security to be free
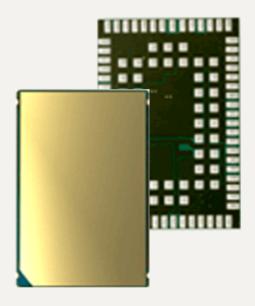
Cinterion® EMS31-X

Hardware Interface Overview

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1 Introduction

This document[1] describes the hardware of the Cinterion® EMS31-X module. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

The EMS31-X module includes a baseband, a complete dual band RF front-end, memory and required circuitry to meet the 3GPP E-UTRA Long Term Evolution - LTE, Release 13 CAT M1 set of specifications.

1.1 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	• LTE Quadband: B2, B4, B12 and B13
Output power	Class 3 ((+23dBm +-2dB) for LTE 1900, LTE HD-FDD B2 Class 3 (+23dBm +-2dB) for LTE AWS, LTE HD-FDD B4 Class 3 (+23dBm +-2dB) for LTE 700, LTE HD-FDD B12 Class 3 (+23dBm +-2dB) for LTE 700, LTE HD-FDD B13
Power supply	3.2V to 5.5V
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Extended operation: -40°C to +95°C
Physical	Dimensions: 27.60mm x 18.80mm x 2.17 mm, with tolerance +0.19/-0.1mm Weight: approx. 2.2g
RoHS	All hardware components fully compliant with EU RoHS Directive
LTE features	
3GPP Release 13	DL 300 kbps, UL 375 kbps LTE Cat. M1 data rates
SMS	Point-to-point MT and MO Text mode Storage in mobile equipment
Software	
AT commands	Hayes, 3GPP TS 27.007, TS 27.005, product specific
SIM Application Toolkit	SAT Release 99
Firmware update	Generic update, incremental update from host application over ASCx Full and incremental OTA update over radio

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1. The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Gemalto M2M product.

Feature	Implementation
Interfaces	
Module interface	Surface mount device with solderable connection pads (SMT application interface). Land grid array (LGA) technology ensures high solder joint reliability and allows the use of an optional module mounting socket. For more information on how to integrate SMT modules see also [3]. This application note comprises chapters on module mounting and application layout issues as well as on SMT application development equipment.
2 serial interfaces	ASC0: • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Default baud rate: 115,200 baud • Adjustable baud rates: 1,200 to 3,686,400 • Supports RTS0/CTS0 hardware flow control. • Indication of incoming data/SMS on RING0 (can be used to wake up host from power down modes) ASC1 (shared with GPIO lines): • 4-wire, unbalanced asynchronous interface • Default baud rate: 115,200 baud • Adjustable baud rates: 1,200 to 3,686,400bps • Supports RTS1/CTS1 hardware flow control
UICC interface	Supported SIM/USIM cards: 3V, 1.8V
Embedded UICC	Module is hardware prepared for an embedded UICC (MIM)
GPIO interface	20 pads of the application interface programmable as GPIO pads: GPIOs can be configured as ASC0 and ASC1 Programming is done via AT commands
Antenna interface pad	50Ω LTE antenna
Power on/off, Reset	
Power on/off	Switch-on by hardware signal ON Switch-off by AT command
Reset	Orderly shutdown and reset by AT command
Evaluation kit	
Evaluation module	EMS31-X module soldered onto a dedicated PCB that can be connected to an adapter in order to be mounted onto the DSB75.
DSB75	DSB75 Development Support Board designed to test and type approve Gemalto M2M modules and provide a sample configuration for application engineering. A special adapter is required to connect the EMS31-X evaluation module to the DSB75.

1.2   EMS31-X System Overview

Note: The following features are not yet available with the current product release: GPIO, I²C, Pulse Counter, PWM, SPI, ADC and 2nd SIM/MIM. Second SIM/MIM interface is hardware prepared only.

Figure 1: EMS31-X system overview

2 Interface Characteristics

EMS31-X is equipped with an SMT application interface that connects to the external application. The SMT application interface incorporates the various application interfaces as well as the RF antenna interfaces.

2.1 Application Interface

2.1.1 Serial Interface ASC0

EMS31-X offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.28 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state).

EMS31-X is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

Figure 2: Serial interface ASC0

Features:
- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 1,200bps up to 3,686,400bps.
- Autobauding (supported by future firmware version)
- Supports RTS0/CTS0 hardware flow control. Communication is possible only by respecting hardware flow control. Otherwise, the module might disregard some data transmitted from host. In case of quitting CTS0 line, only one character can be sent from the host application to the module through TXD0 line.
- Wake up from SLEEP mode by RTS0 activation.

2.1.2   Serial Interface ASC1

EMS31-X provides a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state).

EMS31-X is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to module's TXD1 signal line
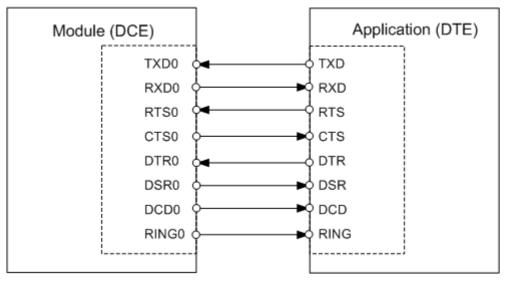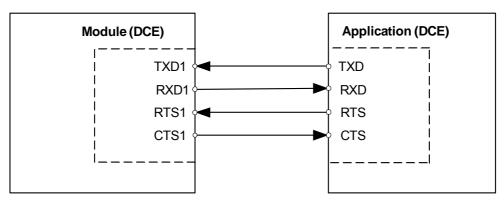- Port RXD @ application receives data from the module's RXD1 signal line

Figure 3: Serial interface ASC1

Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware hand-shake.
- On ASC1 no RING line is available. However, RING0 line can be software configured for URC signalization via ASC1 (see [1]).
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 1,200 bps to 3,686,400bps.
- Supports RTS1/CTS1 hardware flow control. Communication is possible only by respecting hardware flow control. Otherwise, the module might disregard some data transmitted from host. In case of quitting CTS1 line, only one character can be sent from the host application to the module through TXD1 line
- Wake up from SLEEP mode by RTS1 activation.

2.1.3   UICC/SIM/USIM Interface

EMS31-X has two identical integrated UICC/SIM/USIM interfaces compatible with the 3GPP 31.102 and ETSI 102 221. These two interfaces are mutually exclusive, meaning that only one UICC/SIM/USIM interface can be used at a time. This interface is wired to the host interface in order to be connected to an external SIM card holder. Five pads on the SMT application interface are reserved for each SIM interface.

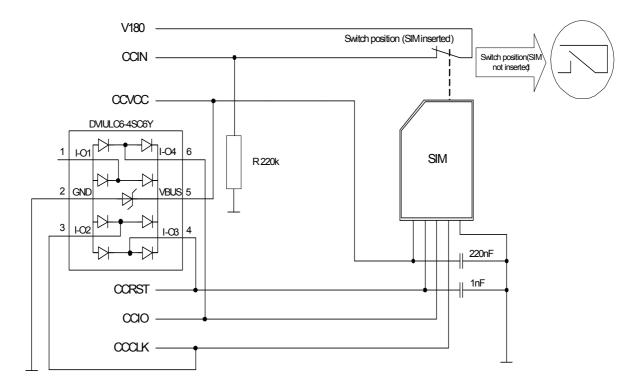The UICC/SIM/USIM interface supports 3V and 1.8V SIM cards.

The CCINx signal serves to detect whether a tray (with SIM card) is present in the card holder. The CCINx signal must be connected to V180 for the detection to work on the module. Otherwise the SIM card can never be detected by the module.

Using the CCINx signal is mandatory for compliance with the GSM 11.11 recommendation if the mechanical design of the host application allows the user to remove the SIM card during operation. To take advantage of this feature, an appropriate SIM card detect switch is required on the card holder. For example, this is true for the model supplied by Molex, which has been tested to operate with EMS31-X and is part of the Gemalto M2M reference equipment submitted for type approval. See Section 7.1 for Molex ordering numbers.

Table 1: Signals of the SIM interface (SMT application interface)

Signal	Description
GND	Separate ground connection for SIM card to improve EMC.
CCCLKx	Chipcard clock
CCVCCx	SIM supply voltage.
CCIOx	Serial data line, input and output.
CCRSTx	Chipcard reset
CCINx	Input on the baseband processor for detecting a SIM card tray in the holder. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCINx signal is by default low and will change to high level if a SIM card is inserted. The CCINx signal is mandatory for applications that allow the user to remove the SIM card during operation. The CCINx signal is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of EMS31-X. If SIM switch is not available, pull-down (or pull-up) resistor must be used with maximum value 220k. In case there is a pull-up resistor, SIM card is inserted. In case there is a pull-down resistor, SIM is not inserted.

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the application must restart EMS31-X.

The figure below shows a circuit to connect an external SIM card holder.

Figure 4: External UICC/SIM/USIM card holder circuit

The total cable length between the SMT application interface pads on EMS31-X and the pads of the external SIM card holder must not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLKx signal to the CCIOx signal be careful that both lines are not placed closely next to each other. A useful approach is using a GND line to shield the CCIOx line from the CCCLKx line.

2.1.4 GPIO Interface

EMS31-X offers a GPIO interface with 20 GPIO lines. The lines are shared with other interfaces or functions: ASC0 (see Section 2.1.1), ASC1 (see Section 2.1.2), status LED (see Section 2.1.5.1), Fast shutdown (see Section 2.1.5.2),
The following table shows the configuration variants for the GPIO pads. All variants are mutually exclusive, i.e. a pad configured for instance as ASC0 is locked for alternative usage.

Table 2: GPIO lines and possible alternative assignment

GPIO*	Fast Shut-down	Status LED	Pulse Counter*	ASC0	ASC1	SPI*	PWM*	WAKE capability
GPIO1				DTR0				Available
GPIO2				DCD0				
GPIO3				DSR0				
GPIO4	FST_SHDN							
GPIO5		LED						
GPIO6							PWM2	
GPIO7							PWM1	
GPIO8			COUNTER					Available
GPIO16					RXD1			
GPIO17					TXD1			
GPIO18					RTS1			Available
GPIO19					CTS1			
GPIO20								
GPIO21								
GPIO22								
GPIO23								
GPIO24				RING0				Available
GPIO25								Available
GPIO26						SPI_CS1		
GPIO27						SPI_CS2		
n/a				RST0				Available

*) Note: The following features are not yet available with the current product release: GPIO, I^2C, Pulse Counter, PWM and SPI.

After startup, the above mentioned alternative GPIO line assignments can be configured using AT commands (see [1]). The configuration is non-volatile and available after module restart.

2.1.5 Control Signals

2.1.5.1 Status LED

The LED line can also be configured as GPIO5 line, and can be used to drive a status LED that indicates different operating modes of the module (for GPIOs see Section 2.1.4). LED and GPIO5 functionality are mutually exclusive.

2.1.5.2 Fast Shutdown

The GPIO4 interface line can be configured as fast shutdown signal line FST_SHDN. The configured FST_SHDN line is an active low control signal.

2.2   RF Antenna Interface

The RF interface has an impedance of 50Ω. EMS31-X RF pads are located on pads 58, 59 and 60 (pad 59 is RF_out pad, and pads 58 and 60 are GND pads). The antenna interface is typically connected by soldering it directly to the application's PCB.

2.2.1   Antenna Interface Specification

The antenna interface is designed to meet signal levels according to 3GPP specification. EMS31-X is capable of sustaining a 10:1 voltage standing wave ratio (VSWR) mismatch at the antenna line without any damage, even when transmitting at maximum RF power. Antenna pad is the antenna reference point (ARP) for EMS31-X. All RF data specified throughout this document is related to ARP.

Note that DC blocking caps are needed in case DC is applied.

EMS31-X operates in the following frequency bands:
- Band 2, PCS (1800/1900 MHz) (LTE HD-FDD)
- Band 4, AWS (1700/2100 MHz) (LTE HD-FDD)
- Band 12, 700 MHz (LTE HD-FDD)
- Band 13, 700 MHz (LTE HD-FDD)

The following table provides basic information about RF parameters

Table 3: RF Antenna interface parameters

Parameter	Conditions	Typical	Unit
Sensitivity[1]	LTE Band 2	-106	dBm
	LTE Band 4	-106	dBm
	LTE Band 12	-106	dBm
	LTE Band 13	-106	dBm
RF Power @ ARP[2]	LTE Band 2	23.5	dBm
	LTE Band 4	23.5	dBm
	LTE Band 12	23.5	dBm
	LTE Band 13	23.5	dBm
Receiver return loss in used band[3]	LTE Band 2	>10	dB
	LTE Band 4	>10	dB
	LTE Band 12	>10	dB
	LTE Band 13	>10	dB

1. The value is valid for 6RB in all possible BW (5, 10, 15, 20MHz)
2. Absolute maximum rating of RF peak power is <27.5 dBm
3. EMS31-X is HD-FDD, what means that the return loss at RX band could be <5dB during transmission

Please be aware that, in TS 36.521-1, Table 7.3.5-1, the power level is $P_{REFSENS}$. This has a fixed relationship with the *RS EPRE* (reference signal energy per resource element), which is:

$$P_{REFSENS} = RS\ EPRE + 10 * \log10(N\_RE),$$

where N_RE is the number of resource elements (12 *[number of RBs]).

2.2.2 Antenna Installation

The distance between the antenna RF pads and its neighboring GND pads has been optimized for best impedance matching. On the application PCB, special attention should be paid to these 3 pads, in order to prevent mismatch.

The wiring of the antenna connection line, starting from the antenna pad to the application antenna should result in a 50Ω line impedance. Line width and distance to the GND plane needs to be optimized with regard to the PCB's layer stack.

To prevent receiver desensitization due to interferences generated by fast transients like high speed clocks on the application PCB, it is recommended to realize the antenna connection line using uninterrupted ground plane and embedded Stripline rather than Microstrip line technology.

2.2.3 Modular Approval Requirements

For type approval purposes (i.e., FCC KDB 996369 related to modular approval requirements) an external application must connect the RF signal in one of the following ways:

- Via 50Ω coaxial antenna connector (common connectors are U-FL or SMA) placed as close as possible to the module's antenna pad.
- By soldering the antenna to the antenna connection line on the application's PCB (without the use of any connector) as close as possible to the module's antenna pad.
- By routing the application PCB's antenna to the module's antenna pad in the shortest way.

Awareness for ESD protection on the RF interfaces should also be considered. This protection could be utilized through the pi-network above (primarily for managing any additional RF optimization needs) or by additional component addition in series with the above pi-network matching.

2.3   Sample Application

Figure 5 shows a typical example of how to integrate an EMS31-X module with an application. Usage of the various host interfaces depends on the desired features of the application.

Since the module is running at high RF power (antenna port peak power may vary up to 27dBm), it is designed to avoid self interference inside the module. Customer application design must also use the best practices to avoid self interference.
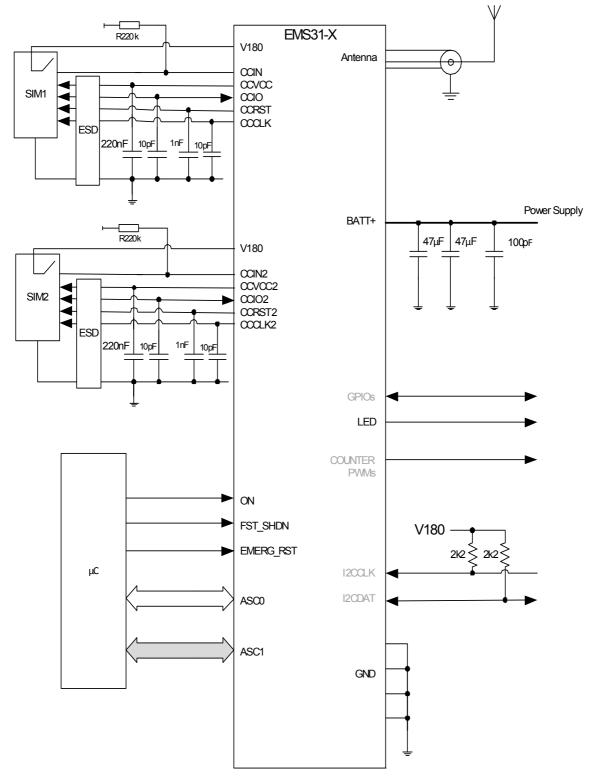
Generally, it is not recommended to have signals other than GND in direct proximity to the antenna line or antenna itself. Antenna connection and the antenna itself must be kept as far as possible from the sources of interference. High-impedance signals are recommended to be kept as short as possible and away from the sources of interference. Decoupling of the supply parts have to be carried out as recommended by the manufacturer. Failure to comply with these generally applicable practices may result in poor, unreliable performance or problems with certification of the customer products.

While developing SMT applications it is strongly recommended to provide test points for certain signals, i.e., lines to and from the module - for debug and/or test purposes. The SMT application should allow for an easy access to these signals. For details on how to implement test points see [3].

The EMC measures are best practice recommendations. In fact, an adequate EMC strategy for an individual application is very much determined by the overall layout and, especially, the position of components.

Note: EMS31-X is not intended for use with cables longer than 3m.

Disclaimer: No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 5 and the information detailed in this section. As functionality and compliance with national regulations depend to a great amount on the used electronic components and the individual application layout manufacturers are required to ensure adequate design and operating safeguards for their products using EMS31-X module.

2.3 Sample Application

Note: The following features are not yet available with the current product release: GPIO, I²C, Pulse Counter, PWM, SPI, ADC and 2nd SIM/MIM. Second SIM/MIM interface is hardware prepared only.

Figure 5: Schematic diagram of EMS31-X sample application

3 Operating Characteristics

3.1 Operating Modes

The table below briefly summarizes the various operating modes referred to throughout the document.

Table 4: Overview of operating modes

Mode	Function	
Normal operation	Active TX	LTE data transfer in progress. Power consumption depends on network settings, data transfer rate and radio conditions.
	IDLE	No data transfer is in progress. The LTE part of the device can be in LTE DRX, LTE eDRX or LTE PSM mode. Activity on ASC0 /ASC1 interfaces can be present. Power consumption depends on the LTE power saving mode and its parameters and on the activity on the ASC interfaces.
Sleep	The module is in low power consumption state. There is no activity inside the module but module preserves the state in which it was before entering the sleep mode, including the electrical states of the GPIOs. The module will enter sleep state only when the LTE part of the module is in LTE DRX, LTE eDRX or LTE PSM mode or if it is in airplane mode. To allow sleep mode the host application shall indicate via RTS lines that it has no intention to send data.	
Power Down	Normal shutdown after sending the power down command. Software is not active. Interfaces are not accessible. Operating voltage remains applied. Suspend mode is foreseen to be implemented in future product variants.	
Suspend Mode	There is no any activity inside the module, only internal counter and circuit for wake-up mechanism are active. The module does not preserve the state in which it was before entering the suspend mode, including the GPIOs. Meaning, the state of the module after waking up from suspend will be the same as after restarting the module. The module will enter suspend mode only when the LTE part of the module is in LTE DRX, LTE eDRX, LTE PSM mode or if it is in airplane mode. To allow suspend mode the host application shall indicate via RTS lines (Legacy mode) or via GPIO25 (Advanced mode) that it has no intention to send data.	
Airplane mode	Airplane mode shuts down the radio part of the module, causes the module to log off from the LTE network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see [1]). Sleep mode can be entered when airplane mode is enabled.	

3.2 Power Supply

The power supply of EMS31-X has to be a single voltage source at BATT+. It must be able to provide the current for all operation modes of the module.

All the key functions for supplying power to the device are handled by the power management section of the analog controller. This IC provides the following features:

- Stabilizes the supply voltages for the baseband using low drop linear voltage regulators and a DC-DC step down switching regulator.
- Switches the module's power voltages for the power-up and -down procedures.
- SIM switch to provide SIM power supply.

4　　Mechanical Dimensions, Mounting and Packaging

The following sections describe the mechanical dimensions of EMS31-X and give recommendations for integrating EMS31-X into the host application.

4.1　　Mechanical Dimensions of EMS31-X

Figure 6 shows the top and bottom view of EMS31-X and provides an overview of the board's mechanical dimensions. For further details see Figure 7.

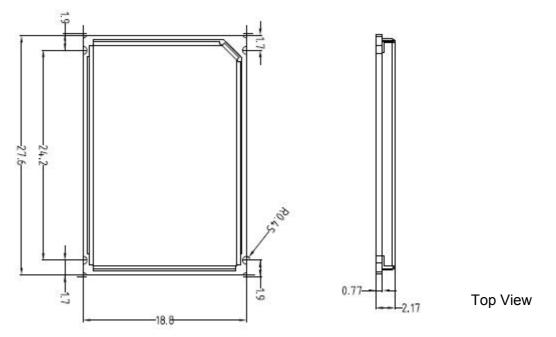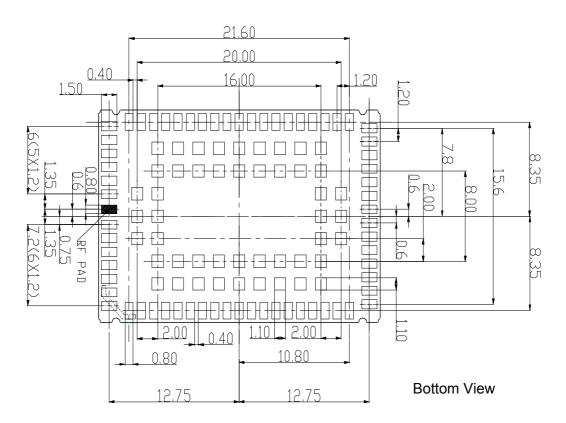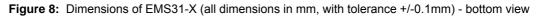**Figure 6:** EMS31-X - top and bottom view

4.1 Mechanical Dimensions of EMS31-X

Figure 7: Dimensions of EMS31-X (all dimensions in mm, with tolerance +0.19/-0.1mm)

Figure 8: Dimensions of EMS31-X (all dimensions in mm, with tolerance +/-0.1mm) - bottom view

5 Regulatory and Type Approval Information

5.1 Directives and Standards

EMS31-X is 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 the "EMS31-X Hardware Interface Description".

Table 5: Directives

2002/95/EC (RoHS 1) 2011/65/EC (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)	

Table 6: Standards of North American type approval

CFR Title 47	Code of Federal Regulations, Part 22 and Part 24 (Telecommunications, PCS); US Equipment Authorization FCC	
OET Bulletin 65 (Edition 97-01)	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields	
UL 60 950-1	Product Safety Certification (Safety requirements)	
California Leadfree Mandate	Covered by European RoHS requirements	
RSS130 (Issue 1) RSS133 (Issue 5) RSS139 (Issue 3)	Canadian Standard	

Table 7: Standards of Verizon type approval

Verizon Wireless Unified Module Process for Compliance Testing and Approval, October 2014	
Verizon Wireless Device Requirements LTE 3GPP Band 13 Network Access, October 2014	
3GPP2 C.S0015-A v1.0	Short Message Service for spread spectrum systems
3GPP TS 51.010-1	Digital cellular telecommunications system (Release 13); Mobile Station (MS) conformance specification;
GCF-CC V3.71.1	Global Certification Forum - Certification Criteria
NAPRD03 V5.36	Version Specific Technical Overview of PTCRB Mobile/User Equipment Type Certification

Table 8: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

Table 9: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11363-2006	"Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06).
SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06). According to the "Chinese Administration on the Control of Pollution caused by Electronic Information Products" (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Gemalto M2M Hardware Interface Description. Please see Table 10 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.

Table 10: Toxic or hazardous substances or elements with defined concentration limits

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal Parts)	O	O	O	O	O	O
电路模块 (Circuit Modules)	X	O	O	O	O	O
电缆及电缆组件 (Cables and Cable Assemblies)	O	O	O	O	O	O
塑料和聚合物部件 (Plastic and Polymeric parts)	O	O	O	O	O	O

O:

表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。

Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:

表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。

Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.

5.2   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 EMS31-X 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 US 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 on US markets

ES 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

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 body of the user.
- 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 transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location.

5.3 Reference Equipment for Type Approval

The Gemalto M2M reference setup submitted to type approve EMS31-X (including a special approval adapter for the DSB75) is shown in the following figure[1]:

Figure 9: Reference equipment for Type Approval

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1. For RF performance tests a mini-SMT/U.FL to SMA adapter with attached 6dB coaxial attenuator is chosen to connect the evaluation module directly to the LTE test equipment instead of employing the SMA antenna connectors on the EMS31-X-DSB75 adapter as shown in Figure 9. The following products are recommended:
Hirose® SMA-Jack/U.FL-Plug conversion adapter HRMJ-U.FLP(40)
(for details see see http://www.hirose-connectors.com/ or http://www.farnell.com/
Aeroflex Weinschel Fixed Coaxial Attenuator Model 3T/4T
(for details see http://www.aeroflex.com/ams/weinschel/pdfiles/wmod3&4T.pdf)

5.4 Compliance with FCC and ISED Rulesand Regulations

The Equipment Authorization Certification for the Gemalto M2M reference application described in Section 5.3 will be registered under the following identifiers:

- *EMS31-X:*
  FCC Identifier: QIPEMS31-X
  Innovation, Science and Economic Development Canada: 7830A-EMS31X
  Granted to Gemalto M2M GmbH

Manufacturers of mobile or fixed devices incorporating EMS31-X modules are authorized to use the FCC Grants and Innovation, Science and Economic Development Certificatesof the EMS31-X modules for their own final products according to the conditions referenced in these documents. In this case, an FCC/ ISED label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID: QIPEMS31-X"and accordingly "Contains IC: 7830A-EMS31X. The integration is limited to fixed or mobile categorized host devices, where a separation distance between the antenna and any person of min. 20cm can be assured during normal operating conditions.

For mobile and fixed operation configurations the antenna gain, including cable loss, must not exceed the limits in the following Table 11 for FCCand ISED.

Table 11: Antenna gain limits for FCC

Operating band	FCC limit	ISED limit	Unit
Maximum gain in higher operating bands with f=1900MHz (LTE Bd2)	11.5	8.0	dBi
Maximum gain in higher operating bands with f=1700MHz (LTE Bd4)	11.5	7.8	dBi
Maximum gain in lower operating bands with f< 1GHz (LTE Bd12)	8.7	5.6	dBi
Maximum gain in lower operating bands with f< 1GHz (LTE Bd13)	TBD	TBD	dBi

IMPORTANT:
Manufacturers of portable applications incorporating EMS31-X modules are required to have their final product certified and apply for their own FCC Grant and Innovation, Science and Economic Development Certificaterelated to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Section 5.2 for detail).

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

Note: Manufacturers/OEM Integrators must ensure that the final user documentation does not contain any information on how to install or remove the module from the final product.

Notes (FCC):

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Notes (ISED):

(EN) This Class B digital apparatus complies with Canadian ICES-003 and RSS-210. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

(FR) Cet appareil numérique de classe B est conforme aux normes canadiennes ICES-003 et RSS-210. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférence et (2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.

(EN) Radio frequency (RF) Exposure Information
The radiated output power of the Wireless Device is below the Innovation, Science and Economic Development (ISED) radio frequency exposure limits. The Wireless Device should be used in such a manner such that the potential for human contact during normal operation is minimized.
This device has also been evaluated and shown compliant with the ISED RF Exposure limits under mobile exposure conditions (antennas at least 20cm from a person's body).

(FR) Informations concernant l'exposltion aux fréquences radio (RF)
La puissance de sortie émise par l'appareil de sans fil est inférieure à la limite d'exposition aux fréquences radio d'Innovation, Sciences et Développement économique Canada (ISDE). Utilisez l'appareil de sans fil de façon à minimiser les contacts humains lors du fonctionnement normal.

Ce périphérique a également été évalué et démontré conforme aux limites d'exposition aux RF d'ISDE dans des conditions d'exposition à des appareils mobiles (les antennes se situent à moins de 20cm du corps d'une personne).

6 Document Information

6.1 Revision History

New document: Cinterion® EMS31-X Version 00.001

Chapter	What is new
--	Initial document setup

6.2 Related Documents

[1] EMS31-X AT Command Set
[2] EMS31-X Release Note
[3] Application Note 48: SMT Module Integration

6.3 Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-digital converter
ANSI	American National Standards Institute
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of the module
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CTS	Clear to Send
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
DNI	Does not implemented
DRX	Discontinuous Reception
eDRX	Enhanced Discontinuous Reception
DSB	Development Support Box
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EMC	Electromagnetic Compatibility
EPRE	Energy per Source Element
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FR	Full Rate
GPIO	General Purpose Input/Output
GSM	Global Standard for Mobile Communications
HiZ	High Impedance

Abbreviation	Description
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
LTE	Long Term Evolution
MIM	Machine Identification Module
MS	Mobile Station (GSM module), also referred to as TE
NI	Not implemented
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PCN	Personal Communications Network, also referred to as DCS 1800
PCS	Personal Communication System, also referred to as GSM 1900
PPP	Point-to-point protocol
PTCRB	PCS Type Certification Review Board
RAM	Random Access Memory
RF	Radio Frequency
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment.
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SIM	Subscriber Identification Module
SMD	Surface Mount Device
SMS	Short Message Service
SMT	Surface Mount Technology
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM module)
TE	Terminal Equipment, also referred to as DTE
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
UICC	Universal Integrated Circuit Card
URC	Unsolicited Result Code
USIM	Universal Subscriber Identity Module
VSWR	Voltage Standing Wave Ratio

6.4   Safety Precaution Notes

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating EMS31-X. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Gemalto M2M assumes no liability for customer's failure to comply with these precautions.

♥	When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy. The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.
✈	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.
※	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
▧	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.
🚗	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for speakerphone operation. Before making a call with a hand-held terminal or mobile, park the vehicle. Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.
SOS	IMPORTANT! Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls. Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may need to deactivate those features before you can make an emergency call. Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

7   Appendix

7.1   List of Parts and Accessories

Table 12: List of parts and accessories

Description	Supplier	Ordering information
EMS31-X	Gemalto M2M	Standard module Gemalto M2M IMEI: Packaging unit (ordering) number: L30960-N4710-A300 Module label number: S30960-S4710-A300-1[1]
EMS31-X Evaluation Module	Gemalto M2M	Ordering number: L30960-N4711-A300
DSB75 Evaluation Kit	Gemalto M2M	Ordering number: L36880-N8811-A100
DSB Mini Compact Evaluation Board	Gemalto M2M	Ordering number: L30960-N0030-A100
Starter Kit B80	Gemalto M2M	Ordering Number L30960-N0040-A100
Multi-Adapter R1 for mount-ing EMS31-X evaluation modules onto DSB75	Gemalto M2M	Ordering number: L30960-N0010-A100
Approval adapter for mount-ing EMS31-X evaluation modules onto DSB75	Gemalto M2M	Ordering number: L30960-N2301-A100
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 13.

1. Note: At the discretion of Gemalto M2M, module label information can either be laser engraved on the module's shielding or be printed on a label adhered to the module's shielding.

Table 13: Molex sales contacts (subject to change)

Molex For further information please click: http://www.molex.com	Molex Deutschland GmbH Otto-Hahn-Str. 1b 69190 Walldorf Germany Phone: +49-6227-3091-0 Fax: +49-6227-3091-8100 Email: mxgermany@molex.com	American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352
Molex China Distributors Beijing, Room 1311, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Fax: +86-10-6526-9730	Molex Singapore Pte. Ltd. 110, International Road Jurong Town, Singapore 629174 Phone: +65-6-268-6868 Fax: +65-6-265-6044	Molex Japan Co. Ltd. 1-5-4 Fukami-Higashi, Yamato-City, Kanagawa, 242-8585 Japan Phone: +81-46-265-2325 Fax: +81-46-265-2365

About Gemalto

Since 1996, Gemalto has been pioneering groundbreaking M2M and IoT products that keep our customers on the leading edge of innovation.

We work closely with global mobile network operators to ensure that Cinterion® modules evolve in sync with wireless networks, providing a seamless migration path to protect your IoT technology investment.

Cinterion products integrate seamlessly with Gemalto identity modules, security solutions and licensing and monetization solutions, to streamline development timelines and provide cost efficiencies that improve the bottom line.

As an experienced software provider, we help customers manage connectivity, security and quality of service for the long lifecycle of IoT solutions.

For more information please visit
www.gemalto.com/m2m, www.facebook.com/gemalto, or Follow@gemaltoIoT on Twitter.

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