XENO+ LTE+GPS NANO CPU MODULE DATASHEET

Eoxys Systems

Revision History		
Version	Date	Description of change
1.0	12-FEB-2022	Initial version
1.1	12-MAR-2022	Corrected the pin mapping issues in the block diagram.
1.2	18-JUN-2022	Updated Bootloader section content.

Table of Contents

1 Overview

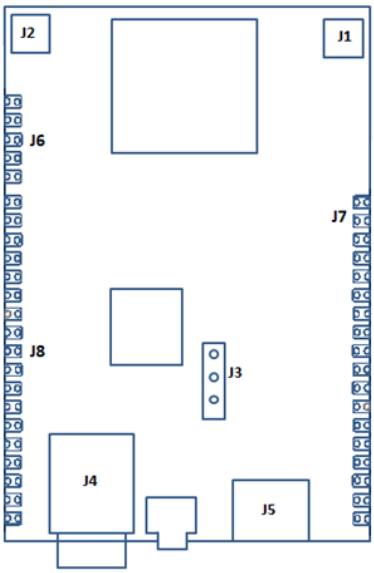
XENO+ LTE+GPS Nano CPU Module is a solderable module and can be used as core CPU module of any new IOT devices design of customers so that customers can focus only on adding sensors and power circuits around this CPU module for building their new IOT devices in short time.

This module readily supports LTE-Cat1, EDGE, GPRS & SMS and GPS along with both Nano SIM slot and e-SIM provisions.

The module has smallest possible size with STM32L4 series ARM Cortex-M4, 1MB Flash, 352KB/128KB RAM, UART/SPI/I2C ports and GPIOs. This module has USB Type C based 5V Power input with serial debug port and Battery power input options. This module has 3 pin SWD pins for SW development and SW debug via STM32CubeIDE for Embedded SW development for the device by the users.

2 LTE+GPS CPU Module Overview

The below table shows the brief overview of modules:

	XNO-L110S
Module Image	
LTE	LTE Cat1/GSM/GPRS/EDGE 900/1800MHz
GPS	GNSS: GPS, GLONASS and BeiDou
Antenna	Separate UFL Antenna for LTE and GPS
Sensor Interface	UART, SPI, I2C, ADC, DAC, PWM and GPIOs
Pins	18x18 Castellated Pins 5x1 Castellated Pins for LTE Module SW upgrade
Size in mm	68 x 48 mm

3 Product Features and Specifications

The XENO+ module product features and specifications are listed below:

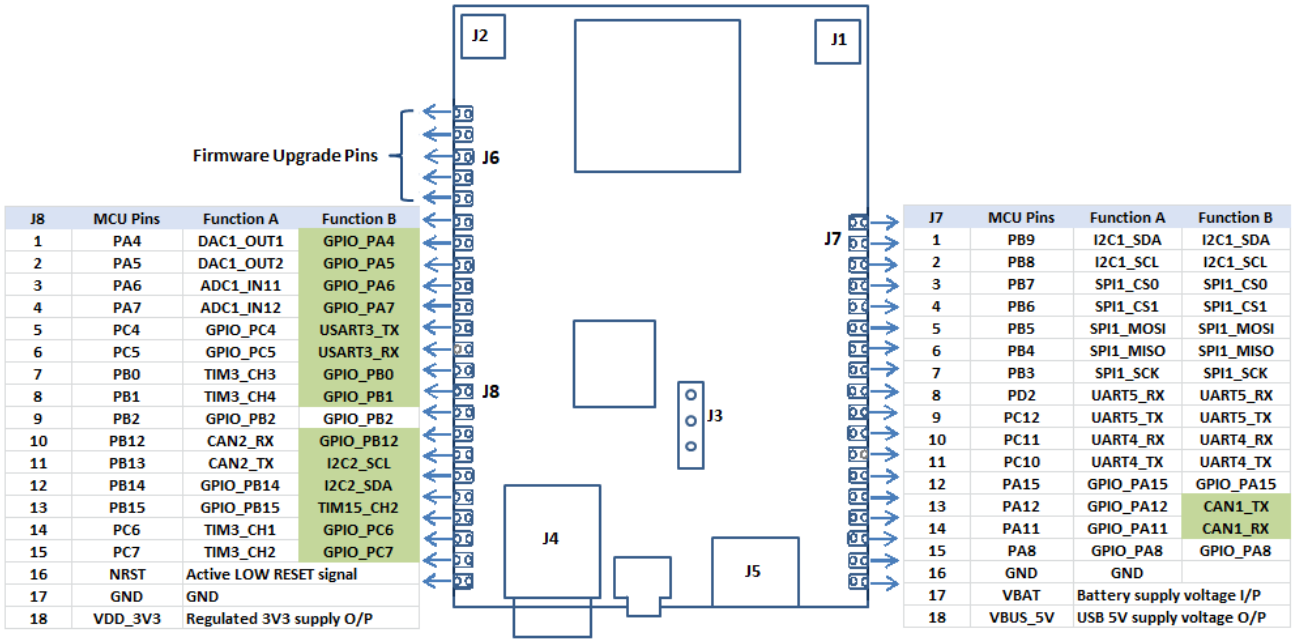
Table-1: The Product features and specifications

No.	Features	Specifications
Electro – Mechanical specification		
1	Boards Mounting	18x18 Castellated Pins
2	Wired interface	1x USB Type C for 5V Power and Serial debug UART interface for debug messages and user inputs.
3	Antenna	2x uFL connectors for external RF LTE antenna and GPS antenna
4	SIM	a) Nano SIM slot for inserting external nano SIM b) e-SIM chip available on-board
5	User SW programming	3 pin SWD pins for SW programming and debug via STM32CubeIDE
6	Operating temperature	-40 ~ + 85 ℃
7	Operating humidity	95% or less
8	Size	68x48 mm
9	Weight	13 grams
Power Specifications		
1	Module input voltage	5V from USB Type C connector * MOSFET based switch to auto cut-off battery power when USB 5V is present.
2	Battery input voltage	2.0V to 5V Battery power from non-rechargeable (or) rechargeable battery. The battery options are listed below: * Two 1.5V AA Type Alkaline/Drycell non-rechargeable batteries connected in series for non-restricted transport. * 3.6V AA type (Li-SOCl2) non-rechargeable battery for Industrial applications. * 4.2V LiFePO4 18650rechargeable battery. The recharging circuit to be added in carrier board by customer.
LTE/GPS Specifications		
1	LTE	LTE-FDD B1/B3/B5/B7/B8/B20 GSM/GPRS/EDGE 900/1800MHz LTE Cat1: Uplink upto 5Mbps, Downlink upto 10Mbps EDGE: Uplink/Downlink upto 236.8Kbps GPRS: 85.6Kbps * uFL connector for external RF LTE Antenna
2	GPS	GNSS GPS: 1575.42+/-1.023MHz GLONASS: 1597.5~1605.8MHz BeiDou: 1561.098+/-2.046MHz
3	LTE Module Data interface	UART based AT command interface
4	LTE Active Mode Power	Max 713mA (@10MHz 23dBm LTE Cat1), Max 286mA (@power level#8 EGSM900 1Rx 4Tx, EDGE) Max 500mA (@power level#5 EGSM900 1Rx 4Tx, GPRS)

		Max 239mA (@power level#5 EGSM900, GSM Talk)
5	LTE Sleep/Idle Mode Power (GNSS Off)	2.5mA in Sleep Mode @DRX=0.32S 21mA in Idle Mode @DRX=0.32S
6	LTE Operational Mode	**GSM/LTE Sleep:** Current consumption is reduce. Module can still receive paging message and SMS. **GSM/LTE Idle:** SW is active. Module registered to network. Module ready to communicate. **GSM/LTE Talk:** Connection between two subscribers is in progress. **GSM/LTE Standby:** Module is ready for data transmission, but no data is sent or received. **GPRS/EDGE/LTE Data Transmission:** There is data transmission is in progress.
7	LTE Other modes	**Minimum functionality mode:** 'AT+CFUN=0' and 'AT+CSCLK=1' can be used to set minimum functionality mode. The RF part of module will not work. **Flight Mode:** 'AT+CFUN=4' can be used to set module to Flight mode. The RF part of module will not work. **Power Off:** 'AT+CPOF' or pull down of PWRKEY can be used to shutdown the power. The serial port and USB are not accessible.
8	LTE Power Shutdown	LTE Power can be shut down by MCU GPIO control signal
9	Antenna	2x uFL connectors for external RF LTE antenna and GPS antenna
CPU & Other Specifications		
1	CPU	STM32L4 series MCU with ARM Cortex-M4 at 80MHz
2	Flash Memory	1MB with Preassigned FOTA section
3	RAM	352KB/128KB SRAM
4	Sensor Interfaces	On Function-A pins: 1x SPI with two chip selects 2x UART 1x I2C 1x CAN 2x ADC 2x DAC 4x PWM 9x GPIOs
5	RTOS	FreeRTOS

4 Module Pinouts:

This module has 18x18 Castellated pins. The Left side 18 pins mapping and Right side 18 pins mapping are listed below. The MCU port pins can be assigned with 2 predefined module functions: Function-A and Function-B. The users can also map custom functions as per STM32L4 native GPIO functions on these pins.



J8	MCU Pins	Function A	Function B
1	PA4	DAC1_OUT1	GPIO_PA4
2	PA5	DAC1_OUT2	GPIO_PA5
3	PA6	ADC1_IN11	GPIO_PA6
4	PA7	ADC1_IN12	GPIO_PA7
5	PC4	GPIO_PC4	USART3_TX
6	PC5	GPIO_PC5	USART3_RX
7	PB0	TIM3_CH3	GPIO_PB0
8	PB1	TIM3_CH4	GPIO_PB1
9	PB2	GPIO_PB2	GPIO_PB2
10	PB12	CAN2_RX	GPIO_PB12
11	PB13	CAN2_TX	I2C2_SCL
12	PB14	GPIO_PB14	I2C2_SDA
13	PB15	GPIO_PB15	TIM15_CH2
14	PC6	TIM3_CH1	GPIO_PC6
15	PC7	TIM3_CH2	GPIO_PC7
16	NRST	Active LOW RESET signal	
17	GND	GND	
18	VDD_3V3	Regulated 3V3 supply O/P	

J7	MCU Pins	Function A	Function B
1	PB9	I2C1_SDA	I2C1_SDA
2	PB8	I2C1_SCL	I2C1_SCL
3	PB7	SPI1_CS0	SPI1_CS0
4	PB6	SPI1_CS1	SPI1_CS1
5	PB5	SPI1_MOSI	SPI1_MOSI
6	PB4	SPI1_MISO	SPI1_MISO
7	PB3	SPI1_SCK	SPI1_SCK
8	PD2	UART5_RX	UART5_RX
9	PC12	UART5_TX	UART5_TX
10	PC11	UART4_RX	UART4_RX
11	PC10	UART4_TX	UART4_TX
12	PA15	GPIO_PA15	GPIO_PA15
13	PA12	GPIO_PA12	CAN1_TX
14	PA11	GPIO_PA11	CAN1_RX
15	PA8	GPIO_PA8	GPIO_PA8
16	GND	GND	
17	VBAT	Battery supply voltage I/P	
18	VBUS_5V	USB 5V supply voltage O/P	

4.1 Left side 18 pins connector signals

SNO	MCU Pins	Function A	Function B
1	PA4	DAC1_OUT1	GPIO_PA4
2	PA5	DAC1_OUT2	GPIO_PA5
3	PA6	ADC1_IN11	GPIO_PA6
4	PA7	ADC1_IN12	GPIO_PA7
5	PC4	GPIO_PC4	USART3_TX
6	PC5	GPIO_PC5	USART3_RX
7	PB0	TIM3_CH3	GPIO_PB0
8	PB1	TIM3_CH4	GPIO_PB1
9	PB2	GPIO_PB2	GPIO_PB2
10	PB12	CAN2_RX	GPIO_PB12
11	PB13	CAN2_TX	I2C2_SCL
12	PB14	GPIO_PB14	I2C2_SDA
13	PB15	GPIO_PB15	TIM15_CH2
14	PC6	TIM3_CH1	GPIO_PC6
15	PC7	TIM3_CH2	GPIO_PC7

16	NRST	Active LOW RESET signal to MCU. The Push button also asserts RESET signal to LOW.
17	GND	GND pin of module.
18	VDD_3V3	Regulated 3V3 supply output from module to other circuits of carrier board.

4.2 Right side 18 pins connector signals

SNO	MCU Pins	Function A	Function B
1	PB9	I2C1_SDA	I2C1_SDA
2	PB8	I2C1_SCL	I2C1_SCL
3	PB7	SPI1_CS0	SPI1_CS0
4	PB6	SPI1_CS1	SPI1_CS1
5	PB5	SPI1_MOSI	SPI1_MOSI
6	PB4	SPI1_MISO	SPI1_MISO
7	PB3	SPI1_SCK	SPI1_SCK
8	PD2	UART5_RX	UART5_RX
9	PC12	UART5_TX	UART5_TX
10	PC11	UART4_RX	UART4_RX
11	PC10	UART4_TX	UART4_TX
12	PA15	GPIO_PA15	GPIO_PA15
13	PA12	GPIO_PA12	CAN1_TX
14	PA11	GPIO_PA11	CAN1_RX
15	PA8	GPIO_PA8	GPIO_PA8
16	GND	GND pin of module	
17	VBAT	Battery supply voltage input to module with 2.0 to 5V range. If Battery is connected, the module works with this battery supply.	
18	VBUS_5V	USB 5V supply voltage output from module to other circuits of carrier board. This is USB 5V supply. When USB cable is removed, the module will switch to Battery supply on-the-fly, if battery is connected.	

4.3 LTE Control and Data signals

LTE control pins:

SNO	Pin name	Description	Behaviour
1	LTE_PWRKEY *(PA1)*	GPIO Output pin. Used as Power on/off of LTE Module. Need to keep HI for 500ms to on/off. Based on the LTE_STATUS pin, the On or Off condition of the module is determined.	Acts as a PWRKEY push button to Power on/off the module. Keep PWRKEY signal HI for at least 500ms. After this, if the LTE_STATUS pin HI, the module is ON, else module is Off
2	LTE_RESET *(PA0)*	GPIO Output pin. Used to Reset the LTE Module. Need to keep HI for 2500ms to reset the module.	Acts as a RESET push button to reset the module. Keep RESET signal HI for at least 2500ms.
3	LTE_RI *(PB11)*	GPIO Input pin. Default state is HIGH. Pulled to LOW for a specific duration to indicate SMS, URC or Phone call ring status to MCU.	SMS - LOW for 120ms URC - LOW for 60ms Phone call - LOW until host accepts the call or caller stops calling
4	LTE_STATUS *(PC9)*	GPIO Input pin. Indicates LTE module On/Off status	1 - Module is ON 0 - Module is OFF
5	LTE_1PPS *(PA2)*	GPIO Input pin. GNSS pulse synchronous clock signal	GNSS pulse synchronous clock signal to MCU
6	LTE_DCD *(PB10)*	GPIO Input pin. Indicates LTE module carrier detection status	1 - carrier is detected 0 - carrier is not detected
7	LTE_DTR *(PC8)*	GPIO output pin. Used to make the LTE module into sleep mode. This pin is effective ONLY after setting "AT+CSCLK=1". Otherwise, this signal is ignored.	1 - entering sleep mode after setting "AT+CSCLK=1" 0 - wakeups the LTE module
8	LTE_PWREN *(PC13)*	GPIO Output pin. Used to enable the power for the LTE module. By default, the LTE module is powered down during the power-on time of module. The MCU SW need to power-up the module by making it LOW during its boot time	0 – ENABLE Power to LTE module 1 – SHUTDOWN Power to LTE module

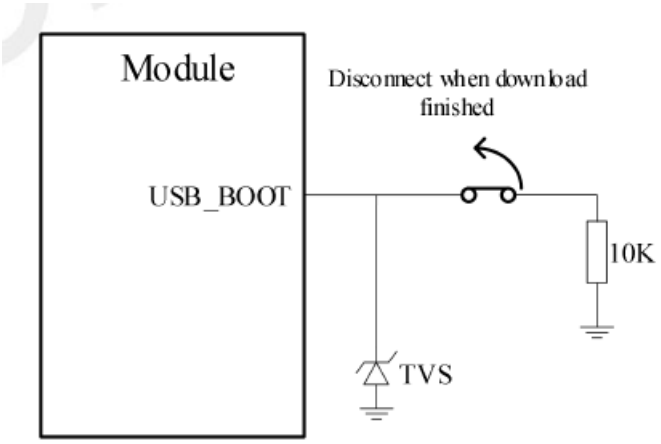
A767X LTE UART pins:

SNO	Pin name	Description	Behaviour
1	LTE_TX *(PC0)*	LPUART1_RX of STM MCU	will be acting as LPUART1 receive pin STM MCU
2	LTE_RX *(PC1)*	LPUART1_TX of STM MCU	will be acting as LPUART1 transmit pin of STM MCU
3	LTE_CTS *(PC3)*	unused	-
4	LTE_RTS *(PC2)*	unused	-

A767X Firmware Upgrade pins:

SNO	Pin name	Description	Behaviour
1	LOG_TXD	Log output of module	This is UART TXD pins for log output of module
2	VBUS	Valid USB detection input. Active high signal.	will be acting as USB detection pin of module
3	USB_DP	Positive line of the differential, bi-directional USB signal	USB positive signal
4	USB_DM	Negative line of the differential, bi-directional USB signal	USB negative signal
5	USB_BOOT	Firmware Upgrade enable signal. Active low signal.	Firmware download guide control input. when pull-down to GND and press PWRKEY, then module will access in USB download mode.

The User can force upgrade the LTE Module through the USB_BOOT pin. Before the module is powered on, need to pull the USB_BOOT pin to GND, then power-on the module, and apply RESET to module to enter firmware download mode. The LTE_RESET (PA0) of MCU GPIO Output pin is used to RESET the LTE Module. Need to keep HI for 2500ms to reset the module. After finishing the firmware download, the user needs to release USB_BOOT by removing the pull-down.



5 SW Functional Specifications

5.1 Boot Application Functional Specifications

This module comes with Bootloader as a standalone Boot time application which is executed by default at the boot time. This Bootloader has capability to download following firmware from FOTA server:

1. STM32 Host firmware

The Bootloader helps in management of the device host MCU firmware image versions and auto updates this device firmware with latest version Over-The-Air (OTA).

1. The Bootloader integrates OTA (Over-The-Air) capability for the deployed IOT devices.

2. The Bootloader uses TCP/IP protocol over LTE/EDGE/GPRS via Socket commands for communicating with FOTA Server (Called as TUNE APP Server). The connection management (connect, dis-connect and re-connect) is handled by the FOTA Downloader.
3. The TUNE APP server allows embedded firmware updates for all deployed IOT devices in the field via LTE/EDGE/GPRS interface. The TUNE APP server will be uploaded with new firmware files so that all deployed IOT devices firmware update is taken care. This TUNE APP server validates the devices credentials and informs device FOTA Downloader to initiate the Over-The-Air download of new device firmware.
4. The Bootloader downloads the new Firmware file from this FOTA server (TUNE APP server).

During the initial 3 to 5 seconds of power-on boot time, the Bootloader code checks the STM32 Host firmware version with FOTA server for any new updated version firmware available in the server. If it is available, it downloads the firmware and updates the STM32 Host firmware.

The module comes with device authentication mechanism part of Bootloader using PKCE (Proof Key for Code Exchange) based Device authentication. The PKCE is used to provide one more security layer to the authorization code flow of OAuth. The devices are authenticated by Server using Device ID and PKCE Secret. The IMEI number is used as Device ID. The server authenticates the devices and generates the access token and refresh token for the device The Bootloader initiates the Device Authorization Flow by requesting a set of verification codes from the authorization server by issuing an TCP/IP socket requests to the authorization server. The server can approve or deny the requests to authorise the device. After successful authentication of device, the server issues valid access token to the device. The access-token has a limited lifetime mentioned in minutes. When it expires the Bootloader can fetch a new refresh-token. This access-token can be read by user's main embedded application.

At the end of Bootloader execution, the Bootloader launches the user's main embedded application.

AT Commands supported during Boot time

The user inputs for device configuration are done via AT Commands through debug console. The user can press escape character during the boot time to initiate AT commands from debug console. The format of AT command is "AT%<cmd>=<args>" where <cmd> is the command name and <args> is the list of arguments. There are four types of AT Commands.

SNO	Types	Description
1	Read command AT%<cmd>?	This command returns currently set value of the parameters.
2	Write command AT%<cmd>=<arg1,arg2,..>	This command sets user defined parameter values.
3	Test command AT%<cmd>=?	This command returns list of supported parameters and its possible values as help info to users.
4	Execution command AT%<cmd>	This command is non-argument command and reads value of parameters.

5.1.1 SW Version Command

SW Version command	
AT%SWVER Execution command	Response: **%SWVER-FIRMNAME: <Device-SW>** **%SWVER-NUM: <V10>** **%SWVER-DATE: <dd-mon-yyyy>** **OK**

5.1.2 Setting LTE Network Configuration

Set LTE Network Configuration	
AT%LTENW=<Opr_Name>,<>,<> Write command	Response: **OK**
AT%LTENW? Read command	Response: **%LTENW-OPR-NAME: <Access point name>** **%LTENW-IMEI-NUMBER: <IMEI Number>** **OK**

5.1.3 Setting FOTA Server Configuration

Setting FOTA Server Configuration	
AT%FOTASER=<Server URL>,<Port> Write command	Response: **OK**
AT%WIFISER? Read command	Response: **%FOTASER-URL: <FOTA server URL>** **%FOTASER-PORT: <Port number>** **OK**

5.1.4 Setting PKCE Configuration

Setting PKCE Configuration	
AT%PKCE=<PKCE Secret> Write command	Response: **OK**
AT%PKCE? Read command	Response: **%PKCE-SECRET: <PKCE Secret>** **OK**

5.1.5 Device Info Command

Device Info command	
AT%DEVINFO Execution command	Response: **%DEVINFO-DEVNAME: <IP Address>** **%DEVINFO-MACID: <WIFI MAC ID>** **%DEVINFO-IPADDR: <IP Address>**

	OK

5.2 User Application Functional Specifications

At the end of Bootloader execution, the Bootloader launches the user's main embedded application. This user application runs as main application which controls the sensors, interfaces, memory, and data transfer of the IOT device. The WiFi module configuration, sensor configuration, sensor data transfer via TCP Sockets/HTTP/MQTT APIs are maintained by the user embedded application.

The embedded device's memory map is defined as per below table so that memory map has 3 sections: 1) Bootloader section, 2) Main user application firmware and 3) Backup user application firmware sections.

Features	Description
Memory map of program flash of embedded device	1. **BOOTLOADER_MEMORY** Contains ISR_VECTOR, FIRMWARE, USER_CONFIG, ACCESS_TOKEN memory segments. 2. **MAIN_FIRMWARE_MEMORY** Contains ISR_VECTOR and Main running app's MAIN_FIRMWARE, MAIN_FIRMWARE_SWVER info memory segments. 3. **BACKUP_FIRMWARE_MEMORY** Contains ISR_VECTOR and Main running app's BACKUP_FIRMWARE, BACKUP_FIRMWARE_SWVER info memory segments

After successful authentication of device, the server issues valid access token to the device and stored in ACCESS_TOKEN memory section. This access-token can be read by User Main Application through App Development Lib APIs from this ACCESS_TOKEN memory section. Also main application firmware name, version number and release date in MAIN_FIRMWARE_SWVER info memory segment.

Features	Description

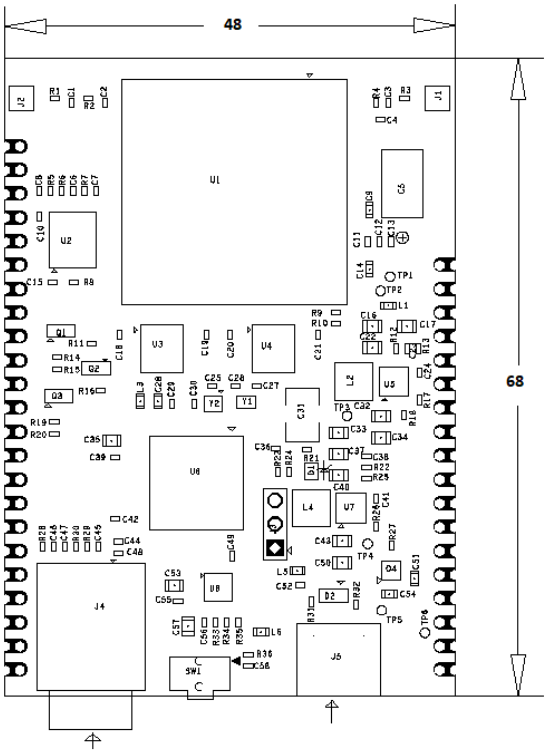
ACCESS_TOKEN memory segment: Access Token memory section	{
	ACCESS_TOKEN: <Access token>
	}

MAIN_FIRMWARE_SWVER memory segment: Main Firmware Info memory section (User application firmware info)	{
	FIRM_NAME: <Device-SW>
	SWVER: <V10>
	DATE: <dd-mon-yyyy>
	}

6 Module Layout and Dimensions

This module layout and dimensions are shown below.

Module Dimensions (in mm)

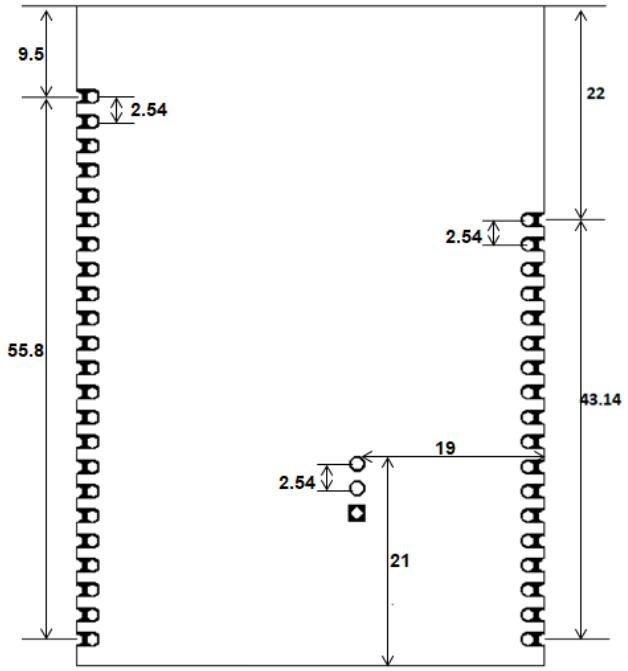


7 Mechanical Specifications

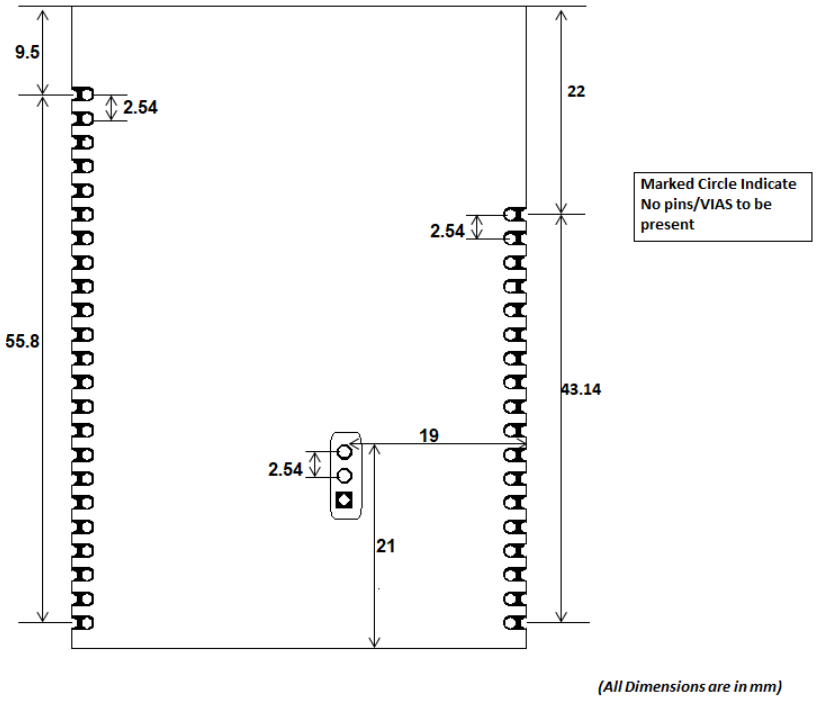
The XENO+ module is a single sided 55x35mm 1mm thick PCB with dual castellated/through-hole pins around the remaining edges. XENO+ module is designed to be usable as a surface mount module as well as being in Dual Inline Package (DIP) type format, with the 36 main user pins on a 2.54mm (0.1") pitch grid with 1mm holes.

Mechanical Specifications

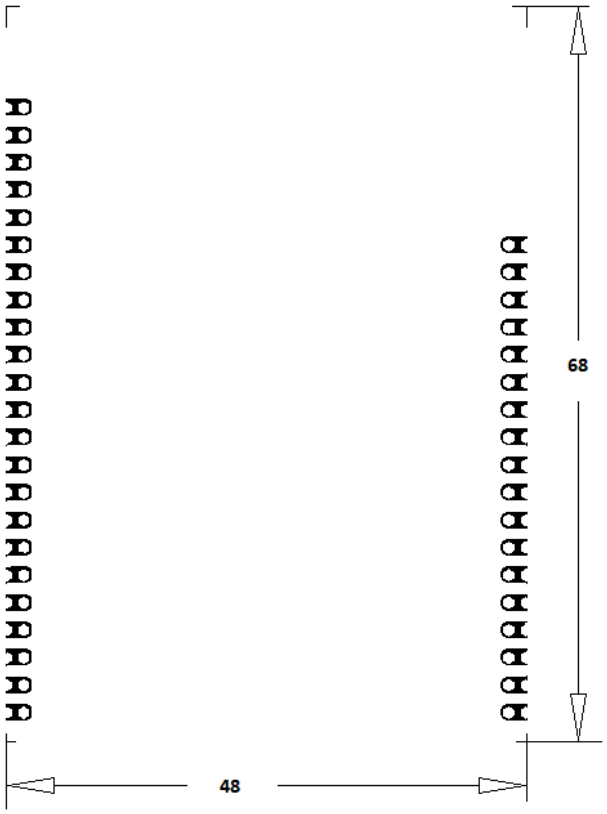
(All Dimensions are in mm)



Mechanical Specifications with no pins/VIAS to be present



Carrier Board PCB Footprint



(All Dimensions are in mm)