Hello world!<CR><LF>
>>>OK<CR><LF>
AT+SEND=1,100:Hello from the other side<CR><LF>
>>>AT_BUSY_ERROR<CR><LF>
```

- If the user tries to change any parameter that the ongoing transmission is using. For example, changing DEVEUI (AT+DEVEUI), right after 'AT+SEND' command before receiving transmission done confirmation message ('txDone') will result in this error.

```
AT+SEND=1,100:Hello world!<CR><LF>
>>>OK<CR><LF>
AT+DEVEUI=DEAD00BEEF00FACE<CR><LF>
>>>AT_BUSY_ERROR<CR><LF>
```

8.6.4 AT_PAYLOAD_SIZE_ERROR

Users will receive this error if the payload size of the transmit packet is larger than the eligible size. The payload size varies by datarate and by region. For example, on US915 region, with DR_0 datarate, payload size cannot be more than 11 bytes.

```
AT+SEND=0,2:Hello, World!<CR><LF>
>>>AT_PAYLOAD_SIZE_ERROR<CR><LF>
```

8.6.5 AT_PARAM_OVERFLOW

Users will receive this error if the length of the command exceeds 256 bytes. For example:

```
AT+SEND=0,8:Analyst: I can give you the numbers, but you can't
go public with it. Manager:I won't.I'll just present it at a
meeting. A:Who's going to be at the meeting? M:Its a
stakeholder meeting. So,whoever wants to come. You know,its
open to the public.
>>>AT_PARAM_OVERFLOW<CR><LF>
```



8.6.6 AT_NO_NETWORK_JOINED

Trying to send data without joining the network first (either in ABP or OTAA mode), will result in this error. For example:

AT+RESET

```
>>>OK<CR><LF>
>>>HXC400 AT Interface<CR><LF>
>>>FW Ver: 1.15<CR><LF>
>>>RDY<CR><LF>
AT+SEND=1,100:BA3D99C02FFE<CR><LF>
>>>AT_NO_NETWORK_JOINED<CR><LF>
```

8.6.7 AT_INVALID_MODE

The HXC Client modules support both LoRaWAN protocol and LoRa only radio communication. Some AT commands are dependent on AT+MODE setting. The Table below shows what commands are dependent on AT+MODE setting. Failure to follow the table will result in AT_INVALID_MODE error.

Table: List of Commands dependent on MODE setting

AT+MODE=LORA	AT+MODE=LORAWAN
AT+TX AT+RX	AT+CLASS AT+JOIN AT+SEND AT+SENDB

8.6.8 AT_RX_ERROR

Users can receive this error for either Parity error, Frame error, Overrun error or Noise error during UART communication.

More details on each command description and examples are described in the next part of this section.



8.7 AT commands

To facilitate the description, all <CR><LF> is intentionally omitted for all the examples listed from here on, unless otherwise specified.

8.7.1 General Commands

8.7.1.1 AT: Attention

This command is used to check if the connection between module and host is OK. *Run* command will respond with an 'OK'. *Help* command provides short help for all the supported commands. There aren't any *Get* or *Set* command for AT. Executing those commands will return AT_ERROR.

AT

```
>>>OK
```

AT?

```
>>>AT+<CMD>?      : Help on <CMD>
>>>AT+<CMD>       : Run <CMD>
>>>AT+<CMD>=<value>: Set the value
>>>AT+<CMD>=?     : Get the value
... ..
... ..
... ..
>>>CH: Add or Remove Channel / Channel Group
>>>TXCW: Turn on Continuous Tx
>>>TX: Send LoRa Packet
>>>RX: Receive LoRa Packet
>>>RADIO: Get Radio IC Version
>>>MODE: Switch Between LoRa & LoRaWAN
>>>OK
```

AT=?

```
>>>AT_ERROR
```

8.7.1.2 AT+RESET: Reset HXC Client Module

This command is used to trigger a CPU reset of the HXC module. *Run* command will respond with an 'OK' following welcome message. There aren't any *Get* or *Set* command for AT+RESET.

AT+RESET?

```
>>>Reset the Module
>>>OK
```

AT+RESET

```
>>>OK
>>>HXC900 AT Interface
>>>FW Ver: 1.15
>>>RDY
```

8.7.1.3 AT+FD: Reset to Factory Defaults and Reset HXC Client Module



This command is used to reset all AT parameters to their default value, erase all saved parameters in EEPROM and trigger a CPU reset of the HXC module. There aren't any *Get* or *Set* command for AT+FD.

AT+FD?

```
>>>Reset AT Params to default
>>>OK
```

AT+FD

```
>>>OK
>>>HXC900 AT Interface
>>>FW Ver: 1.15
>>>RDY
```

Users can receive a busy error if the EEPROM is busy or not accessible during the command execution.

AT+FD

```
>>>AT_BUSY_ERROR
```



8.7.2 LoRaWAN Keys

This section provides commands specific to the keys and identifiers used in the HXC client module that is required for connecting to a LoRaWAN network. Different keys are required for different authentication schemes.

OTAA requires 3 keys to authenticate against the LoRaWAN Network Server. The Network Server dynamically provides the remaining keys when the network is joined.

AppEUI
AppKey
DevEUI

ABP requires 5 keys to be statically configured on the module. All 5 keys must be configured for the module to successfully encrypt and send or receive a message.

DevEUI
AppKey
DevAddr
Nwkskey
Appskey

NOTE: ABP is a less secure connectivity option for LoRaWAN, as the keys are statically configured and are not reset at every JOIN.

Appendix II and III lists set of AT commands to use for OTAA and ABP authentication schemes, respectively.

8.7.2.1 AT+DEVEUI: Device EUI

The device address is an EUI-64 value that is unique to the device. All HXC modules contain a globally unique EUI-64 address burned in during manufacturing. This address can be used by configuring the DEVEUI value to "AUTO", which is the default value. Users can use custom 16digit (8byte) hex value. Hex values are case-insensitive. Any change of DEVEUI using *Set command* is saved in module's EEPROM and can be retained after a Reset.

Format: AT+DEVEUI = <Param>

AT+DEVEUI?

```
>>>Get or Set Device EUI
>>>OK
```

AT+DEVEUI=AUTO

```
>>>OK
```

AT+DEVEUI=?

```
>>>10:01:13:1b:10:10:1f:15 //Globally unique ID, different for every other device
>>>OK
```




```
AT+DEVEUI=8899aabbccddeeff
>>>OK
```

Users can receive `AT_PARAM_ERROR` if the parameter has less than 16 digits (8 bytes).

```
AT+DEVEUI=8899aabbccdee
>>>AT_PARAM_ERROR
```

Users can receive `AT_BUSY_ERROR` if this command is used during a LoRa transmission (Join, Data Send or Continuous Tx). The user will have to wait till the transmission is done.

```
AT+DEVEUI=11de45ad0000face
>>>AT_BUSY_ERROR
```

Users can receive `AT_BUSY_ERROR` during **AUTO** command if the processor fails to read the EUI64 bytes.

```
AT+DEVEUI=AUTO
>>>AT_BUSY_ERROR
```

8.7.2.2 *AT+DEVADR: Device Address*

This command allows users to access the device address. Default value is 00:00:00:00. OTAA authentication scheme will provide the DEVADR during JOIN procedure. During ABP, the user will have to define the DEVADR. The command takes 8digit (4byte) hex value. Hex values are case-insensitive. Any change of DEVADR using *Set command* is saved in EEPROM and can be retained after a Reset.

Format: `AT+DEVADR = <param>`

```
AT+DEVADR?
>>>Get or Set Device Address
>>>OK
```

```
AT+DEVADR=?
>>>00:00:00:00
>>>OK
```

```
AT+DEVADR=112233AA
>>>OK
```

Users can receive `AT_PARAM_ERROR` if the parameter has less than 8 digits (4 bytes).

```
AT+DEVADR=112233A
>>>AT_PARAM_ERROR
```



Users can receive `AT_BUSY_ERROR` if this command is used during a LoRa transmission (Join, Data Send or Continuous Tx). The user will have to wait till the transmission is done.

8.7.2.3 AT+APPEUI: Application Identifier

This command allows users to access the global application identifier. Default value is 00:00:00:00:00:00:00:00. The command takes 16digit (8byte) hex value. Hex values are case-insensitive. Any change of APPEUI using *Set command* is saved in EEPROM and can be retained after a Reset.

Format: AT+APPEUI=<Param>

```

AT+APPEUI?
>>>Get or Set Application EUI
>>>OK
AT+APPEUI=?
>>>00:00:00:00:00:00:00:00
>>>OK
AT+APPEUI=11ca7f00d0000001
>>>OK

```

Users can receive `AT_PARAM_ERROR` if the parameter has less than 16 digits (8 bytes).

```

AT+APPEUI=11223344556677
>>>AT_PARAM_ERROR

```

Users can receive `AT_BUSY_ERROR` if this command is used during a LoRa transmission (Join, Data Send or Continuous Tx). The user will have to wait till the transmission is done.

8.7.2.4 AT+APPKEY: Application Key

This command allows users to set the application session key. For security reasons, this value is a **write-only** parameter. The command takes 32digit (16byte) hex value. Hex values are case-insensitive. Default value is 00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00. Any change of APPKEY using *Set command* is saved in EEPROM and automatically set as APPKEY after a reset.

```

AT+APPKEY?
>>>Set Application Key
>>>OK
AT+APPKEY=00112233445566778899aabbccddeeff
>>>OK

```

Users can receive `AT_ERROR` if they try to read the key.



```
AT+APPKEY=?
>>>AT_ERROR
```

Users can receive AT_PARAM_ERROR if the parameter has less than 32 digits (16 bytes).

```
AT+APPKEY=112233445566778899
>>>AT_PARAM_ERROR
```

Users can receive AT_BUSY_ERROR if this command is used during a LoRa transmission (Join, Data Send or Continuous Tx). The user will have to wait till the transmission is done.

8.7.2.5 AT+APPSKEY: Application Session Key

This command allows users to set the application session key. For security reasons, this value is a **write-only** parameter. Default value is 00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00. Using OTAA scheme will set the APPSKEY during JOIN procedure. The command takes 32digit (16byte) hex value. Hex values are case-insensitive. Any change of APPSKEY using *Set command* is saved in EEPROM and automatically set as APPSKEY after a reset.

```
AT+APPSKEY?
>>>Set Application Session Key
>>>OK
AT+APPSKEY=00112233445566778899aabbccddeeff
>>>OK
```

Users can receive AT_ERROR if they try to read the key.

```
AT+APPSKEY=?
>>>AT_ERROR
```

Users can receive AT_PARAM_ERROR if they supply less than 32 digits (16 bytes).

```
AT+APPSKEY=112233445566778899
>>>AT_PARAM_ERROR
```

Users can receive AT_BUSY_ERROR if this command is sent during LoRa transmission (Join, Data Send or Continuous Tx). Users will have to wait till the transmission is done.

8.7.2.6 AT+NWKSKEY: Network Session Key

This command allows users to set the network session key. For security reasons, this value is a **write-only** parameter. Default value is 00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:



00:00:00:00:00. Using OTAA scheme will set the APPSKEY during JOIN procedure. The command takes 32digit (16byte) hex value. Hex values are case-insensitive. Any change of NWKSKEY using *Set command* is saved in EEPROM and automatically set as NWKSKEY after a reset.

```
AT+NWKSKEY?
>>>Set Network Session Key
>>>OK
AT+NWKSKEY=00112233445566778899aabbccddeeff
>>>OK
```

Users can receive AT_ERROR if they try to read the key.

```
AT+NWKSKEY=?
>>>AT_ERROR
```

Users can receive AT_PARAM_ERROR if the parameter has less than 32 digits (16 bytes).

```
AT+NWKSKEY=112233445566778899
>>>AT_PARAM_ERROR
```

Users can receive AT_BUSY_ERROR if this command is used during a LoRa transmission (Join, Data Send or Continuous Tx). Users will have to wait till the transmission is done.

8.7.3 Join, Sending and Receiving Data

To send data, the HXC module must have the correct keys loaded and join the network.

8.7.3.1 AT+NJM: LoRa[®] Network Join Mode

This command allows users to access to the network join mode. The command only takes either 'ABP' or 'OTAA'. The default join mode is OTAA. Any change of NJM using *Set command* is saved in EEPROM and can be retained after a Reset.

```
AT+NJM?
>>>Get or Set Network Join Mode
>>>OK
AT+NJM=?
>>>OTAA
AT+NJM=ABP
>>>OK
AT+NJM=?
>>>ABP
```

The user can receive AT_PARAM_ERROR if the parameter is neither ABP nor OTAA.



```
AT+NJM=5
>>>AT_PARAM_ERROR
```

8.7.3.2 AT+JOIN: Join LoRa[®] Network

This command sends a join request to the network. If the join mode is OTAA, this command will send the Join Request and wait for JN1DL milliseconds for RX1 window and JN2DL milliseconds for the RX2 window to listen for an ACK from the server.

The client module takes three attempts (default) to join with a network server and then go back to sleep. The users can change the number of retries using *Set Command*, but it has to be more than three. During ABP join mode, although the Join Request isn't necessary, users will have to use this command to set the client module's JOIN flag.

Note: Users can send a join request anytime they want, even if the device is already joined, to update the dynamic security session keys.

```
AT+JOIN?
>>>Join Network
>>>OK

// OTAA - Successfully joined on 1st attempt
AT+JOIN
>>>OK
>>>txDone
>>>rxDone
>>>JOINED

// OTAA - Failed to join
AT+JOIN=4
>>>OK
>>>txDone // 1st attempt
>>>rx1TimeOut
>>>rx2TimeOut
>>>txDone // 2nd attempt
>>>rx1TimeOut
>>>rx2TimeOut
>>>txDone // 3rd attempt
>>>rx1TimeOut
>>>rx2TimeOut
>>>txDone // 4th attempt
>>>rx1TimeOut
>>>rx2TimeOut

// ABP Join Scheme
AT+JOIN
>>>OK
>>>JOINED
```



Users can receive `AT_BUSY_ERROR` if the command is used during a LoRa transmission (Join, Packet Send or Continuous Tx).

```
AT+JOIN
>>>AT_BUSY_ERROR
```

Users can receive `AT_PARAM_ERROR` if the join retries number is less than three.

```
AT+JOIN=2
>>>AT_PARAM_ERROR
```

The status of the Join Request can be verified with `AT+NJS`.

8.7.3.3 `AT+NJS`: LoRa[®] Network Join Status

This command allows users to access to the current status of the LoRa[®]. It is a read-only command. The response can be either `JOINED` or `NOT JOINED`. The command provides the last join request status.

```
AT+NJS?
>>>Get Join Status
>>>OK

AT+JOIN
>>>OK
>>>txDone
>>>rxDone
>>>JOINED
AT+NJS=?
>>>JOINED
AT+JOIN // Sending join request again to update dynamic session keys
>>>OK
>>>txDone
>>>rx1Timeout
>>>rx2Timeout
>>>txDone
>>>rx1Timeout
>>>rx2Timeout
>>>txDone // Device failed to connect during 2nd join request
>>>rx1Timeout
>>>rx2Timeout
AT+NJS=?
>>>NOT JOINED // NJS provides the last join request status
```

8.7.3.4 `AT+SEND`: Send ASCII Bytes



This command provides a way to send ASCII bytes on a dedicated port number, with acknowledgment configuration (Confirmed/Unconfirmed). The confirmed message takes 8 attempts to receive ACK from Network Server before it goes back to sleep.

Format: AT+SEND=<ack>,<port>:<ASCII bytes>

<ack> = 0(:Unconfirmed) or 1(:Confirmed)

<port>= 1 to 223

AT+SEND?

```
>>>Send ASCII Bytes
```

```
>>>OK
```

```
// Unconfirmed message in Class A
```

```
AT+SEND=0,12:T=32.32F
```

```
>>>OK
```

```
>>>txDone
```

```
>>>rx1TimeOut
```

```
>>>rx2TimeOut
```

```
// Unconfirmed message in Class C. In Class C there aren't any rx2Timeout.
```

```
// Class C always listens on Receive Window 2
```

```
AT+SEND=0,12:T=32.32F
```

```
>>>OK
```

```
>>>txDone
```

```
>>>rx1TimeOut
```

```
// Confirmed message – with ACK received from NS
```

```
AT+SEND=1,12:T=32.32F
```

```
>>>OK
```

```
>>>txDone
```

```
>>>rxDone
```

```
// Confirmed message – with no ACK from NS in Class A
```

```
AT+SEND=1,12:T=32.32F
```

```
>>>OK
```

```
>>>txDone // 1st attempt
```

```
>>>rx1TimeOut
```

```
>>>rx2TimeOut
```

```
... ..
```

```
>>>txDone // 8th attempt
```

```
>>>rx1TimeOut
```

```
>>>rx2TimeOut
```

Users can receive AT_BUSY_ERROR if the command is used during a LoRa transmission (Join, Packet Send or Continuous Tx).



```
AT+SEND=1,12:T=32.32F
>>>AT_BUSY_ERROR
```

Users can receive AT_NO_NETWORK_JOINED if the command is used before joining a network (using AT+JOIN), for both OTAA and ABP join mode.

```
AT+SEND=1,12:Temp=32.32F
>>>AT_NO_NETWORK_JOINED
```

Users can receive AT_PAYLOAD_SIZE_ERROR if the payload size is greater than the eligible size. For example, on US915 region, with DR_0 datarate, payload size can't be more than 11 bytes.

```
AT+SEND=0,12:How big is the payload?
>>>AT_PAYLOAD_SIZE_ERROR
```

Users can receive AT_PARAM_ERROR if the command format is not right or the <ack>/<port> value is out of range.

8.7.3.5 AT+SENDB: Send Hexadecimal Bytes

This command provides a way to send hexadecimal bytes on a dedicated port, with acknowledgment configuration (Confirmed/Unconfirmed). The confirmed message takes 8 attempts to receive ACK from Network Server before it goes back to sleep.

Each byte of the hex data consists of two digits. Hence, the length of the binary data is always even. For example, if the user wants to send 0x1, s/he will have to send "01" instead of "1". Hex digits are case-insensitive.

Format: AT+SENDB=<ack>,<port>:<Hexadecimal bytes>

<ack> = 0(:Unconfirmed) or 1(:Confirmed)

<port>= 1 to 223

```
AT+SENDB?
>>>Send Hexadecimal Bytes
>>>OK
```

```
// Unconfirmed message in Class A
```

```
AT+SENDB=0,21:C0C0C0FFEE
```

```
>>>OK
>>>txDone
>>>rx1TimeOut
>>>rx2TimeOut
```

```
// Confirmed message – with ACK received from NS
```

```
AT+SENDB=1,21:DEAD89FACE
```

```
>>>OK
```




```

>>>txDone
>>>rxDone

// Confirmed message – with no ACK from NS in Class C
AT+SENDB=1,21:CA70F00D
>>>OK
>>>txDone // 1st attempt
>>>rx1TimeOut
>>>txDone // 2nd attempt
>>>rx1TimeOut
.
.
.
>>>txDone // 8th attempt
>>>rx1TimeOut

```

Users can receive `AT_BUSY_ERROR` if the command is used during a LoRa transmission (Join, Data Send or Continuous Tx).

```

AT+SENDB=0,24:1234BEEF
>>>AT_BUSY_ERROR

```

Users can receive `AT_NO_NETWORK_JOINED` if the command is sent before joining a network, for both OTAA and ABP join mode.

```

AT+SENDB=1,42:bad12bed
>>>AT_NO_NETWORK_JOINED

```

Users can receive `AT_PARAM_ERROR` if the command format is not right, the `<ack>/<port>` value is out of range or if the message doesn't have an even number of digits.

8.7.3.6 Received Packet

The received data is printed automatically in hexadecimal bytes along with the port number and Network Server (NS) requested ACK flag (0/1).

```

>>>rxDone<CR><LF>
>>>rxdata:<port>,<ackRequested>,<hexadecimal bytes><CR><LF>

```

HXC client module will **acknowledge automatically** during the **next regular LoRa packet transmission** if the NS requested an ACK. It's up to the application layer/user **when** to send a packet. 'ackRequested' just informs the application layer/user that NS requested an acknowledgment so that user can schedule a packet transmission.



In Class A, the receive windows are open after a packet transmission (AT+SEND/SENDB). During Class C, data can be received anytime on receive window 2. AT+RSSI and AT+SNR can be used after a received packet to check the quality of the message.

Example:

Data received at port 4 in Class A:

```
AT+SENDB=0,4:10666040
```

```
>>>txDone
```

```
>>>rxDone
```

```
>>>rxdata:4,0,C0010CA7
```

Data received at port 4 and NS request for an acknowledgement in Class C:

```
>>>rxDone
```

```
>>>rxdata:4,1,BAD0CA7
```

```
AT+SENDB=0,4:DE666AD // A regular LoRaWAN transmission. The acknowledgement for the
```

```
>>>txDone // received data will be added automatically with this transmission
```

```
>>>rx1Timeout // Note: There aren't any rx2Timeout for Class C
```

8.7.3.7 AT+CFS: Confirm Status

This command allows the users to check the status of the last LoRaWAN packet transmission. It can be either 0(Unconfirmed) or 1(Confirmed). It is a read-only command.

```
AT+CFS?
```

```
>>>Get Confirmation Status of the last TX packet
```

```
>>>OK
```

```
AT+SEND=0,2:T=-2.3C // Unconfirmed Transmission
```

```
>>>OK
```

```
>>>txDone
```

```
>>>rx1Timeout
```

```
>>>rx2Timeout
```

```
AT+CFS=?
```

```
>>>0 // Unconfirmed
```

```
AT+SEND=1,2:T=99.3F // Confirmed Transmission
```

```
>>>OK
```

```
>>>txDone
```

```
>>>rxDone
```

```
AT+CFS=?
```

```
>>>1 // Confirmed
```

```
AT+SEND=1,2:T=99.3F // Confirmed Transmission
```

```
>>>OK
```

```
>>>txDone // 1st attempt
```

```
>>>rx1Timeout
```

```
>>>rx2Timeout
```

```
... ..
```



```
>>>txDone // 8th attempt
>>>rx1Timeout
>>>rx2Timeout
AT+CFS=?
>>>0 // Unconfirmed
```



8.7.4 LoRaWAN Network Management

This section provides commands that enable network management functions.

8.7.4.1 AT+CH: Add or Remove Channel

This command allows the user to add or remove channels. Channel configurations are different for different regions.

CN470 region:

HXC400 supports CN470 region. There will be three default channels. The channel configurations can be found in [section 5.4.1.1](#). Users can add up to 16 channels (including default channels). The range of channel ID is 0 to 15. All channels are configurable including default channels, but default channels cannot be removed. All channel configurations are saved in EEPROM.

Format:

Add Channel: AT+CH=<Ch ID>,<Freq HZ>,<DRmax>,<DRmin>

Remove Channel: AT+CH=<Ch ID>,0

AT+CH?

```
>>>Add or Remove Channel
>>>OK
```

AT+CH=?

// Region_CN470 Default channels

```
>>>0,471500000,5,0
>>>1,471700000,5,0
>>>2,471900000,5,0
>>>OK
```

AT+CH=5,472100000,3,0

```
>>>OK
```

AT+CH=?

```
>>>0,471500000,5,0
>>>1,471700000,5,0
>>>2,471900000,5,0
>>>5,472100000,3,0
>>>OK
```

AT+CH=5,0

```
>>>OK
```

AT+CH=?

```
>>>0,471500000,5,0
>>>1,471700000,5,0
>>>2,471900000,5,0
>>>OK
```

Users can receive AT_PARAM_ERROR if the command format is not right, any of the input parameter is out of range or user is trying to remove default channels. Frequency range is 433MHz – 510MHz. Datarate range is 0 to 5.



```
AT+CH=1,0
>>>AT_PARAM_ERROR
```

```
AT+CH=5,92300000,7,0
>>>AT_PARAM_ERROR
```

US915 region:

HXC900 supports US915 region. There will be 8 default channels. The channel configurations are shown in [section 5.4.2.1](#). Users can add up to 72 channels (including default channels). The channels are configurable by group. Each group represents 8 channels. For example, group-0 represents channel 0 to 7, group-1 represents channel 8 to 15 and so on. There are total 9 groups. All groups are configurable. You can also remove the channels by group except group zero (Channel 0 to 7). All channel configurations are saved in EEPROM.

The command takes a base frequency. The first channel of a group will use the base frequency and the consecutive channels' frequency will be incremented by 200KHz. Group 8 represents special channels (channel 64 to 71), which uses 500KHz bandwidth. The consecutive channels' frequency of group 8 will be incremented by 1.6MHz from the base frequency.

Format:

Add Channel: AT+CH=<Group ID>,<Base Freq HZ>,<DRmax>,<DRmin>

Remove Channel: AT+CH=<Group ID>,0

```
AT+CH?
>>>Add or Remove Channel
>>>OK
AT+CH=? // Region_US915 Default channels
>>>0,902300000,3,0
>>>1,902500000,3,0
>>>2,902700000,3,0
>>>3,902900000,3,0
>>>4,903100000,3,0
>>>5,903300000,3,0
>>>6,903500000,3,0
>>>7,903700000,3,0
>>>OK
AT+CH=1,912300000,3,0
>>>OK
AT+CH=?
>>>0,902300000,3,0
>>>1,902500000,3,0
>>>2,902700000,3,0
```



```

>>>3,902900000,3,0
>>>4,903100000,3,0
>>>5,903300000,3,0
>>>6,903500000,3,0
>>>7,903700000,3,0
>>>8,912300000,3,0
>>>9,912500000,3,0
>>>10,912700000,3,0
>>>11,912900000,3,0
>>>12,913100000,3,0
>>>13,913300000,3,0
>>>14,913500000,3,0
>>>15,913700000,3,0
>>>OK
AT+CH=1,0
>>>OK
AT+CH=?
>>>0,902300000,3,0
>>>1,902500000,3,0
>>>2,902700000,3,0
>>>3,902900000,3,0
>>>4,903100000,3,0
>>>5,903300000,3,0
>>>6,903500000,3,0
>>>7,903700000,3,0
>>>OK

```

Users can receive `AT_PARAM_ERROR` if the command format is not right, any of the input parameter is out of range or user is trying to remove default channels. Frequency range is 902.3MHz – 930MHz. Datarate range is 0 to 4.

```

AT+CH=0,0
>>>AT_PARAM_ERROR

AT+CH=5,900000000,7,0
>>>AT_PARAM_ERROR

```

8.7.4.2 *AT+RX1FR: Downlink Receive Window 1 Frequency (HXC400 only)*

This command allows users to read and modify downlink receive window 1 frequency of a channel. The default downlink receive-window-1 frequency of a channel is same as transmit frequency of that channel. The range of applicable values is 433MHz to 510MHz. Data rates are same as channel data rates. These configurations are saved in EEPROM.

```

AT+RX1FR?
>>>Get or Set Downlink RX1 Freq
>>>OK

```



```

AT+RX1FR=? // Region_CN470 Default Downlink Freq
>>>0,471500000
>>>1,471700000
>>>2,471900000
>>>OK

AT+RX1FR=2,472100000
>>>OK

```

Users can receive `AT_PARAM_ERROR` if the command format is not right, any of the input parameters is out of range or if the user tries to change the downlink frequency of a non-existing channel.

```

AT+CH=?
>>>0,471500000,5,0 // Default channels
>>>1,471700000,5,0
>>>2,471900000,5,0
>>>OK

AT+RX1FR=3,471900000
>>>AT_PARAM_ERROR

```

8.7.4.3 AT+ADR: Adaptive Datarate

This command allows users to access the adaptive data rate parameter. The command will take either 0(:Disabled) or 1(:Enabled). The default value of the ADR is 0 (Disabled). This setting is saved in EEPROM.

```

AT+ADR?
>>>Get or Set Adaptive Data Rate
>>>OK

AT+ADR=?
>>>0 // Disabled

AT+ADR=1 // Enable ADR
>>>OK

```

8.7.4.4 AT+CLASS: LoRa[®] Class

This command allows the user to access the LoRaWAN™ Classes. Currently, HXC Client Module supports Class A and C (Class B is not supported yet). The default value is Class A. This setting is saved in EEPROM.

```

AT+CLASS?
>>>Get or Set Device Class
>>>OK

AT+CLASS=?

```



```
>>>A
```

```
AT+CLASS=C
```

```
>>>OK
```

```
AT+CLASS=B
```

```
>>>AT_PARAM_ERROR
```

8.7.4.5 AT+DCS: Duty Cycle settings (European Region only)

This command allows the user to access to the duty cycle parameter. This command is for testing only. The command takes either 0(:Disable) or 1(:Enable). The default value is 0(:Disable).

```
AT+DCS?
```

```
>>>Get or Set ETSI Duty Cycle (Only for testing)
```

```
>>>OK
```

```
AT+DCS=?
```

```
>>>0 // Disabled
```

```
AT+DCS=1
```

```
// Enable Duty Cycle
```

```
>>>OK
```

```
AT+DCS=2
```

```
>>>AT_PARAM_ERROR
```

8.7.4.6 AT+DR: Data Rate

This command allows the user to access to the data rate (corresponding to DR_X). The Data Rates vary by region. Data Rate may be manually set only when ADR is disabled. The default value varies by region. This setting is saved in EEPROM.

```
AT+DR?
```

```
>>>Get or Set TX Data Rate
```

```
>>>OK
```

```
AT+DR=?
```

```
>>>0 // Default DR on Region_CN470
```

```
AT+DR=1
```

```
>>>OK
```

The user can receive AT_PARAM_ERROR if the command parameter is out of range. The range varies by region.

```
AT+DR=5
```

```
>>>AT_PARAM_ERROR // Region_US915
```

8.7.4.7 AT+FCU: Uplink Frame Counter



This command allows the user to read and modify the LoRaMac uplink frame counter. Each time a packet is set the counter is incremented.

```
AT+FCU?  
>>>Get or Set Uplink Frame Counter  
>>>OK  
  
AT+FCU=?  
>>>0  
  
AT+FCU=1  
>>>OK
```

8.7.4.8 AT+FCD: Downlink Frame Counter

This command allows the user to read and modify the LoRaMAC downlink frame counter. Each time a packet is sent the counter is incremented.

```
AT+FCD?  
>>>Get or Set Downlink Frame Counter  
>>>OK  
  
AT+FCD=?  
>>>0  
  
AT+FCD=10  
>>>OK
```

8.7.4.9 AT+JN1DL: Join Accept Delay of RX window 1

This command allows the user to read and modify the join accept delay for Rx window 1, in milliseconds. The default value is 5000ms (5s).

```
AT+JN1DL?  
>>>Get or Set Join Accept Delay for RX1 Window  
>>>OK  
  
AT+JN1DL=?  
>>>5000  
  
AT+JN1DL=1000  
>>>OK
```

The user can receive AT_BUSY_ERROR if the command is sent during an RF transmission (Join request, Packet send or Continuous Tx).

```
AT+JN1DL=5000  
>>>AT_BUSY_ERROR
```



8.7.4.10 AT+JN2DL: Join Accept Delay of RX window 2

This command allows the user to read and modify the join accept delay for Rx window 2, in milliseconds. The default value is 6000ms (6s).

```
AT+JN2DL?  
>>>Get or Set Join Accept Delay for RX2 Window  
>>>OK
```

```
AT+JN2DL=?  
>>>6000
```

```
AT+JN2DL=1000  
>>>OK
```

The user can receive AT_BUSY_ERROR if the command is sent during an RF transmission (Join request, Packet send or Continuous Tx).

```
AT+JN2DL=6000  
>>>AT_BUSY_ERROR
```

8.7.4.11 AT+RX1DL: Received Window 1 Delay

This command allows users to read and modify the delay between Tx and Rx window 1, in milliseconds. The default value is 1000ms (1s).

```
AT+RX1DL?  
>>>Get or Set Delay Between TX & RX1 Window  
>>>OK
```

```
AT+RX1DL=?  
>>>1000
```

```
AT+RX1DL=3000  
>>>OK
```

The user can receive AT_BUSY_ERROR if the command is sent during an RF transmission (Join request, Packet send or Continuous Tx).

```
AT+RX1DL=3000  
>>>AT_BUSY_ERROR
```

8.7.4.12 AT+RX2DL: Received Window 2 Delay

This command allows the user to read and modify the delay between Tx and Rx window 2, in milliseconds. The default value is 2000ms (2s).

```
AT+RX2DL?  
>>>Get or Set Delay Between TX & RX2 Window
```



```
>>>OK
```

```
AT+RX2DL=?
```

```
>>>2000
```

```
AT+RX2DL=3000
```

```
>>>OK
```

The user can receive AT_BUSY_ERROR if the command is sent during an RF transmission (Join request, Packet sending or Continuous Tx).

```
AT+RX2DL=3000
```

```
>>>AT_BUSY_ERROR
```

8.7.4.13 AT+RX2WND: Configure Receive Window 2

This command allows users to access to the data rate (corresponding to DR_X) and frequency (in Hz) of receive window 2. The range of frequency and data rate varies by the region. Format: AT+RX2WND=<Freq>,<DR>

```
AT+RX2WND?
```

```
>>>Configure RX2 Window Freq & Datarate
```

```
>>>OK
```

```
AT+RX2WND=?
```

```
>>>923300000,8 // Region_US915
```

```
AT+RX2WND=923900000,8
```

```
>>>OK
```

Users can receive AT_PARAM_ERROR if the command format is not right or parameters are out of range. The parameter range varies by region.

```
AT+RX2WND=510000000,8
```

```
>>>AT_PARAM_ERROR // Region_CN470
```

Users can receive AT_BUSY_ERROR if the command is used during a LoRa packet transmission (Join, Packet send or Continuous Tx).

```
AT+RX2WND=510000000,4
```

```
>>>AT_BUSY_ERROR
```

8.7.4.14 AT+TXP: Transmit Power

This command allows the user to read and modify the transmit power. The default value and input parameter range vary by region.

```
AT+TXP?
```

```
>>>Get or Set Transmit Power
```

```
>>>OK
```



```
AT+TXP=?  
>>>5 // Region_US915  
AT+TXP=6  
>>>OK
```

Users can receive AT_PARAM_ERROR if the input parameter is not supported by the region.

```
AT+TXP=0  
>>>AT_PARAM_ERROR // Region_US915
```

8.7.4.15 AT+PNM: Public Network Mode

This command allows the user to read and modify the public network mode. The input parameter can take 0(:Disable, i.e. network mode will be private) and 1(:Enable). The default value is 1.

```
AT+PNM?  
>>>Get or Set Public Network Mode  
>>>OK  
AT+PNM=?  
>>>1 // Enabled (Default Value)  
AT+PNM=0 // Disable i.e. Private mode  
>>>OK
```

Users can receive AT_PARAM_ERROR if the input parameter is not either 0 or 1.

```
AT+PNM=2  
>>>AT_PARAM_ERROR
```



8.7.5 LoRa Only Commands

This section provides a set of commands to use LoRa physical layer to send and receive radio packets, bypassing the LoRaWAN protocol.

8.7.5.1 AT+MODE: Switch Between LoRa and LoRaWAN

The command allows users to switch between the LoRa and LoRaWAN mode. The default mode is LoRaWAN. Changing the mode to LoRa will allow users to use LoRa only specific commands.

```

AT+MODE?
>>>Switch between LoRa and LoRaWAN
>>>OK
AT+MODE=?
>>>LORAWAN // LoRaWAN Enabled (Default)
>>>OK
AT+MODE=LORA
>>>OK
    
```

Users can receive AT_PARAM_ERROR if the input parameter is neither LORA nor LORAWAN.

```

AT+MODE=OTHER
>>>AT_PARAM_ERROR
    
```

Users can receive AT_BUSY_ERROR if the command is used during a LoRa packet transmission (Join, Packet send or Continuous Tx).

8.7.5.2 AT+RFCFG: LoRa Packet Configuration

This command allows users to change the parameters for LoRa packet transmission and reception. This command doesn't depend on AT+MODE configuration.

Format: AT+RFCFG=<Freq Hz>,<SF>,<BW>,<PWR>,<Rx Preamble>, <Tx Preamble>

Parameters	HXC400	HXC900
Frequency	137 – 525 MHz	860 – 1020 MHz
Spreading Factor	6 - 12	
Bandwidth	125, 250, 500 KHz	
Power	-1 to 20 dBm	
Rx and Tx Preamble	6 to 65535	

```

AT+RFCFG?
>>>Config LoRa Only Param
>>>OK
AT+RFCFG=?
>>> Freq=902300000Hz // Region_US915
>>> SF=10
>>> Bandwidth=125kHz
    
```



```
>>> Power=20dBm
>>> RxPreamble=8
>>> TxPreamble=8
>>> OK
AT+RFCFG=903900000,10,250,17,8,8 // Region_US915
>>>OK
```

Users can receive `AT_PARAM_ERROR` if the command format is not right or parameters are out of range. The parameter range varies by region.

```
AT+RFCFG=903900000,10,250,17,8,8
>>>AT_PARAM_ERROR // Region_CN470
```

8.7.5.3 AT+TX: Transmit LoRa Packet

This command allows users to send LoRa only packet (bypassing LoRaWAN) using the parameters set by `AT+RFCFG`. The mode needs to be set to LORA (`AT+MODE`) before using this command. Format: `AT+TX=<ASCII Bytes>`

```
AT+TX?
>>>Send LoRa Only Packet
>>>OK
AT+TX=temp:32F, humidity:64%
>>> OK
>>> txDone
```

Users can receive `AT_BUSY_ERROR` if the command is used during a LoRa packet transmission (Join, Packet send or Continuous Tx).

```
AT+TX=You are not going anywhere!
>>>AT_BUSY_ERROR
```

Users can receive `AT_INVALID_MODE` if the `MODE` is not LORA.

```
AT+TX=What mode are you?
>>>AT_INVALID_MODE
```

8.7.5.4 AT+RX: Receive LoRa Packet

This command allows users to receive LoRa packet (bypassing LoRaWAN) using the parameters set by `AT+RFCFG`. Turning on the reception will let users listen for LoRa packets continuously until they turn it off. The mode needs to be set to LORA (`AT+MODE`) before using this command. Format: `AT+RX=<on(1)/off(0)>`

```
AT+RX?
>>>Receive LoRa Only Packet
>>>OK
AT+RX=1 // Turn on the reception.
>>> OK
```



```
AT+RX=0 // Turn off the reception.
>>> OK
```

The received data will be printed using UART.

```
>>> rxDone
>>> rxdata:<Hex Bytes>
```

Users can receive `AT_BUSY_ERROR` if the command is used during a LoRa packet transmission (Join, Packet send or Continuous Tx).

```
AT+RX=1
>>> AT_BUSY_ERROR
```

Users can receive `AT_INVALID_MODE` if the `+MODE` is not LORA.

```
AT+RX=1
>>> AT_INVALID_MODE
```

8.7.5.5 AT+TXCW: Continuous Transmit

This command allows the user to set the radio to output the fundamental frequency (unmodulated). It is mainly used for ETSI and FCC certification. It will use `AT+RFCFG` command's `<Freq>`, `<SF>`, `<BW>`, `<PWR>` parameters. This command doesn't depend on `AT+MODE` configuration.

Format: `AT+TXCW=<timeout in seconds>`

```
AT+TXCW?
>>> Turn ON Continuous Tx
>>> OK
AT+TXCW=60
>>> OK
```

Users can receive `AT_BUSY_ERROR` if the command is used during a LoRa packet transmission (Join, Packet sending or Continuous Tx).

```
AT+TXCW=10
>>> AT_BUSY_ERROR
```

8.7.6 Diagnostic Commands

This section provides a set of commands to provide diagnostic information on the RF signal quality and battery level.

8.7.6.1 AT+BAT: Set Battery Level

This command allows users to set the battery level of the client. If the network server requests for device status (`DevStatusReq`) this battery level, along with the last received packet's SNR, will be incorporated in the '`DevStatusAns`'.

Battery	Description
0	The end-device is connected



	to an external power source
1 to 254	The battery level, 1 being at minimum and 254 being at maximum.
255	The end-device was not able to measure the battery level.

AT+BAT?

```
>>>Set Battery Level
>>>OK
```

AT+BAT=125

```
>>>OK
```

8.7.6.2 AT+RSSI: RSSI of Received Packet

This command allows users to read the RSSI (in dBm) of the last received packet. It is a read-only command.

AT+RSSI?

```
>>>Get RSSI of Last Received Packet
>>>OK
```

AT+RSSI=?

```
>>>21
```

AT+RSSI=0

```
>>>AT_ERROR
```

8.7.6.3 AT+SNR: Signal to Noise Ratio

This command allows the user to read the SNR (in dBm) of the last received packet. It is a read-only command.

AT+SNR?

```
>>>Get SNR of Last Received Packet
>>>OK
```

AT+SNR=?

```
>>>21
```

AT+SNR=0

```
>>>AT_ERROR
```

8.7.6.4 AT+VER: Version of the Firmware

This command allows the user to get the version of the HXC module firmware. Both *Run* and *Get command* will provide the version number.



AT+VER?

```
>>>Get FW Version  
>>>OK
```

AT+VER=?

```
>>>1.15  
>>>OK
```

AT+VER

```
>>>1.15  
>>>OK
```



9 Appendix I: USB-to-Serial Connection and Terminal Setup for Windows 10

- Connect your HXC Client Module with an USB-to-Serial converter or if you have an HXC Client USB Board then connect the board to a USB port.

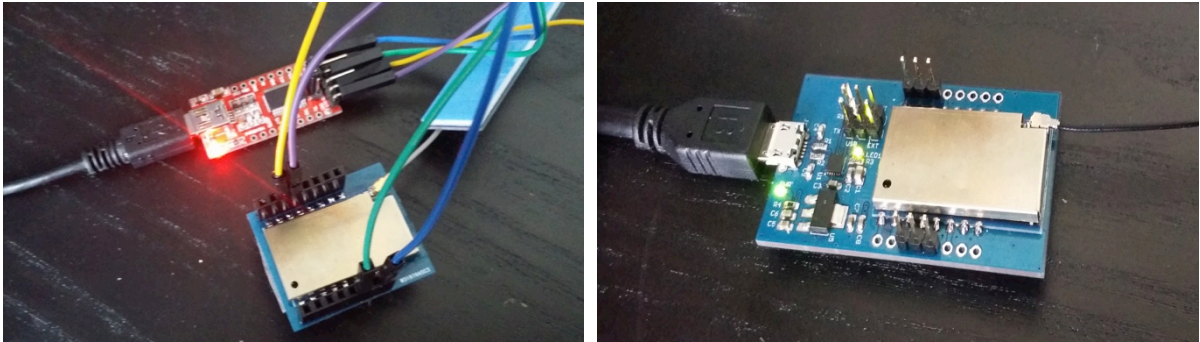


Figure: (a) HXC Client connected to a USB-to-Serial Converter (b) HXC Client USB Board

- If this is the first time the converter or the USB board has been connected, Windows 10 will automatically install the driver. Once that is done, open your device manager (Control Panel->Device Manager) to note down the COM port.

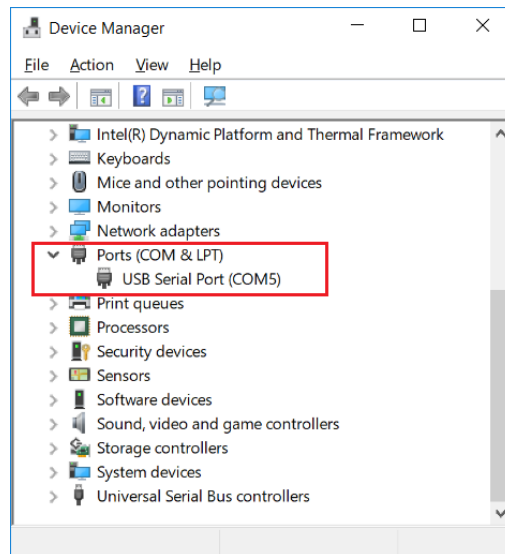


Figure: USB-to-Serial Converter showed up as COM5

- Open Tera Term. Select appropriate COM port ('COM5' in our case) from 'Serial Port' drop-down menu.

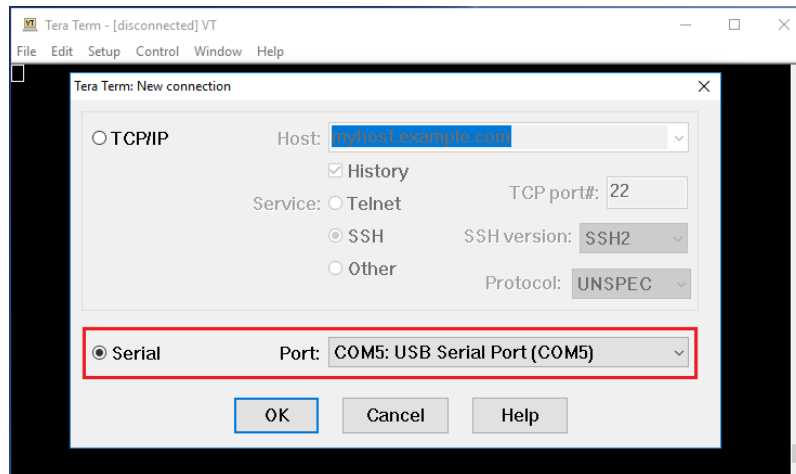


Figure: Tera Term connection window

- Go to Setup->Terminal... and make changes according to the figure below.
 Note: All AT commands need to end with <CR><LF>. Don't forget to enable 'Local Echo'.

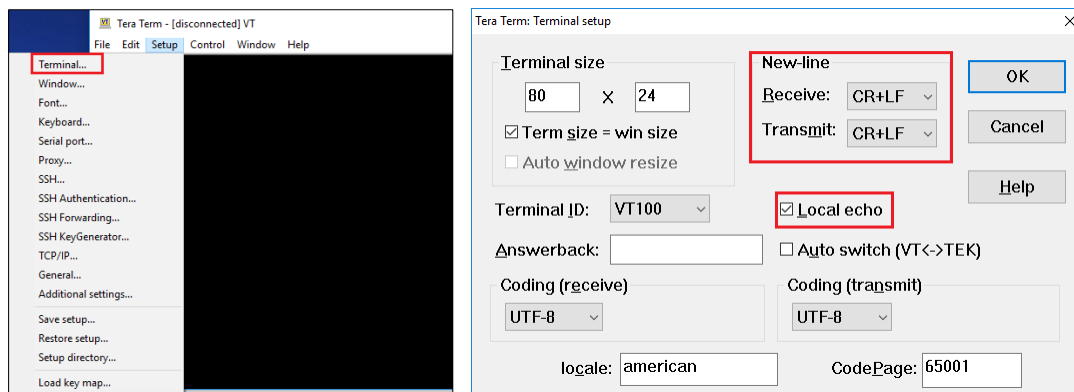


Figure: Tera Term terminal setup

- Go to Setup->Serial port... and change the serial port configuration.

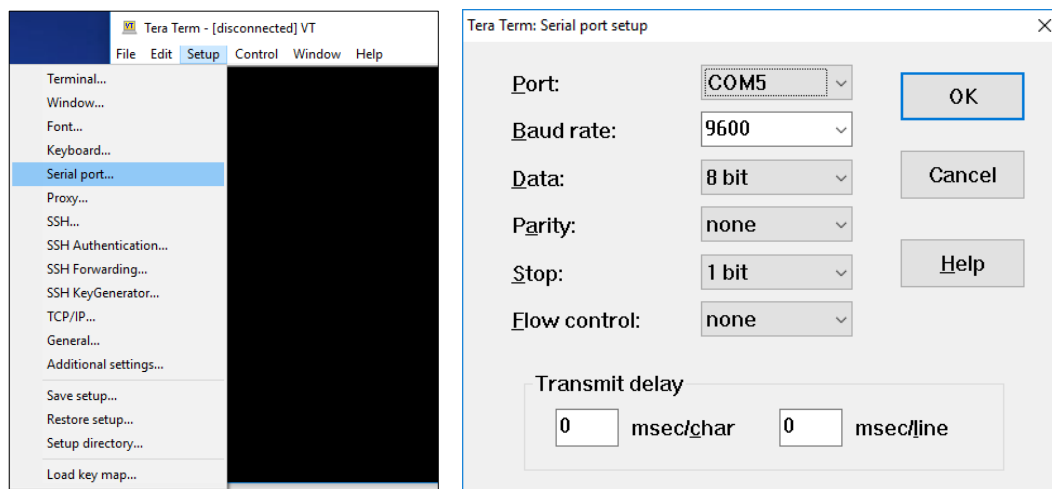


Figure: Tera Term Serial setup



- You can now type any AT commands and the terminal window will show responses.

```
COM5 - Tera Term VT
File Edit Setup Control Window Help
AT
OK
AT+NMJ?
Get or Set Network Join Mode
OK
AT+NMJ=?
OTAA
OK
AT+ADR=0
OK
```

Figure: Executing AT commands



10 Appendix II: List of AT Commands for OTAA

The following list shows the bare minimum AT commands to send a packet using OTAA join mode. HXC400 and HXC900 commands are exactly same except the channel configuration.

To facilitate the example, all <CR><LF> is intentionally omitted. All commands will have to end with <CR><LF>.

10.1 HXC400 with Class A

```

AT+FD // Factory reset the module, to make sure the module
>>>OK // starts with default values.
>>>HXC400 AT Interface
>>>FW Ver: 1.15
>>>RDY
AT+NJM=OTAA // Set join mode
>>>OK
AT+CLASS=A // Set class
>>>OK
/*
* You can use default channels, or you can define your custom channels using AT+CH
*/
AT+CH=?
>>>0,471500000,5,0
>>>1,471700000,5,0
>>>2,471900000,5,0
>>>OK
AT+DEVEUI=be7a0000000042c
>>>OK
AT+APPEUI=be7c00000000178
>>>OK
AT+APPKEY=3e03deb24a835b3be54ca996c334408a
>>>OK
AT+JOIN
>>>OK
>>>txDone
>>>rxDone
>>>JOINED
AT+SEND:0,12:Eureka!
>>>OK
>>>txDone
>>>rx1TimeOut // Assuming there isn't a downlink packet from NS
>>>rx2TimeOut

```



10.2 HXC900 with Class C

AT+FD

```
>>>OK
>>>HXC900 AT Interface
>>>FW Ver: 1.15
>>>RDY
```

AT+NJM=OTAA

```
>>>OK
```

AT+CLASS=C

```
>>>OK
```

AT+CH=?

// Region_US915 Default channels

```
>>>0,902300000,3,0
>>>1,902500000,3,0
>>>2,902700000,3,0
>>>3,902900000,3,0
>>>4,903100000,3,0
>>>5,903300000,3,0
>>>6,903500000,3,0
>>>7,903700000,3,0
>>>OK
```

AT+DEVEUI=be7a0000000042c

```
>>>OK
```

AT+APPEUI=be7c00000000178

```
>>>OK
```

AT+APPKEY=3e03deb24a835b3be54ca996c334408a

```
>>>OK
```

AT+JOIN

```
>>>OK
>>>txDone
>>>rxDone
>>>JOINED
```

AT+SEND:0,21:Bingo!

```
>>>OK
```

```
>>>txDone
```

```
>>>rx1TimeOut
```

```
// Assuming there isn't a downlink packet from NS.
// Class C always listens on receive window 2.
```



11 Appendix III: List of AT Commands for ABP

11.1 HXC400 with Class A

```

AT+FD // Factory reset the module to make sure the module
>>>OK // starts with default values.
>>>HXC400 AT Interface
>>>FW Ver: 1.15
>>>RDY
AT+NJM=ABP
>>>OK
AT+CLASS=A
>>>OK
AT+DEVEUI=BE7A00000000042C
>>>OK
AT+APPEUI=BE7C000000000178
>>>OK
AT+APPKEY=3E03DEB24A835B3BE54CA996C334408A
>>>OK
AT+DEVADR=BADC0FFE
>>>OK
AT+APPSKEY=C87430800BADC0FFE33440000C001CA7
>>>OK
AT+NWKSKEY=DEA24D83FC3BE00CA996C33BADC0FFE8
>>>OK
AT+JOIN
>>>OK
>>>JOINED
AT+NJS=?
>>>JOINED
AT+SEND:0,12:Eureka!
>>>OK
>>>txDone
>>>rx1TimeOut // Assuming there isn't any downlink packet from NS
>>>rx2TimeOut

```



12 Appendix IV: Document Information

12.1 Version History

Version	Date	Author	Description
V1.00	07/07/17	Fahad Mirza	Initial Release
V1.01	08/06/17	Fahad Mirza	Dimension and Connection diagram added.
V1.02	08/10/17	Fahad Mirza	List of error codes added.
V1.03	08/14/17	Fahad Mirza	Updated AT command examples.
V1.04	08/15/17	Fahad Mirza	Appendix I,II,III added.
V1.05	08/16/17	Fahad Mirza	<ul style="list-style-type: none"> • Updated AT commands. • Updated Table of Contents.
V1.06	08/22/17	Fahad Mirza	<ul style="list-style-type: none"> • Added +RESET, +FD, +RX1FR, +TxCW. • Updated region specific parameter table. • Added WC message section. • Fixed several AT command ranges.
V1.07	10/12/17	Fahad Mirza Nik Kitson	<ul style="list-style-type: none"> • RESET pin info updated. • DEVEUI error response updated. • Physical Characteristics added.
V1.08	11/02/17	Fahad Mirza	<ul style="list-style-type: none"> • Pinout diagram added. • HXC900 parameter table added.
V1.09	01/16/18	Fahad Mirza	<ul style="list-style-type: none"> • US915 channel configuration added. • Updated appendix examples. • AT+BAT added. • AT+PAYLOAD_SIZE_ERROR added. • FCC and IC statements added.

12.2 List of Abbreviations

Acronym	Definition
LoRa [®]	Long range radio modulation scheme
LoRaWAN [™]	LoRa [®] wide-area network protocol
RF	Radio frequency
RSSI	Received signal strength indicator
SNR	Signal to noise ratio
OTAA	Over-the-air Activation
ABP	Activation by personalization
ETSI	European telecommunications standards institute
FCC	Federal Communications Commission
AES	Advanced Encryption Standard
NS	Network Server



13 Appendix V: FCC and IC Compliance

The below statements are applicable for HXC Client Module 900Mhz (Model: HXC900).

13.1 Federal Communication Commission (FCC)

13.1.1 Compliance Statement (Part 15.19)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

13.1.2 Warning (Part 15.21)

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

13.1.3 FCC Interference Statement (Part 15.105 (b))

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

To comply with FCC/IC RF exposure limits for general population/uncontrolled exposure during indoor application, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

To comply with FCC/IC RF exposure limits for general population/uncontrolled exposure during outdoor application, the antenna(s) used for this transmitter must be installed on outdoor permanent structures to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.



13.2 Industry Canada (IC)

13.2.1 Section 8.4 of RSS-GEN

This Device complies with Industry Canada License-exempt RSS standard(s). Operation is subject to the following two conditions: 1) this device may not cause interference, and 2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux normes RSS exemptes de licence d'Industrie Canada. Son fonctionnement est soumis aux deux conditions suivantes: 1) cet appareil ne doit pas provoquer d'interférences et 2) cet appareil doit accepter toute interférence, y compris les interférences pouvant entraîner un fonctionnement indésirable de l'appareil.

13.2.2 Section 8.3 of RSS-GEN

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

En vertu des règlements d'Industrie Canada, cet émetteur radio ne peut fonctionner qu'avec une antenne de type et un gain maximum (ou moindre) approuvé pour l'émetteur par Industrie Canada. Pour réduire les interférences radio potentielles avec d'autres utilisateurs, le type d'antenne et son gain doivent être choisis de manière à ce que la puissance isotrope rayonnée équivalente (e.i.r.p.) ne soit pas supérieure à celle nécessaire pour une communication réussie.

13.3 OEM Responsibilities to comply with FCC and Industry Canada Regulations

The HXC Client Module (HXC900) has been certified for integration into products only by OEM integrators under the following conditions:

- The antenna(s) must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times.
- The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator



will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

13.3.1 End Product Labelling

The HXC Client Module (HXC900) is labeled with its own FCC ID and IC Certification Number. If the FCC ID and IC Certification Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

“Contains Transmitter Module FCC ID: 2ANQY-HXC900”

“Contains Transmitter Module IC: 23185-HXC900”

Or

“Contains FCC ID: 2ANQY-HXC900”

“Contains IC: 23185-HXC900”

The OEM of the HXC Client Module (HXC900) must only use the approved antenna(s), which have been certified with this module. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

The user manual for the end product must also include the following information in a prominent location:

“To comply with FCC and Industry Canada RF radiation exposure limits for general population, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.”