MTX-65i Family

User Manual

General Notes

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Important information

This technical description contains important information for the start up and use of the MTX-65i modems.

Read it carefully before you start working with the MTX-65i modems.

The warranty will be void should damage occur due to non-compliance with these instructions for use.

We cannot accept any responsibility for consequential loss.

Service and Support

To contact customer support please use the contact details below:

Matrix Electrónica
Alejandro Sánchez, 109
28019 Madrid (SPAIN)
gsmsupport@matrix.es

Information about the MTX-65i product and its accessories is available on the following web site:

www.mtxm2m.com

Or contact your local distributor / sales agent.

Revision information

Revision	Date	Author	Changes
2.0	2014/01	JS	Added MTX-65i-RS485 and MTX-65i+G
2.1	2014/05	JS	Approvals information updated
3.0	2014/06	AEM	New document format and general revision
3.1	2014/10	AEM/TP	Language style revision Added MTX-65i-BAT device
3.2	2014/12	AEM	Minor revision
3.3	2015/02	AEM	Minor revision
3.4	2015/04	AEM	Minor revision
3.5	2015/10	AEM	Minor revision
3.6	2016/01	JS	Minor revision – deleted ST/T1113634-2006 directive
3.7	2016/04	AEM	Added MTX-65i-RS485 FW2.00 (AUTO-ON) device

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1. Introduction

1.1 Description

The MTX-65i modems family is an innovative and powerful all-in-one solution that enables GSM, SMS, fax and 2.5G (GPRS) data transmission. It has an intrinsic TCP/IP communication stack with Internet Services such as TCP, UDP, HTTP, FTP, SMTP, and POP3.

The MTX-65i is Java J2ME programmable and can host and control your wireless applications, minimizing the need for extra hardware components.

It has a complete set of interfaces (RS232, RS485, USB, Analog audio, GPIO, I2C, optoisolated IOs, Analog-to-Digital converter) avoiding need for further hardware components, shortening the time to market and reducing costs. It also has a wide range of options (depending on the model) allowing it to be used in infinite M2M applications:

- **Ultra Low Power**: 2.5µA power consumption in sleep mode. Ideal in remote-battery operated systems
- **GNSS module inside**: GPS and GLONASS receiver modules allows track & location applications. GLONASS feature must be ordered as an option
- **Hardware Watchdog** and internal **Li-Po battery**
- **RS485 port**: isolated input/output for industrial use

Please read Section 1.3 to view the specific features of each modem.

The MTX-65i family is industrially featured: the modem can be used in industrial environments due to its extended operating temperature range. It also features an automatic restart after shutdown function in case of power glitches or faulty conditions.

The MTX-65i is a self contained modem with its own SIM card holder, USB 2.0 High Speed and RS232/485 interfaces (among others), which minimize the need for further hardware development. This modem can be used as a powerful and flexible device that can be integrated in a wide range of telemetry applications that rely on the remote exchange of data, SMS or faxes via the GSM cellular network.

With quad-band 900/1800MHz and 850/1900MHz, your applications can be deployed all over the world.

The MTX-65i modems can also be controlled via AT commands and standard interfaces such us USB 2.0 High Speed or RS232 with Linux and Windows® drivers.

The MTX-65i family is RoHS & WEEE compliant and it is manufactured following the ISO 9001 & IS0 14001 Quality certifications.

A full list of antennas, cables and accessory supplies are available.

The MTX-65i modems are powered by an internal Cinterion® TC65i module

1.2 Ordering information

199801311: MTX-65i
2xRS232, USB, I2C, 2xADC, 1xDAC, 4xGPIO

199801133: MTX-65i-RS485 FW2.00
1xRS485, 1x RS232, USB, I2C, 2xADC, 4xOptoIO, Sleep mode

199801394: MTX-65i-RS485 FW2.00 (AUTO-ON)
1xRS485, 1x RS232, USB, I2C, 2xADC, 4xOptoIO, Sleep mode, **no AUTO-ON-disable terminal**

199801123: MTX-65i-RS485-LC
1xRS485, 1x RS232, USB, I2C, 2xADC, 4xOptoIO, Sleep mode

199801119: MTX-65i-ULP
Ultra Low Power, 2xRS232, USB, I2C, 2xADC, 1xDAC, 5xGPIO, 4xOptoIO

199801310: MTX-65i+G V6
GPS, 1xRS232, USB, I2C, 2xADC, 1xGPIO, 6xOptoIO, Accelerometer, Sleep mode, Hardware Watchdog

199801302: MTX-65i+G+B V7
GPS, Li-Po battery, 1xRS232, USB, I2C, 2xADC, 1xGPIO, 6xOptoIO, Accelerometer, Sleep mode, Hardware Watchdog

199801307: MTX-65i-BAT
Li-Po battery, 1xRS232, USB, I2C, 2xADC, 1xGPIO, 6xOptoIO, Accelerometer, Sleep mode, Hardware Watchdog

1.3 Features by model

Depending on the device model you have selected, there are a set of features available as described in the table below. Please ask us at gsmsupport@matrix.es if you need any other combination of features, or one that is not listed here.

	MTX-65i	MTX-65i-BAT	MTX-65i-RS485 FW2.00	MTX-65i-RS485 FW2.00 (AUTO-ON)	MTX-65i-RS485-LC	MTX-65i+G V6	MTX-65i+G+B V7	MTX-65i-ULP
RS232 (8-wire)	X							X
RS232 (4-wire)		X	X	X	X	X	X	X
RS232 (2-wire)	X							
RS485			X	X	X			
USB	X	X	X	X	X	X	X	X
I2C	X	X	X	X	X	X	X	X
ADC	x2	x2	x2	x2	x2	x2	x2	x1
DAC	x1							x1
GPIO	x4	x1				x1	x1	x5
Optoisolated IO		x6	x4	x4		x6	x6	
Accelerometer		X				*2	X	
RTC	X	X	X	X	X	X	X	X
Sleep mode		X	*1	*1		X	X	
Ultra Low Power mode								X
Wake Up (by RTC)		X	*1	*1	X	X	X	
Wake Up (by Accelerometer)		X				X	X	
Power On (by RTC)								X
Power On (by Opto IO)								X
Li-Po Battery		X					X	
HD WatchDog		X				X	X	
Auto On	X	X	X	X	X	X	X	X
Auto On disable		X	X			X	X	
GPS						X	X	
GPS/GLONASS		*3				*3	*3	

*1: only if AUTO ON is disabled by hardware
*2: upon request
*3: GLONASS can be ordered upon request

1.4 Differences between MTX-65i+G V6 and MTX-65+G V3

MTX-65i+G V6 is an enhanced version of the old MTX-65+G V3 modem, with full backwards compatibility but with differences in its functional features

- Internal Hardware Watchdog

A hardware watchdog can be used to restart the module inside. By default, the watchdog is not active. It is handled by two GPIOs.

MTX-65+g V6 has a new internal hardware watchdog component which allows the module to be reset when the internal Java program is not refreshed in a period of 120 seconds, meaning that it hang-ups or does not respond in this time.

- The internal GSM module has been changed from TC65 to TC65i:
  - ARM9 MTX65i+G V6 vs. ARM7 in MTX-65+G V3. More computational power
  - Operational temperature range has been extended to support restricted operation down to -40ºC
  - Lower current consumption in all sleep modes, cut down to less than the half the range of TC65. When in Idle mode, the current is about 40% lower than TC65
  - In transfer modes the current consumption has been minimized by up to 50% depending the connection type
  - Manufacturer Name, USB Vendor ID changed from Siemens to Cinterion
  - With TC65i, Cinterion introduces an improved multiband selection procedure.
  - TC65i provides dedicated Java APIs for direct access to module interfaces: I2C, SPI, DAC and ADC.
  - Simple AGPS feature

- The internal GPS module has been changed
  - A Condor C1216 GS module can be put in low power and active mode with the NMEA command
  - NMEA command for GPS antenna supervision is available
  - Better sensitivity. 5Hz update rate

- Added I2C bus IO expander chip (optional)

	MTX-65+G V3	MTX-65i+G V6
Cinterion module	XT65 rel. 2	TC65i rel. 2
API for I2C, SPI, DAC, ADC	No	Yes
Transparent TCP Service	No	Yes
TLS/SSL for TCP Client, Transparent TCP and HTTP	No	Yes
Tunneling mode	Only transparent GPS mode	Yes
Informal network scan (without SIM)	No	Yes
SMS based diagnostics	No	Yes
GPS inside	ANTARIS 4	C1216 (Trimble)
AT commands to use GPS	AT^SGPSS, AT^SGPSC, AT^SGPSP, AT^SGPSR	Not supported
	Location APS (JSR179) for GPS	Java Location API The package com.cinterion.location includes a Location API to support external GPS applications: - Coordinates Class - Landmark Class - LandmarkStore Class - QualifiedCoordinates Class - AddressInfo Class
Custom Options		TC65i-X: - 2MB RAM - 8MB flash - FOTA without external memory I2c chip to GPIO extender: - Switch off/on the GPS - Control second watchdog
Battery and accelerometer	MTX-65+G+B V5	MTX-65i+G+B V7
MTX-TUNNEL GPS	v2.5	v2.8

1.5 Highlights

Interfaces

- GSM FME M antenna connector
- GPS SMA F antenna connector (*)
- USB 2.0 High Speed port up to 480Mbps
- SIM card interface 1.8V and 3V
- DB9 female connector: complete 8-wire RS232 modem interface (*)
- DB15 female connector:
    - 1x RS232 (2 or 4-wire) port
    - 1x I2C port
    - 5x GPIO (*)
    - 6x Optoisolated I/Os (*)
    - 2x analog inputs (*)
    - 1x analog output (*)
- 1x RS485 port (5-way plug-in terminal block) (*)
- Operating status LEDs
- Audio handset interface (RJ11 connector) (*)
- Plug-in power supply (RJ11 connector)

General features

- Quad band GSM/GPRS 850/900/1800/1900MHz
- GPRS multislot class 12, GSM release 99
- Output power:
    - Class 4 (2W) for EGSM850 & EGSM900
    - Class 1 (1W) for GSM1800 & GSM1900
- SIM Application Toolkit, 3GPP release 99
- Control via AT commands (Hayes, 3GPP TS 27.007, TS 27.005)
- TCP/IP stack access via AT commands
- Internet services: TCP, UDP, HTTP, FTP, SMTP, POP3
- Power consumption at 12V (average)
    - Ultra Low Power: 2.5µA (*)
    - Sleep mode: 7mA (*)
    - Idle (USB active): 17mA
    - Speech mode (850/900MHz): 98.3mA
    - GPRS class 12 (850/900MHz): 201mA
- Operating temperature range: -30ºC to +80ºC
- Dimensions, excluding connectors: 78.1 x 66.8 x 37.2mm
- Weight: < 190 g
- IP30 enclosure
- Internal Hardware Watchdog (*)
- Internal 1650mAh Li-Po battery (*)
- 3-Axis Accelerometer (±2g/±4g/±8g) (*)
- Powered by Cinterion TC65i module

Drivers

- RIL driver for Microsoft® Windows CE™ based devices
- Multiplex Driver driver for Microsoft® Windows and Linux

Specifications

- GPRS data transmission
  - GPRS class 12
  - Mobile station class B
  - PBCCH support
  - Coding schemes CS 1-4
- CSD data transmission
  - Up to 14.4kbps
  - V.110
  - Non-transparent mode
  - USSD support
- Voice features
  - Triple-rate codec for HR, FR and EFR
  - Adaptive multirate AMR
  - Basic hands-free operation
  - Echo cancellation
  - Noise reduction
- SMS
  - Point-to-point MO and MT
  - SMS cell broadcast
  - Text and PDU mode

Java™ features

- JavaTM profile IMP-NG & CLDC 1.1 Hl, GPS support
- Multi-threading programming and program execution
- Memory space for Java applications: 1.7MB RAM & 8MB Flash

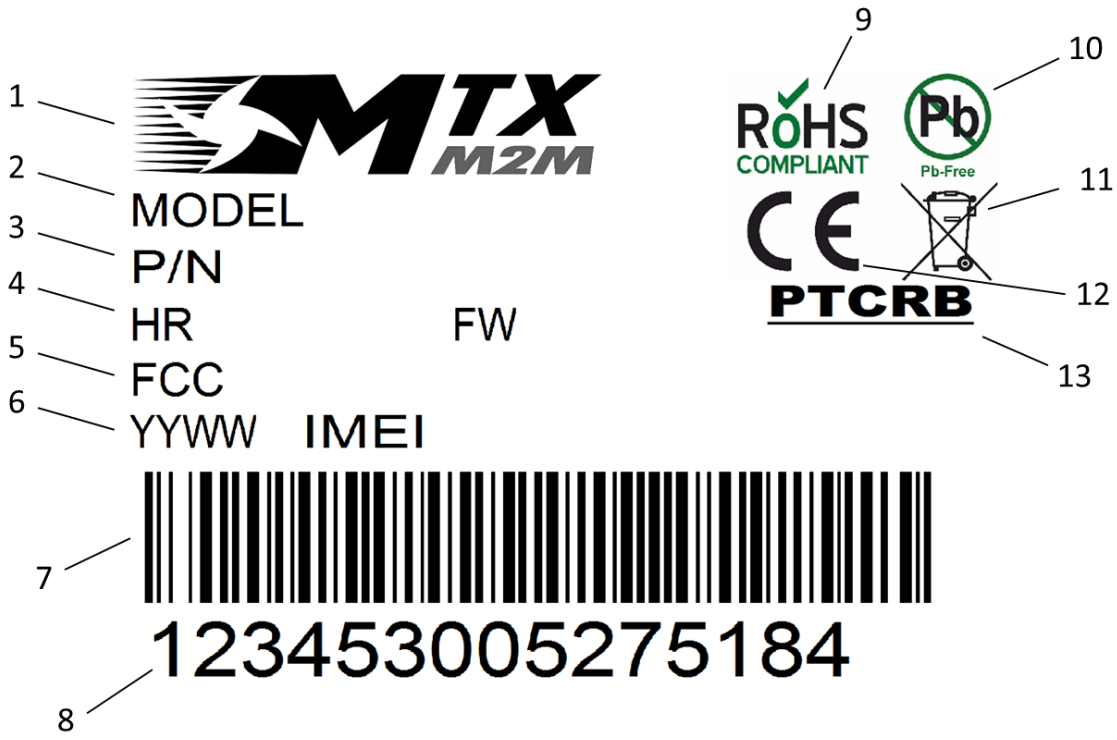
Special features

- Secure data transmission with HTTPS, SSL and PKI
- Serial interface modem for Microsoft® 7™/XP™/Vista™
- RLS Monitoring (Jamming detection)
- Firmware update via USB/RS232
- Integrated Firmware Update Over The Air (FOTA), configurable and royalty free
- TLS for IP over AT
- Tunneling mode for external serial devices
- Real time clock with alarm functionality
- Informal Network Scan

*: depending on model, see Section 1.3

1.6 Product label

The label fixed to the bottom of a MTX Terminal comprises the following information:



No.	Information
1	MTX Terminals logo
2	Product name (model)
3	Product ordering number
4	Hardware and Firmware Revisions
5	FCC ID
6	Year/Week of fabrication
7	Barcode (Code 128) (IMEI)
8	Product IMEI
9	RoHS symbol
10	Pb-Free symbol
11	WEEE symbol
12	CE logo
13	PTCRB Certification logo

1.7 Main features and services

The MTX-65i performs a set of telecom services (TS) according to GSM standard phase 2+, ETSI and ITU-T. The services and functions of the MTX-65i are implemented by issuing customized applications embedded on the device, by AT commands issued internally or over the USB, RS232 or RS485 interface.

1.7.1 Key features at a glance

The MTX-65i is a GSM/GPRS band mobile station with the characteristics shown in the table below.

Feature	Implementation
General	
Frequency bands	GSM/GPRS: Quad band, 850/900/1800/1900MHz
GSM class	Small MS
Output power	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900 The values stated above are maximum limits. According to Release 99, the maximum output power in a multislot configuration may be lower. The nominal reduction of maximum output power varies with the number of uplink timeslots used and amounts to 2.0dB for 2Tx, 4.0dB for 3Tx and 6.0dB for 4Tx.
Power supply	Single supply voltage Maximum: 6.5 to 40V (without damage the device)* Recommended: 7 to 35V **(Device operation from 6.5 to 7V is not guaranteed over the whole temperature range / Supplies from 35 to 40V may damage the device during a extended use)*
Physical	Dimensions: 78,1 x 66,8 x 37,2 mm Weight: approx. 190g
RoHS	All hardware components are fully compliant with the EU RoHS Directive
GSM / GPRS features	
Data transfer	GPRS • Multislot Class 12 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 CSD • V.110, RLP, non-transparent • 9.6kbps • USSD PPP-stack for GPRS data transfer
SMS	Point-to-point MT and MO Cell broadcast Text and PDU mode Storage: SIM card plus 25 SMS locations in mobile equipment Transmission of SMS alternatively over CSD or GPRS. Preferred mode can be user defined
Fax	Group 3; Class 1
Audio	Speech codecs: • Half rate HR (ETS 06.20) • Full rate FR (ETS 06.10) • Enhanced full rate EFR (ETS 06.50/06.60/06.80) • Adaptive Multirate AMR

	Line echo cancellation, noise reduction, DTMF, 7 ringing tones
Software	
AT commands	Hayes, 3GPP TS 27.007, 27.005, Gemalto M2M
Java™ Open Platform	Java™ Virtual Machine with APIs for amongst others AT Parser, Serial Interface, FlashFile System and TCP/IP Stack. Major benefits: seamless integration into Java applications, ease of programming, no need for application microcontroller, extremely cost-efficient hardware and software design – an ideal platform for industrial GSM applications. The memory space available for Java programs is around 1.7MB in the flash file system and around 6MB RAM. Application code and data share the space in the flash file system and in the RAM.
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
Remote SIM Access	MTX-65i supports Remote SIM Access. RSA enables MTX-65i to use a remote SIM card via its serial interface and an external application, in addition to the SIM card locally attached to the modem. The connection between the external application and the remote SIM card can be a Bluetooth wireless link or a serial link. The necessary protocols and procedures are implemented according to the "SIM Access Profile Interoperability Specification of the Bluetooth Special Interest Group"
Firmware update	Firmware update from host application over RS232/USB. Over-the-air (OTA) firmware is also possible.
Interfaces (depending on models)	
USB	Supports a USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant
RS232 (8-wire)	Adjustable baud rates: 1200bps to 921600bps Autobauding: 1200 to 230400bps Supports RTS/CTS hardware flow control Multiplex ability according to GSM 07.10 Multiplexer Protocol
RS232 (4-wire)	Adjustable baud rates: 1200bps to 921600bps Autobauding: 1200 to 230400bps Supports RTS/CTS hardware flow control Multiplex ability according to GSM 07.10 Multiplexer Protocol
RS485	Adjustable baud rates: 1200bps to 921600bps Autobauding: 1200 to 230400bps Half-duplex
I2C interface	Supports I2C serial interface up to 400kbps
Audio	RJ11 connector provides balanced analog inputs and outputs for a microphone and an earpiece.
GPIO	Up to 5 GPIO lines and 6 Optoisolated I/O's
ADC	Up to 2 analog-to-digital converters
DAC	1 digital-to-analog converter
Status	Bi-colour LED to indicate network connectivity status.
UICC interface	Supported chip cards: UICC/SIM/USIM 3V, 1.8V
Antenna	50 Ohms. GSM/UMTS main antenna
Power on/off, Reset	
Power on/off	Automatic switch-on at power supply Switch off by AT command Switch off by hardware signal TURN_OFF Automatic switch-off in case of critical temperature or voltage conditions
Software Reset	Orderly shutdown and reset by AT command
Hardware Reset	Emergency reset by hardware signal TURN_OFF
Special features	
Antenna	SAIC (Single Antenna Interference Cancellation) / DARP (Downlink Advanced Receiver Performance) Rx Diversity (receiver type 3i – 64-QAM) / MIMO

1.7.2 Operating modes

The table below briefly summarizes the various operating modes referred to in the following chapters.

Limits	Function	
Normal operation	GSM / GPRS SLEEP	Various power saving modes set using the AT+CFUN command. Software is active to a minimum extent. If the modem was registered to the GSM network in IDLE mode, it is registered and paging with the BTS in SLEEP mode too. Power saving can be chosen at different levels: the NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The CYCLIC SLEEP modes AT+CFUN=7 and 9 can be used to alternately activate and deactivate the AT interfaces to allow permanent access to all AT commands.
	GSM IDLE	Software is active. Once registered to the GSM network, paging with BTS is carried out. The modem is ready to send and receive.
	GSM TALK	Connection between two subscribers is in progress. Power consumption depends on the individual settings of network coverage such as DTX off/on, FR/EFR/HR, hopping sequences, and antenna.
	GPRS IDLE	Terminal is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. used multislot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).
Sleep mode	Normal shutdown after sending the AT^SMSO command. The internal GSM engine enters in a power down mode where only a voltage regulator is active for powering the internal RTC. Software is not active. Interfaces are not accessible.	
Ultra Low Power mode	Only available in MTX-65i-ULP modems. All the electronic systems remain disconnected from the power supply input, with the exception of a little piece of logic which allows for waking up the modem again.	
Airplane mode	Airplane mode shuts down the radio part of the modem, causes the modem to log off from the GSM/GPRS network, and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by using the AT commands AT^SCFG and AT+CALA: • With AT^SCFG=MEopMode/Airplane/OnStart, the modem can be configured to enter Airplane mode each time it is switched on or reset • The parameter AT^SCFG=MEopMode/Airplane can be used to switch back and forth between Normal mode and Airplane mode at any point during operation. • Setting an alarm with AT+CALA followed by AT^SMSO wakes the modem up into Airplane mode at the scheduled time.	

1.7.3 Power Consumption

It is recommended to use 12V/1.5A power supply.

	Description	Conditions		Typical	Unit
IIN[1]	ULP mode supply current	Ultra Low Power Mode		2.5	µA
	Sleep mode supply current	Internal GSM module powered down		7	mA
	GSM/GPRS supply current	IDLE (UART activated but no communication)	USB disconnected	13	mA
			USB active	17	mA
		GSM call (GSM850/900; P_{RFOUT}=2W; 1Tx/1Rx; ROPR=1..3)	Average	98.3	mA
			Burst	553	mA
		GPRS Class 8 (GSM850/900; P_{RFOUT}=2W; 1Tx/4Rx; ROPR=1..3)	Average	95	mA
			Burst	553	mA
		GPRS Class 10 (GSM850/900; P_{RFOUT}=2W; 2Tx/3Rx; ROPR=1)	Average	170	mA
			Burst	553	mA
		GPRS Class 10 (GSM850/900; P_{RFOUT}=1W; 2Tx/3Rx; ROPR=2/3)	Average	143	mA
			Burst	451	mA
		GPRS Class 12 (GSM850/900; P_{RFOUT}=1W; 4Tx/1Rx; ROPR=1)	Average	201	mA
			Burst	382	mA
		GPRS Class 12 (GSM850/900; P_{RFOUT}=0.5W; 4Tx/1Rx; ROPR=2/3)	Average	170	mA
			Burst	307	mA
		GSM call (GSM1800/1900; P_{RFOUT}=1W; 1Tx/1Rx; ROPR=1..3)	Average	75	mA
			Burst	348	mA
		GPRS Class 8 (GSM1800/1900; P_{RFOUT}=1W; 1Tx/4Rx; ROPR=1..3)	Average	75	mA
			Burst	348	mA
		GPRS Class 10 (GSM1800/1900; P_{RFOUT}=1W; 2Tx/3Rx; ROPR=1)	Average	116	mA
			Burst	348	mA
		GPRS Class 10 (GSM1800/1900; P_{RFOUT}=0.5W; 2Tx/3Rx; ROPR=2/3)	Average	102	mA
			Burst	297	mA
		GPRS Class 12 (GSM1800/1900; P_{RFOUT}=0.5W; 4Tx/1Rx; ROPR=1)	Average	143	mA
			Burst	245	mA
		GPRS Class 12 (GSM1800/1900; P_{RFOUT}=0.25W; 4Tx/1Rx;ROPR=2/3)	Average	133	mA
			Burst	218	mA

1. With an impedance of Z_{LOAD}=50Ohm at the antenna port.
2. Measurements start 6 minutes after switching ON the modules
   Average times: SLEEP and ULP mode – 3 minutes, transfer modes – 1.5 minutes
   Communication tester settings: no neighbor cells, no cell reselection etc., RMC (reference measurement channel)

Description	Conditions	Typ	Max	Unit
ULP mode supply current	T_A = 25ºC	2.5	5	µA
	T_A = 85ºC	8.5	34	µA

1.7.4 RF antenna interface description

The table below briefly summarizes the RF Antenna interface GSM/UMTS

Parameter	Conditions	Min.	Typical	Max.	Unit
Frequency range Uplink (MS → BTS)	GSM 850	824		849	MHz
	EGSM 900	880		915	MHz
	GSM 1800	1710		1785	MHz
	GSM 1900	1850		1910	MHz
Frequency range Uplink (BTS → MS)	GSM 850	869		894	MHz
	EGSM 900	925		960	MHz
	GSM 1800	1805		1880	MHz
	GSM 1900	1930		1990	MHz
RF Power @ ARP with 50Ohm Load	GSM 850	31	33	35	dBm
	EGSM 900[1]	31	33	35	dBm
	GSM 1800[2]	28	30	32	dBm
	GSM 1900	28	30	32	dBm
Number of carriers	GSM 850		124		
	EGSM 900		174		
	GSM 1800		374		
	GSM 1900		299		
Duplex spacing	GSM 850		45		MHz
	EGSM 900		45		MHz
	GSM 1800		95		MHz
	GSM 1900		80		MHz
Carrier spacing			200		kHz
Multiplex, Duplex		TDMA/FDMA, FDD			
Time slots per TDMA frame			8		
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Static Receiver Input Sensitivity @ ARP	GSM 850	-102	-108		dBm
	EGSM 900	-102	-108		dBm
	GSM 1800	-102	-107		dBm
	GSM 1900	-102	-107		dBm

1. Power control level PCL 5
2. Power control level PCL 0

1.7.5 SIM Card

The MTX-65i family supports an external SIM card through the integrated SIM holder. Both 3V and 1.8V SIM technology is supported. The older 5V SIM technology is not supported.

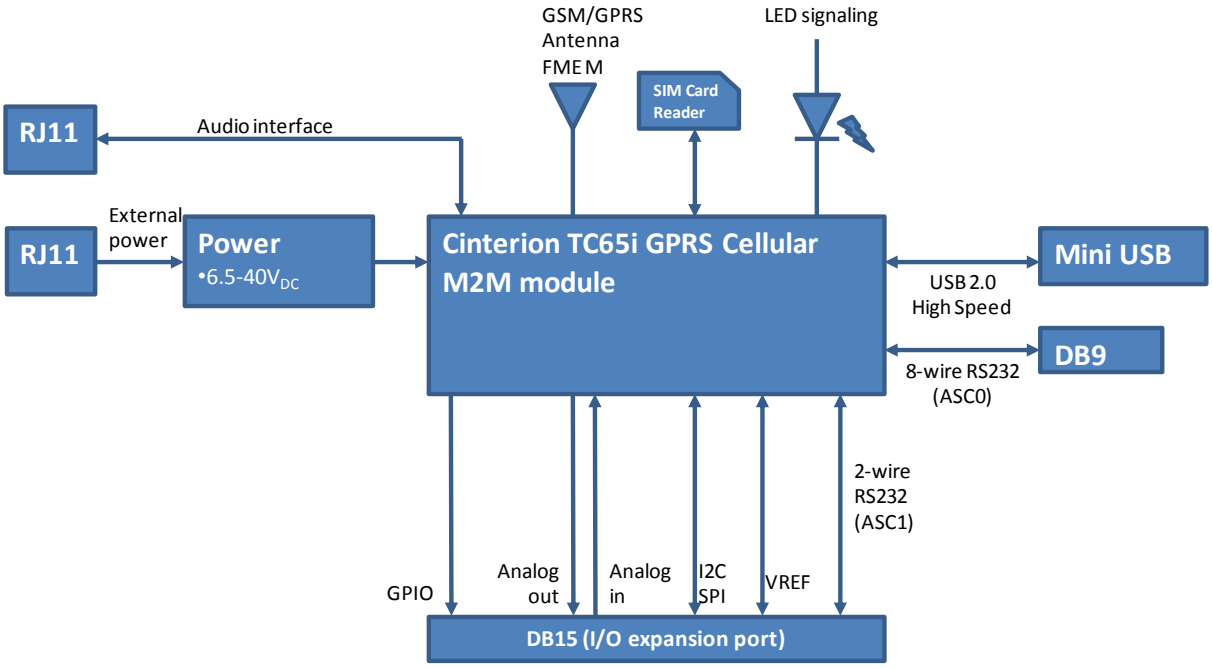
1.8 Precautions

MTX-65i as a standalone item is designed for indoor use only. For outdoor use it must be integrated into a weatherproof enclosure. Do not exceed the environmental and electrical limits as specified in Technical Data

1.9 Block diagram

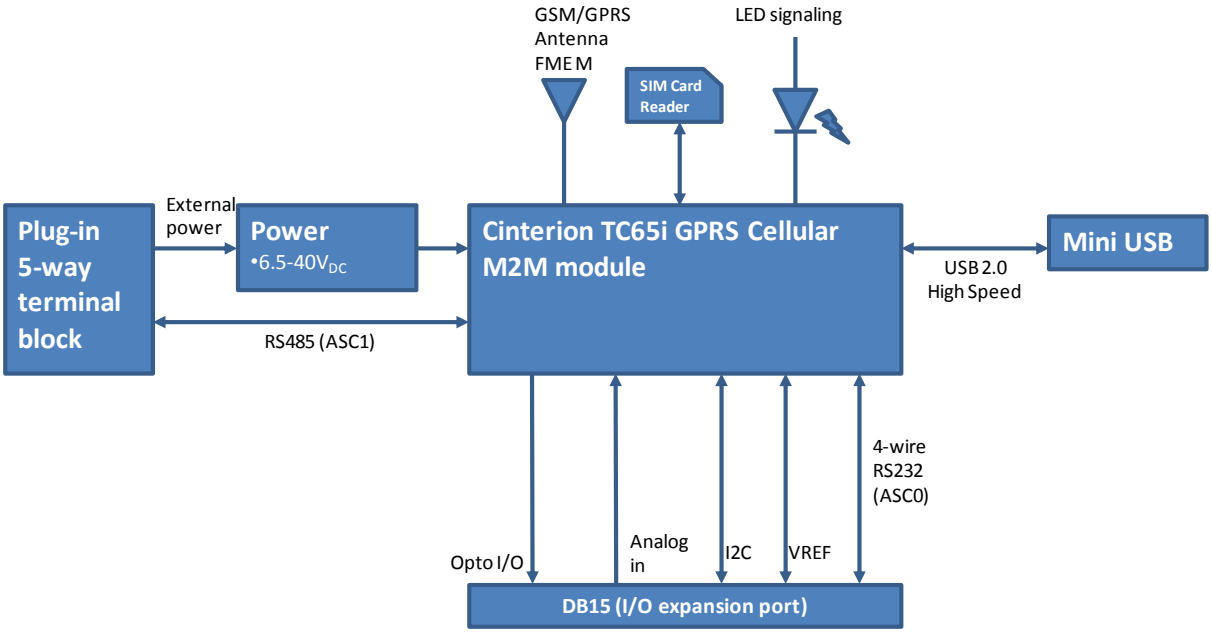
1.9.1 MTX-65i

The base MTX-65i modem's block diagram is shown in the following figure:



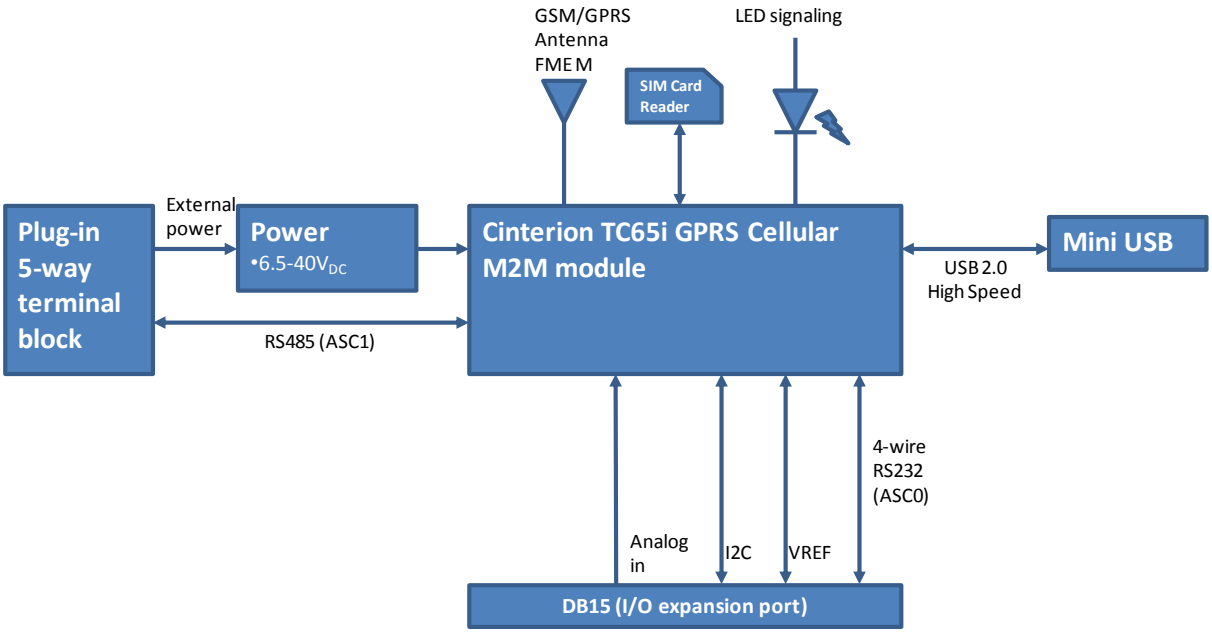
1.9.2 MTX-65i-RS485

The MTX-65i-RS485 modem's block diagram is shown in the following figure:



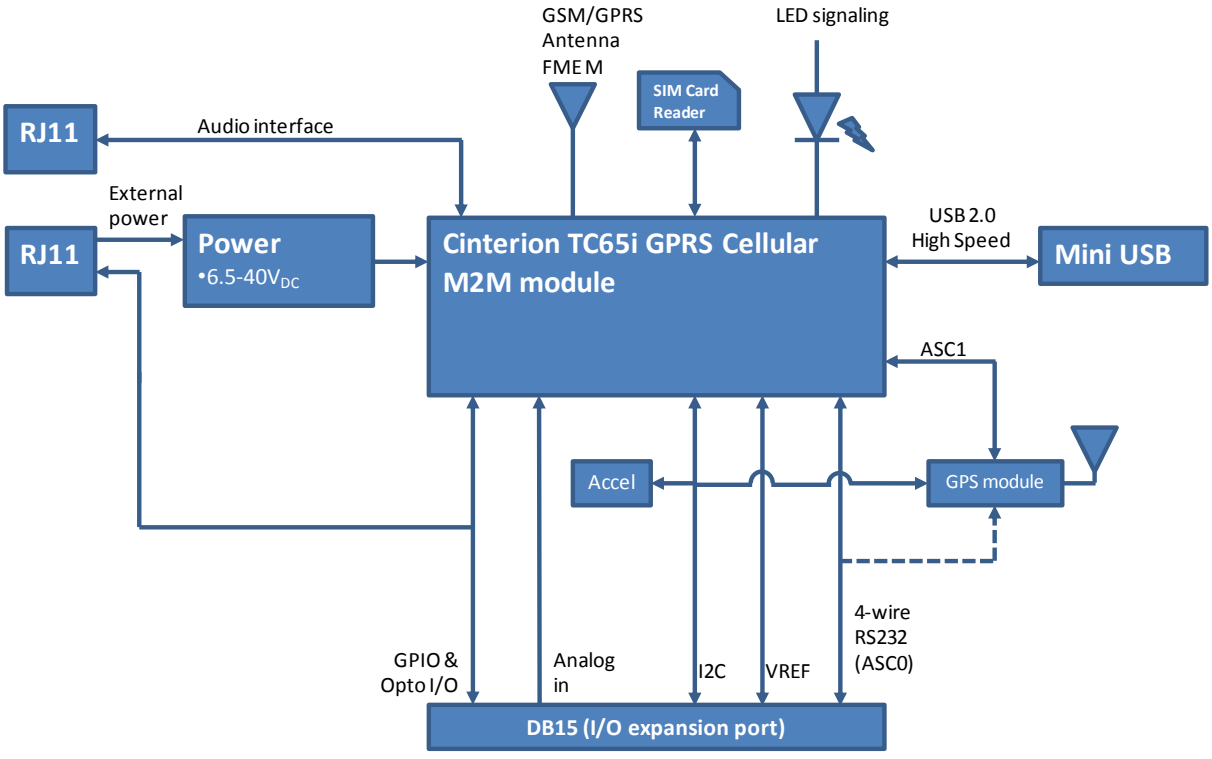
1.9.3 MTX-65i-RS485-LC

The MTX-65i-RS485-LC modem's block diagram is shown in the following figure:



1.9.4 MTX-65i+G V6, MTX-65i+G+B V7 and MTX-65i-BAT

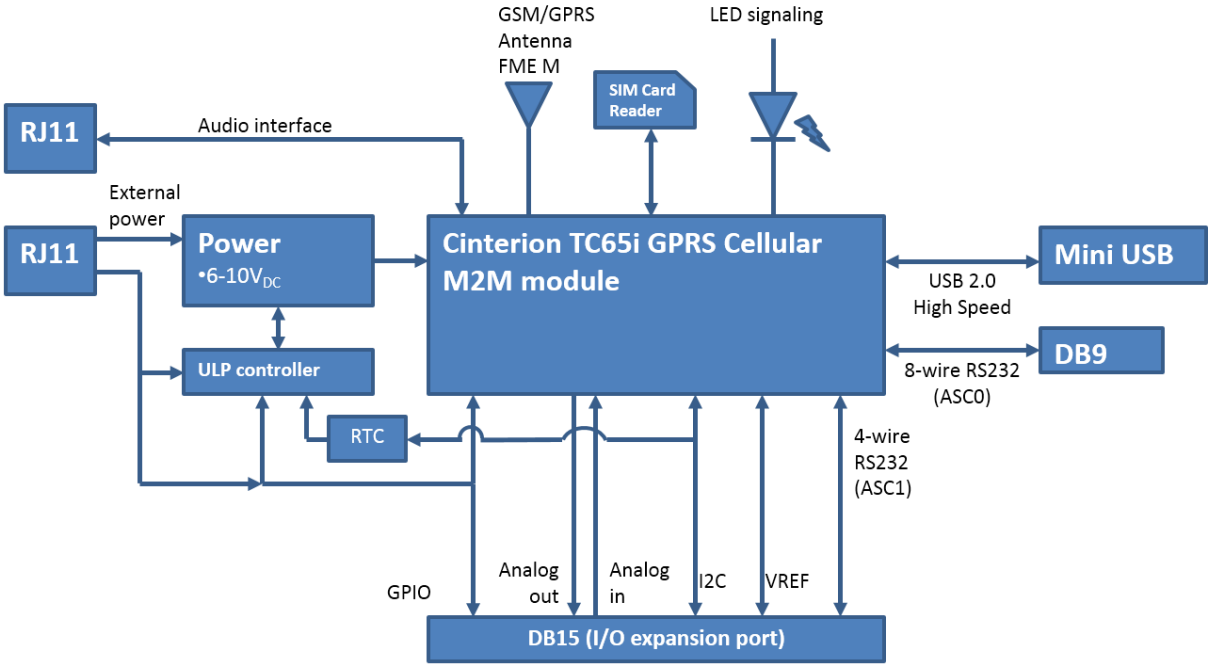
The MTX-65i+G V6 and MTX-65i+G+B V7 modem's block diagram is shown in the following figure:



Note: MTX-65i-BAT does not include the GPS module

1.9.5 MTX-65i-ULP

The general MTX-65i-ULP modem's block diagram is shown in the following figure:



1.10 Hardware revisions

MTX-65i

Hardware Revision	Starting production date	Changes
2.03	01/2014	Initial version

MTX-65i-ULP

Hardware Revision	Starting production date	Changes
2.03	01/2014	Initial version
2.03.01	06/2014	DB15 connector: functionality of pins 9 and 10 is switched: • Before: pin 9 → VEXT, pin 10 → DAC_OUT • Now: pin 9 → DAC_OUT, pin 10 → VEXT

MTX-65i-RS485 and MTX-65i-RS485-LC

Hardware Revision	Starting production date	Changes
1.02	01/2014	Initial version

MTX-65i+G V6 and MTX-65i+G+B V7

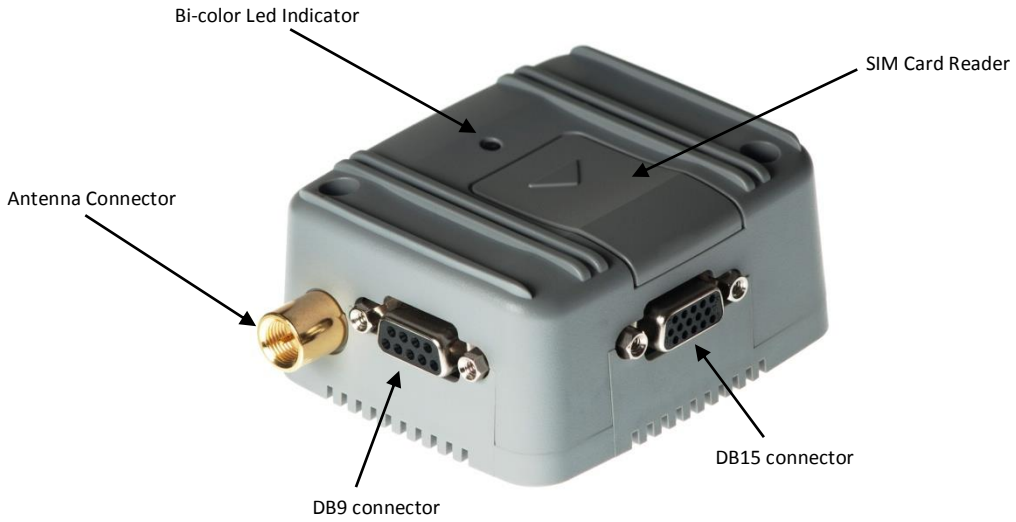
Hardware Revision	Starting production date	Changes
5.02	01/2014	Initial version

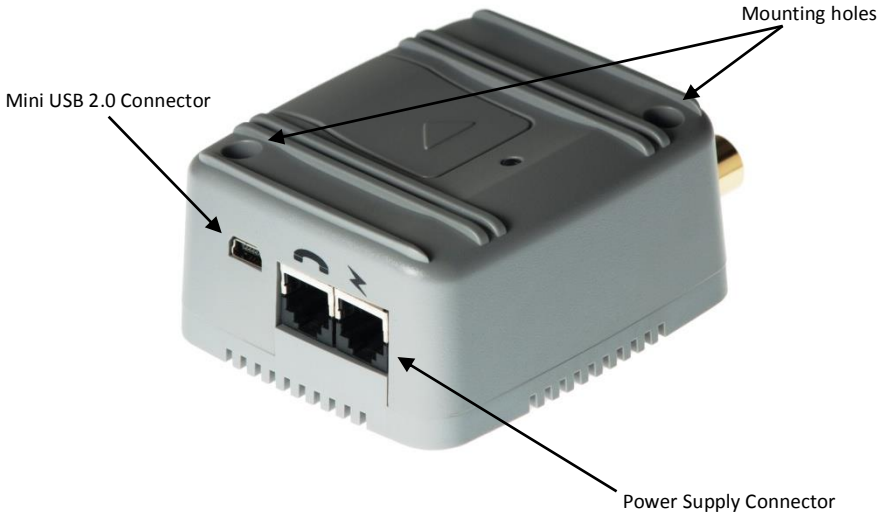
2. Mechanical description

2.1 MTX-65i and MTX-65i-ULP

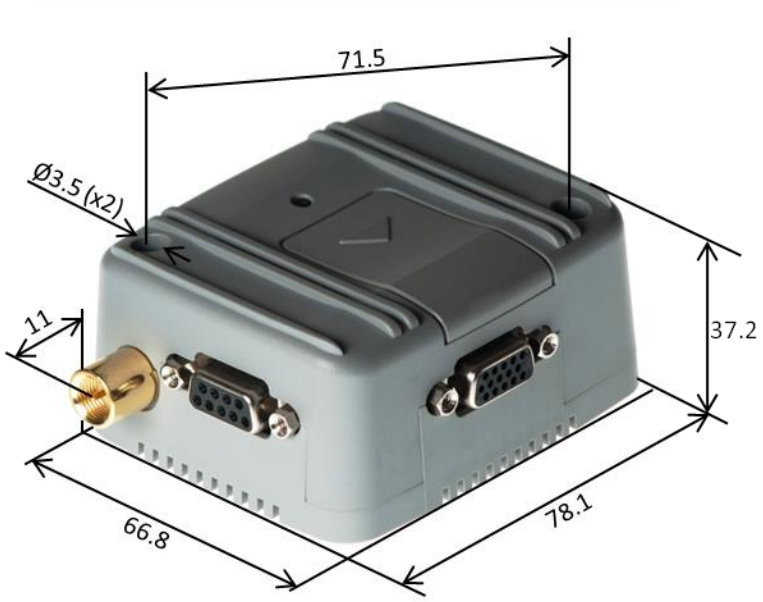
2.1.1 Overview

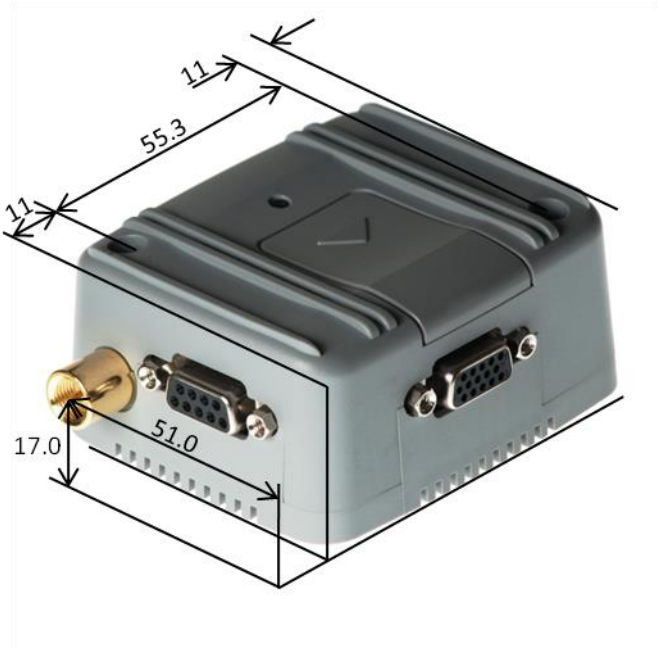
The pictures below show the mechanical design of the modem along with the positions of the different connectors and mounting holes. The modem case is made of durable PC/ABS plastic.





2.1.2 Dimensions





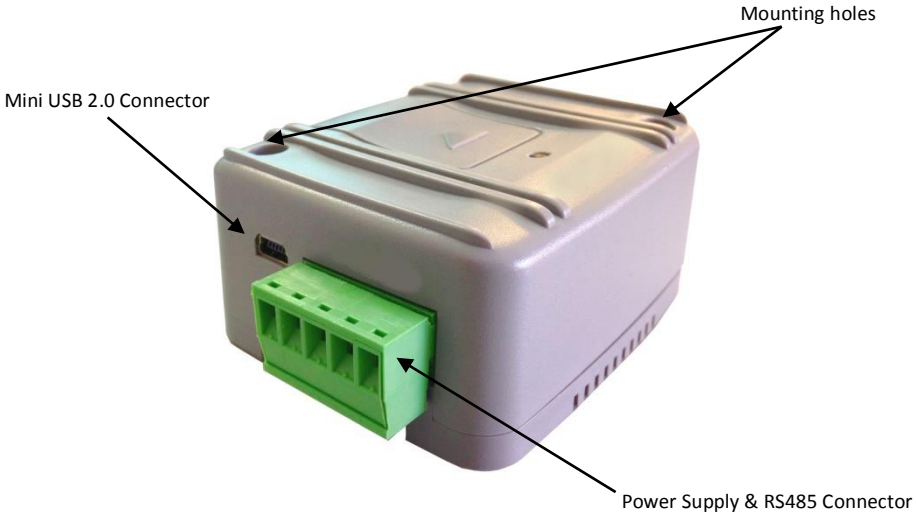
All dimensions are in millimeters

All dimensions are in millimeters

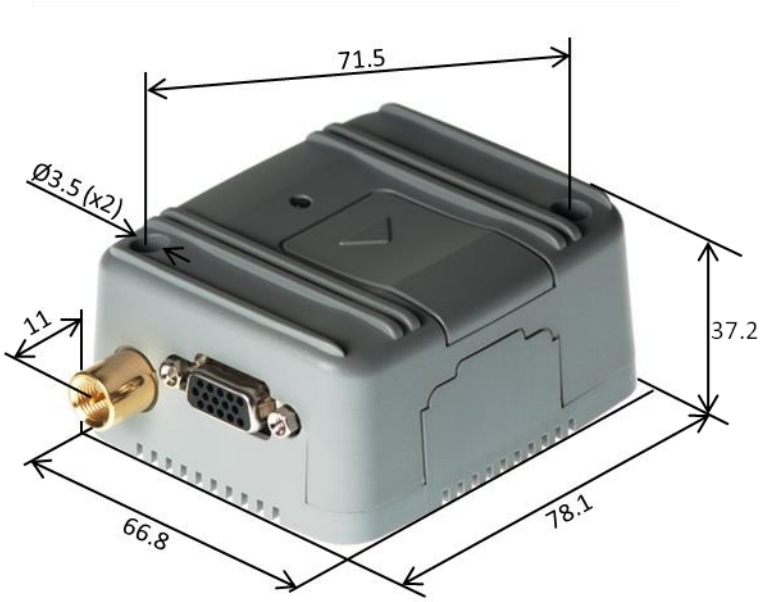
2.2 MTX-65i-RS485 and MTX-65i-RS485-LC

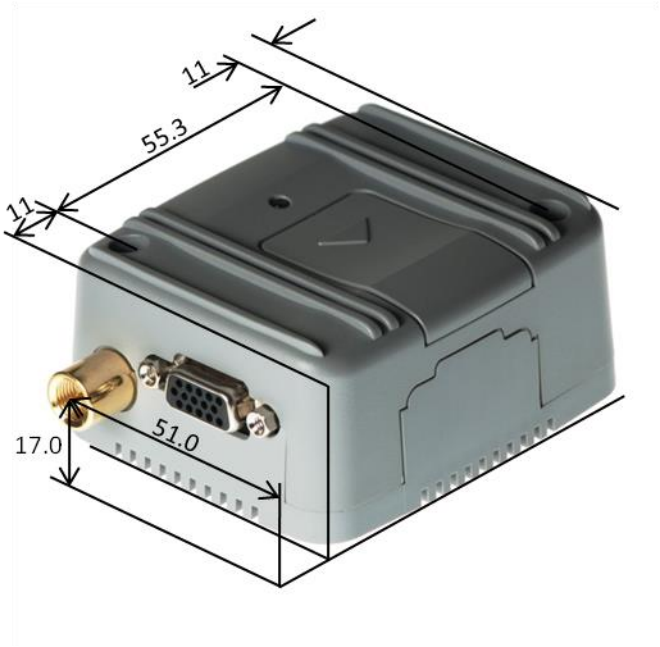
2.2.1 Overview

The pictures below show the mechanical design of the modem along with the positions of the different connectors and mounting holes. The modem case is made of durable PC/ABS plastic.

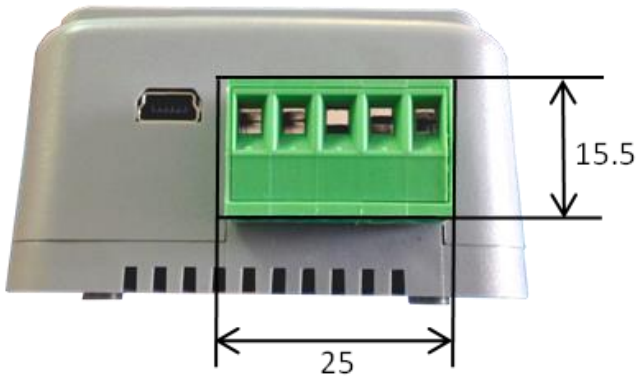


2.2.2 Dimensions





All dimensions are in millimeters

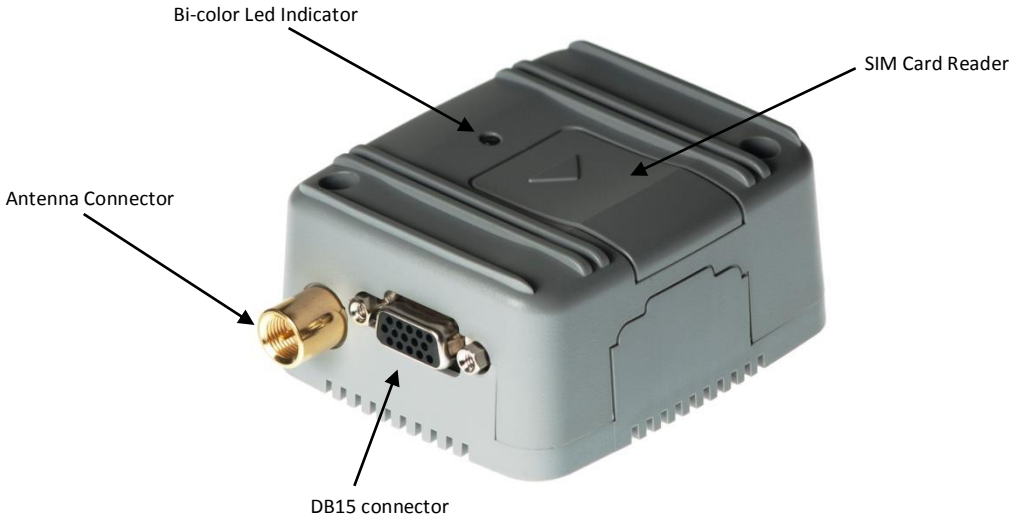


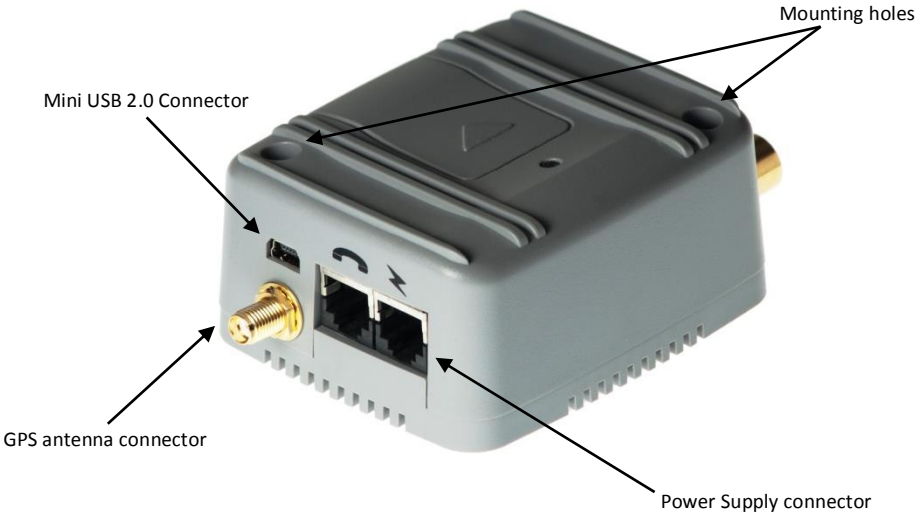
All dimensions are in millimeters

2.3 MTX-65i+G V6, MTX-65i+G+B V7 and MTX-65i-BAT

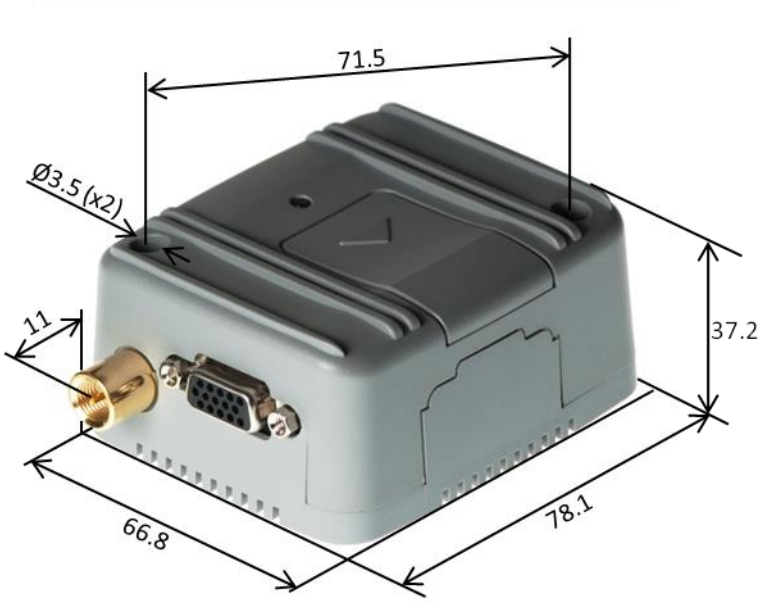
2.3.1 Overview

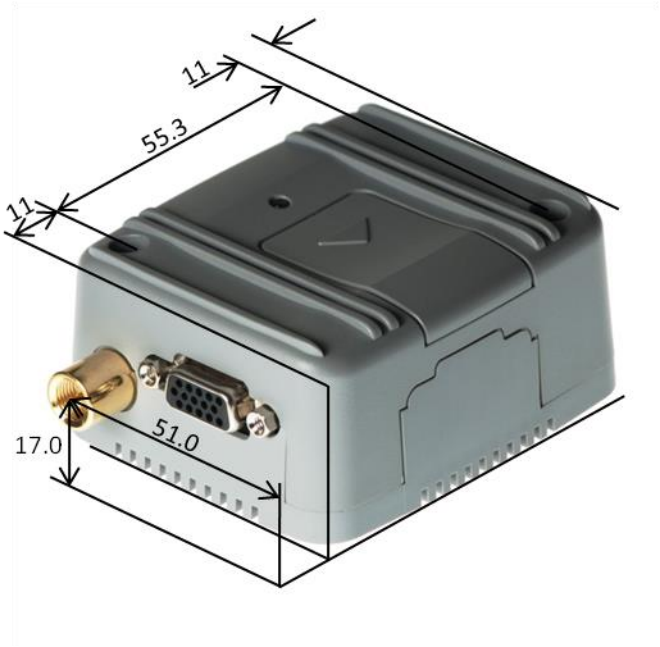
The pictures below show the mechanical design of the modem along with the positions of the different connectors and mounting holes. The modem case is made of durable PC/ABS plastic.



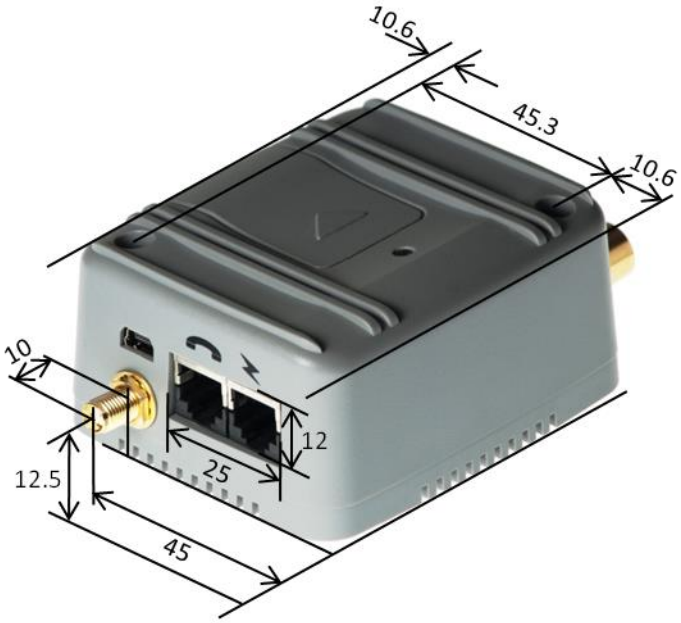


2.3.2 Dimensions





All dimensions are in millimeters



All dimensions are in millimeters

3. Electrical and environmental characteristics

3.1 Electrical specifications

3.1.1 Power supply

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
VIN	Supply voltage	All models except ULP devices	0	45	V
VIN	Supply voltage	All ULP devices	0	10	V

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
VIN	Supply voltaje (all models except ULP)	Maximum	6.5		40	V
		Recommended	7		35	V
VIN	Supply voltaje (all ULP devices)	Maximum	6		10	V
		Recommended	6.5	7.2	9.5	V
IIN	Supply current		-	*	-	A
η	Efficiency	VIN=12V, IIN=2A, 25ºC		80		%
f_O	Switching Frequency		127	150	173	kHz

* See section 1.6.3

3.1.2 RS232 interface

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Input voltage range	Drivers	-0.3	6	V
		Receivers	-25	25	V
V_O	Output voltage range	Drivers	-13.2	13.2	V
		Receivers	-0.3	5	V
	Electrostatic discharge	Human body model		2	kV

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
V_{OH}	Driver high-level output voltage	R_L=3kΩ to GND	5	5.4		V
V_{OL}	Driver low-level output voltage	R_L=3kΩ to GND	-5	-5.4		V
r_o	Driver output resistance	VIN = 0V	300	10M		Ω
V_{IT+}	Receiver positive-going input threshold voltage			1.5	2.4	V
V_{IT-}	Receiver negative-going input threshold voltage		0.6	1.2		V
V_{hys}	Receiver input hysteresis (V_{IT+} - V_{IT-})			0.3		V
r_i	Receiver input resistance	Input voltage ±3 to ±25V	3	5	7	kΩ

3.1.3 RS485 interface

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Voltage input range, transient pulse, A and B, through 100 Ω			±50	V
I_O	Receiver output current			±11	mA
	Electrostatic discharge	Human body model		±16	kV
		Chraged-device model		±1	kV

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
$\|V_{OD}\|$	Driver differential output voltage	I_O =0	2		3	V
		R_L=54kΩ	-5	-5.4		V
$C_{(OD)}$	Driver differential output capacitance	V_{OD} =0.4sin(4Eπt)+0.5V		16		pF
I_{OS}	Driver short-circuit output current		-250		+250	mA
V_{IT+}	Receiver positive-going input threshold voltage	I_O =-8mA		-0.065	-0.01	V
V_{IT-}	Receiver negative-going input threshold voltage	I_O =8mA	-0.2	-0.1		V
V_{hys}	Receiver input hysteresis (V_{IT+} - V_{IT-})			35		mV
$C_{(ID)}$	Receiver differential input capacitance	V_{OD} =0.4sin(4Eπt)+0.5V		15		pF

Note: The RS485 interface does not include any serial or parallel terminator resistors. Users should mount them depending on their needs

3.1.4 I2C/SPI interface

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Input voltage range		-0.3	+3.5	V

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
V_{IH}	High-level input voltage		2.15		3.05	V
V_{IL}	Low-level input voltage				0.8	V
V_{OH}	High-level output voltage	I=-0.5mA	2.55		3	V
V_{OL}	Low-level output voltage	I=2mA			0.2	V

3.1.5 Audio interface

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Input voltage		-0.3	3.5	V

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
Output						
V_{OD}	Audio output differential voltage	Audio mode 5, Outstep 4, no load, minimum differential load 7.5Ω		4.2	6	Vpp
R_o	Differential output load resistance		7.5	8		kΩ
G_E	Absolute output gain error	outBbcGain=2	-0.1		0.1	dB
N	Idle output channel noise	outBbcGain=2		-83	-75	dBm
SNR	Output Signal to Noise and Distortion	outBbcGain=2	47			dB
	Output Frequency response	0-100Hz			-34	dB
		200Hz		-1.1		dB
		300-3350Hz	-0.2		0.1	dB
		3400Hz		-0.7		dB
		4000Hz		-39		dB
		≥4400Hz			-75	dB
Input						
V_{ID}	Full scale input voltage	Audio mode 5		1.6		Vpp
	Input amplifier gain in 6dB steps		0		42	dB
N	Idle input channel noise			-82	-76	dBm
SNR	Input Signal to Noise and Distortion			70	77	dB
	Input Frequency response	0-100Hz			-34	dB
		200Hz		-1.1		dB
		300-3350Hz	-0.2		0.1	dB
		3400Hz		-0.7		dB
		4000Hz		-39		dB
		≥4400Hz			-75	dB

3.1.6 GPIO

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Input voltage range		-0.5	3.5	V

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
V_{IH}	High-level input voltage		2.15		3.05	V
V_{IL}	Low-level input voltage				0.8	V
V_{OH}	High-level output voltage	I=-0.5mA	2.55		3	V
V_{OL}	Low-level output voltage	I=2mA	2.5		0.2	V

3.1.7 Optoisolated Input/Output

ABSOLUTE MAXIMUM RATINGS (TCMD4000 OPTOCOUPLER)					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
Input					
V_R	Reverse voltage			6	V
I_F	Forward current			60	mA
I_{FSM}	Forward surge current			1.5	A
P_{diss}	Power dissipation			100	mW
Output					
V_{CEO}	Collector-emitter voltage			35	V
V_{ECO}	Emitter-collector voltage			7	V
I_C	Collector current			80	mA
I_{CM}	Collector peak current	$t_P/T=0.5$, $t_P \leq 10ms$		100	mA
P_{diss}	Power dissipation			150	mW
Coupler					
V_{ISO}	AC isolation test voltage (RMS)			3750	V_{RMS}
P_{tot}	Total power dissipation			250	mW

CHARACTERISTICS (TCMD4000 OPTOCOUPLER)						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
Input						
V_F	Forward voltage	I_F =50mA		1.25	1.6	V
C_j	Junction capacitance	V_R =0V, f=1MHz		50		pF
Output						
V_{CEO}	Collector-emitter voltage	I_C =100µA	35			V
V_{ECO}	Emitter-collector voltage	I_E =100µA	7			V
I_{CEO}	Collector dark current	V_{CE}=10V, I_F =0			100	nA
Coupler						
V_{CEsat}	Collector-emitter saturation voltage	I_F =20mA, I_C =5mA			1	V
f_c	Cut-off frequency	I_F =10mA, V_{CE}=5V, R_L=100Ω		10		kHz
C_k	Coupling capacitance	f=1MHz		0.3		pF
I_C /I_F	Current transfer ratio	V_{CE} =2V, I_F=1mA	600	800		%
t_r	Rise time	V_{CE} =2V, I_F=1mA, R_L=100Ω		300		µs
t_{off}	Turn-off time	V_{CE} =2V, I_F=1mA, R_L=100Ω		250		µs

Please see equivalent circuits in Section 4.5.6 to view voltage input/output ranges and determine operating conditions in each case.

3.1.8 Analog Input/Output

ABSOLUTE MAXIMUM RATINGS					
Symbol	**Parameter**	**Conditions**	**Min.**	**Max.**	**Unit**
V_I	Input voltage		-0.3	3.5	V

CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
$V_{OH(PWM)}$	PWM/DAC High-level output voltage	I=-0.5mA	2.55		3	V
$V_{OL(PWM)}$	PWM/DAC Low-level output voltage	I=2mA			0.2	V
$DC_{(PWM)}$	PWM/DAC Duty cycle in percentage steps		0		100	%
$f_{(PWM)}$	PWM frequency		320, 970, 8125, 16250, 32500, 65000			Hz
V_{ia}	ADC input voltage range		0		2.4	V
R_i	ADC input resistance			750		kΩ
T_m	Measurement interval		0.1		30	s
	Resolution	1 step = 1mv		2400		steps
	Total accuracy				±2	mV
f_c	Cut-off frequency			30		Hz
	Accuracy				±0.5	mV
E_L	ADC Linearity error				±0.5	mV
E_T	ADC Temperature error				±0.5	mV
E_B	ADC Burst error				±0.5	mV

3.2 Operating temperatures

Please note that the modem's lifetime, i.e., the MTTF (mean time to failure) may be reduced if operated outside the extended temperature range.

Parameter	Min	Typ	Max	Unit
Normal operation	-30	+25	+70	°C
Restricted operation[1]	-40 to -30		+70 to +75	°C
Automatic shutdown[2]	<-40		>+80	°C

1. Restricted operation allows speech calls and data transmissions in normal mode for a limited time until the automatic thermal shutdown mode takes effect. The duration of emergency calls is unlimited because the automatic thermal shutdown is deferred until the call is hung up. Within the extended temperature range (outside the operating temperature range) the specified electrical characteristics may be increased or decreased.
2. Due to uncertainty in the temperature measurement, a tolerance of ±5ºC on the stated shutdown thresholds may occur.

Note that within the specified operating temperature ranges, the modem temperature may vary to a great extent depending on the operating mode, frequency band used, radio output power and current supply voltage.

3.3 Storage conditions

The conditions stated below are only valid for modems in their original packed state in weather protected, non-temperature-controlled storage locations. Normal storage time under these conditions is a maximum of 12 months. The modems will be delivered in a packaging that meets the requirements according “IPD/JEDEC J-STD-033B.1” for Low Temperature Carriers.

Type	Condition	Unit	Reference
Air temperature: Low High	-30 +75	ºC	ETS 300 019-2-1: T1.2, IEC 60068-2-1 Ab ETS 300 019-2-1: T1.2, IEC 60068-2-2 Db
Relative humidity: Low High Condensation	10 90 at 30ºC 90-100 at 30ºC	%	--- ETS 300 019-2-1: T1.2, IEC 60068-2-56 Cb ETS 300 019-2-1: T1.2, IEC 60068-2-30 Db
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1:1K4 IEC TR 60271-3-1:1K4
Movement of surrounding air	1.0	m/s	IEC TR 60271-3-1:1K4
Water: rain, dripping, icing and frosting	Not allowed	-	-
Radiation: Solar Heat	1120 600	W/m2	ETS 300 019-2-1: T1.2, IEC 60068-2-2Bb ETS 300 019-2-1: T1.2, IEC 60068-2-2Bb
Chemically active substances	Not recommended		IEC TR 60271-3-1:1C1L
Mechanically active substances	Not recommended		IEC TR 60271-3-1:1S1
Sinusoidal Vibration: Displacement Acceleration Frequency range	 1.5 5 2-9 9-200	 mm m/s2 Hz	IEC TR 60271-3-1:1M2
Shocks: Shock spectrum Duration Acceleration	 semi-sinusoidal 1 50	 ms m/s2	IEC 60068-2-27 Ea

4. Interface description

All electrical connections to the modem are protected in compliance with the standard air and contact Electrostatic Discharge (ESD).

The modem family uses the following industry standard connectors:

- USB mini connector
- DB9 female (main RS232 port)
- DB15 female (main RS232 and/or I/O expansion connector)
- RJ11 6-way (power supply connector)
- RJ11 6-way (audio handset connector)
- 5 way plug-in terminal block (power supply and RS485 bus)
- SIM card reader
- FME male coaxial jack (antenna connector)
- SMA female coaxial jack (GPS/GNSS antenna connector) or other RF options

4.1 Power supply connector

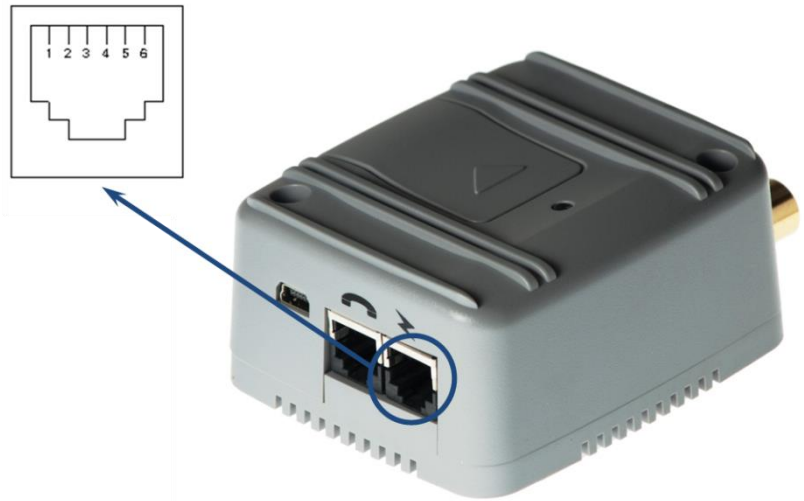
Depending on the specific modem you are using, you will dispose of one of the connectors described in the sections below. Please read them carefully.

4.1.1 RJ11 (MTX-65i)

An RJ11 6-way connector, as shown and described below, serves as a means of supplying and controlling DC power to the modem.

The power supply voltage (VCC) required by the modem is in the range of 6.5 to 40VDC. We recommend a 12V DC power supply. The power supply has to be a single voltage source capable of providing a current peak during an active transmission. The uplink burst causes strong ripples (drop) on the power lines.

By default, the MTX-65i will automatically switch on when power supply is applied at PIN 1 and PIN 6.



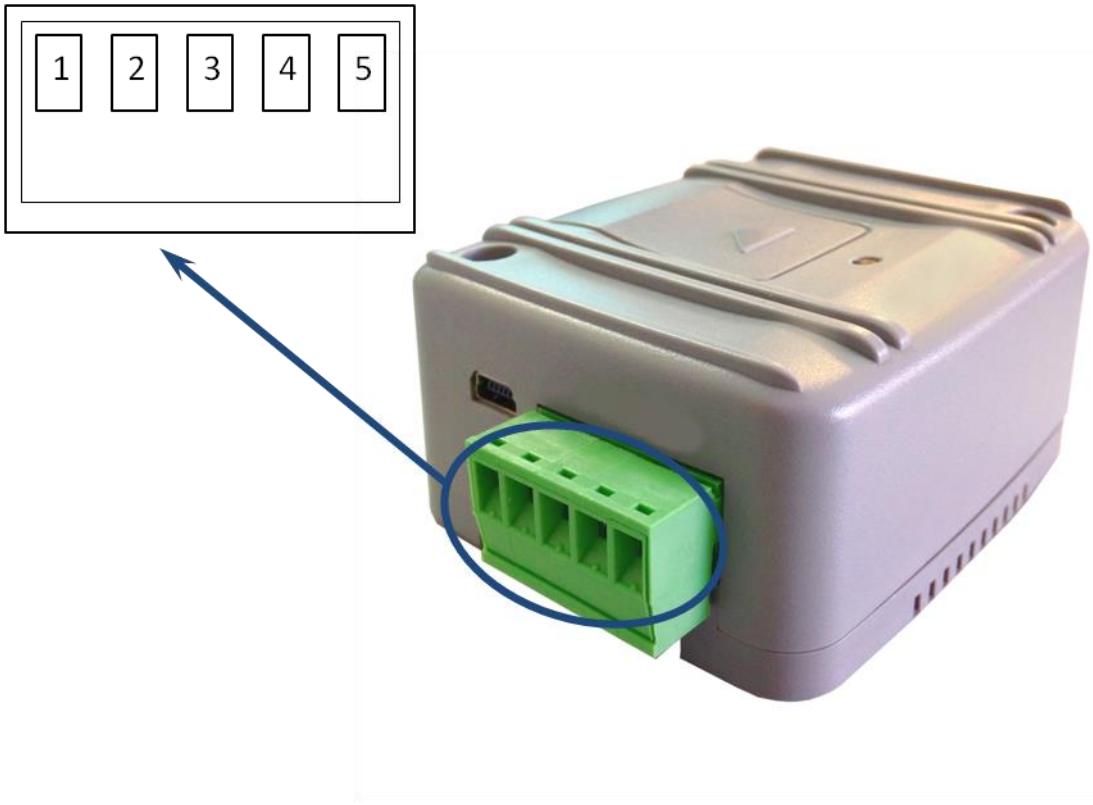
Pin	Signal	Direction	Limits	Description
1	VIN	Input	6.5-40VDC	Positive power input
2	Not connected			Reserved for future uses
3	TURN_OFF	Input	Vmax: VIN	Active high control line used to switch off or reset the modem VIH>5V, VIL<2V Power off: t >10ms
4	Not connected			Reserved for future uses
5	Not connected			Reserved for future uses
6	GND	Input		Negative power (ground)

4.1.2 5 way plug-in terminal block (MTX-65i-RS485 and MTX-65i-RS485-LC)

A 5 way plug-in terminal block connector shared with RS485 bus, as shown and described below, supplies and controls the D.C. power to the modem.

The supply voltage, VCC, required by the modem is in the range of 6.5 to 40VDC. We recommend a 12VDC power supply. The power supply has to be a single voltage source capable of providing a peak during an active transmission. The uplink burst causes strong ripples (drop) on the power lines.

By default, the MTX-65i-RS485 will automatically switch on when power supply is applied at PIN 4 and PIN 5.



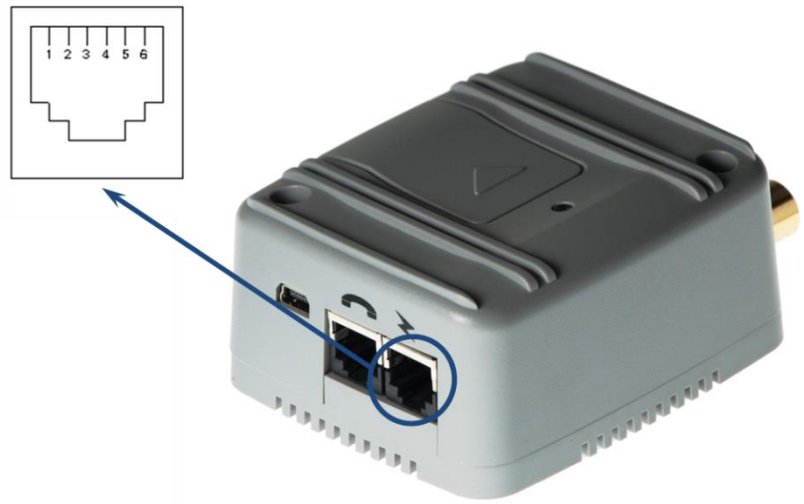
Pin	Signal	Direction	Limits	Description
1	-RxB	I/O		RS485 B signal (see section 4.6 for details)
2	+RxA	I/O		RS485 A signal (see section 4.6 for details)
3	AUTO ON	Input	0-VIN	Automatic Restart after Shutdown Enable Signal (not available in MTX-65i-RS485 FW2.00 (AUTO-ON) and MTX-65i-RS485-LC)
4	VIN	Input	6.5-40VDC	Positive power input
5	GND	Input		Negative power (ground)

4.1.3 RJ11 (MTX-65i-ULP)

An RJ11 6-way connector, as shown and described below, serves as a means of supplying and controlling DC power to the modem.

The power supply voltage (VCC) required by the modem is in the range of 6.5 to 10VDC (9.8 to 13.9VDC can be ordered upon request). The power supply has to be a single voltage source capable of providing a current peak during an active transmission. The uplink burst causes strong ripples (drop) on the power lines.

Application of the power supply voltage to PIN 1 does not switch the modem on by default. The user has to use whatever wake-up source once the modem is powered.



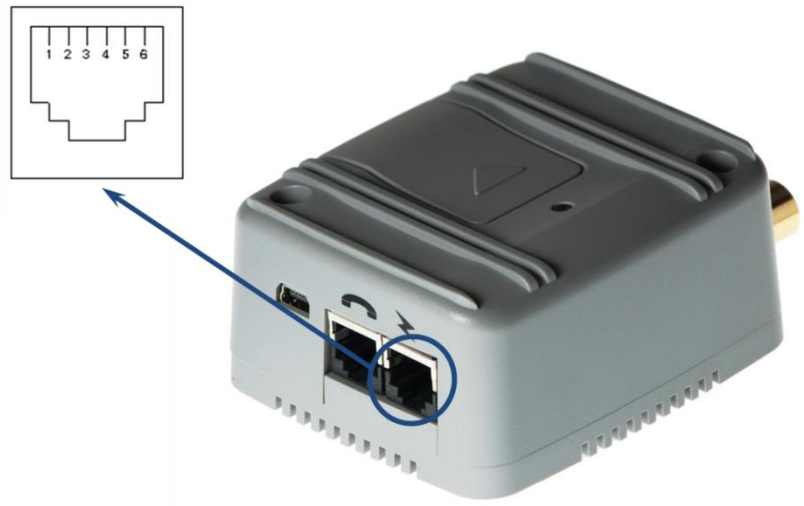
Pin	Signal	Direction	Limits	Description
1	VIN	Input	6.5-10VDC 7.2 typ.	Positive power input
2	Wake-up 1 (GPIO6)	Input	0-VIN	Optoisolated wake up active low input signal
3	Wake-up 2 (GPIO7)	Input	0-VIN	Optoisolated wake up active low input signal
4	Wake-up 3 (GPIO8)	Input	0-VIN	Optoisolated wake up active high input signal (VIH min 3V, max VIN)
5	Wake-up 4 (GPIO9)	Input	0-VIN	Optoisolated wake up active high input signal (VIH min 3V, max VIN)
6	GND	Input		Negative power (ground)

4.1.4 RJ11 (MTX-65i+G V6, MTX-65i+G+B V7 and MTX-65i-BAT)

An RJ11 6-way connector, as shown and described below, serves as a means of supplying and controlling DC power to the modem.

The power supply voltage (VCC) required by the modem is in the range of 6.5 to 40VDC. We recommend a 12V DC power supply. The power supply has to be a single voltage source capable of providing a current peak during an active transmission. The uplink burst causes strong ripples (drop) on the power lines.

By default, MTX-65i devices are shipped to automatically switch on only with supply at PIN 1 and PIN 6. If you disable the "Automatic power up" feature you will need to use the additional active-low control signal TURN_ON, which must be applied for a time of 0.2 seconds or greater.



Pin	Signal	Direction	Limits	Description
1	VIN	Input	6.5-40VDC	Positive power input
2	OUT4	Output	Vmax: VIN	Opto-isolated output GPIO6 + Red LED Logic 0: Hi-Z Logic 1: Active = VIN-0.2
3	TURN_OFF	Input	0-VIN	Opto-isolated active low control line used to switch off or reset the modem Power off: t >10ms
4	TURN_ON	Input	0-VIN	Opto-isolated active low control line used to switch on the modem (only when automatic restart is disabled) Power on: t >0.4s
5	IN4	Input	0-VIN	Opto-isolated input GPIO5 7 to VIN: logic 0
6	GND	Input		Negative power (ground)

4.2 Mini USB connector

The MTX-65i supports a USB 2.0 High Speed (480Mbit/s) device interface. The USB interface is primarily intended for use as a command and data interface and for downloading firmware. The USB I/O pins are capable of driving the signal at a minimum of 3.0V. They are 5V I/O compliant.

The USB port has different functions depending on whether Java is running or not. With Java, the lines may be used for debugging purposes. If Java is not used, the USB interface is available as a command and data interface and for downloading firmware.

To properly connect the module's USB interface to the host, a USB 2.0 compatible connector is required. Furthermore, the USB modem driver which is delivered with MTX-65i must be installed as described below.

The USB host is responsible for supplying power across the VUSB_IN line to the module's USB interface. This is because MTX-65i is designed as a self powered device compliant with the *"Universal Serial Bus Specification Revision 2.0".*

The MTX-65i cannot be powered by a USB port. If you need this feature, contact gsmsupport@matrix.es. Only modems that have a mounted internal Li-Po battery (+B) can operate with USB power voltage.

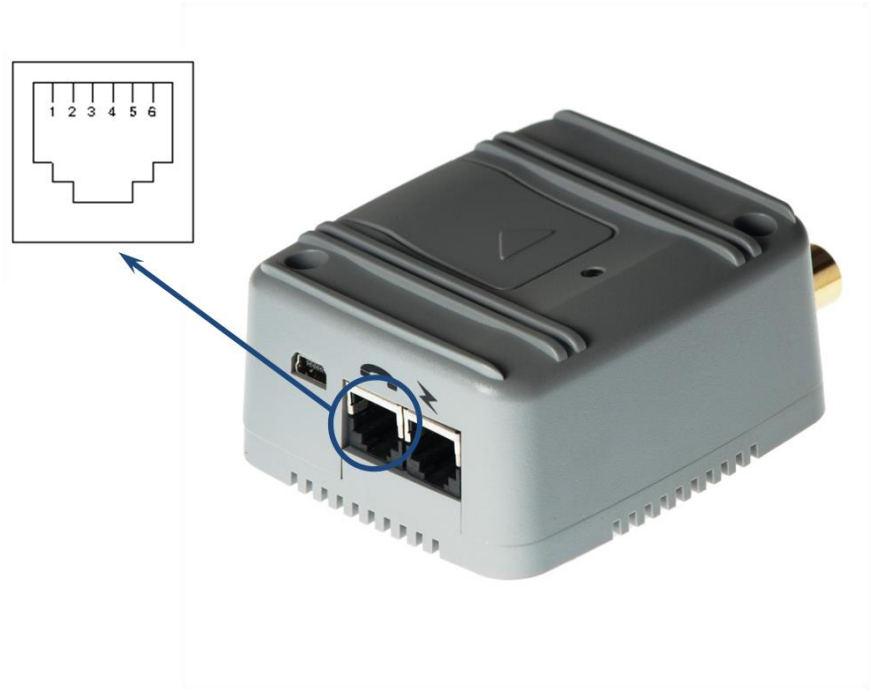
There are drivers available for Windows and Linux environment applications. Visit the MTX-65i web page at www.mtxm2m.com

4.3 Audio connector (MTX-65i, MTX-65i+G V6, MTX-65i+G+B V7, MTX-65i-BAT and MTX-65i-ULP)

A 6-way 4-pole RJ connector, as shown below, allows a telephone handset to be plugged into the modem, giving access to the microphone and earpiece signals. The connector may also be used to drive other analog audio sub-systems or devices.

The audio interface provides one analog input for a microphone and one analog output for an earpiece.

- The microphone input and the earpiece output are balanced
- For electret microphones a supply source is implemented
- The MTX-65i is pre-configured to work with a range of handsets, the audio interface is flexible and its performance can be configured, using AT commands, to match a particular handset or audio subsystem
- Earpiece outputs are short-circuit protected



Pin	Signal	Direction	Description
1	Not connected		
2	MICN	Input	Microphone negative input
3	EPN	Output	Earpiece negative output
4	EPP	Output	Earpiece positive output
5	MICP	Input	Microphone positive input
6	Not connected		

To suit the different types of accessories, the audio interfaces can be configured for different audio modes via the AT^SNFS command. The electrical characteristics of the voiceband part vary with the audio mode. For example, sending and receiving amplification, sidetone paths, noise suppression etc. depend on the selected mode and can be altered with AT commands (except for mode 1).

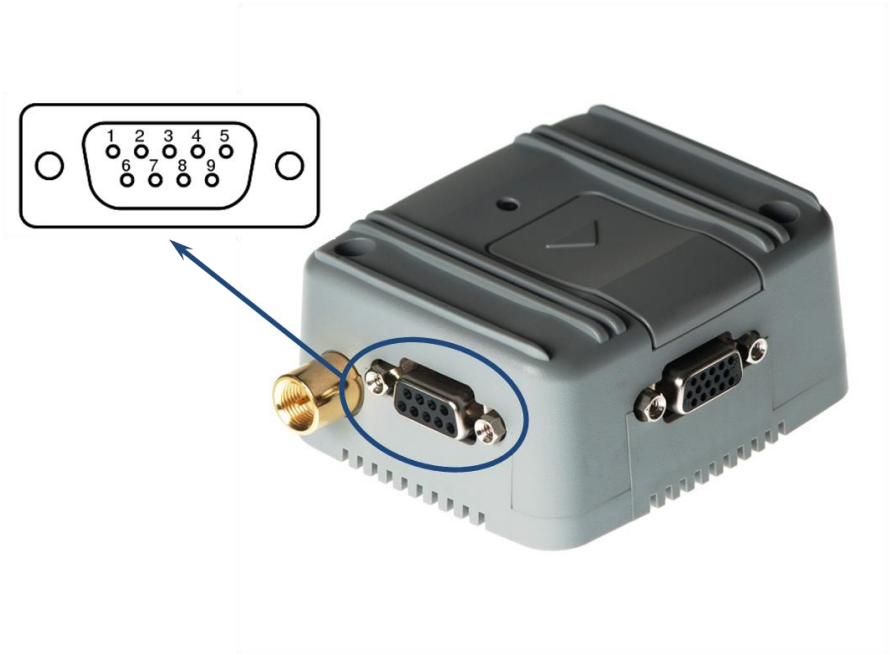
Both analog audio interfaces can be used to connect headsets with microphones or speakerphones. Headsets can be operated in audio mode 3 and speakerphones in audio mode 2. Audio mode 5 can be used for direct access to the speech coder without signal pre- or post-processing.

When shipped from the factory, all audio parameters of MTX-65i are set to interface 1 and audio mode 1. This is the default configuration optimized for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the MTX Terminals reference configuration. Audio mode 1 has fixed parameters which cannot be modified. To adjust the settings of the Votronic handset simply change to another audio mode.

Audio mode no. AT^SNFS=	**1 (Default settings, not adjust- able)**	**2**	**3**	**4**	**5**	**6**
Name	Default Handset	Basic Handsfree	Headset	User Handset	Plain Codec 1	DTMF
Purpose	DSB with Votronic handset	Car Kit	Headset	DSB with individual handset	Direct access to speech coder	Tip and Ring interface for DTMF end-to-end transmission
Gain setting via AT command. Defaults: inBbcGain outBbcGain	Fix 5 2	Adjustable 2 2	Adjustable 5 1	Adjustable 5 2	Adjustable 0 1	Adjustable 1 1
Default audio inter-face	**1**	2	2	1	1	2
Power supply VMIC	ON	ON	ON	ON	ON	ON
Sidetone	Fix	---	Adjustable	Adjustable	Adjustable	Adjustable
Volume control	Fix	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Echo canceller	ON	ON	ON	ON	OFF	ON
Noise reduction	6dB	12dB	12dB	6dB	OFF	OFF
MIC input signal for 0dBm0 1 -10dBm0 f=1024 Hz	16mV 5mV	---2 90mV	18mV 16mV	16mV 5mV	400mV 126mV	200mV 63mV
EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain) / @ 3.14 dBm0	660mV	240mV default @ max volume	740mV default @ max volume	660mV default @ max volume	1.47V Vpp = 6.2V	735mV Vpp=3.13V
Sidetone gain at default settings	21dB	-∞dB	10.0dB	21dB	-∞dB	-∞dB

4.4 DB9 connector: main RS232 port (MTX-65i and MTX-65i-ULP)

The modem supports a standard RS232 8-wire serial interface (EIA/TIA 574) via its 9 pin Sub-D connector, shown below. It is connected to the modem's ASC0 main port using a level shifter converter.



The MTX-65i modem is designed to be used as a DCE (data circuit-terminating equipment). Based on the conventions for DCE-DTE connections, it communicates with the customer application (DTE- data terminating equipment) using the following signals:

- Port TxD @ application sends data to TXD of MTX-65i Terminal
- Port RxD @ application receives data from RXD of MTX-65i Terminal

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T V.24 Interchange Circuits DCE. It is configured for 8 data bits, no parity and 1 stop bit and can be operated at fixed bit rates from 1200bps to 921600bps.

Autobauding supports bit rates from 1200bps to 230400bps. Autobauding is not compatible with multiplex mode. Hardware handshake using the /RTS and /CTS signals and XON/XOFF software flow control are supported.

In addition, the modem control signals DTR, DSR, DCD and RING are available. The MODEM control RING signal (Ring Indication) can be used to indicate, to the cellular device application, that an incoming call or Unsolicited Result Code (URC) is received. It can also be used to send pulses to the host application; for example, to wake the application up from the power saving mode.

The DB9 connector pinout is shown in the table below:

Pin	Signal	Direction	Description
1	DCD	Output	Data carrier detected
2	RD 0	Output	Received data
3	TD 0	Input	Transmitted data
4	DTR	Input	Data terminal ready
5	GND	-	Ground connection
6	DSR	Output	Data set ready
7	RTS	Input	Request to send
8	CTS	Output	Clear to send
9	RI	Output	Ring indicator

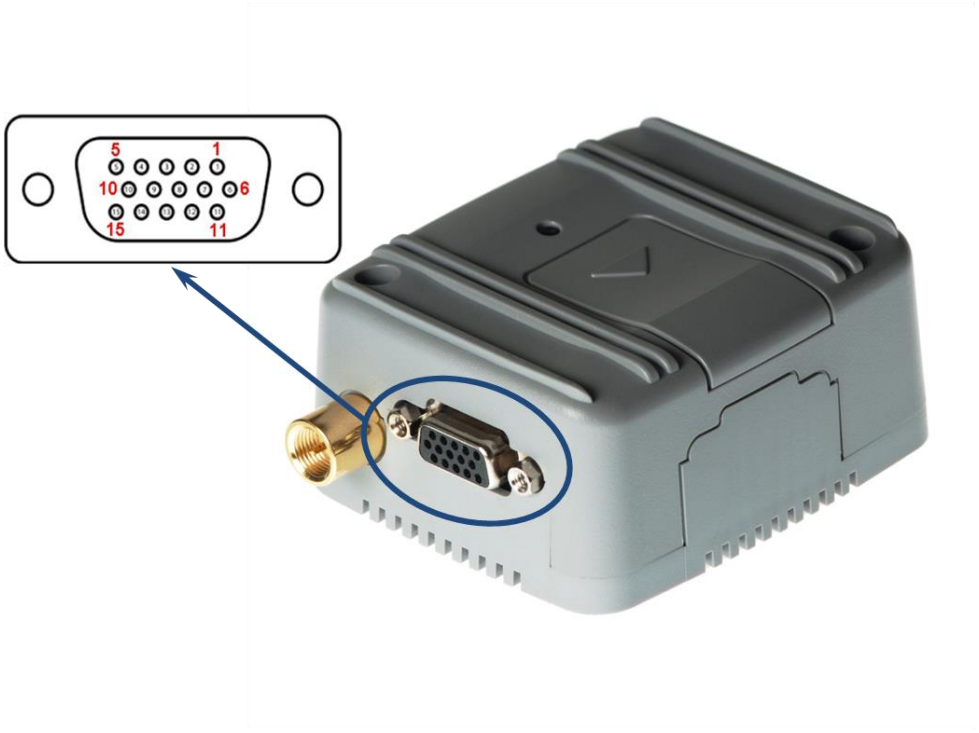
Features

- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and also the modem control lines DTR0, DSR0, DCD0 and RING0.
- ASC0 is primarily designed for controlling voice calls, transferring CSD, fax and GPRS data and for controlling the GSM engine with AT commands.
- Full Multiplex capability allows the interface to be partitioned into three virtual channels, but with CSD and fax services only available on the first logical channel. Please note that when the ASC0 interface runs in Multiplex mode, ASC1 cannot be used.
- The DTR0 signal will only be polled once per second from the internal firmware of MTX-65i
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application; for example, to wake the application up from the power saving mode. To configure the RING0 line, use the following AT Command: AT^SCFG.
- The default configuration is 8 data bits, no parity and 1 stop bit. The setting can be changed using the AT command AT+ICF and, if required, AT^STPB.
- ASC0 can be operated at fixed bit rates from 1200bps to 921600bps.
- **The default serial speed for MTX-65i is 115200bps.**

4.5 DB15 connector: I/O expansion port

4.5.1 Connector pinouts

Depending on the specific modem you are using, the DB15 connector pinout will be different and there will be different resources available on it.



Common terminals available in all models

Pin	Signal	Direction	Description
1	**I2CCLK**	Output	I2C clock signal
2	*DOM*		
3	*DOM*		
4	*DOM*		
5	*DOM*		
6	**I2CDAT**	I/O	I2C data line
7	*DOM*		
8	*DOM*		
9	*DOM*		
10	*DOM*		
11	*DOM*		
12	*DOM*		
13	*DOM*		
14	**GND**		Ground connection
15	**ADC 1**	Input	Analog to Digital converter input 1

DOM: depending on model

MTX-65i

Pin	Signal	Direction	Description
1	I2CCLK/SPICLK	Output	I2C clock signal / SPI clock signal
2	RD 1	Output	Secondary RS232 ASC1 UART signal: Received data
3	TD 1	Input	Secondary RS232 ASC1 UART signal: Transmitted data
4	GPIO 1	I/O	CMOS General Purpose Digital Input/Output 1
5	GPIO 3	I/O	CMOS General Purpose Digital Input/Output 3
6	I2CDAT/SPIDO	I/O	I2C data line / SPI data out line
7	SPIDI	Input	SPI data in line
8	SPICS	Output	SPI chip select line
9	VEXT	Output	Output voltage reference (3V, 50mA max.)
10	DAC_OUT	Output	Digital to Analog converter
11	GPIO 2	I/O	CMOS General Purpose Digital Input/Output 2
12	GPIO 4	I/O	CMOS General Purpose Digital Input/Output 4
13	ADC 2	Input	Analog to Digital converter input 2
14	GND		Ground connection
15	ADC 1	Input	Analog to Digital converter input 1

MTX-65i-RS485

Pin	Signal	Direction	Description
1	I2CCLK	Output	I2C clock signal
2	RD 0	Output	Main RS232 ASC0 UART signal: Received data
3	TD 0	Input	Main RS232 ASC0 UART signal: Transmitted data
4	NC		
5	OUT 3	Output	Opto-isolated output GPIO8 (open collector)
6	I2CDAT	I/O	I2C data line
7	RTS 0	Input	Main RS232 ASC0 UART signal: Request to send
8	CTS 0	Output	Main RS232 ASC0 UART signal: Clear to send
9	IN 10	Input	Opto-isolated input GPIO10
10	VEXT	Output	Output voltage reference (4.1V)
11	IN 2	Input	Opto-isolated input GPIO7
12	OUT 4	Output	Opto-isolated output GPIO4 (open collector)
13	ADC 2	Input	Analog to Digital converter input 2
14	GND		Ground connection
15	ADC 1	Input	Analog to Digital converter input 1

MTX-65i-RS485-LC

Pin	Signal	Direction	Description
1	I2CCLK	Output	I2C clock signal
2	RD 0	Output	Main RS232 ASC0 UART signal: Received data
3	TD 0	Input	Main RS232 ASC0 UART signal: Transmitted data
4	NC		
5	NC		
6	I2CDAT	I/O	I2C data line
7	RTS 0	Input	Main RS232 ASC0 UART signal: Request to send
8	CTS 0	Output	Main RS232 ASC0 UART signal: Clear to send
9	NC		
10	VEXT	Output	Output voltage reference (4.1V)
11	NC		
12	NC		
13	ADC 2	Input	Analog to Digital converter input 2
14	GND		Ground connection
15	ADC 1	Input	Analog to Digital converter input 1

MTX-65i-ULP

Pin	Signal	Direction	Description
1	I2CCLK	Output	I2C clock signal
2	RD 1	Output	Secondary RS232 ASC1 UART signal: Received data
3	TD 1	Input	Secondary RS232 ASC1 UART signal: Transmitted data
4	GPIO 1	I/O	CMOS General Purpose Digital Input/Output 1
5	GPIO 3	I/O	CMOS General Purpose Digital Input/Output 3
6	I2CDAT	I/O	I2C data line
7	RTS 1	Input	Secondary RS232 ASC1 UART signal: Request to send
8	CTS 1	Output	Secondary RS232 ASC1 UART signal: Clear to send
9	DAC_OUT	Output	Digital to Analog converter
10	VEXT	Output	Output voltage reference (3V, 50mA max.)
11	GPIO 2	I/O	CMOS General Purpose Digital Input/Output 2
12	GPIO 4	I/O	CMOS General Purpose Digital Input/Output 4
13	ADC 2	Input	Analog to Digital converter input 2
14	GND		Ground connection
15	ADC 1	Input	Analog to Digital converter input 1

MTX-65i+G V6, MTX-65i+G+B V7 and MTX-65i-BAT

Pin	Signal	Direction	Description
1	I2CCLK	Output	I2C clock signal
2	RD 0	Output	Main RS232 ASC0 UART signal: Received data
3	TD 0	Input	Main RS232 ASC0 UART signal: Transmitted data
4	IO 1 (GPIO 9)	I/O	CMOS General Purpose Digital Input/Output 1
5	OUT 2	Output	Opto-isolated output GPIO8 (open collector)
6	I2CDAT	I/O	I2C data line
7	RTS 0	Input	Main RS232 ASC0 UART signal: Request to send
8	CTS 0	Output	Main RS232 ASC0 UART signal: Clear to send
9	ADC 2	Input	Analog to Digital converter input 2
10	VEXT	Output	Output voltage reference (3.86V)
11	IN 2	Input	Opto-isolated input 2 GPIO7
12	OUT 3	Output	Opto-isolated output GPIO4 (open collector)
13	IN 3	Input	Optoisolated input 3 GPIO10
14	GND		Ground connection
15	ADC 1	Input	Analog to Digital converter input 1

4.5.2 RS232 interface

The modem supports a standard RS232 4-wire (2-wire in the case of the base MTX-65i) serial interface (EIA/TIA 574) via its 15 pin Sub-D connector, shown below. This interface is connected to the ASC0 port using a level shifter converter, except on the base MTX-65i and MTX-65i-ULP, which use an ASC1 port instead of ASC0.

The MTX-65i modem is designed to be used as a DCE (data circuit-terminating equipment). Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE- data terminating equipment) using the following signals:

- Port TxD @ application sends data to MTX-65i Terminal's TD.
- Port RxD @ application receives data from MTX-65i Terminal's RD.

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T V.24 Interchange Circuits DCE. It is configured for 8 data bits, no parity and 1 stop bit and can be operated at fixed bit rates from 300bps to 460.8kbps.

Autobauding supports bit rates from 1.2kbps to 460.8kbps. Hardware handshake using the /RTS and /CTS signals and XON/XOFF software flow control are supported.

The electrical characteristics of the serial port signals are shown below:

Signal	Direction	Description
RD0	Output	Received data
TD0	Input	Transmitted data
GND	-	Ground connection
RTS	Input	Request to send
CTS	Output	Clear to send

Features (ASC1)

- Includes data lines TD1 and RD1 (2-wire/4-wire)
- Includes the status lines RTS0 and CTS0 and supports hardware flow control (4-wire only)
- On ASC1 no RING line is available. The indication of URCs on the second interface depends on the settings made with the AT^SCFG command.
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 1200 bps to 921600 bps. Autobauding is not supported on ASC1.

Features (ASC0)

- Includes the data lines TD0 and RD0, the status lines RTS0 and CTS0 and also the modem control lines DTR0, DSR0, DCD0 and RING0.
- ASC0 is primarily designed for controlling voice calls, transferring CSD, fax and GPRS data and for controlling the GSM engine with AT commands.

- Full Multiplex capability allows the interface to be partitioned into three virtual channels, but with CSD and fax services only available on the first logical channel. Please note that when the ASC0 interface runs in Multiplex mode, ASC1 cannot be used.
- The DTR0 signal will only be polled once per second from the internal firmware of MTX-65i
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application; for example, to wake the application up from the power saving mode. To configure the RING0 line, use the following AT Command: AT^SCFG.
- The default configuration is 8 data bits, no parity and 1 stop bit. The setting can be changed using the AT command AT+ICF and, if required, AT^STPB.
- ASC0 can be operated at fixed bit rates from 1200bps to 921600bps.
- **The default serial speed for MTX-65i is 115200bps.**

4.5.3 I2C bus

I2C is a serial, 8-bit oriented data transfer bus for bit rates up to 400kbps in Fast mode. It consists of two lines, the serial data line I2CDAT and the serial clock line I2CCLK.

The MTX-65i modem acts as a single master device, e.g. the clock I2CCLK is driven by the modem. I2CDAT is a bi-directional line.

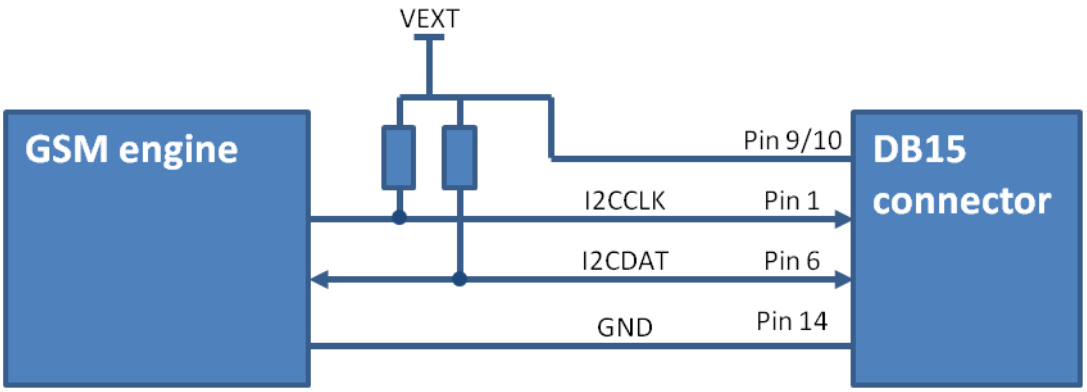
Each device connected to the bus is software which is identified by a unique 7-bit address. Simple master/slave relationships exist at all times; the modem operates as a master-transmitter or as a master-receiver. The customer application transmits or receives data only at the modem's request.

Signal	Direction	Description
I2CCLK	Output	I2C bus clock signal[1234]
I2CDAT	I/O	I2C data bus[1234]
GND	-	Ground connection

1. I2C lines are Open Drain. Internal 10kOhm pull-up resistors are mounted, so there is no need to fit them to the host application.
2. According to the I2C Bus Specification Version 2.1, a maximum rise time of300ns is permitted for the fast mode.
3. The value of the pull-up depends on the capacitive load of the whole system (I2C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is 4mA.
4. If lines are unused, keep pins open

Use the AT^SSPI command or Java class to configure and activate the I2C bus.

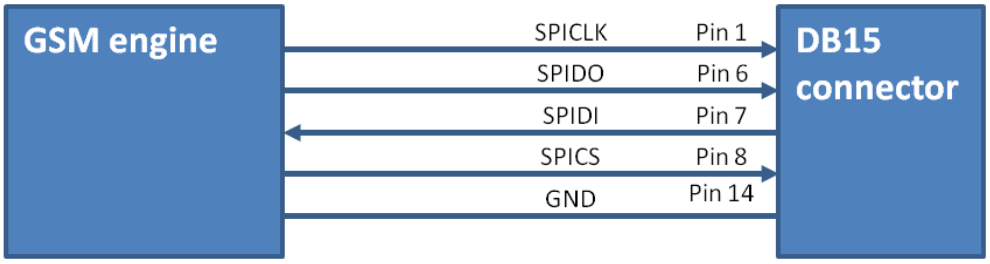
The picture below shows the I2C interface is powered from an internal VEXT supply line so the I2C interface will be properly shut down when the modem enters the Power-down mode.



4.5.4 SPI bus (MTX-65i)

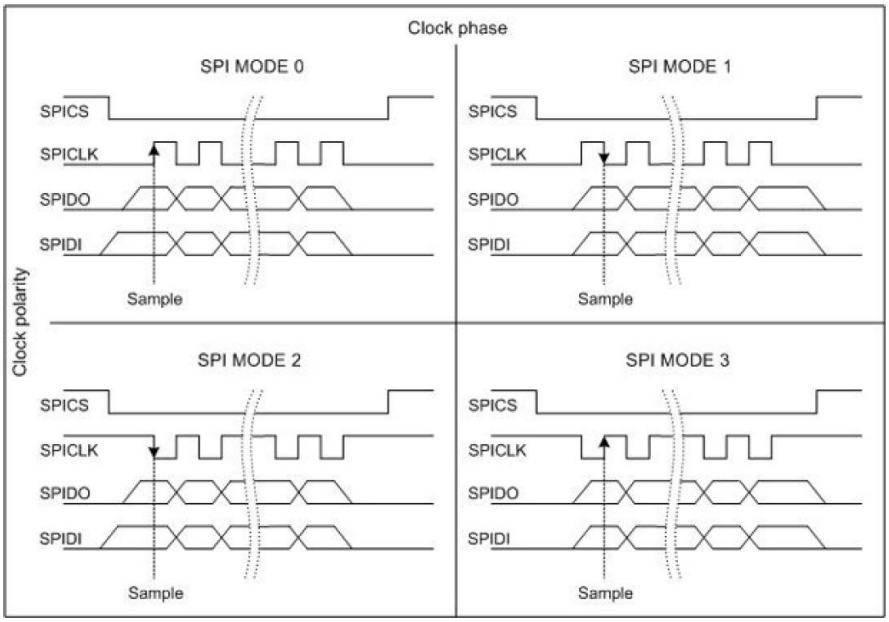
The SPI bus (Serial Peripheral Interface) is a synchronous serial interface for control and data transfer between the MTX-65i modem and the connected application. Only one application can be connected to the module's SPI. The interface supports transmission rates of up to 6.5Mbps. It consists of four lines: the two data lines SPIDI/SPIDO, the clock line SPICLK and chip select line SPICS.

The MTX-65i modem acts as a single master device, e.g. the clock SPICLK is driven by the modem. Whenever the SPICS pin is in a low state, the SPI bus is activated and data can be transferred from the module and vice versa. The SPI interface uses two independent lines for data input (SPIDI) and data output (SPIDO).



To configure and activate the SPI bus use the AT^SSPI command. If the SPI bus is active, the lines I2CCLK and I2CDAT are locked for use as SPI lines.

SPI supports four operation modes. The modes are different in clock phase and clock polarity. The module's SPI mode can be configured by using the AT command AT^SSPI. Make sure the module and the connected slave device works with the same SPI mode. The following picture shows the characteristics of the four SPI modes. The SPI modes 0 and 3 are the most commonly used modes.



The SPI interface is only available if the pins 1 and 6 of the I/O interface connector are not used for the I2C interface.

4.5.5 Analog-to-Digital and Digital-to-Analog converters

The ADC of the MTX-65i consists of two independent, unbalanced, multiplexed analog inputs that can be used for measuring external DC voltages in the range of 0mV…+2400mV. The ADC has a resolution of 12 bits.

Use the command AT^SRADC to select the analog inputs ADC1_IN or ADC2_IN, to set the measurement mode and to read out the measurement results. The measured values are indicated in mV.

There is no out of range detection. Voltages beyond these limits cannot be measured:

- Underflow: Values ≤ -25mV
- Overflow: Values > 2425mV

The sample period is adjustable from 30s up to 100ms by AT^SRADC. Only during sample time (ts~400µs) is the S&H switch closed.

The DAC of the MTX-65i consists of one independent and unbalanced PWM digital output that can be used to generate signals in the range of 0mV...3000mV.

Use the command AT^SWDAC to set the PWM frequency and the duty cycle. You can use the following values of frequency: 320, 970, 8125, 16250, 32500 or 65000Hz. It is possible to set the duty cycle in percentage steps between 0 and 100%.

You can use an external filter (such as a simple RC filter) to smoothen the PWM signal and obtain the baseband signal.

4.5.6 General Purpose and Optoisolated I/O

Depending on the model you use, you will dispose of the following set of GPIOs and Optoisolated IOs:

Model	Power Connector	DB15 connector
MTX-65i and MTX-65i-ULP		4x CMOS inputs/output (bidirectional GPIO)
MTX-65i-RS485		2x Optoisolated inputs 2x Optoisolated outputs
MTX-65i+G V6 and MTX-65i+G+B V7	1x Optoisolated input 1x Optoisolated output	2x Optoisolated inputs 2x Optoisolated outputs 1x CMOS input/output (bidirectional GPIO)

Please refer to Section 4.1 and Section 4.5.1 to view the exact location of each I/O.

Both the GPIOs and Optoisolated I/Os are controlled directly by the GPIO lines of the internal TC65i module.

For the MTX-65i-RS485 modem there are two available optoisolated inputs and two optoisolated outputs, which are mapped to the TC65i GPIO lines as shown in the following table:

Terminal's optoisolated I/O	GPIO number
IN 2 (pin to ground)	GPIO 7
IN 10 (pin to ground)	GPIO 10
OUT 3 (open-collector)	GPIO 8
OUT 4 (open collector)	GPIO 4

For the MTX-65i+G V6 and MTX-65i+G+B V7 there are six available optoisolated I/O's and 1 CMOS bidirectional I/O, which are mapped to the TC65i GPIO lines as shown in the following table:

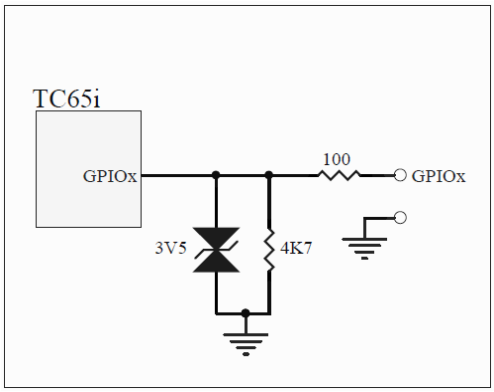
Terminal's optoisolated I/O	GPIO number
IN 2 (pin to ground)	GPIO 7
IN 3 (pin to ground)	GPIO 10
IN 4 (pin to power supply)	GPIO 5
OUT 2 (open collector)	GPIO 8
OUT 3 (open collector)	GPIO 4
OUT 4 (open emitter)	GPIO 6

Terminal's CMOS I/O	GPIO number
IO 1	GPIO 9

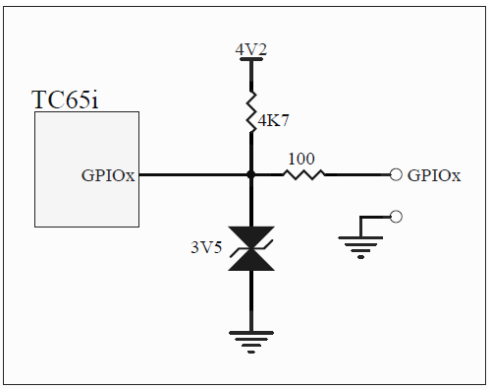
Please take care with the following points:

- Each GPIO port can be configured as an input (Hi-Z) or output (strong drive push-pull drivers)
- When optoisolated I/O's are available, you always must assure that:
  - MTX-65i-RS485:
    - GPIO 4 and GPIO 8 are configured as outputs
    - GPIO 7 and GPIO 10 are configured as inputs
  - MTX-65i+G V6 and MTX-65i+G+B V7:
    - GPIO 4, GPIO 6 and GPIO 8 are configured as outputs
    - GPIO 5, GPIO 7 and GPIO 10 are configured as inputs

The electrical equivalent circuits for GPIOs connected to the DB15 connector for all MTX-65i family modems are shown in the following figure

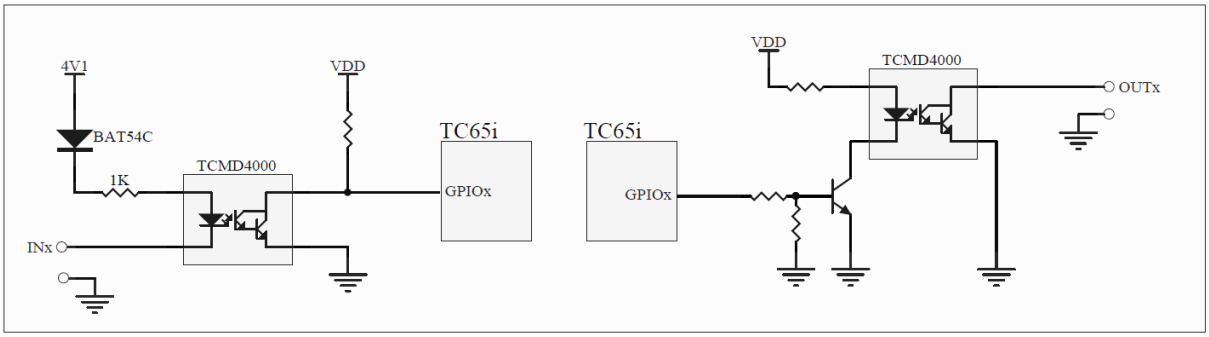


MTX-65i & MTX-65i-ULP GPIO equivalent circuit



MTX-65i+G V6 & MTX-65i+B+G V7 GPIO equivalent circuit

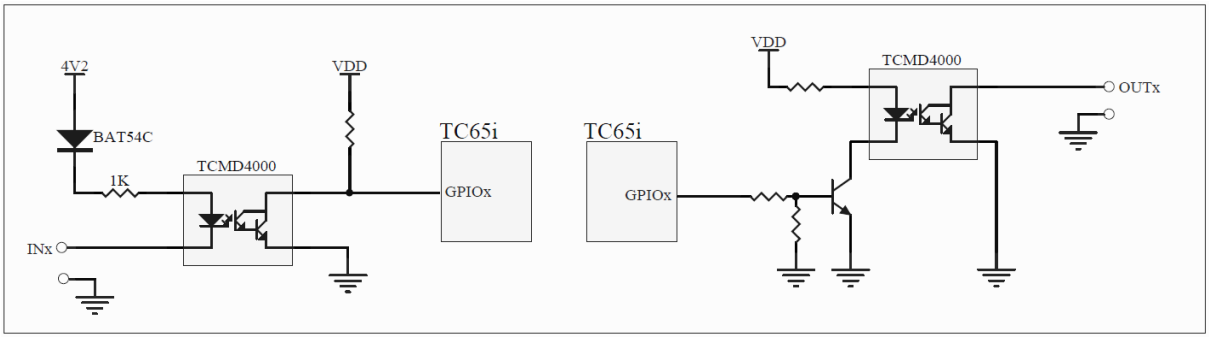
The electrical equivalent circuits for MTX-65i-RS485 are shown in the following figure



Optoisolated inputs/outputs equivalent circuit

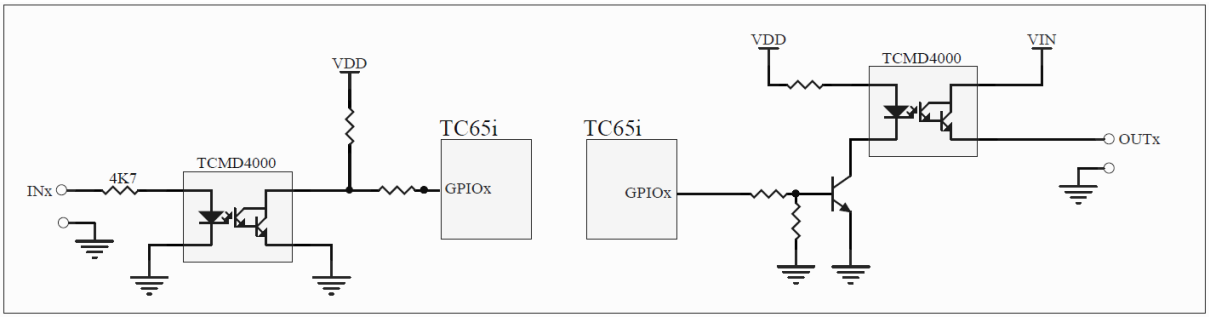
INPUT	OUTPUT
0V ≤ V_{IN} ≤ 2.5V → Logic '0'	Logic '0' → V_{OUT} = HiZ
2.7V ≤ V_{IN} ≤ 40V → Logic '1'	Logic '1' → V_{OUT} = 1V (max)

The electrical equivalent circuits for MTX-65i+G V6 and MTX-65i+G+B V7 are shown in the following figure



Optoisolated IN/OUT 2&3 equivalent circuit

INPUT	OUTPUT
0V ≤ V_{IN} ≤ 2.5V → Logic '0'	Logic '0' → V_{OUT} = HiZ
2.7V ≤ V_{IN} ≤ 40V → Logic '1'	Logic '1' → V_{OUT} = 1V (max)



Optoisolated IN/OUT 4 equivalent circuit

INPUT	OUTPUT
0V ≤ V_{IN} ≤ 1.1V → Logic '1'	Logic '0' → V_{OUT} = HiZ
1.5V ≤ V_{IN} ≤ 40V → Logic '0'	Logic '1' → V_{OUT} = VIN-1V (min)

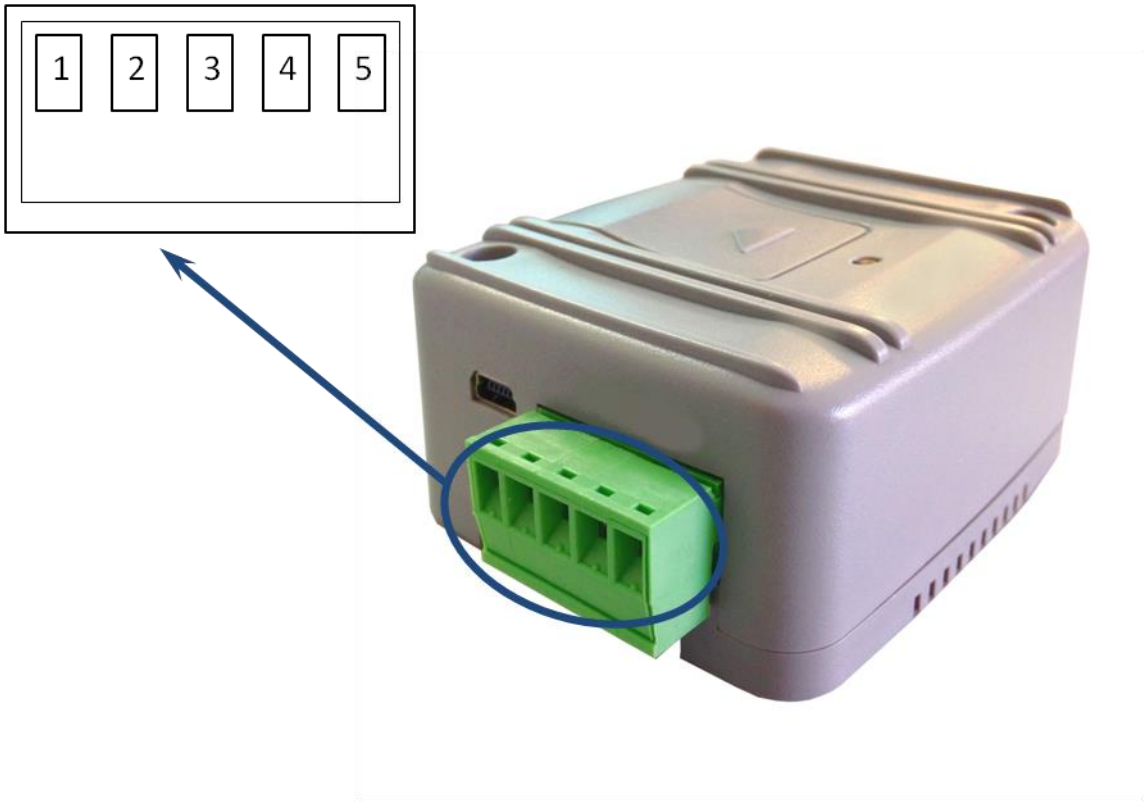
4.6 RS485 bus

A terminal block with a 5-way connector and shared Power Section, as shown and described below, is used to implement the RS485 interface

The RS485 bus is connected to the modem's ASC1 port using a level shifter converter.

It meets or exceeds the requirements of ANSI TIA/EIA-485-A.

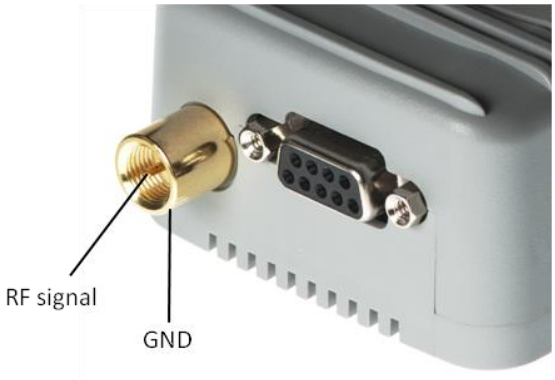
The RS485 bus does not include any serial or parallel terminator resistor. Users should mount them depending on their needs



Pin	Signal	Direction	Limits	Description
1	-RxB	I/O		RS485 B signal
2	+RxA	I/O		RS485 A signal
3	AUTO ON	Input	0-VIN	Automatic Restart after Shutdown Enable Signal (not available in MTX-65i-RS485-LC)
4	VIN	Input	6.5-40VDC	Positive power input
5	GND	Input		Negative power (ground)

4.7 GSM/GPRS antenna connector

The antenna connector allows radio frequency (RF) transmission signals between the modem and an external customer-supplied antenna. The modem is fitted with a 50Ω, FME male coaxial jack.



The external antenna must be matched properly to achieve the best performance regarding radiated power, DC-power consumption, modulation accuracy and harmonic suppression.

4.8 SIM card reader

The MTX-65i modem is fitted with a SIM card reader designed for 1.8V and 3V SIM cards. It is the flip-up type which is lockable in the horizontal position and is accessed through a removable panel as shown below.

The card holder is a five wire interface according to GSM 11.11. It has a SIM card detector switch to detect whether or not the SIM card drawer is inserted.

Removing and inserting the SIM card during operation requires the software to be reinitialized. Therefore, after reinserting the SIM card it is necessary to restart the MTX-65i modem.

The full operation of the MTX-65i relies on a SIM card being inserted. Some MTX-65i functionality may be lost if you try to operate the control modem without a SIM card.

4.9 3-axis accelerometer (MTX-65i+G V6, MTX-65i+G+B V7 and MTX-65i-BAT)

The internal 3-axis accelerometer is available in MTX-65i+G+B V7 by default and MTX-65i+G V6 upon request and is based on an LIS331DLM chip. It has a dynamically user selectable full scale measure range of ±2g/±4g/±8g and is capable of measuring accelerations with output data rates from 0.5Hz to 400Hz with a resolution of 8 bits.

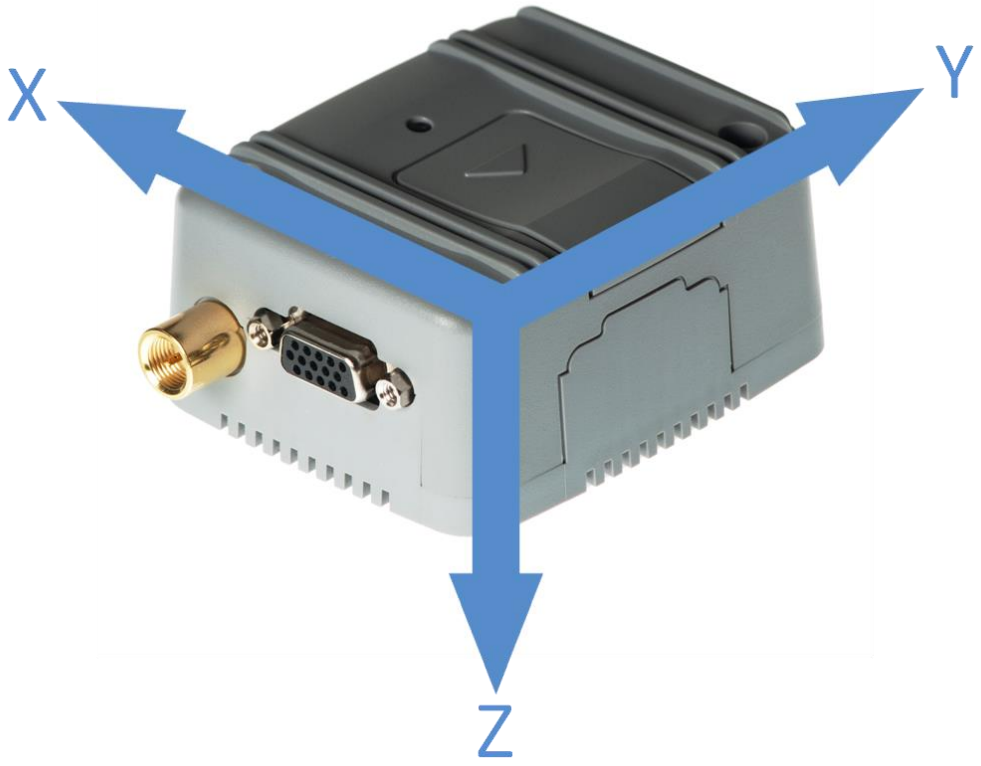
The device may also be configured to generate an interrupt signal by inertial wake-up/free-fall events as well as by the position of the device itself. Thresholds and timing of interrupt generators are programmable by the user on the fly. This feature could be used by the MTX-65i modem family to wake the GSM engine module up from the sleep mode.

The LIS331DLM is connected to the TC65i module via the internal I2C bus, at a 7-bit address 0x09 hexadecimal.

You can configure and use the ADC/DAC converters by issuing I2C related AT commands or via the I2C Java class.

Please refer to the device datasheet or the Java code examples available at www.mtxm2m.com in the *Downloads* section in order to learn how to use the I/Os.

In the following picture you can see how the accelerometer axes are located within the modem box.



4.10 Internal Li-Po battery (MTX-65i+G+B V7 and MTX-65i-BAT)

In the MTX-65i modem family, the +B suffix means that the internal 3.7V 1650mAh Li-Po battery is attached. The unit is shipped with the battery disconnected. Please open the unit and connect the battery connector to the main board and then plug in the power supply to the RJ power connector for around 5 hours to fully charge the battery.

Internal batteries can be ordered for MTX-65i modems with GPS. In any case, you can ask to remove the GPS.

The battery level can be known by using the AT command AT^SBV. The command result is given in mV. When charging, the previous value is increased by +200mV. It is also possible to know whether the charger is connected by testing the DTR signal.

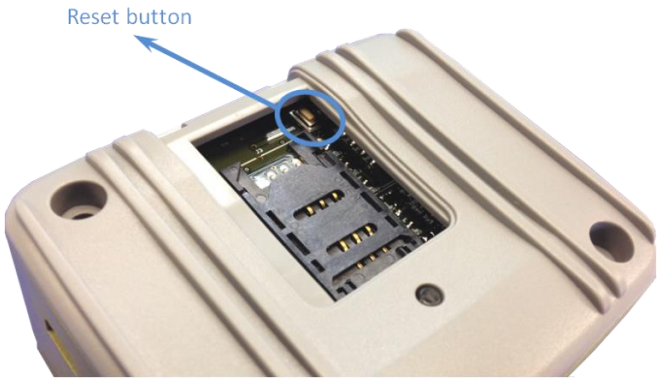
With battery attached, the VEXT voltage value (DB15 connector, pin 10) is approximately 3.86V when the charger is plugged in. If not, this values drops to approximately 3.46V.

We do not guarantee fully working features for battery voltages below 3.6V. We strongly recommend that you switch the modem off completely when this occurs. To do this, please follow this procedure:

- Disable Automatic restart after shutdown. Please remember that this feature is active by default and so the modem will try to switch on again automatically
- Close all threads
- Close all sockets or internet services
- Call garbage collector
- Switch off modem using the AT^SMSO command

Note: the VEXT voltage will be only present when external power is applied (i.e. charging battery)

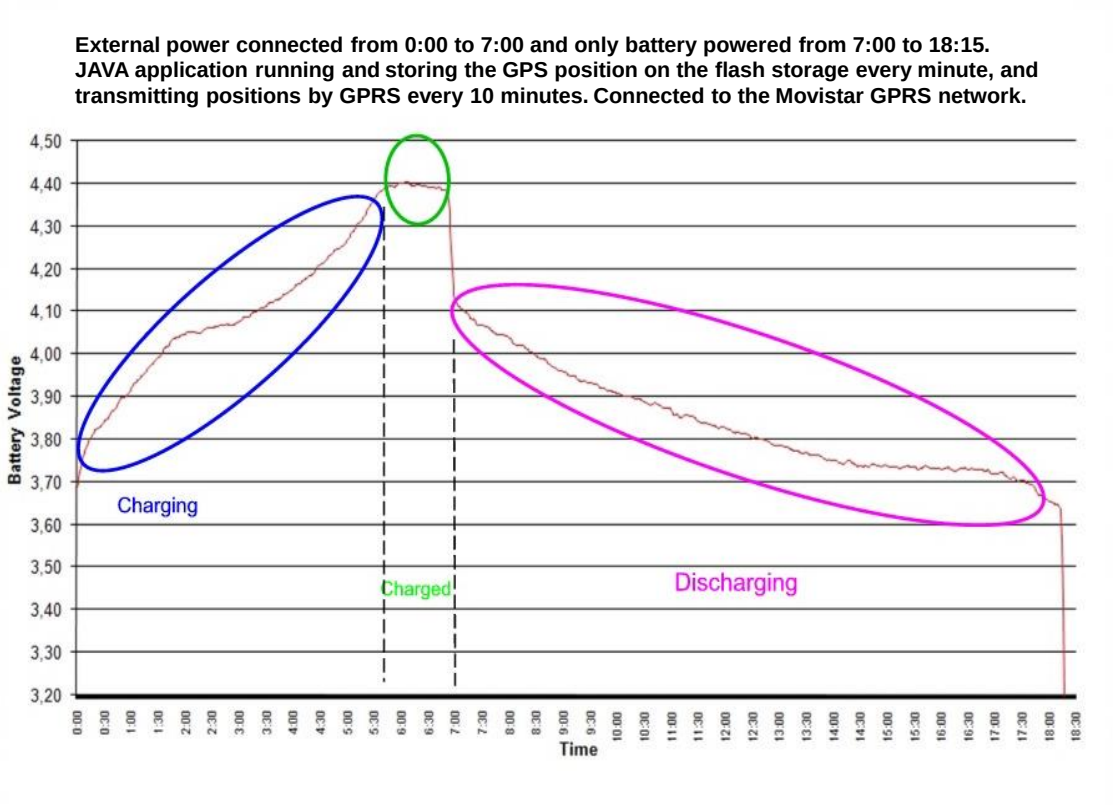
When the battery is attached, as “automatic restart” is featured by default, the modem will always be powered on and cannot be switched off. If you need to stop the Java application when Automatic Restart is enabled, you should press the switch button located near the SIM holder as shown in the picture below.



The duration of discharge depends on the end application. It is very sensitive to transmission (Voice and Data) so we recommend making as few as possible and keeping them as short as possible. Please disable GPS, or keep it in a low power mode when possible to extend battery life when longer periods of use (without charging) are required.

Keep in mind that the battery will be 100% operative once a few charge and discharge cycles have been performed.

Example 1. Li-Po battery attached, 25ºC ambient temperature



The blue colored circle shows when the battery is being charged. When it reaches 4.40V (to be checked using the AT^SBV command), the battery is fully charged (green colored circle). In the above example, charging time is 6 hours 30 minutes.

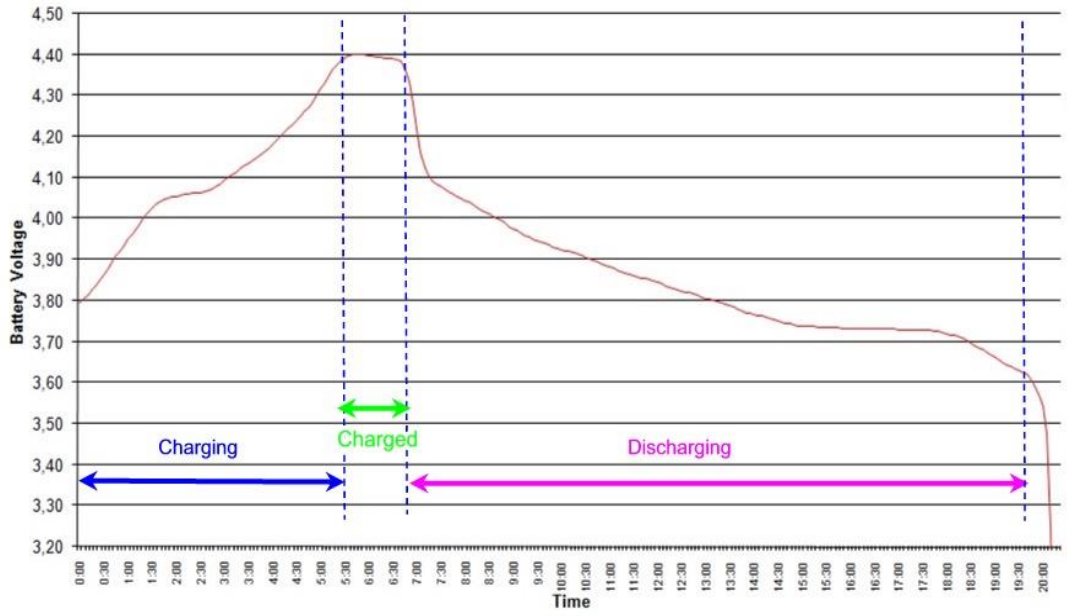
If the charger is disconnected, the battery starts to discharge. The duration of the battery is very dependent upon the applications used; in the example above, the battery lasts approximately 11 hours 30 minutes. Please note that the minimum battery level module switches off automatically, when the battery voltage is around 3.65V (please remember to check using the AT^SBV command).

Example 2. Li-Po battery attached, 25ºC ambient temperature

Example 2 has the same charging time (indicated by the blue arrow) as in example 1 (6 hours 30 minutes); at this time the battery is fully charged; checking using the AT^SBV command, we discover it is around 4.40V (indicated by the green arrow).

Discharging time in these conditions is around 12 hours, so the more often you connect to GPRS, the shorter the battery will last. Keep GPRS connections short and infrequent where possible to extend battery life if you require longer periods of use without charging.

External power connected from 0:00 to 7:00 and only battery powered from 7:00 to 20:00.
JAVA application running and storing the GPS position on the flash storage every five minutes, and transmitting positions by GPRS every 30 minutes. Connected to the Movistar GPRS network.



Note: there are two internal LEDs that provide information about the battery status:

- A red LED will illuminate when the battery is charging.
- A green LED will illuminate when external power is applied.

4.11 Real Time Clock

4.11.1 All models except MTX-65i-ULP

The TC65i module attached to MTX-65i modems contains a real time clock (RTC) to maintain accurate timekeeping and to enable you to “time stamp” messages.

This RTC is supplied by a separate voltage regulator which is also active when the MTX-65i is in power down mode and the power supply VIN is available. An alarm function is provided that allows the MTX-65i to wake up in Airplane mode without logging onto the GSM network.

The MTX-65i modems can also accommodate an independent battery or super-cap inside to maintain the date and time of the RTC when the power supply is disconnected. Both the battery and the super-cap will be charged when power supply is present again.

The size of the capacitor determines the duration of buffering when no voltage is applied to MTX-65i; the larger the capacitor, the longer the date and time will be saved. A serial 1kΩ resistor placed on the board next to VDDLP limits the charged current of an empty capacitor or battery.

This capacitor is not fitted by default and must be ordered separately. Please contact gsmsupport@matrix.es for more details.

4.11.2 MTX-65i-ULP

The module’s internal RTC is not used in the MTX-65i-ULP modem because it has its own external low-power battery operated RTC. The RTC used is a DS1337 connected to the module’s I2C bus at a 7-bit address 0x68 hexadecimal.

If you need the internal TC65i RTC, please contact gsmsupport@matrix.es

Please refer to the DS1337 datasheet for details about using the RTC. You can configure it by issuing I2C related AT commands or via the I2C Java class. You can also contact gsmsupport@matrix.es

You can program alarms to wake-up the modem at a specified date and time. Please refer to Section 5.3 to more information about Ultra Low Power features.

4.12 Internal Hardware Watchdog (MTX-65i+G V6, MTX-65i+G+B V7 and MTX65i-BAT)

The MTX-65i has a new internal hardware watchdog component which allows the module to be reset when the internal Java program is not refreshed in 120±60 seconds, meaning that it has hang-ups or that it does not respond in this time.

The MTX-65i are configured and shipped with watchdog disabled in the factory default settings.

In order to use this watchdog, two GPIOs must be handled:

- GPIO1 (which must be configured as output) sets/resets watchdog
- GPIO2 (which must be configured as output) must change cycle in less than 120 seconds

To enable this feature, use the following AT command sequences

- Configuration sequence

AT^SPIO=1
AT^SCPIN=1,0,1 (GPIO1 as output, Set-Reset Watchdog)
AT^SCPIN=1,1,1 (GPIO2 as output, Clock - to be refreshed-)

- Enable sequence

AT^SSIO=0,0 (enable)
AT^SSIO=1,0 (clock cycle)
AT^SSIO=1,1 (clock cycle)

- Disable sequence

AT^SSIO=0,1 (disable)
AT^SSIO=1,0 (clock cycle)
AT^SSIO=1,1 (clock cycle)

- Refresh watchdog

AT^SSIO=1,0 (clock cycle)
AT^SSIO=1,1 (clock cycle)

This configuration is stored into the modem as long as power is still applied. This is, when the modem resets because watchdog is operative, it is not necessary to repeat the procedure.

For further information, please ask gsmsupport@matrix.es or visit the Downloads section at www.mtxm2m.com

You can configure both the “Automatic Restart” and the “Watchdog” features in your Java routine source code using initialization code.

4.13 GPS (MTX-65i+G V6 and MTX-65i+G+B V7)

The MTX-65i has an internal GPS receiver which offers the full performance of GPS technology. The GPS receiver continuously tracks all satellites in view, thus providing accurate satellite positioning data.

4.13.1 GPS antenna connector

The antenna connector allows for the transmission of radio frequency (RF) signals between the modem and an external customer-supplied antenna. The modem is fitted with a 50Ω, SMA F coaxial jack.

It is possible to connect active or passive GPS antennas. In either case they must have 50 Ohm impedance.

4.13.2 GPS application interface

The MTX-65i has an internal GPS receiver which offers the full performance of GPS technology. The GPS receiver continuously tracks all satellites in view, thus providing accurate satellite positioning data.

The GPS receiver supports implemented NMEA protocols. It is able to recognize input messages from any of these protocols (e.g., GGA, RMC GSA, GSV) and respond to them accordingly. Input messages can be arbitrarily mixed.

The NMEA protocol is an industry standard protocol developed for marine electronics. It was originally designed to allow data exchange between various sensors and navigation equipment aboard ships. Nowadays, it is a de-facto standard for GPS receiver data output. For more information on the NMEA Standard please refer to www.nmea.org.

The GPS receiver can be software controlled using NMEA protocol. We recommend the use of Java code to read NMEA sentences.

The GPS receiver is connected to the TC65i ASC1 port and NMEA data at 9600 bauds is present. JAVA code needs to open the ACS1 port and collect all these protocols and parses to calculate latitude and longitude positions.

To help all customers, Matrix Electronica provides “as is” (without further technical support, warranties, etc.) PARSER source code to improve the time to market in JAVA developing code.

4.13.3 GPS Parser

Matrix Electronica provides MTXParser for developing purposes at no cost.

MTXParser is JAVA source code which basically handles the GPS unit installed on the internal module and translates this into useful information such as positioning, as well as carrying out other useful features like:

- Obtaining GPS positioning in the same format as XT65
- A function to activate/deactivate AutoPowerON feature.
- A function to activate/deactivate/refresh the Hardware Watchdog feature.
- A function to read X,Y,Z acceleration values.
- A function to configure MTX-65i-GPS and power up the alarm: after switching off, the modem will power UP when one axis (X, Y, Z) reaches the trigger acceleration value. Useful to save battery power consumption.
- A function to assist GPS (AGPS). Please ask gsmsupport@matrix.es
- A function to switch ON/OFF secondary red LED for user purposes.

MTXParser can be used as a library/example. We supply this code “as is”: this means that there will be no documentation, no further support will be provided and no warranties will be given regarding functionality. Matrix has tested it and uses it for internal purposes and customer support. It is not commercial software/code.

Please ask gsmsupport@matrix.es to obtain a free copy.

4.13.4 Power saving

Power saving can be enabled on the GSM part (using the AT+CFUN function). On the GPS receiver it is possible to use a special NMEA command. For more information on the AT command AT+CFUN, see the AT command manual.

For more information about the NMEA internal GPS module please ask gsmsupport@matrix.es

4.14 Software updates

It is possible and sometimes necessary to update the MTX-65i software.
Updates must be carried out by an approved technician.
Please contact your supplier for details regarding Servicing/Programming.

5. Operation

5.1 Switching on the modem. New *"Automatic restart after shutdown"* feature

There is no special way to turn the modem on: just apply power to the VIN terminal via a power connector (see Section 4.1). The modem will be fully operational after 4 to 9 seconds. Logging onto a network may take longer than this and is out of the modem's control.

The *Automatic Restart after Shutdown* feature is enabled as part of the factory default settings. This means that if/when the modem has to be switched off, due to a critical power supply, the modem will restart itself within a few seconds. This feature allows an application to be switched on all the time and also allows it to restart itself.

The *Automatic Restart after Shutdown* feature cannot be disabled in the base MTX-65i and MTX-65i-ULP modems. In the MTX-65i-RS485 FW2.00 modem there is an AUTO_ON terminal in the Power Connector (see Section 4.1) which allows for the enabling or disabling of this function. In the MTX-65i+G V6 and MTX-65i+G+B V7 modems this feature can be disabled by software using GPIO3 and then you can switch on the modem with the TURN_ON pin at the power connector.

5.2 Switching off the modem

There are several ways to switch off (power down) the modem:

- Using the TURN_OFF pin (see section 4.1 to see the modems that use it). Continuously pressing the TURN_OFF pin (for at least 1 second) causes the modem to enter power down mode. Its use is not recommended except in an emergency. A delay of up to 10 seconds is experienced until the modem logs out of the network. The RTC stays active.

- AT^SMSO command: this allows the modem to log out of from the network and allows the software to enter into a secure state and save data before disconnecting the power supply. A delay of up to 10 seconds is experienced until the modem logs out of the network. The RTC stays active.

- In the MTX-65i-ULP models, the only way to switch off the modem and enter into the Ultra Low Power mode is to clean the input latches and execute the AT^SMSO command.

5.3 Ultra Low Power mode (MTX-65i-ULP)

MTX-65i-ULP modems can enter into an Ultra Low Power mode. In this mode, all the board devices are disconnected from the power supply, except a little portion of digital logic and the RTC that allows the modem to exit from this mode and go back into the normal mode.

The first time the MTX-65i-ULP modem is powered up, it will switch on normally. When an ULP modem enters in power down mode, you can wake up again in several ways:

- By **optoisolated inputs** (see Section 4.1.3): there are two active-high inputs and two active-low inputs allowing the modem to power up again.
- By the **RTC alarm** (see Section 4.11): you can configure the RTC to power on the modem at a specified date and time

It is possible to know if the modem has been woken up by inputs or the RTC alarm by reading the status latches with AT commands or the Java application.

WAKEUP input	GPIO number
Wake-up 1	GPIO 6
Wake-up 2	GPIO 7
Wake-up 3	GPIO 8
Wake-up 4	GPIO 9

Keep in mind that those inputs and the RTC can only be programmed when MTX-65i-ULP is in normal mode. The only way to enter in Ultra Low Power mode is to clean/reset the input latches and execute the AT^SMSO command.

5.4 Sleep mode

The modems that can disable the *Automatic Restart after Shutdown* feature are able to enter into a sleep mode. In this mode all the electronic systems are powered and enabled, but the GSM engine enters into a power down mode where only the module's internal RTC stays active (see Section 4.11.1).

To enter in Sleep mode, follow these steps:

1. Disable Automatic Restart after Shutdown
2. Use the AT^SMSO command to disconnect the modem from the cellular network and shutdown the modem

There are several ways to wake up the modem:

- Programming a time/date alarm in the module's internal RTC (AT+CALA command)
- Using TURN_ON signal at the power connector
- With an acceleration threshold interrupt from the internal accelerometer (see Section 4.9)

5.5 Status LEDs

The MTX-65i modem family has a bicolor status LED (green and red).

The green color LED is handled automatically by the modem and indicates its different operating modes, as shown in table below. The LED mode configuration is set by the AT^SSYNC command.

LED behavior	ME operating status if AT^SSYNC=1	ME operating status if AT^SSYNC=2
Permanently off	ME is in one of the following modes: - POWER DOWN mode - AIRPLANE mode - CHARGE ONLY mode - NON-CYCLIC SLEEP mode - CYCLIC SLEEP mode with no temporary wake-up event in progress	ME is in one of the following modes: - POWER DOWN mode - AIRPLANE mode - CHARGE ONLY mode
600 ms on / 600ms off	Limited Network Service: No SIM card inserted or no PIN entered, or network search in progress, or ongoing user authentication, or network login in progress.	Same as for AT^SSYNC=1
75 ms on / 3 s off	IDLE mode: The mobile is registered to the GSM network (monitoring control channels and user interactions). No call is in progress.	Same as for AT^SSYNC=1
75 ms on / 75 ms off / 75 ms on / 3 s off	One or more GPRS PDP contexts activated.	Same as for AT^SSYNC=1
500 ms on / 50 ms off	Packet switched data transfer is in progress.	Same as for AT^SSYNC=1
Permanently on	Depending on type of call: Voice call: Connected to remote party. Data call: Connected to remote party or exchange of parameters while setting up or disconnecting a call.	Same as for AT^SSYNC=1
<n> ms on / <n> ms off	Not possible: With AT^SSYNC=1, LED signalization is disabled in SLEEP mode.	SLEEP mode is activated (AT+CFUN parameter <fun> ≠ 1), but the ME is not registered to the GSM network (e.g. SIM not inserted or PIN not entered, and therefore, either no network service or only Limited Network Service is available.
25 ms on / 4 * <n> ms off	Not possible: With AT^SSYNC=1, LED signalization is disabled in SLEEP mode.	SLEEP mode is activated (AT+CFUN parameter <fun> ≠ 1) while the ME is registered to the GSM network and in IDLE mode.
25 ms on / <m> ms off / 25 ms on / 3 * <m> ms off	Not possible: With AT^SSYNC=1, LED signalization is disabled in SLEEP mode.	SLEEP mode is activated (AT+CFUN parameter <fun> ≠ 1) while the ME is registered to the GSM network. Additionally, PDP context is activated.

The red color LED (not available in MTX-65i-ULP) is connected to the GPIO5 in MTX-65i, MTX-65i-RS485 and MTX-65i-RS485-LC and to the GPIO6 in MTX-65i+G V6 and MTX-65i+G+B V7 (shared with an OUT4 optoisolated output). This allows the user to define the functionality of this LED by issuing AT commands or through a Java embedded code (see Section 4.5.6).

6. AT command interpreter

After a successful installation of the TC65i driver package, the physical USB interface of the modem is represented in the operating system by two virtual interfaces, each assigned to a virtual COM port of its own:

- **Modem interface:**

This interface is referred to as "Modem" if queried using the AT^SQPORT command. In the quick reference tables it is named USB0-MDM.

The Modem interface is intended particularly for data transmission (UMTS or GPRS).

All URCs are normally issued on the Application interface. URCs related to data calls (RING, NO CARRIER) as well as the "^SYSSTART" URC are issued on the Modem interface.

- **Application interface:**

This interface is referred to as "Application" if queried using the AT^SQPORT command. In the quick reference tables it is named USB0-APP.

The Application interface is designed especially for controlling the MTX-65i, i.e. for entering AT commands, receiving URCs, or sending and receiving short messages. It cannot be used as a data interface for UMTS, or GPRS.

Please note that URCs are normally indicated only on this interface, no matter whether the Modem interface or the Application interface was used to send the AT commands to activate their presentation. This URC management scheme is the default configuration recommended for a typical MTX-65i application.

Bear in mind that the Modem interface and the Application interface are handled by the same AT command interpreter.

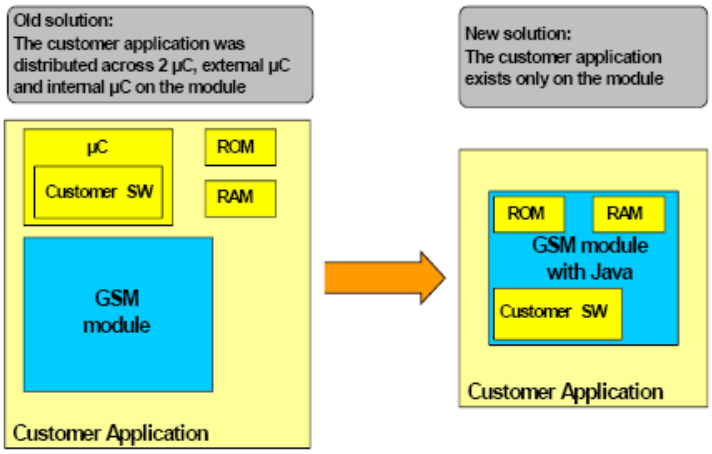
As a result, AT commands entered on both interfaces are not executed in parallel but sequentially, one after the other. So, an AT command issued on one interface will be buffered on this interface to be executed after the other interface has completed processing earlier AT command(s).

When a data connection is established over the Modem interface, the Application interface can be used simultaneously for any control functions. This eliminates the need for the user to enter AT commands, such as +++ and ATO, as well as switching back and forth between command and online mode when working on one interface only.

See the MTX-65i Quick Start guide for a complete step by step installation process.

7. Embedded applications

The MTX-65i can embed an internal application written in popular JAVA language. Java technology and several peripheral interfaces on the modem allow you to easily integrate your application. This way, the customer application can be reduced because all the resources (Microcontroller, Flash & RAM memory and all kind of I/O and bus peripheral) can be used by the customer. This solution saves the external intelligence with all the associate costs and also saves space and power consumption.



Features:

- Oracle Java ME Embedded 3.2 Compliant to CLDC 1.1 HI (JSR139) and IMP-NG (JSR228) Java standards.
- Capable of running multiple MIDlets in parallel with inter-MIDlet communication.
- Additional Java standard APIs:
  - JSR75 (FileConnection)
  - JSR177 (CRYPTO)
  - JSR280 (XML)
- Additional Java proprietary APIs:
  - AT Command API
  - Watchdog API
- Additional accessible periphery for Java applications
  - I/O pins- I2C Interface, SPI interface, DAC,ADC
  - Serial interfaces (API): (ASC0, ASC1, USB*) can be used to connect external devices
- Memory space for Java programs:
  - Flash File System: around 8 MB
  - RAM: around 6MB
  - Just-in-Time Compiler execution optimization
- Over-the-air update
  - Application SW: OTAP
  - Firmware: FOTA (OMA compliant)

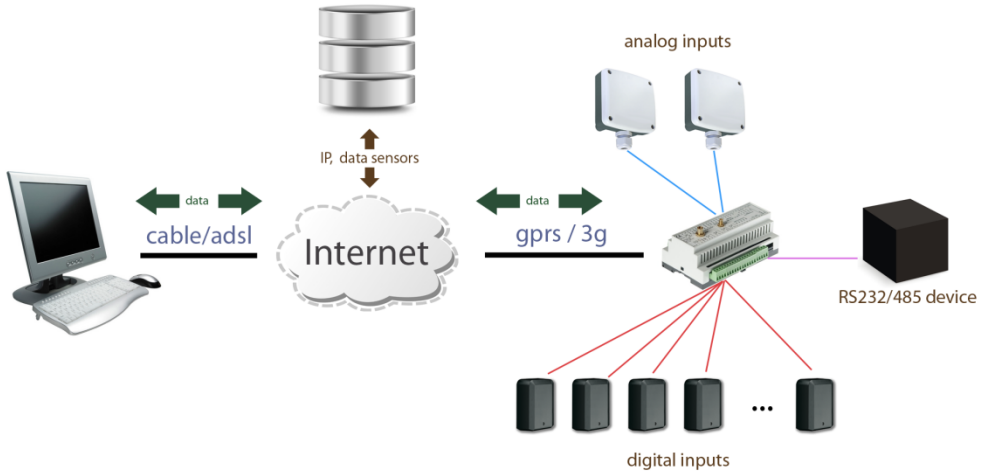
Ask gsmsupport@matrix.es for application notes and a free Cinterion SDK (Software Development Kit); we will provide Matrix FTP server to download it.

7.1 MTX-Tunnel software application

If you are not a JAVA expert and you do not have experts on hand in your company, we have a readily compiled JAVA code which fits into 99% of M2M applications: MTX-TUNNEL. This is optional and must be ordered separately.

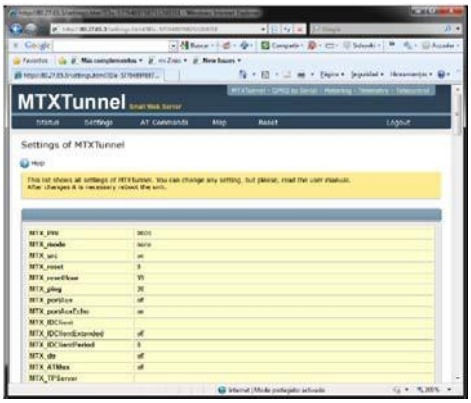
MTX-TUNNEL is an application running in the GSM/GPRS/UMTS modems and is based on the Cinterion TC65i module which is designed for communicating with remote devices that have RS232/I2C ports.

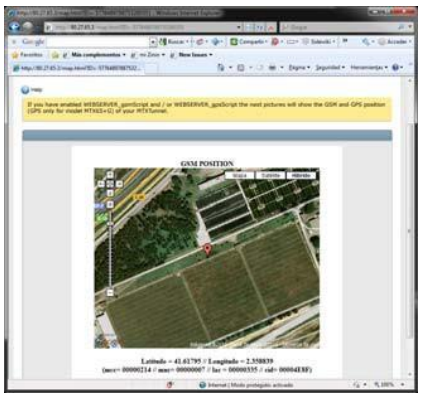
Frequently, remote meters, network switches, routers or other devices need to connectto the network, but they only have an RS232 port and the only possible way to reach them is using the GSM/GPRS Network. MTX-TUNNEL is ready-to-go solution for such cases.

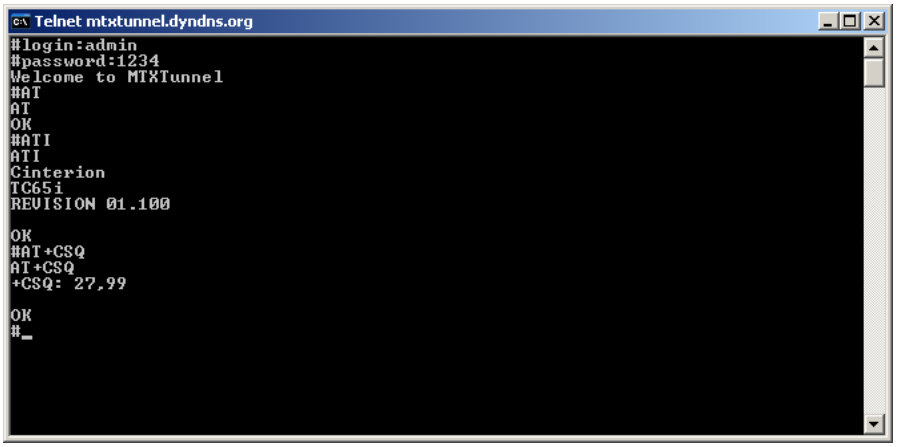


It acts as a transparent RS232 port. You will see your remote devices as if they were directly connected to the computer.

MTX-TUNNEL V8 has extra features like WebServer, SMS telemetry, Telnet, DNS, ModBus and Gateway RF.







Features:

- GPRS-SERIAL TUNNEL
  - TCP Client
  - TCP Server
  - UDP Client / Server
- GPRS connection modes:
  - Permanent mode
  - Upon request (SMS or missed calls, authorized or blocked phone numbers)
  - Change on an input digital level
  - An analog input is out of the selected level window (MIN, MAX)
  - Serial data present on RS232/RS485 port
  - Scheduled date/hour timing
- WebServer
- Telnet
- SMS Alarms and Output control
- IPs dynamic resolution:
  - DynDNS
  - Private DNS
  - SMS
- SSL Security
- Firewall IP
- User API
- Telemetry (GPIOs and GPS)
- Serial RS232/485 – HTTP tunnel
- Serial RS232/485 – SMS tunnel
- Timing synchronization
- ModBus
- RF Gateway

8. Safety and product care

Please read the information in this section and the information in "Installation of the Modem", before starting your integration work!

8.1 Safety instructions

PLEASE READ THESE SAFETY INSTRUCTIONS AND KEEP A COPY OF THEM

- Always ensure that use of the modem is permitted. The modem may present a hazard if used in proximity to personal electronic medical devices. As a rule, the modem must not be used in hospitals, airports or planes.

- Never use the modem at a gas station, refuelling point, blasting area or in any other environment where explosives may be present.

- Operating the modem close to other electronic devices, such as antennas, television sets, and radios may cause electromagnetic interference.

- This product is intended to be used with the antenna or other radiating element at least 20cm away from any part of the human body. In applications where this rule cannot be applied, the application designer is responsible for providing the SAR measurement test report and declaration.

- You are responsible for observing your country's safety standards, and where applicable, the relevant wiring rules.

8.2 General precautions

The MTX-65i Terminal as a standalone item is designed for indoor use only. For outdoor use it must be integrated into a weatherproof enclosure. Do not exceed the environmental and electrical limits as specified in "Technical Data".

- Avoid exposing the modem to lighted cigarettes, naked flames or to extreme hot or cold temperatures.

- Never try to dismantle the modem yourself. There are no components inside the modem that can be serviced by the user. If you attempt to dismantle the modem, you may invalidate the warranty.

- The MTX-65i Terminal must not be installed nor located in areas where the surface temperature of the plastic case could exceed 85°C.

In order to provide strain relief and to avoid transmitting excessive vibration to the modem during installation, all cables connected to the MTX-65i Terminal must be secured or clamped immediately adjacent to the modem's connectors.

- To protect the power supply cables, and in order to comply with the fire safety requirements, when the unit is powered from a battery or a high current supply, a fast 1.25A fuse should be connected in line with the positive supply.

- Any incompatible components or products must not be connected to the MTX 65i Terminal.

Note! MTX-65i distributors and sales offices may refuse warranty claims where evidence of product misuse is found.

8.3 SIM card precautions

Before handling the SIM card in your application, ensure that you are not charged with static electricity. Use proper precautions to avoid electrostatic discharges.

- When the SIM card hatch is opened, the SIM card connectors lie exposed under the SIM card holder.

Caution! Do not touch these connectors! If you do, you may release an electrical discharge that could damage the modem or the SIM card.

- When designing your application, the SIM card's accessibility should be taken into account. We always recommend that you have the SIM card protected by a PIN code. This will ensure that the SIM card cannot be used by an unauthorized person.

8.4 Antenna precautions

If the antenna is to be mounted outside, consider the risk of lightning. Follow the instructions provided by the antenna manufacturer.

- Never connect more than one modem to a single antenna. The modem can be damaged by radio frequency energy from the transmitter of another modem.

- Like any mobile station, the antenna of the modem emits radio frequency energy. To avoid EMI (electromagnetic interference), you must determine whether the application itself, or equipment in the application's proximity, needs further protection against radio emission and the disturbances it might cause. Protection is secured either by shielding the surrounding electronics or by moving the antenna away from the electronics and the external signal cable.

- The modem and antenna may be damaged if either come into contact with ground potentials other than the one in your application. Beware: ground potentials are not always what they appear to be.

8.5 Radio Frequency (RF) exposure and SAR

Your wireless modem device is a low-power radio transmitter and receiver (transceiver). When it is turned on, it emits low levels of radio frequency energy (also known as radio waves or radio frequency fields).

Governments around the world have adopted comprehensive international safety guidelines, developed by scientific organizations such as ICNIRP (International Commission on Non-Ionizing Radiation Protection) and IEEE (The Institute of Electrical and Electronics Engineers Inc.), through periodic and thorough evaluation of scientific studies. These guidelines establish permitted levels of radio wave exposure for the general population. The levels include a safety margin designed to assure the safety of all persons, regardless of age and health, and to account for any variations in measurements.

Specific Absorption Rate (SAR) is the unit of measurement for the amount of radio frequency energy absorbed by the body when using a transceiver. The SAR value is determined at the highest certified power level in laboratory conditions, but the actual SAR level of the transceiver while operating can be well below this value. This is because the transceiver is designed to use the minimum power required to reach the network.

The MTX-65i wireless modem device has been approved for applications where the antenna is located more than 20cm from the body. In all other configurations **the user** is responsible for meeting the local SAR regulations.

Users of the MTX-65i wireless modem device are responsible for ensuring that they meet the SAR regulatory requirements of the countries in which they intend to operate the device and that their documentation contains the relevant SAR declaration, certification information and user guidance as appropriate.

8.6 Personal medical devices

Wireless modem devices may affect the operation of cardiac pacemakers, hearing aids and certain other implanted equipment. If a minimum distance of 15 cm (6 inches) is maintained between the MTX-65i modem radiating antenna and a pacemaker, the risk of interference is limited. If the user's application is likely to be situated in the vicinity of personnel, a suitable warning should be contained in the equipment manual to this effect.

9. Modem installation

This chapter gives you advice and helpful hints on how to integrate the MTX-65i Terminal into your application from a hardware perspective.

9.1 Where to install the modem

There are several conditions which need to be taken into consideration when designing your application as they might affect the modem and its function. They are:

9.1.1 Environmental conditions

The modem must be installed so that the environmental conditions stated in the Technical Data chapter such as temperature, humidity and vibration are satisfied.
Additionally, the electrical specifications in the Technical Data section must not be exceeded.

9.1.2 Signal strength

The modem has to be placed in a way that ensures sufficient signal strength. To improve signal strength, the antenna can be moved to another position. Signal strength may depend on how close the modem is to a radio base station. You must ensure that where you intend to use the modem is within the network coverage area. Degradation in signal strength can be the result of disturbance from another source; for example, an electronic device in the immediate vicinity. More information about possible communication disturbances can be found in section 9.3.5.

When an application is completed, you can verify the signal strength by issuing the AT command AT+CSQ.

Tip! Before installing the modem, use an ordinary mobile telephone to check a possible location for it. In determining the location for the modem and antenna, you should consider signal strength as well as cable length.

9.1.3 Connections of components to MTX-65i Terminal

The user is responsible for the final integrated system. If not correctly designed or installed, external components may cause radiation limits to be exceeded. For instance, improperly made connections or improperly installed antennas can disturb the network and lead to malfunctions in the modem or equipment.

9.1.4 Network and subscription

Before your application is used, you must ensure that your chosen network provides the necessary telecommunication services. Contact your service provider to obtain the necessary information.

- If you intend to use SMS in the application, ensure this is included in your (voice) subscription.
- Consider the choice of supplementary services

9.2 How to install the modem

9.2.1 Power supply

Use a high-quality power supply cable with low resistance. This ensures that the voltages at the connector pins are within the allowed range, even during the maximum peak current.
When the unit is powered from a battery or a high current supply, connect a fast 1.25A fuse in line with the positive supply. This protects the power cabling and modem.

9.2.2 Securing the modem

Before securing the modem take into account the amount of additional space required for the mating connectors and cables that will be used in the application.

- Where access is restricted, it may be easier to connect all the cables to the modem prior to securing it in the application.
- Securely attach the MTX-65i Terminal modem to the host application using two 3mm diameter pan-head screws

9.3 Antenna

9.3.1 General

The antenna is the component in your system that maintains the radio link between the network and the modem. Since the antenna transmits and receives electromagnetic energy, its efficient function will depend on:

- The type of antenna (for example, circular or directional);
- The placement of the antenna;
- Communication disturbances in the vicinity in which the antenna operates.

In the sections below, issues concerning antenna type, antenna placement, antenna cable, and possible communication disturbances are addressed. In any event, you should contact your local antenna manufacturer for additional information concerning antenna type, cables, connectors, antenna placement, and the surrounding area.

You should also determine whether the antenna needs to be grounded or not. Your local antenna manufacturer might be able to design a special antenna suitable for your application.

9.3.2 Antenna type

Make sure that you choose the right type of antenna for the modem. Consider the following requirements:

- The antenna must be designed for one of the frequency bands in use; please ask your network provider for more information:
  - GSM 850/900/1800/1900 MHz
- The impedance of the antenna and antenna cable must be 50Ω;
- The antenna output-power handling must be a minimum of 2W

9.3.3 Antenna placement

The antenna should be placed away from electronic devices and other antennas. The recommended minimum distance between adjacent antennas, operating in a similar radio frequency band, is at least 50cm. If the signal strength is weak, it is useful to face a directional antenna towards the closest radio base station. This can increase the strength of the signal received by the modem. The modem's peak output power can reach 2W.

RF field strength varies with antenna type and distance. At 10cm from the antenna the field strength may be up to 70V/m and at 1m it will have reduced to 7V/m. In general, CE-marked products for residential /commercial areas and the light industry can withstand a minimum of 3V/m.

9.3.4 The antenna cable

Use 50Ω impedance low-loss cable and high-quality 50Ω impedance connectors (frequency range up to 3GHz) to avoid RF losses. Ensure that the antenna cable is as short as possible. The Voltage Standing-Wave Ratio (VSWR) may depend on the effectiveness of the antenna, cable and connectors. In addition, if you use an adaptor between the antenna cable and the antenna connector, it is crucial that the antenna cable is a high-quality, low-loss cable. Minimize the use of extension cables, connectors and adapters. Each additional cable, connector or adapter causes a loss of signal power.

9.3.5 Possible communications disturbances

Possible communication disturbances include the following:

- **Noise** can be caused by electronic devices and radio transmitters.
- **Path-loss** occurs as the strength of the received signal steadily decreases in proportion to the distance from the transmitter.
- **Shadowing** is a form of environmental attenuation of radio signals caused by hills, buildings, trees or even vehicles. This can be a particular problem inside buildings, especially if the walls are thick and reinforced.
- **Multi-path fading** is a sudden decrease or increase in the signal strength. This is the result of interference which is caused when direct and reflected signals reach the antenna simultaneously. Surfaces such as buildings, streets, vehicles, etc., can reflect signals.
- **Hand-over** occurs as you move from one cell to another in the GSM network. Your mobile application call is transferred from one cell to the next. Hand-over can briefly interfere with communication and may cause a delay, or at worst, disruption.

10. Conformity assessment

MATRIX ELECTRONICA S.L.U.
C/ Alejandro Sanchez 109
28019 Madrid
Spain

10.1 Standards of European Type Approval

We declare under our sole responsibility that the products, MTX-65i Terminal 0 containing Cellular Engine Cinterion engine TC65i (Type L30960-N1150-A200), to which this declaration relates, are labeled with the CE conformity mark.

DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.

ETSI EN 301 511 V9.0.2: Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC) (GSM 13.11 version 7.0.1 Release 1998).

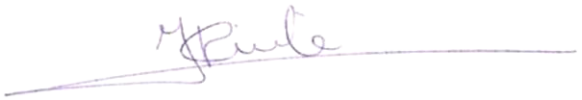
ETSI EN 301 489-1 V1.8.1: Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements

ETSI EN 301 489-7 V1.3.1: Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS).

IEC/EN 60950-1:2005 / EN 60950-1:2006+A11:2009: Health and Safety

The technical documentation relevant to the above equipment will be held at
MATRIX ELECTRONICA S.L.U.
Alejandro Sanchez 109
28019 Madrid
Spain

Madrid, 20/05/2013.
Mr. J. Vicente
Managing Board



10.2 PTCRB approval

PTCRB is the regional approval needed in North American Market.

MTX-65i is now PTCRB Certified:
Request #: 37494
Manufacturer: Matrix Electronica
Model #: MTX-65i
Technologies and Frequency Bands: GSM 850/900/1800/1900
FCCID: QIPTC65i
Industry Canada #: 7830A-TC65i
IMEI TAC: 01096900
Hardware Version: 2.02
Software Version: 2.004
SVN: 09
NAPRD.03 Version: GSM Test: 5.9/OTA Performance Test: 5.9

10.3 FCC Compliant and SAR information

MTX-65i and any variants contain FCC ID: QIPTC65i. The FCC Equipment Authorization Certification for the TC65i Module is listed under the FCC identifier QIPTC65i
Industry Canada Certification Number: 7830A-TC65i granted to Gemalto M2M GmbH.

The Gemalto reference application of the TC65i module registered under the above identifier is certified to be in accordance with the following Rules and Regulations of the Federal Communications Commission (FCC). Power listed is ERP for Part 22 and EIRP for Part 24. It is compliant with FCC regulations.

Equipment class: PCS Licensed Transmitter
Notes: Quad band GSM/GPRS Modem

10.3.1 SAR information

Cinterion Wireless Modules models: TC65i is marketed without a defined antenna.

The Maximum Antenna Gain using indoor antennas depends on the distance from the antenna to any nearby persons when in normal operation. It should not exceed the values showns on the table below.

According to the limit in 47 CFR 1.1310, we get the value of the maximum antenna gain as follows:

The maximum measured power output in the 850 MHz band is 1866.38 mW (32.71 dBm, see 7layers test report MDE_Siem_0714_FCCb).
The maximum permissible exposure is defined as 47 CFR 1.1310 with 0.55773 mW/cm².
The maximum measured power output in the 1900 MHz band is 974.99 mW (29.89 dBm, see 7layers test report MDE_Siem_0714_FCCc).
The maximum permissible exposure is defined as 47 CFR 1.1310 with 1 mW/cm².

According to the limit in 47 CFR 1.1310, we get the value of the maximum antenna gain as follows:

$S = P*G/4\pi R^2$
$S = 0.55773$ mW/cm² or 1 mW/cm²
P = 1866.38 mW or 974.99 mW
R = 20 cm or 100cm
$\pi = 3.1416$
G(dBi)=10*log10(G)

Solving for G; the maximum antenna gain is

Band	Distance	Maximum Gain in dBi
850MHz	20cm	1.7669
850MHz	50cm	9.7257
1900MHz	20cm	7.1227
1900MHz	50cm	15.0815

11. Declaración de conformidad (Spanish)

MATRIX ELECTRONICA S.L.U.
C/ Alejandro Sanchez 109
28019 Madrid
Spain

11.1 Standards of European Type Approval

Declaramos bajo nuestra responsabilidad que los productos MTX-65i Terminal 0 que contienen un modulo celular Cinterion TC65i (tipo L30960-N1150-A200), al cual se refiere esta declaración, están etiquetados con el marcado CE de conformidad.

DIRECTIVA 2006/95/EC DEL PARLAMENTO EUROPE Y DEL CONSEJO del 12 de Diciembre de 2006 sobre la armonización de las leyes de los estados miembros relacionadas con los equipos eléctricos diseñados para su uso bajo ciertos límites de voltaje.

ETSI EN 301 511 V9.0.2: Sistema Global de Comunicaciones Móviles (GSM); estándar unificado para estaciones móviles en las bandas GSM 900 y DCS 1800, que cubren los requisitos esenciales del artículos 3.2 de la directiva R&TTE (1999/5/EC) (GSM 13.11 versión 7.0.1 Release 1998).

ETSI EN 301 489-1 V1.8.1: Cuestiones sobre Compatibilidad Electromagnética y espectro Radioeléctricos (ERM); estándar de compatibilidad electromagnética (EMC) para equipos y sistema de radio; Parte 1: Requisitos Técnicos Comunes

ETSI EN 301 489-7 V1.3.1: Cuestiones sobre Compatibilidad Electromagnética y espectro Radioeléctricos (ERM); estándar de compatibilidad electromagnética (EMC) para equipos y sistema de radio; Parte 7: Condiciones específicas para equipos de radio móviles y portátiles y equipos auxiliares de sistemas de radiocomunicaciones móviles digitales (GSM y DCS).

IEC/EN 60950-1:2005 / EN 60950-1:2006+A11:2009: Salud y Seguridad

La documentación técnica referente al equipo anterior está disponible en:
MATRIX ELECTRONICA S.L.U.
Alejandro Sanchez 109
28019 Madrid
España

Madrid, 20/05/2013.
Mr. J. Vicente
Managing Board

11.2 PTCRB approval

PTCRB es un aprobado regional necesario en el mercado norteamericano.

MTX-65i tiene la certificación PTCRB:
Número de solicitud: 37494
Fabricante: Matrix Electronica
Modelo: MTX-65i
Tecnologías y bandas de frecuencia: GSM 850/900/1800/1900
FCC ID: QIPTC65i
Industry Canada #: 7830A-TC65i
IMEI TAC: 01096900
Versión Hardware: 2.02
Versión Software: 2.004
SVN: 09
NAPRD.03 Version: GSM Test: 5.9/OTA Performance Test: 5.9

11.3 FCC Compliant and SAR information

MTX-65i y todas sus variantes contienen el FCC ID: QIPTC65i. El Certificado de Autorización de Equipo de la FCC para el módulo EHS6 está listado con el identificador FCC QIPTC65i
Número de Certificación de Industria en Canadá: 7830A-TC65i asignado a Gemalto M2M GmbH.

El formulario de referencia del módulo TC65i registrado bajo el anterior identificador está conforme con las siguientes Reglas y Regulaciones de la Comisión Federal de Comunicaciones (FCC). La potencia listada como ERP para la parte 22 y como EIRP para la parte 24 cumple con las regulaciones de la FCC.

Clase de equipo: Transmisor PCS Licenciado
Notas: Quad band GSM/GPRS Modem

11.3.1 Tasa de absorción específica (SAR)

El modulo Cinterion TC65i es comercializado sin una antena definida. La ganancia máxima de antena usando antenas de interior depende de la distancia de esta a las personas cercanas y en condiciones normales no debe sobrepasar los límites mostrados en la tabla siguiente.

La máxima potencia de salida medida en la banda de 850MHz es 1866.38 mW (32.71 dBm, ver el reporte de test de 7layers MDE_Siem_0714_FCCb).
La máxima exposición permisible se define en 47 CFR 1.1310 con un valor de 0.55773 mW/cm².
La máxima potencia de salida medida en la banda de 1900 MHz es 974.99 mW (29.89 dBm, ver el reporte de test de 7layers MDE_Siem_0714_FCCc).
La máxima exposición permisible se define en 47 CFR 1.1310 con un valor de 1 mW/cm².

De acuerdo al límite en 47 CFR 1.1310, obtenemos el valor de la máxima ganancia de antena como sigue:

$S = P*G/4\pi R^2$
$S = 0.55773$ mW/cm² o 1 mW/cm²
P = 1866.38 mW o 974.99 mW
R = 20 cm o 100cm
$\pi = 3.1416$
G(dBi)=10*log10(G)

Despejando G; la máxima ganancia de antena es:

Banda	Distancia	Ganancia Máxima en dBi
850MHz	20cm	1.7669
850MHz	50cm	9.7257
1900MHz	20cm	7.1227
1900MHz	50cm	15.0815

12. Regulatory and type approval information

12.1 Directives and standards

The MTX-65i family modems have been designed to comply with the directives and standards listed below.

It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards, as well as with the technical specifications provided in this document.

Directives	
1999/05/EC	Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (in short referred to as R&TTE Directive 1999/5/EC). The product is labeled with the CE conformity mark
2011/65/EU (RoHS 2)	Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

Standards of North American type approval	
CFR Title 47	Code of Federal Regulations, Part 22 and Part 24 (Telecommunications, PCS); US Equipment Authorization FCC
UL 60 950-1	Product Safety Certification (Safety requirements)
NAPRD.03 V5.15	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132 (Issue2)	Canadian Standard

Standards of European type approval	
3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
ETSI EN 301 511 V9.0.2	Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC)
GCF-CC V3.43	Global Certification Forum - Certification Criteria
ETSI EN 301 489-01 V1.8.1	Candidate Harmonized European Standard (Telecommunications series) Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements
ETSI EN 301 489-07 V1.3.1	Candidate Harmonized European Standard (Telecommunications series) Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
IEC/EN 60950-1:2006	Safety of information technology equipment

Requirements of quality	
IEC 60068	Environmental testing
DIN EN 60529	IP codes

12.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable TC65i based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design, manufacturers are advised to submit their product for approval if designed for portable use. For European markets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

Products intended for sale in US markets

EN 59005/ANSI C95.1: Considerations for evaluation of human exposure to Electromagnetic Fields (EMFs) from Mobile Telecommunication Equipment (MTE) in the frequency range 30MHz – 6GHz

Products intended for sale in European markets

EN 50360: Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300MHz - 3GHz)

Please note that SAR requirements are specific only for portable devices and not for mobile devices as defined below:

- Portable device:
  A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the user's body.
- Mobile device:
  A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitters's radiating structure(s) and the user's body or that of nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and cannot be easily moved to another location.

12.3 SELV requirements

The power supply connected to the MTX-65i modem shall be in compliance with the SELV requirements defined in EN 60950-1.

13. RoHS Statement

The MTX-65i modem is compliant with the 2002/95/EC Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).

14. Disposal of old electrical & electronic equipment

This symbol, applied on our products and/or on its packaging, indicates that this product should not be treated as household waste when you wish to dispose of it. Instead, it should be handed over to an applicable collection point for the recycling of electrical and electronic equipment. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences to the environment and human health, which could otherwise be caused by inappropriate disposal of this product. The recycling of materials will help to conserve natural resources. For more detailed information about the recycling of this product, please contact your local city office, household waste disposal service or the retail store where you purchased this product.

15. Abbreviations

Abbreviation	Description
ADC	Analog-to-digital converter
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of TC65i
B	Thermistor Constant
BER	Bit Error Rate
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DAI	Digital Audio Interface
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Gemalto M2M module)
DCS 1800	Digital Cellular System, also referred to as PCN
DL	Download
dnu	Do not use
DRX	Discontinuous Reception
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically a computer, terminal, printer or, for example, a GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EDGE	Enhanced Data rates for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic Compatibility
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (U.S.)
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access

FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion/Li+	Lithium-Ion
Li battery	Rechargeable Lithium Ion or Lithium Polymer battery
LPM	Link Power Management
MBB	Moisture barrier bag
Mbps	Mbits per second
MCS	Modulation and Coding Scheme
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station (GSM module), also referred to as TE
MSISDN	Mobile Station International ISDN number
MSL	Moisture Sensitivity Level
MT	Mobile Terminated
nc	Not connected
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PA	Power Amplifier
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800
PCS	Personal Communication System, also referred to as GSM 1900
PD	Pull Down resistor (appr. 100k)
PDU	Protocol Data Unit
PLL	Phase Locked Loop
PPP	Point-to-point protocol
PS	Packet Switched
PSK	Phase Shift Keying
PSU	Power Supply Unit

PU	Pull Up resistor (appr. 100k)
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RLS	Radio Link Stability
RMS	Root Mean Square (value)
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment.
ROM	Read-only Memory
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SAW	Surface Acoustic Wave
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMD	Surface Mount Device
SMS	Short Message Service
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SRB	Signalling Radio Bearer
TA	Terminal adapter (e.g. GSM module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TLS	Transport Layer Security
TPC	Transmit Power Control
TS	Technical Specification
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
UICC	USIM Integrated Circuit Card
UL	Upload
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USB	Universal Serial Bus
USIM	UMTS Subscriber Identification Module
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access

16. AT command summary

The AT standard is a line-oriented command language. AT is an abbreviation of ATtention and it is always used to send a command line from the terminal equipment (TE) to the terminal adaptor (TA). The command line consists of a string of alphanumeric characters. It is sent to the MTX-65i to instruct it to perform the commands specified by the characters.

The AT commands listed below are supported from within the MTX-65i. The AT Command Set manual can be downloaded from the MTX-65i web page at www.mtxm2m.com.

AT Command	Description
+++	Switch from data mode or PPP online mode to command mode
A/	Repeat Previous Command Line
AT&C	Set Data Carrier Detect (DCD) Line Mode
AT&D	Set Data Terminal Ready (DTR) Line Mode
AT&F	Reset AT Command Settings to Factory Default Values
AT&S	Set Data Set Ready (DSR) Line Mode
AT&V	Display current configuration
AT&W	Store AT Command Settings to User Defined Profile
AT+CACM	Accumulated call meter (ACM) reset or query
AT+CALA	Alarm Configuration
AT+CAMM	Accumulated call meter maximum (ACMmax) set or query
AT+CAOC	Advise of Charge Information
AT+CBST	Select Bearer Service Type
AT+CCFC	Call forwarding number and conditions control
AT+CCLK	Real Time Clock
AT+CCUG	Closed User Group
AT+CCWA	Call Waiting
AT+CEER	Extended Error Report
AT+CFUN	Functionality Level
AT+CGACT	PDP context activate or deactivate
AT+CGANS	Manual response to a network request for PDP context activation
AT+CGATT	GPRS attach or detach
AT+CGAUTO	Automatic response to a network request for PDP context activation
AT+CGDATA	Enter data state
AT+CGDCONT	Define PDP Context
AT+CGEQMIN	Rel. 99 Quality of Service Profile (Minimum acceptable)
AT+CGEQREQ	Rel. 99 Quality of Service Profile (Requested)
AT+CGMI	Request manufacturer identification
AT+CGMM	Request model identification
AT+CGMR	Request revision identification of software status
AT+CGPADDR	Show PDP address
AT+CGQMIN	Quality of Service Profile (Minimum acceptable)
AT+CGQREQ	Quality of Service Profile (Requested)
AT+CGREG	GPRS Network Registration Status
AT+CGSMS	Select service for MO SMS messages
AT+CGSN	Request International Mobile Equipment Identity (IMEI)
AT+CHLD	Call Hold and Multiparty
AT+CHUP	Hang up call
AT+CIMI	Request International Mobile Subscriber Identity (IMSI)
AT+CIND	Indicator control
AT+CLCC	List of current calls
AT+CLCK	Facility lock
AT+CLIP	Calling Line Identification Presentation

AT+CLIR	Calling Line Identification Restriction
AT+CLVL	Loudspeaker volume level
AT+CMEE	Error Message Format
AT+CMER	Common Event Reporting Configuration
AT+CMGC	Send SMS Command
AT+CMGD	Delete short message
AT+CMGF	Select SMS message format
AT+CMGL	List SMS messages from preferred store
AT+CMGR	Read SMS messages
AT+CMGS	Send SMS
AT+CMGW	Write Short Messages to Memory
AT+CMSS	Send short messages from storage
AT+CMUT	Mute control
AT+CMUX	Multiplex mode
AT+CNMA	New Message Acknowledgement to ME/TE
AT+CNMI	SMS Event Reporting Configuration
AT+CNUM	Read own numbers
AT+COLP	Connected Line Identification Presentation
AT+COPN	Read operator names
AT+COPS	Operator Selection
AT+CPAS	Activity Status
AT+CPBR	Read from Phonebook
AT+CPBS	Select phonebook memory storage
AT+CPBW	Write into Phonebook
AT+CPIN	PIN Authentication
AT+CPIN2	PIN2 Authentication
AT+CPMS	Preferred SMS message storage
AT+CPOL	Preferred Operator List
AT+CPUC	Price per unit and currency table
AT+CPWD	Change Password
AT+CR	Service reporting control
AT+CRC	Incoming Call Indication Format
AT+CREG	Network Registration Status
AT+CRLP	Configure RLP Parameters for Outgoing Non-Transparent Data Calls
AT+CRSM	Restricted SIM Access
AT+CSCA	SMS Service Center Address
AT+CSCB	Select Cell Broadcast Message Indication
AT+CSCS	Character Set
AT+CSDH	Show SMS text mode parameters
AT+CSIM	Generic SIM Access
AT+CSMP	Set SMS Text Mode Parameters
AT+CSMS	Select Message Service
AT+CSNS	Single Numbering Scheme
AT+CSQ	Signal quality
AT+CSSN	Supplementary service notifications
AT+CUSD	Unstructured Supplementary Service Data
AT+CXXCID	Display card ID
AT+FCLASS	Fax: Select, read or test service class
AT+FRH	Receive Data Using HDLC Framing
AT+FRM	Receive Data
AT+FRS	Receive Silence
AT+FTH	Transmit Data Using HDLC Framing
AT+FTM	Transmit Data
AT+FTS	Stop Transmission and Wait
AT+GCAP	Capabilities List

AT+GMI	Request manufacturer identification
AT+GMM	Request model identification
AT+GMR	Request revision identification of software status
AT+GSN	Request International Mobile Equipment Identity (IMEI)
AT+ICF	Character Framing
AT+IFC	Flow Control
AT+ILRR	Bit Rate Reporting
AT+IPR	Bit Rate
AT+VTD	Tone duration
AT+VTS	DTMF and tone generation
AT+WS46	Select wireless network
AT\Q	Flow Control
AT\V	Set CONNECT result code format
AT^MONI	Monitor idle mode and dedicated mode
AT^MONP	Monitor neighbor cells
AT^SACM	Advise of charge and query of ACM and ACMmax
AT^SAIC	Audio Interface Configuration
AT^SALS	Alternate Line Service
AT^SATR	Query SIM's Answer to Reset Data
AT^SBC	Battery Charge Control
AT^SBNR	Binary Read
AT^SBNW	Binary Write
AT^SBV	Battery/Supply Voltage
AT^SCCNT	Configure Pulse Counter
AT^SCFG	Extended Configuration Settings
AT^SCID	SIM Identification Number
AT^SCKS	Query SIM and Chip Card Holder Status
AT^SCML	List Concatenated Short Messages from preferred store
AT^SCMR	Read Concatenated Short Messages
AT^SCMS	Send Concatenated Short Messages
AT^SCMW	Write Concatenated Short Messages to Memory
AT^SCNI	List Call Number Information
AT^SCPIN	Pin Configuration
AT^SCPOL	Polling Configuration
AT^SCPORT	Port Configuration
AT^SCSL	Customer SIM Lock
AT^SCTM	Critical Operating Temperature Monitoring
AT^SDLD	Delete the 'last number redial' memory
AT^SDPORT	Delete a Port Configuration
AT^SFDL	Firmware Download
AT^SFNUR	Select the fixed network user rate
AT^SGACT	Query all PDP context activations
AT^SGAUTH	Set type of authentication for PPP connection
AT^SGCONF	Configuration of GPRS related Parameters
AT^SGIO	Get IO state of a specified pin or port
AT^SHOM	Display Homezone
AT^SHUP	Hang up call(s) indicating a specific 3GPP TS 24.008 release cause
AT^SICC	Internet Connection Close
AT^SICI	Internet Connection Information
AT^SICO	Internet Connection Open
AT^SICS	Internet Connection Setup Profile
AT^SIND	Extended Indicator Control
AT^SISC	Internet Service Close
AT^SISE	Internet Service Error Report
AT^SISI	Internet Service Information

AT^SISO	Internet Service Open
AT^SISR	Internet Service Read Data
AT^SISS	Internet Service Setup Profile
AT^SIST	Enter Transparent Access Mode
AT^SISW	Internet Service Write Data
AT^SISX	Internet Service Execution
AT^SJNET	Set Dialup Network Access Parameters
AT^SJOTAP	Over The Air Application Provisioning
AT^SJRA	Run Java Application
AT^SJSEC	Write Binary Java Security Data
AT^SLCC	Extended list of current calls
AT^SLCD	Display Last Call Duration
AT^SLCK	Facility lock
AT^SLMS	List SMS Memory Storage
AT^SM20	Set M20 compatibility mode
AT^SMGL	List Short Messages from preferred store without setting status to REC READ
AT^SMGO	Set or query SMS overflow presentation mode or query SMS overflow
AT^SMGR	Read short message without setting status to REC READ
AT^SMONC	Cell Monitoring
AT^SMOND	Cell Monitoring
AT^SMONG	Packet Data Monitor
AT^SMSO	Switch Off TC65i
AT^SNFA	Set or query of microphone attenuation
AT^SNFD	Set audio parameters to manufacturer default values
AT^SNFG	Generate Tone
AT^SNFI	Set microphone path parameters
AT^SNFM	Set microphone audio path and power supply
AT^SNFO	Set audio output (= loudspeaker path) parameter
AT^SNFPT	Set progress tones
AT^SNFS	Select audio hardware set
AT^SNFTTY	Signal TTY/CTM audio mode capability
AT^SNFV	Set loudspeaker volume
AT^SNFW	Write audio setting in non-volatile store
AT^SNMON	Network monitoring
AT^SOPS	Extended Operator Selection
AT^SPBC	Find first matching entry in sorted phonebook
AT^SPBD	Purge phonebook memory storage
AT^SPBG	Display phonebook entries in alphabetical order
AT^SPBS	Step through the selected phonebook alphabetically
AT^SPBW	Write into Phonebook with location report
AT^SPCL	Set Preferred Cell List
AT^SPIC	Display PIN counter
AT^SPIO	GPIO Driver Open/Close
AT^SPLM	Read the PLMN list
AT^SPWD	Change Password
AT^SRADC	Configure and Read ADC Measurement
AT^SRPN	Replace Operator Names
AT^SRSA	Remote SIM Access (RSA) Activation
AT^SRSM	Remote SIM Access Message
AT^SRTC	Ring tone configuration
AT^SSCNT	Start and Stop Pulse Counter
AT^SSCONF	SMS Command Configuration
AT^SSDA	Set SMS Display Availability
AT^SSET	SIM Data Ready Indication
AT^SSIO	Set IO state of a specified pin or port

AT^SSMSS	Set Short Message Storage Sequence
AT^SSPI	Serial Protocol Interface
AT^SSTA	Remote-SAT Interface Activation
AT^SSTGI	SAT Get Information
AT^SSTGI	SAT Get Information - Refresh (1)
AT^SSTGI	SAT Get Information - Set Up Event List (5)
AT^SSTGI	SAT Get Information - Set Up Call (16)
AT^SSTGI	SAT Get Information - Send SS (17)
AT^SSTGI	SAT Get Information - Send USSD (18)
AT^SSTGI	SAT Get Information - Send Short Message (19)
AT^SSTGI	SAT Get Information - Send DTMF (20)
AT^SSTGI	SAT Get Information - Launch Browser (21)
AT^SSTGI	SAT Get Information - Play Tone (32)
AT^SSTGI	SAT Get Information - Display Text (33)
AT^SSTGI	SAT Get Information - Get Inkey (34)
AT^SSTGI	SAT Get Information - Get Input (35)
AT^SSTGI	SAT Get Information - Select Item (36)
AT^SSTGI	SAT Get Information - Set up Menu (37)
AT^SSTGI	SAT Get Information - Set up Idle Mode Text (40)
AT^SSTGI	SAT Get Information - Language Notification (53)
AT^SSTGI	SAT Get Information - Open Channel (64)
AT^SSTGI	SAT Get Information - Close Channel (65)
AT^SSTGI	SAT Get Information - Receive Data (66)
AT^SSTGI	SAT Get Information - Send Data (67)
AT^SSTR	SAT Response
AT^SSTR	SAT Response - Refresh (1)
AT^SSTR	SAT Response - Set Up Event List (5)
AT^SSTR	SAT Response - Set Up Call (16)
AT^SSTR	SAT Response - Send SS (17)
AT^SSTR	SAT Response - Send USSD (18)
AT^SSTR	SAT Response - Send Short Message (19)
AT^SSTR	SAT Response - Send DTMF (20)
AT^SSTR	SAT Response - Launch Browser (21)
AT^SSTR	SAT Response - Play Tone (32)
AT^SSTR	SAT Response - Display Text (33)
AT^SSTR	SAT Response - Get Inkey (34)
AT^SSTR	SAT Response - Get Input (35)
AT^SSTR	SAT Response - Select Item (36)
AT^SSTR	SAT Response - Setup Menu (37)
AT^SSTR	SAT Response - Set Up Idle Mode Text (40)
AT^SSTR	SAT Response - Language Notification (53)
AT^SSTR	SAT Response - Open Channel (64)
AT^SSTR	SAT Response - Close Channel (65)
AT^SSTR	SAT Response - Receive Data (66)
AT^SSTR	SAT Response - Send Data (67)
AT^SSTR	SAT Event - Menu Selection (211)
AT^SSTR	SAT Event - User Activity (232)
AT^SSTR	SAT Event - Idle Screen Available (233)
AT^SSTR	SAT Event - Language Selection (235)
AT^SSTR	SAT Event - Browser Termination (236)
AT^SSTR	SAT Event - Terminate Command (254)
AT^SSYNC	Configure SYNC Pin
AT^STCD	Display Total Call Duration
AT^STPB	Transmit Parity Bit (for 7E1 and 7O1 only)
AT^SWDAC	PWM Signal Configuration for DAC

AT^SXSM	Extended SIM Access
ATA	Connect to Incoming Call
ATA	Manual acceptance of a network request for PDP context activation
ATD	Mobile originated call to specified number
ATD*98#	Request GPRS IP service
ATD*99#	Request GPRS service
ATD><mem><n>	Mobile originated call using specific memory and index number
ATD><n>	Mobile originated call from active memory using index number
ATD><str>	Mobile originated call from active memory using corresponding field
ATDI	Mobile originated data call to ISDN number
ATDL	Redial last number used
ATE	AT Command Echo
ATH	Disconnect existing connection
ATH	Manual rejection of a network request for PDP context activation
ATI	Display product identification information
ATL	Set monitor speaker loudness
ATM	Set monitor speaker mode
ATO	Switch from command mode to data mode / PPP online mode
ATP	Select pulse dialing
ATQ	Result Code Presentation Mode
ATS0	Set number of rings before automatically answering a call
ATS0	Automatic Response to Network Request for PDP Context Activation
ATS10	Set disconnect delay after indicating the absence of data carrier
ATS18	Extended call release report
ATS2	Set escape sequence character
ATS3	Command Line Termination
ATS4	Response Formatting
ATS5	Command Line Editing
ATS6	Set pause before blind dialing
ATS7	Set number of seconds to wait for connection completion
ATS8	Comma Dial Pause Time
ATT	Select tone dialing
ATV	Result code format mode
ATX	CONNECT Result Code Format
ATZ	Restore AT Command Settings from User Defined Profile

17. Accessories

The MTX-65i family has a wide range of available accessories, including:

- Power supplies
- All type of antennas (indoor, outdoor, high gain, etc…)
- Cables and DIN adapters

The MTX-65i is shipped without any accessories.

Please visit the following web sites to see the full range of accessories:

- www.mtxm2m.com

18. Sales contact

www.mtxm2m.com

Matrix Madrid	Matrix Barcelona	Matrix Bilbao	Matrix Valencia
Matrix Electrónica S.L. C/ Alejandro Sánchez, 109 28019 Madrid (SPAIN) Phone 1: 902 19 81 46 Phone 2: +34915602737 Fax 1: 902 99 54 14 Fax 2: +34915652865	Matrix Electrónica S.L. Ctra. Rubí a Sabadell Km 13 Nave 109, Oficinas 6-9 08191 Rubí, Barcelona (SPAIN) Phone 1: 902 19 81 46 Fax 1: 902 99 54 14	Matrix Electrónica S.L. Pol. Aliendalde, 11 Oficina 2G 48200 - Durango, Vizcaya (SPAIN) Phone 1: 902 19 81 46 Fax 1: 902 99 54 14	Matrix Electrónica S.L. Valencia (SPAIN) Phone 1: 902 19 81 46 Fax 1: 902 99 54 14
Matrix Sevilla	**Matrix Lisboa**	**Matrix Santiago de Chile**	
Matrix Electrónica S.L. Sevilla (SPAIN) Phone: 902 19 81 46 Fax: 902 99 54 14 Phone 1: 902 19 81 46 Fax 1: 902 99 54 14	LusoMatrix Lda. Av. Coronel Eduardo Galhardo, 7 1ºC 1170-105 - Lisboa (PORTUGAL) Phone 1: +351218162625 Fax 1: +351218149482	Matrix Electrónica S.L. Calle Badajoz, 100 Oficina 1305 Santiago de Chile (CHILE) Phone 1: +56(9)53369943 Phone 2: +56(9)74822647	