

# Maximos

## Technical Specifications



## Release & Revision History

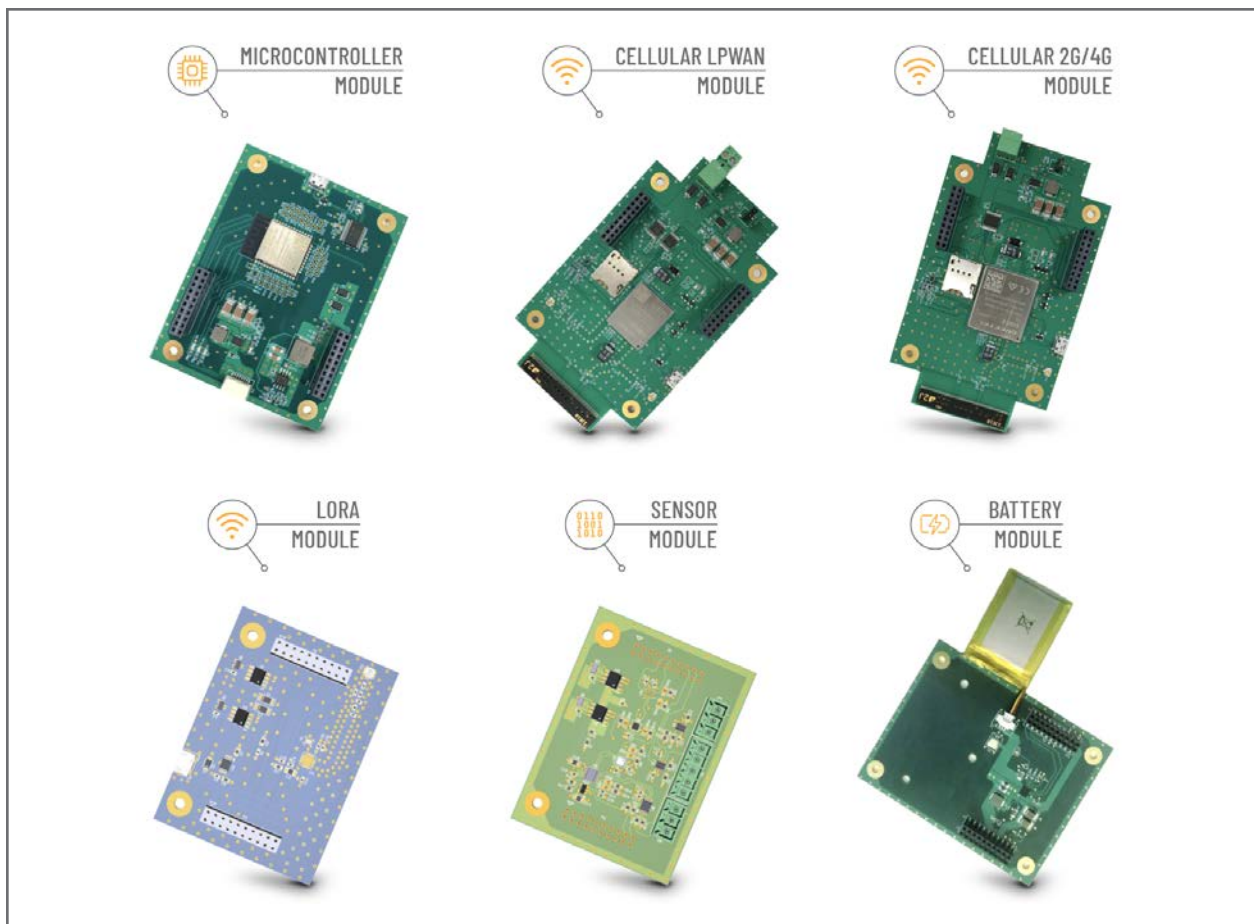
Version	Date	Release/Revision Content	Writer	Auditor
1.0	10.03.2021	Added technical specifications per available module	Tobias Görgen	Ulf Theobald

# 1 Overview

The IoT device *Maximos* by X-CITE is a multi-functional device that acts as an independent sensor, as an interface for connecting and gathering data from (third party) sensors, and as an advanced connectivity enabler.

*Maximos* is designed as a modular device, meaning that the final sensor and its features can be assembled from a set of modules that are provided by X-CITE. As an example, in case NB-IoT or LTE-M connectivity is requested for a particular use case, the *Cellular LPWAN Module* will be installed. However, in case LTE connectivity is requested, the *Cellular 2G/4G Module* will be installed. The modules that are available for assembling the *Environmental Sensor* are listed in **Figure 1**.

**Figure 1** Overview of available modules for the *Maximos Sensor*



## 2 Microcontroller Module

The *Microcontroller Module* of the *Environmental Sensor* is equipped with the powerful, generic and adaptive *nRF5340 Wi-Fi+BT+BLE ESP32-WROOM Microcontroller (MCU)* that is tailored for low power cost applications such as low-power sensing. The *MCU* is interfacing with the other modules of *Maximos* and supports *uTensor* based ML inferencing.

nRF5340 Microcontroller	
<b>Package</b>	aQFN-94
<b>Supply Voltage</b>	1.7V to 5.5V supply voltage range
	1.8V to 3.3V regulated supply for external components
<b>Operation</b>	Single 32 MHz crystal operation
<b>Operating Temperature</b>	-40 C° to +105 °C
Application Core	
<b>Arm Cortex -M33 with TrustZone technology</b>	128 MHz or 64 MHz operation
	510 EEMBC CoreMark score running from flash memory
	Single-precision floating-point unit (FPU)
	Digital signal processing (DSP) instructions
	Data watchpoint and trace (DWT) Embedded trace macrocell (ETM) Instrumentation trace macrocell (ITM) Cross trigger interface (CTI)
	Serial wire debug (SWD)
	Trace port interface unit (TPIU): <ul style="list-style-type: none"> <li>4-bit parallel trace of ITM and ETM trace data</li> <li>Serial wire output (SWO) trace of ITM data</li> </ul>
<b>RAM</b>	1 MB flash
	512 kB low leakage
<b>Arm TrustZone CryptoCell -312 security subsystem</b>	NIST 800-90B, AIS-31, and FIPS 140-2 compliant random number generator
	AES-128 and 256: ECB, CBC, CMAC/CBC-MAC, CTR, CCM/CCM*, GCM
	SHA-1, SHA-2 up to 256 bits
	Keyed-hash message authentication code (HMAC)
	RSA public key cryptography with up to 3072-bit key size

	ECC support for most used curves
	Application key management using derived key model
<b>Cache</b>	Two-way set associative cache towards flash and QSPI XIP code regions
<b>Peripheral</b>	QSPI peripheral for communicating with an external flash memory device
<b>NFC</b>	Near field communication (NFC-A) tag with wake-on field & touch-to-pair support
<b>SPI</b>	Up to 3x SPI master/slave with EasyDMA
<b>I2C</b>	Up to 2x I2C compatible two-wire master/slave with EasyDMA
<b>UART</b>	Up to 2x UART (CTS/RTS) with EasyDMA & optional, built-in, flow control (CTS, RTS)
<b>Audio Peripherals</b>	I2S, digital microphone interface (PDM)
<b>PWM</b>	Up to 3x pulse width modulator (PWM) units with EasyDMA
<b>ADC</b>	12-bit, 200 ksps ADC with EasyDMA - eight configurable channels with programmable gain
<b>Timer</b>	Up to 3x 32-bit timer with counter mode
<b>RTC</b>	Up to 2x 24-bit real-time counter (RTC)
<b>QDEC</b>	Quadrature decoder supported
<b>DPPI</b>	Distributed programmable peripheral interconnect supported
<b>IPC</b>	Inter-processor communication supported
<b>MUTEX</b>	Mutually exclusive peripheral supported
<b>Pins</b>	48 general purpose I/O pins
<b>Network Core</b>	
	64 MHz operation
	238 EEMBC CoreMark score running from flash memory
<b>Arm Cortex-M33</b>	Cross trigger interface (CTI)
	Serial wire debug (SWD)
	SWO trace port
<b>Flash</b>	256 kB
<b>Low Leakage RAM</b>	64 kB
	-97.5 dBm sensitivity in 1 Mbps Bluetooth low energy mode
<b>Bluetooth 5.1, IEEE 802.15.4-2006, 2.4 GHz transceiver</b>	-20 to +3 dBm configurable TX power
	On-air compatible with nRF52, nRF51, nRF24L, and nRF24AP Series

	Bluetooth 5.1: 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps
	IEEE 802.15.4-2006: 250 kbps
	Proprietary 2.4 GHz: 2 Mbps, 1 Mbps
	Single-ended antenna output (on-chip balun)
	128-bit AES/ECB/CCM/AAR co-processor (on-the-fly packet encryption)
	3.2 mA run current in TX (0 dBm)
	2.6 mA run current in RX
	RSSI (1 dB resolution)
<b>SPI</b>	SPI master/slave with EasyDMA
<b>I2C</b>	I2C compatible two-wire master/slave with EasyDMA
<b>UART</b>	UART (CTS/RTS) with EasyDMA
<b>Timer</b>	Up to 3x 32-bit timer with counter mode
<b>RTC</b>	Up to 2x real-time counter (RTC)
<b>Sensing</b>	Embedded temperature sensor
<b>DPPI</b>	Distributed programmable peripheral interconnect supported
<b>IPC</b>	Inter-processor communication supported
<b>MUTEX</b>	Mutually exclusive peripheral supported

## 3 Connectivity Modules

Maximos is able to use one of three different connectivity modules that provide specific connectivity options. Those are the LPWAN module, the 2G/4G module and the LoRa module. Technical specifications for each module are given in the upcoming sections.

### 3.1 Cellular LPWAN Module (BG95-M3)

The *Cellular LPWAN Module* of Maximos is able to establish *LTE-M (LTE Cat. M1)* and *NB-IoT (Cat. NB2)* connectivity, using the *Quectel BG95-M3* module. The *BG95-M3* is a multi-mode LPWAN module supporting LTE Cat M1/Cat NB2/EGPRS and integrated GNSS. It is 3GPP Rel. 14 compliant and offers maximum data rates of 588 kbps DL and 1119 kbps UL under LTE Cat M1. The *BG95-M3* boasts a comprehensive set of hardware-based security features and enables trusted applications to run directly on the Cortex A7 TrustZone engine.

Quectel BG95-M3		
<b>Region/Operator</b>		For the Global
<b>Dimensions (mm)</b>		23.6 x 19.9 x 2.2
Temperature Range		
<b>Operating Temperature</b>		-35°C to +75°C
<b>Extended Temperature</b>		-40°C to +85°C
Frequency Bands		
<b>LTE-FDD</b>	<b>Cat M1</b>	B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B27/B28/B66/B85
	<b>Cat NB2</b>	B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85
<b>GSM/EDGE</b>		850/900/1800/1900 MHz
<b>GNSS</b>		GPS/GLONASS/BeiDou/Galileo/QZSS
Data Rates (in kbps)		
<b>LTE-M</b>	<b>Cat M1</b>	Max. 588 (DL), Max. 1119 (UL)
	<b>Cat NB2</b>	Max. 127 (DL), Max. 158.5 (UL)
<b>NB-IoT</b>	<b>Cat NB1</b>	Max. 32 (DL), Max. 70 (UL)
<b>EDGE</b>		Max. 296 (DL), Max. 236.8 (UL)
<b>GPRS</b>		Max. 107 (DL), Max. 85.6 (UL)

Interfaces		
<b>(U)SIM</b>		x 1 (1.8 V only)
<b>UART</b>		x 3
<b>USB 2.0</b>		x 1
<b>PCM*</b>		x 1 (for VoLTE only)
<b>I2C*</b>		x 1 (for VoLTE only)
<b>Antenna</b>		x 2
<b>GPIO</b>		x 9
<b>GRFC</b>		x 2
Voice		
<b>VoLTE</b>		VoLTE for Cat M1, CS Voice for GSM
SMS		
<b>SMS</b>		Point-to-point MO/MT, SMS Cell Broadcast, Text and PDU Mode
Enhanced Features		
<b>DFOTA</b>		Supported
<b>QuecOpen</b>		Supported
<b>QuecLocator</b>		Cell ID Positioning
<b>SoftSIM</b>		Supported
<b>IoT Platform Access</b>		AWS/Azure
Software Features		
<b>Protocols</b>		PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S)/NITZ/PING/MQTT/LwM2M/CoAP/IPv6
<b>USB Serial Driver</b>		Windows 7/8/8.1/10, Linux 2.6-5.4*, Android 4.x-10.x*
<b>GNSS/RIL Driver</b>		Android 4.x - 10.x*
Certifications		
<b>Carrier</b>	<b>Europe</b>	Vodafone*/Deutsche Telekom*/Telefónica*
	<b>America</b>	Verizon/ AT&T/Sprint/T-Mobile*
	<b>Canada</b>	Rogers*/Telus*
	<b>China</b>	China Telecom*/China Mobile*/China Unicom*
<b>Regulatory</b>	<b>Global</b>	GCF

<b>Europe</b>	CF
<b>North America</b>	PTCRB
<b>America</b>	FCC
<b>Canada</b>	IC
<b>Brazil</b>	Anatel
<b>Mexico</b>	IFETEL*
<b>China</b>	SRRC*/NAL*/CCC*
<b>South Korea</b>	KC*
<b>Taiwan China</b>	NCC*
<b>Japan</b>	JATE*/TELEC*
<b>Australia/NZ</b>	RCM
<b>Thailand</b>	NBTC*
<b>Singapore</b>	IMDA*
<b>Others</b>	RoHS/PEN/ATEX*

### Electrical Features

<b>Supply Voltage (V)</b>	3.3-4.3, typ. 3.8	
<b>Max Output Power (dBm)</b>	Power Class 5, 21 @ LTE Bands	
<b>Power Consumption @ PSM (<math>\mu</math>A)</b>	3.9	
<b>Power Consump. @ LTE Cat M1 (<math>\mu</math>A)</b>	<b>Sleep Mode</b>	1.65 @ DRX = 1.28 s, 0.63 @ e-IDRX = 81.92 s
	<b>Idle Mode</b>	18.9 @ DRX = 1.28 s, 18.2 @ e-IDRX = 81.92 s
	<b>Active Mode</b>	199 @ 21 dBm, GNSS off
<b>Power Consump. @ LTE Cat NB1 (<math>\mu</math>A)</b>	<b>Sleep Mode</b>	1.56 @ DRX = 1.28 s, 0.67 @ e-IDRX = 81.92 s
	<b>Idle Mode</b>	14.8 @ DRX = 1.28 s, 14.3 @ e-IDRX = 81.92 s
	<b>Active Mode</b>	172 @ 21 dBm, GNSS off

\*=under development/on-going/planning



## 3.2 Cellular 2G/4G Module

The *Cellular 2G/4G Module* of *Maximos* is able to establish *GSM (2G)* and *LTE (4G LTE Cat. 1)* connectivity, using the *Quectel EG91-E* module. The *Quectel EG91-E* is a LTE category 1 module optimized specially for M2M and IoT applications. Adopting 3GPP Rel. 11 LTE technology, it delivers maximum data rates up to 10Mbps downlink and 5Mbps uplink. These make EG91 an ideal solution for numerous IoT applications that are not reliant on high speed connectivity but require the longevity and reliability of LTE networks.

Quectel EG91-E	
<b>Region/Operator</b>	EMEA
<b>Dimensions (mm)</b>	29.0 x 25.0 x 2.3
Temperature Range	
<b>Operating Temperature</b>	-35°C to +75°C
<b>Extended Temperature</b>	-40°C to +85°C
Frequency Bands	
<b>LTE-FDD</b>	B1/B3/B7/B8/B20/B28A
<b>WCDMA</b>	B1/B8
<b>GSM/EDGE</b>	B3/B8
Data Rates	
<b>LTE FDD (Mbps)</b>	10 (DL) / 5 (UL)
<b>DC-HSPA+ (Mbps)</b>	42 (DL) / 5.76 (UL)
<b>WCDMA (kbps)</b>	384 (DL) / 384 (UL)
<b>EDGE (kbps)</b>	296 (DL) / 236.8 (UL)
<b>GPRS (kbps)</b>	107 (DL) / 85.6 (UL)
Interfaces	
<b>(U)SIM</b>	x 2
<b>UART</b>	x 2
<b>USB 2.0</b>	x 1
<b>Audio Digital (PCM)</b>	x 1
<b>I2C*</b>	x 1

<b>NETLIGHT</b>	x 1
<b>SPI</b>	x 1
<b>Main Antenna</b>	x 1
<b>Rx-Diversity Antenna</b>	x 1
<b>PWRKEY</b>	x 1
<b>RESET_N</b>	x 1
<b>USB_BOOT</b>	x 1
<b>Voice</b>	
<b>Speech Codec Modes</b>	HR/FR/EFR/AMR/AMR-WB
<b>Echo Arithmetic</b>	Echo Cancellation/Noise Suppression
<b>VoLTE (Optional)</b>	Digital Audio and VoLTE (Voice over LTE)
<b>Enhanced Features</b>	
<b>eCall*</b>	Supported
<b>DTMF</b>	Supported
<b>DFOTA</b>	Supported
<b>QMI/RmNet</b>	Supported
<b>Audio Playback/Audio Recording*</b>	Optional
<b>QuecFile</b>	Supported
<b>QuecLocator*</b>	Supported
<b>(U)SIM Card Detection</b>	Supported
<b>Drivers</b>	
<b>USB Serial Driver</b>	Windows 7/ 8/ 8.1/ 10, Linux 2.6~5.4
<b>GNSS/RIL Driver</b>	Android 4.x~ 9.x
<b>NDIS Driver</b>	Windows 7/ 8/ 8.1/ 10
<b>MBIM Driver</b>	Windows 8/8.1/10, Linux 3.18~5.4
<b>GobiNet Driver</b>	Linux 2.6~5.4
<b>QMI_WWAN Driver</b>	Linux 3.4~5.4
<b>Certifications</b>	
<b>Carrier</b>	<b>Europe</b> Deutsche Telekom

<b>Regulatory</b>	<b>Global</b>	GCF
	<b>Europe</b>	CF
	<b>Brazil</b>	Anatel*
	<b>Australia/NZ</b>	RCM
	<b>Russia</b>	FAC
<b>Others</b>		WHQL/RoHS
<b>Electrical Features</b>		
<b>Supply Voltage (V)</b>		3.3V-4.3V, 3.8V Typ.
<b>Power Consumption</b>		13µA @Power off 2.6mA @Sleep, Typ. 29mA @Idle

\*=under development/on-going/planning

### 3.3 LoRa Module

The *LoRa Module* of *Maximos* is able to establish non-cellular *LoRa 2.4GHz* or *LoRa 868MHz* connectivity. It provides high sensitivity, low energy consumption and excellent blocking immunity, being perfect for communicating with *IoT* sensors in rural areas that require long battery lifetimes.

## 4 Sensor Module

The *Sensor Module* of *Maximos* is able to measure humidity, luminosity, temperature, barometric pressure and *volatile organic compounds (VOCs)*. The *Sensor Module* also contains an accelerometer and gyroscope (IMU) for registering proper acceleration, device orientation and angular velocity. It provides *SDI-12*, *I2C* and *ANA* connectors for physically linking third party sensors and processing the related data.

## 5 Battery Module

The *Battery Module* of *Maximos* is equipped with a rechargeable *Li-Po* battery with the power of 3.7V and 800mAh. Consumption details depend on the specific assembly for a dedicated use case.